Ecological Investigation Report

Oregon Silverspot Butterfly (Speyeria zerene hippolyta)

Forest Service · USDA
Pacific Northwest Region

ECOLOGICAL INVESTIGATION REPORT:

OREGON SILVERSPOT BUTTERFLY

(*Speyeria zerene hippolyta*)

By

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with the assistance of

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and

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Forest Service USDA

Pacific Northwest Region

Siuslaw National Forest

September, 1980

Plate I Frontispiece

The Hippolyta Silverspot, *Speyeria zerene hippolyta*, nectaring on *Aster chilensis*. This female was taken at the Rock Creek meadow in Lane County, Oregon on September 7, 1974.

The darkness of the basal area of the wings, the hairiness of the area surrounding the body, and the average size of the Hippolyta Silverspots are all adaptations to a stringent thermal environment such as that prevailing during windy or foggy summer days at the seacoast.

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PREFACE

The purpose of this study is to provide baseline data on the butterfly *Speyeria zerene hippolyta* to the Forest Service which will enable their land managers to make more informed decisions on land use that may affect the future of this subspecies. This insect is listed in the federal registry as a threatened species.

To meet this objective, the data compilation and research efforts have centered on the following:

1) a clarification of the taxonomic distinction of this butterfly
2) a documentation of its past distribution
3) a clarification of its present reduced distribution
4) a determination especially of its current status at the Rock Creek and Tenmile Creek meadows in Lane County, Oregon and at Mt. Hebo in Tillamook County, Oregon
5) a characterization of its habitat, its present condition, and the butterflies' use of the habitat at the first two sites (but primarily the Rock Creek site) in the main report and at the Mt. Hebo site in the supplemental report
6) an assessment of the probable reasons for this subspecies' threatened status, and finally,
7) an attempt to determine possible ways of improving its habitat and expanding its range so that its threatened status will be remedied.

The principle investigator in this study is Dr. David V. McCorkle of Oregon College of Education, Monmouth, Oregon.

ACKNOWLEDGMENTS

I wish to thank those who assisted with the preparation of this report. Dr. Milton Parsons, fisheries biologist for the Siuslaw National Forest, organized and supervised this study. His encouragement and guidance was especially helpful. Dr. Paul Hammond wrote the section on the systematics of this insect (Appendix I), assisted with portions of the field work, and offered many helpful suggestions.[1] Ms. Glory Penington helped prepare the habitat maps, did the typing, helped with portions of the field work, and otherwise patiently assisted with the project.

Thanks are also due Mr. Charles Holstein and Mr. Lloyd Collet of the Waldport District Office of the Siuslaw National Forest who kindly contributed their assistance. Special gratitude is extended to Mr. and Mrs. John S. Cameron (Elizabeth Starker) and Mr. Clyde Hall who were kind enough to permit the inclusion of their properties, at Big Creek and at Tenmile Creek respectively, in the study. Without their cooperation, the study would have been significantly limited.

Finally, I wish to thank the many others who have assisted me with the project in smaller, but never-the-less important ways.

David V. McCorkle

September, 1980

[1] Dr. Hammond also conducted the field work for the Mt. Hebo site and wrote the Mt. Hebo report supplement.

Explanation of the Common Names for Speyeria zerene hippolyta

Speyeria zerene hippolyta has been listed under the common name "The Oregon Silverspot" on the Endangered Species List of the U. S. Department of the Interior. The name had previously been used by the press. This is unfortunate for two reasons.

First, it is better known as the Hippolyta Fritillary (or Silverspot) among lepidopterists (Dornfeld, 1980, p. 77), having been named for Queen Hippolyta of the Amazons of Greek mythology.

Second, only the naive expect no other Silverspots in Oregon to eventually become threatened or endangered. Already the Willamette Valley's version of S. z. bremnerii is apparently extinct. The future of S. z. gloriosa (zerene s. str. group) of the Illinois River Valley (Josephine County, Oregon) foothills is gloomy in view of the potential strip mining of the "serpentine" soils of its habitat for nickel and cobalt. Certainly this butterfly is no less an Oregon resident than is Hippolyta!

For these reasons, I have chosen the "Hippolyta Silverspot" as the common name of preference in the text of this report.

Definition of the Hippolyta Silverspot

The Hippolyta Silverspot is a medium-sized, dark, reddish-brown butterfly with black veins and spots on the upper surface of its wings (frontispiece; Pl. VIII, fig. 1), and with a yellowish submarginal band and bright metallic silver spots on its wings beneath (Plate II; Pl. VIII, fig. 2). Its spiny larva (Pl. VI, fig. 2) is also dark, but with a pair of pale lines running down the back, each of which has a row of black patches running parallel to it on the outside. The bases of the spines, especially those of the lateral rows, are of a straw color similar to that of the lines on the back. In both cases, this color blends nicely with the dried grass leaves amongst which the larvae take refuge when not feeding on the violets which constitute their exclusive food plant (Plate V).

The eggs from which the larvae hatch are creamy when first laid, but darken to pinkish-tan by the second day if they are fertile. The fully fed mature larva constructs a shelter of vegetation with its silk and soon, losing its larval skin, enters the quiescent pupal stage (Plate VII). This pupa is smooth, rounded, and mostly dark brown, but with paler areas especially on the abdomen and often on the wingcovers. It is from this hidden pupa that the beautiful adult insect emerges to inflate and harden its wings.

There is another more widespread species belonging to the same group (genus) of butterflies that may be encountered in the forests near the coast, S. hydaspe. It can easily be distinguished from the Hippolyta Silverspot by its substitution of cream color for silver in the spots of the wing undersurface (Plate X, fig.1).

The relationship of S. z. hippolyta to its relatives is treated in Appendix I. Several other species of dark butterflies that have been found in the vicinity of the Hippolyta Silverspot's coastal habitat are illustrated in Plate X, fig. 2. These are all widespread in the Pacific Northwest and are not endangered at this time. The glossy blue, also appearing in this figure, has a localized population in the Rock Creek meadow where its larvae apparently feed on the native spring-bank clover. The coastal form of this butterfly may be as rare as the Hippolyta Silverspot, but its coastal distribution has not been well researched at this time. (Dornfeld's *The Butterflies of Oregon* shows only one other coastal locality for this species in Oregon, although other forms of it are common inland.)

Because of its virtual restriction to the coastal salt-spray meadows of Oregon and Washington, and the continual loss of this meadow habitat to human activities and natural plant community succession, the Hippolyta Silverspot has been officially listed as a threatened "species" in the U. S. Department of the Interior's Endangered Species List, effective October 15, 1980.

Historical Perspective; Hippolyta Silverspot Distribution

The Hippolyta Silverspot was originally described from three males and one female taken in Oregon, exact locality unknown (Edwards, 1879). An additional male from "northern California" was included. However, the present author does not consider the California population to presently belong biologically to this subspecies. Rather, it is more likely either a convergent "ecotype" derived from the adjacent inland S. z. behrensii or perhaps, S. z. gloriosa, or a somewhat divergent relict hippolyta form now separated from the parent populations to the north by the extensive and active sand dune system in the middle Oregon coast.[1] (But see also Hammond's view in Appendix I.)

The lectotype male is figured in Howe, 1975, Plate 22, fig. 9 and 10. Howe gives the subspecies range as primarily the Oregon Coast Ranges, but states that it has also been taken inland at Diamond Lake in Douglas County and inland along the Columbia River. The disposition of these specimens is not documented. A small zerene does occur on the east slope of the Cascades in central Oregon. I have a series from Odell Creek near Davis Lake, Klamath County which is north of Diamond Lake. It is, with little doubt, a derivitive of S. z.conchyleatus, a subspecies well represented in the mountains centrally near the California border, and is treated as such in Dornfeld, 1980. True hippolyta, on the other hand, is allied closely to the subcoastal S. z. bremnerii with which it apparently intergrades progressively inland in southwestern Washington, perhaps formerly including along the Columbia River[2]. In this area the hippolyta - bremnerii boundary would depend upon frequencies of the two forms in the populations and probably fluctuates.

(Footnotes for this section are on p. 9.)

True hippolyta is apparently a product of the genetically selective action of the coastal weather environment and is thus best considered to be restricted to the immediate coast where it is centered in salt-spray meadows. The populations on Saddle Mountain in Clatsop County and on Mt. Hebo in Tillamook County, both in Oregon, may also best be included.[3]

These populations likewise occur in wind-swept meadows similar to those near the beach. These meadows, or grass balds, were probably originally caused by fire disturbance. Ecological succession past the meadow community may be delayed here more by the paucity of soil covering the rock substrate than by a herbicide effect of wind-born salt as occurs in the true salt-spray meadows on the immediate coast.

Personal Involvement

I first observed and collected S. z. hippolyta as a lad on the Washington Coast near Westport on August 31, 1950. I found them amongst the old sand dunes not far from my family's campsite. I saw only females which were present in numbers and somewhat worn. It is a fond memory. Six of these specimens are in my collection. Another I sent to William Howe who figured it in a freshened condition on Plate 22 in his The Butterflies of North America (Howe, 1975).

My interest in this genus grew in subsequent years. In 1963 and 64 I worked out a successful technique for rearing their larvae using a modification of a procedure used by Dietrich Magnus on the European fritillary Argynnis paphia L. (Magnus, 1958). I published on the behavior of the larvae of several species of fritillaries (silver spots) in 1965 (McCorkle, 1965) and have continued to rear all of the North American species, including many of the subspecies, until the present.

But it wasn't until September of 1968 that I again encountered the Hippolyta Silverspot. I had been asked to look for coastal S. zerene by a correspondant. So I chose the coastal route to return from a meeting at Berkely, California. I first discovered a previously unrecorded colony of a small zerene at Kamph Memorial Park on the northern California coast just two miles from the Oregon border.[4] Two days later one of my students, Glen Hawk (now Dr.), and I returned to the Oregon coast and discovered another, much smaller colony of S. zerene at Boiler Bay. This proved to be true hippolyta. It was obvious that the habitat for this colony had once been considerably more extensive, before much of the area had been converted to lawn and parking lot at the state park to the north and to building sites to the south. The remaining habitat was apparently privately owned and eventually to be developed. (This colony is now extinct.)

To document the initiation of the effort to save the Hippolyta Silverspot, I quote from a letter I wrote to C. William Nelson, dated November 2, 1968.

> "Knowing now how to look for hippolyta, I went to the coast west of here on the 12th with Glen. We found one very, very small colony at Boiler Bay on land just to the south of the parking area. The violets that apparently serve as host are limited to only a few square yards. The land is for sale, probably for a fantastic price since it has both beachfront and highway front. Bill, the beaches are going fast! Somebody needs to do a lot of exploring for Lepidoptera before it's too late! Next year I want to try the Washington Coast, too. Many years ago I took hippolyta near Westport. I tried again recently, but saw none."

During the next several years, as opportunity arose, I explored the Oregon coast for more _hippolyta_ colonies and other insects of interest. Fig. 1 outlines those of my activities and others concerned with the Hippolyta Silverspot.

The following is a chronological account of the discoveries of all the recorded localities for the Hippolyta Silverspot. Included are the collectors' names and the collections now containing the specimens, if known.

Aug. 18, 1895: Newport, Ore., collector unknown (O.S.U. coll.)

1920's: Astoria vicinity, S. Jewett, Jr. leg. (Jewett interview, 1980)

July 17, 1934: Squaw Creek (7 mi. S. of Yachats), Lane Co., Ore., S. Jewett, Jr. leg. (O.S.U. coll.)

Aug. 26, 1935: Netarts, Tillamook Co., Ore., A. Walker leg. (R. Albright coll.)

July 29, 1937: Oceanside, Tillamook Co., Ore., R. Macy leg. (American Museum coll.)

July 10, 1938: Nahcotta (Long Beach Peninsula), Pacific Co., Wash., T. Kincaid leg. (D. Frechin coll.)

Aug. 31, 1950: Westport, Harbor Co., Wash., D. McCorkle leg. (McCorkle and W. Howe coll.)

Sept. 1, 1952: Cullaby Lake, Clatsop Co., Ore., S. Jewett, Jr. leg. (O.S.U. coll.)

Aug. 15, 1967: Cape Meares, Tillamook Co., Ore., C. W. Nelson leg. (O.S.U. coll.)

Aug. 15, 1967: Mt. Hebo, Tillamook Co., Ore., C. W. Nelson leg. (O.S.U. coll.)

Sept.12, 1968: Boiler Bay, Lincoln Co., Ore., D. McCorkle and G. Hawk leg. (McCorkle coll.)

Aug. 19, 1969: Yachats, Lincoln Co., Ore., P. Hammond leg. (Hammond coll.)

Sept. 2, 1970: Tenmile Creek, Lane Co., Ore., D. McCorkle leg. (McCorkle coll.)

Sept. 8, 1971: Rock Creek - Big Creek, Lane Co., Ore., D. McCorkle leg. (McCorkle coll.)

Sept.10, 1973: Gearhart, Clatsop Co., Ore., D. McCorkle leg. (McCorkle coll.)

Sept.10, 1973: Saddle Mt., Clatsop Co., Ore., D. McCorkle leg. (McCorkle coll.)

Aug. 24, 1975: Loomis Lake (Long Beach Peninsula), Pacific Co., Wash., R. Pyle leg. (Pyle coll.)

Even though its foodplant, Viola adunca, occurred north along the Olympic Peninsula,[5] the Hippolyta Silverspot has not been recorded north of Westport, Washington. It may be that the summer storm pattern along the north coast of Washington and British Columbia has a severity frequency that precludes the butterfly's establishment. Unfortunately, the outer Vancouver Island coast is poorly explored for butterflies. Dr. Paul Hammond informs me, however, that there is a record of a S. zerene form near hippolyta from Haines, Alaska. This may represent a relict population, perhaps from the altithermal period of warmer climate.

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Rock Creek				9/8 +	8/19a 1m 1f 9/16 1f	8/4a 2m 8/17,29 1f	9/7 3f	8/12 +m 1f 9/15 1f			10/3 -	9/15 4f	6/14 ** 4 la. 7/5 1m,1la. 8/1-3, 20-22 +
Tenmile Creek			9/2 +	9/8 +	9/16 + 9/30 -	9/3 2m	8/18a ?/20m	8/3a /?20m 9/4i 4f		5/14 1 la.	10/3 -		8/2 - 8/22 3m
Boiler Bay	9/12b 1m 1f	8/1b + 8/31b 1m 6f 9/11 1f 10/4b -	8/27 3m 9/2 2m	9/6 + 8/23i 1m									
Cape Meares 1920's cd + 8/15/67 e +	(7)	9/5 -				7/27 -					9/2 -		
Mt. Hebo 8/15/67 e +			9/14 1f	8/24i 4m 5f		7/27 1m							9/11 10/1[illegible] + 2f
Gearhart						9/10 2f					8/26 -		
Cullaby Lake 9/1/52 d +				8/25i 2m 2f		9/10 -					7/?g +	- g	8/23a -
Saddle Mountain						9/10 1m 1f							8/23a -
Long Beach Peninsula								8/24h 3m 1f	8/28 +				8/23a 1s
Salmon River			8/27 -										
Yachats		8/19 2f											

a - Paul Hammond
b - Glen Hawk
c - Ralph Macy
d - Stanley Jewett
j - Milton Parsons

e - C. William Nelson
g - Charles Crowe
h - Robert Pyle
i - John Hinchliff
k - Glory Penington

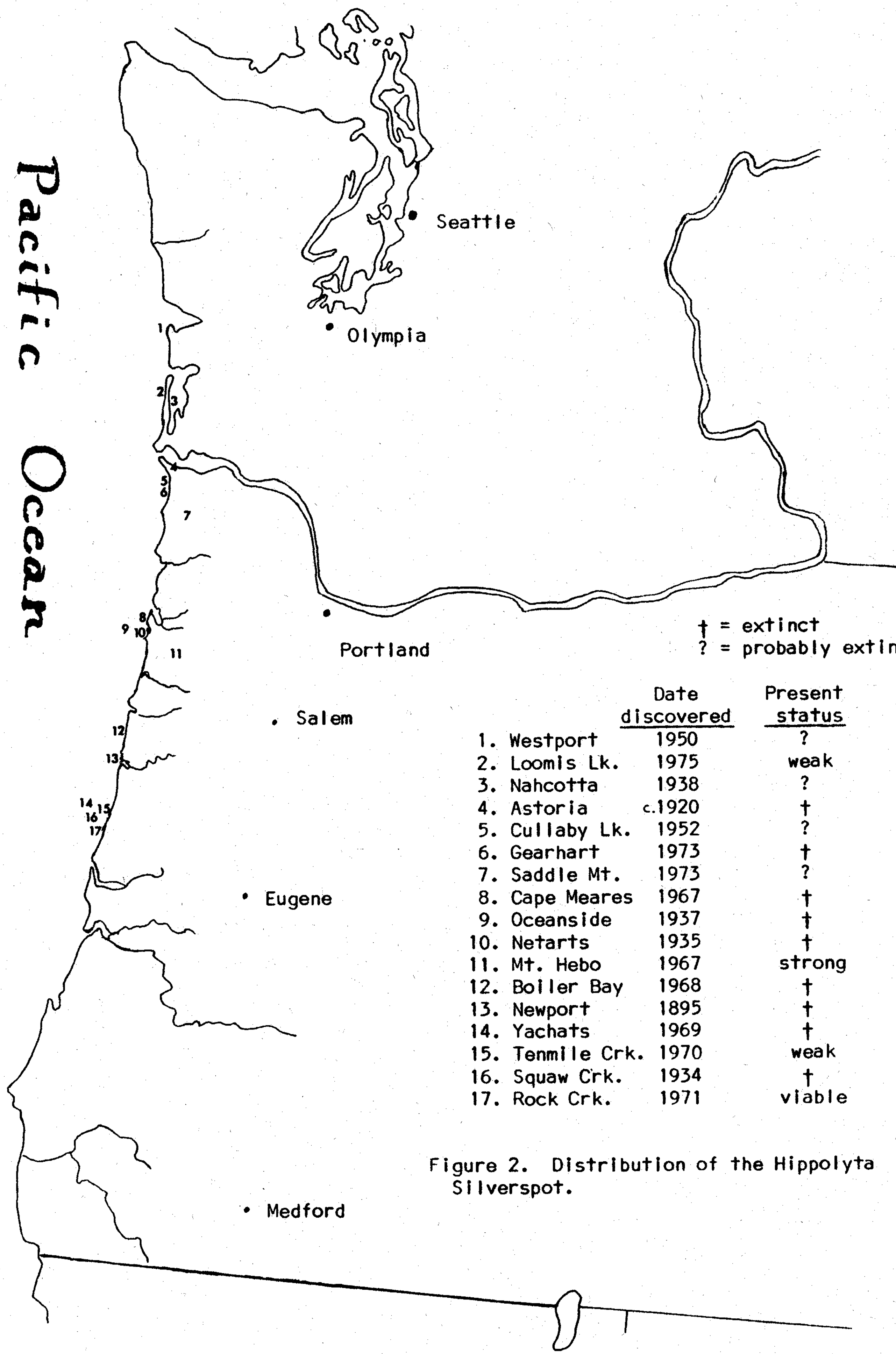
s - sight record
f - female
m - male
la - larva

\- none seen
\+ unknown number seen/taken

All unmarked entries are David V. McCorkle.
* also includes McCorkle

** also; 9/4ak*
\+

Figure 1. Recent <u>Speyeria zerene hippolyta</u> records.



† = extinct
? = probably extinct

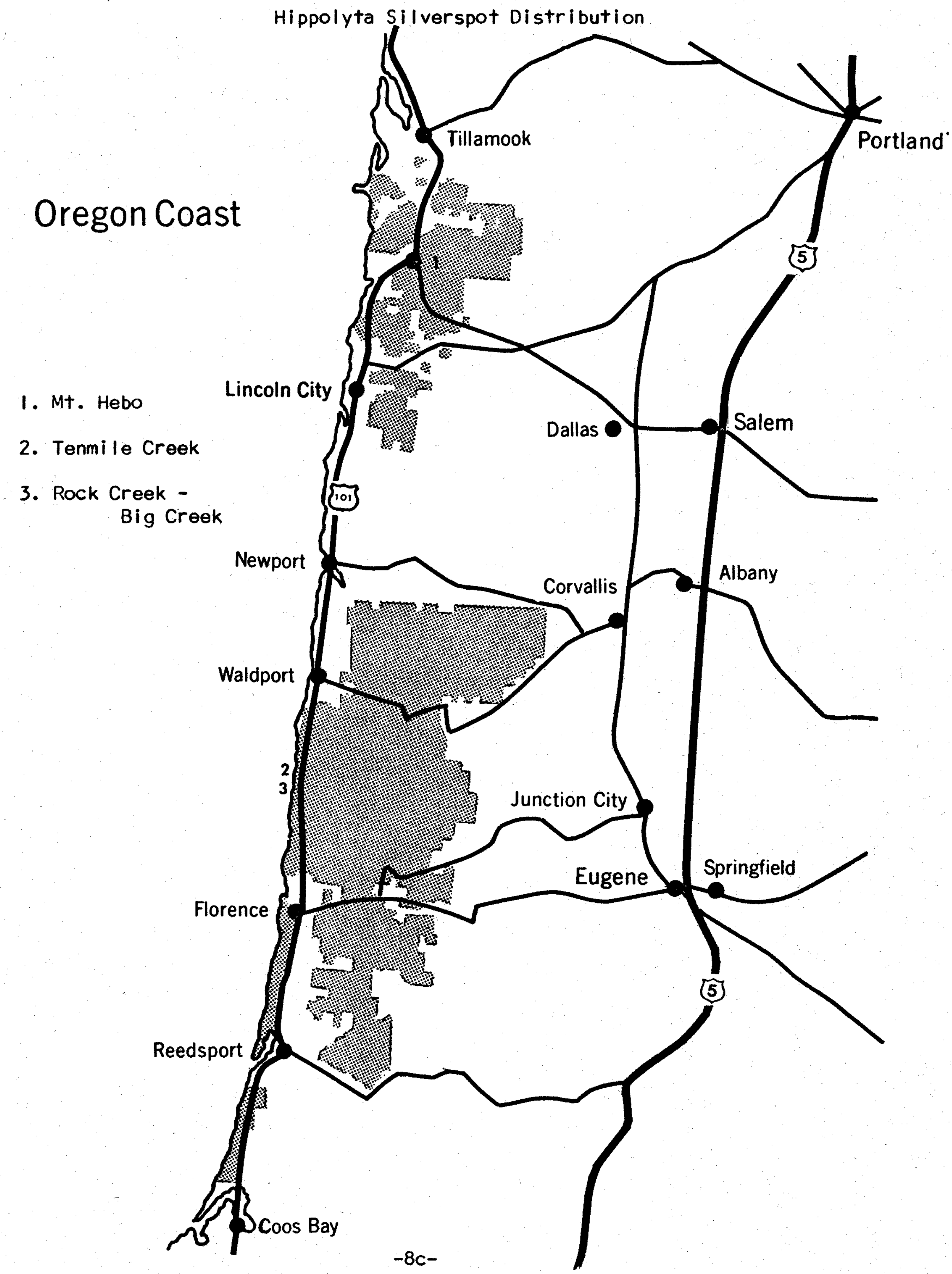
	Date discovered	Present status
1. Westport	1950	?
2. Loomis Lk.	1975	weak
3. Nahcotta	1938	?
4. Astoria	c.1920	†
5. Cullaby Lk.	1952	?
6. Gearhart	1973	†
7. Saddle Mt.	1973	?
8. Cape Meares	1967	†
9. Oceanside	1937	†
10. Netarts	1935	†
11. Mt. Hebo	1967	strong
12. Boiler Bay	1968	†
13. Newport	1895	†
14. Yachats	1969	†
15. Tenmile Crk.	1970	weak
16. Squaw Crk.	1934	†
17. Rock Crk.	1971	viable

Figure 2. Distribution of the Hippolyta Silverspot.

Figure 3

Siuslaw National Forest

Location Map



Footnotes

1) The Goldbeach and Cape Blanco _zerene_ populations, characterized by somewhat larger individuals, are apparently recent arrivals on the coast or are still strongly influenced by gene flow from inland _zerene_ by way of the Rogue River populations which are apparently continuous through to the east side of the Coast Range.

2) Mr. Stanley Jewett, Jr. reports that a Mrs. Veazie found a _zerene_ form common on Deer Island in the Columbia River, Columbia County in the 1920's (Jewett interview, 1980).

3) Dr. Hammond's 1980 field check (August 23) failed to reveal _hippolyta_ still extant at Saddle Mountain. However, Hammond and Parsons found them in numbers at Mt. Hebo (September 11).

4) See discussion of this northern California coastal form on Page 4.

5) This violet was used by some Indians (Gunther, 1945, revised 1973).

Historical Perspective of the Rock Creek Meadow Site

Although a more thorough study of the history of the coastal region of the Siuslaw National Forest is apparently to be contracted soon (Beckham interview, 1980), the following will serve to highlight the events and types of human activity that have impacted the coastal salt-spray meadows in general and the Rock Creek meadow in particular.

The climate of the Pacific Northwest was apparently quite cool and moist 10,500 to 8,000 years ago in the period following the retreat of the continental glaciers.[1,2] The altithermal period followed (8,000 to 2,000 years ago) during which the region was drier and warmer, even more than at present. At this time the Willamette Valley was apparently dominated by lodgepole pine.[2] Also, during this time the continental shelf gradually sunk beneath sea level so that the Pacific Northwest shoreline took its approximate present appearance by 5,000 years ago.[2] Because of the submergence and erosion of the ancient coastlines, little evidence remains of their ecological condition or of human activities upon them. To date, the oldest record of Indian presence in the Willamette Valley is 8,000 years ago (Cascadia Cave) and on the Oregon coast a mere 500 years ago (Netarts Sand Spit).[2] It is, however, expected that Indians occupied the now destroyed coastal area for a much longer period.[2]

During the period of Indian occupancy heavy forests prevailed in some areas (Beckham, 1977, p. 31); however, periodic forest fires cleared other areas extensively. There is evidence that the Indians set fires to clear at least some of the headlands, annually in some cases (Beckham interview, 1980).

(Footnotes for this section are on p. 18.)

The Rock Creek - Big Creek area was occupied by the Alsea Indians whose lands stretched from Heceta Head north to the vicinity of the Alsea River. There is evidence from their middens that the Indians at Big Creek used seafoods extensively, including shellfish, fish (probably salmon) and even whale when washed ashore. In this area the beach is easily traveled by foot. For what reason they might burn to clear the nearby forest is uncertain, if indeed they did so purposely. Perhaps it was to maintain the berries that need a meadow habitat.

Even so, it is quite evident that succession occurs very slowly here where the land is unprotected from the salt-laden winds (see Plate IV, fig.1, Plate XIII, figs. 1,2). Presently trees some 60 cm. or more in diameter in the lee of the inland hills show an age of 60 to 70 years by ring count (Sherwood discussion, 1980), whereas a 54 year-old tree sampled near the edge of the meadow in an exposed position is a mere 5.5 cm. in diameter, inclusive of the bark.

The presence of native species of meadow plants such as Viola adunca itself, the seeds of which apparently do not easily spread great distances (Meeuse, 1978), and the paucity of fossil root channels in the exposed soil profile along the beach-facing bank (Plate XV, fig. 1) are evidence that a meadow community has been semi-permanent at this site.

There is also evidence that at times the meadow community has been much more extensive than it is presently. The evidence for this will be presented later.

The history of White Man's activity at nearby Heceta Head is documented in Finucane (1980 a). The following account draws upon this source and others as indicated.

The Rock Creek area lay within the initial boundaries of Benton County between 1847 and 1851, at which time Lane County was created (Loy, et al, 1976). After the establishment of the Siletz Indian Reservation in the 1850's (Loy, et al, 1976), certain lands along this part of the coast were allotted to these Indians. They usually chose coastal meadow land so that it is likely that the Rock Creek site was involved (Beckham, 1980 interview). In 1865 an executive act of the President opened some of the lands in this area to homesteading. Then in 1875 a Homestead Act of Congress closed the Indian occupancy and declared the area south of Waldport on to the Siuslaw River open to homesteading. Unrestricted burning was apparently prohibited at this time as well (Beckham interview, 1980).[3]

In 1888, Welcome and Dolly Warren claimed 164 acres on Heceta Head and adjacent lands. In 1902, Charles Stonefield bought Warrens' homestead and other nearby holdings. Sheep and cattle were raised here. One enterprising youngster trapped moles (a meadow animal) and sold their pelts. Highway 101, the Roosevelt Highway, was constructed through this part of the coast between 1930 and 1932, originally as a military road.

During this time Rufus Stonefield, apparently a son of Charles, owned and operated a cattle ranch near Heceta Head. (All from Finucane, 1980).

To the north, the area that is now the Charles Washburn State Park was homesteaded by Mr. Herman Larsen's family where they raised sheep and cattle. Herman attended the Heceta school as a youngster. Alfred Johansen homesteaded the land just south of Rock Creek sometime before 1917. The Rock Creek meadow was "cleared and windrowed", then burned, including the stumps. During the 1930's, Fred Stonefield (apparently another son of

Charles) owned the land starting at the present Ponsler State Park and extending five miles north along the coast with the exception of 20 acres just north of Rocky Knoll (at Rock Creek) which acreage was state land. (All from Larsen interview, 1980).

Mrs. John G. Cameron (Elizabeth Starker) (interview, 1980), learned from a Marie Stonefield (80 years old in 1955) that she had homesteaded the land near the mouth of Big Creek as a single person and made her living by hunting and native food gathering much as had the Indians before her. Her house stood just north of the present junction of the Big Creek road with Highway 101. Her relationship to the other Stonefields nearby is unknown to us. She would have been in her late twenties when Charles Stonefield bought Warrens' homestead at Heceta Head (1902). Perhaps she was a sister. Or was she at some time married to a Stonefield, perhaps leaving a son, Fred, to add the Johansen property and more to their holdings during the 1930's? Possibly the historical study soon to be contracted will clarify some of these questions.

It is interesting to note that the older trees on the inland backslopes between Rock Creek and Big Creek are about 70 years old (Sherwood discussion, 1980). This dates them back to the early 1900's and matches nicely Mr. Larsen's approximate dating of the Johansen homestead. Most likely the clearing he describes was of a previous forest stand on these same slopes. Possibly it involved brush removal on the shoreside lands, but, as mentioned earlier, it is unlikely that the present meadow area was forested to any degree even then.

Of the documented forest fires since 1843, the 1849 fire which burned 325,000 ha between the Siuslaw and Siletz Rivers (Loy, et al, 1976, p. 150) was the most likely to have impacted the Rock Creek - Big Creek area. It is probably the fire that "Indian Jeff" (80 years old in 1917) told about, according to Mr. Larsen. Apparently the fire burned for several years (Larsen interview, 1980). (If indeed this fire did burn the Rock Creek area timber, Mr. Johansen would have cleared trees some 60 years in age to re-establish grassland for his pasture.)

The fall of 1936 was the hottest and dryest on record. Sixty Class C fires occurred in the Waldport District that season. On September 26, 1936 it was 97°F at the Waldport Ranger Station with the humidity down to 14 - 16% while a 24 mph east wind blew. A fire started on this day that eventually burned over some 10,000 acres of the Blodgett Tract forest lands (Finucane, 1980 b, p. 28). However, this fire apparently missed the Rock Creek - Big Creek area. Finucane quotes a Newport Journal article that states that the fire fighters set up their camp at Big Creek (Finucane, 1980 b, p. 29). It seems unlikely that they would choose either a recently burned area or one in danger of being burned.

Thus it appears that the last fire to affect the Rock Creek meadow area was near the turn of the century (c. 1907) when Johansen apparently cleared and control-burned the area at least in part. From that time to the present, the areas most exposed to the summer salt winds and, perhaps, of particular soil types, have been meadow.

Fred Stonefield's cattle were apparently the last to graze the Rock Creek - Big Creek meadows. No cattle have been kept there since at least the early 1950's (Camaron interview, 1980). To what extent the presence of cattle had affected the rate of brush encroachment is speculative at this point. It is likely, however, that most of the introduced weeds now present colonized the area during this period. (Notable among them is the false dandylion, Hypocheris radicata, which has become a frequently used nectar source for the Hippolyta Silverspot. At the same time, it may be crowding out Viola adunca in places.)

At present, brush - primarily salal - is becoming established and spreading in some areas of the meadow (see habitat map). Salal is obviously resistant to the salt winds (see Plate XIII, fig. 1). Apparently, the osmotic strain created by the damp salt coating together with the persistent summer wind has a localized herbicide effect upon essentially all of the exposed vegetation, but least upon salal. The salal acts to protect other shrubs and young trees from exposure, allowing their establishment and slow growth. (One Sitka spruce took 54 years to grow to a diameter of 5.5 cm.!)

The winter winds from the northwest seem to have little salt pruning effect, probably for two reasons. First, they usually coincide with heavy rains which must act to wash the vegetation free of any salt coating and prevent excessive water loss from evaporation. Secondly, the shrubby vegetation should be more resistant in its dormant state.

Grasses dominate in the meadows. Together with most of the meadow plants, they put on their growth during the spring, again at a time of rain-cleansing. By the time salt-spray laden southwest summer winds begin with any force, the grass has gone to seed and has begun to dry out. (Very little, if any, rain falls at this season.) This grass apparently provides an important protective layer for the meadow herbs which seldom exceed this layer in height. (See fig. 8 for an illustration of violets from grass cover of different heights.) Anywhere the grass is absent, most of the herbs have a vary low profile. A few other plants, such as the spring-bank clover [4], put on spring growth and die back by the time of the summer winds, thus also acting to protect other shorter plants much as does the grass. Aster chilensis and yarrow seem somewhat resistant to the salt wind effect and bloom during the late summer. By contrast, the thistle Cirsium edule and even the recently introduced tansy ragwort tend to die back in the face of the wind's onslaught, but these last two plants usually have outgrown the grass in height considerably.

The overview of successional ecology at S. z. hippolyta habitat sites that thus appears is as follows. Periodic disturbances such as natural fires or man's clearing and burning, result in opened areas which first are occupied by meadow species which colonize from nearby parent meadows or whose seeds may survive in the soil from past meadows. If this burning has been extensive, there may follow a period of widespread but temporary meadow habitat into which the surviving pockets of the Hippolyta Silverspct expand.[5] Perhaps hippolyta colonized its Mt. Hebo site in Tillamook County, Oregon (twelve miles inland) in the aftermath of the Hebo burn of 1910, deriving from some coastal population nucleus. (There is evidence that the present Hebo meadow was at least mostly wooded prior to that fire. But Viola adunca probably predates the fire at this site.)

Brush apparently establishes rapidly in the inland protected areas near the coast. It did so within a five year span in much of the Blodgett burn area (Finucane, 1980 b, p. 33). Succession to the brush and forest stages may be much slower in these situations: where the soil thinly overlays rock, such as on some headlands, where the soil is otherwise poorly suited to plants requiring deep rooting (e. g. Blacklock soils which are acid and infertile; see Martin and Frenkel, 1978) or, as in the case of the Rock Creek site, where there is exposure to the salt winds. Here often a disturbance may again occur starting the process of succession over before it has initially concluded. The pattern of differential succession rates is probably similar each time. Plate XV, fig. 1 and Plate XIV compare respectively the beach exposed soil profiles at the present Rock Creek meadow and at the stunted forest near China Creek to the south. Deep "fossil" root channels occur in the latter but are virtually absent in the former. And yet the whole area was grassland during the early 1900's (Larsen interview, 1980). Thus an ancient forest, perhaps likewise stunted, and an ancient meadow apparently occupied locations similar to those they presently occupy. Now that fires are prevented and other disturbances stopped, at least at this site, succession is beginning to advance past the meadow stage even in the wind-exposed portions. (See the Rock Creek habitat map for the present distribution of brush.) Consequently, the Hippolyta Silverspot's breeding habitat is continually reduced. Many of the nearby brushfields, especially to the south, were undoubtedly suitable meadow within the last fifty years.[6]

Footnotes

1) These retreating glaciers left rocky deposits in the Tenino, Washington area where later *S. z. bremnerii* would take a stronghold.

2) (Beckham, 1977)

3) In the Willamette Valley the deliberate setting of fires had been made illegal by 1864, and by 1911 all forest lands of the region were required to be protected from fire (Loy et al, 1976, p. 150).

4) Spring-bank clover, *Trifolium wormskjoldii*, is the apparent foodplant here of a Lycaenid butterfly, the glossy blue, *Plebejus saepiolus* (Plate X, fig. 2).

5) Apparently the rootstocks and buried seeds of violets can survive fire. Such appears to be the case in the recently burned over forest near Big Lake to the south of Santiam Pass in the Oregon Cascade Mountains. Here on August 16, 1980, Hammond and McCorkle found the yellow prairie violet, *Viola nuttallii*, growing well amongst the charred stumps of the burned forest. *Speyeria hydaspe* and *S. mormonia* adults were present in the burned area.

6) A 1952 aerial photo shows meadow extending most of the way to Ponsler State Park south of Big Creek.

A General Description of the Rock Creek and Tenmile Creek Meadow Sites

Soils and Climate

Map 16 of the Heceta Head, Oregon area in the Soil Resource Atlas, Siuslaw National Forest, Westside, classes the soils at the Rock Creek and Tenmile Creek meadow as soil type 8. This soil and its environment are described as: "wind-swept colluvial slopes", and, "Occurs along the ocean front and is directly affected by the storm winds and salt-spray which has rendered it essentially non-forest land." "The soils are very to extremely gravelly, cobbly and stony loams with up to two feet total depth. Rock outcrops are commonly associated with this unit." (Badúra, et al, 1974, p. 12.)

The isohyetal map on Page 63 of the Siuslaw National Forest Soil Resource Inventory (Badura, et al, 1974), shows the Rock Creek area receiving an annual average of 80 inches of rainfall. The temperature rarely exceeds 100°F and never falls below zero. January is the coldest month and July the warmest. Winds of hurricane force (75 mph.) strike the coast several times a year.

During the fall and winter, low pressure systems with counter-clockwise air circulation predominate. This results in a prevailing southwest air flow. Forty to 50% of the total annual rainfall ordinarily comes between December and February and 20 to 25% during the fall months. During the spring, again 20 to 25% of the yearly rainfall occurs. The low pressure systems typically move north during the summer and are replaced with high pressure systems characterized by clockwise air flow. Thus the prevailing winds shift to the northwest during this period. Only 6% of the annual rainfall typically occurs during the summer. The coast has a normal dry period during the late summer. Table 1, modified from Martin and Frenkel, 1978, p. 25, gives climate data for Cape Blanco on the south Oregon coast. The values undoubtedly differ from what must occur at Rock Creek and Tenmile Creek, but the pattern most likely is similar.

Table 1. Climate data at Cape Blanco.

Month	Temperature* F	(C)	Precipitation* inch	(cm)	Wind Speed# mph	(kmph)
J	46	(8)	14.2	(36.1)	18.5	(29.6)
F	46	(8)	12.4	(31.5)	19.9	(31.8)
M	45	(7)	11.4	(29.0)	17.3	(27.7)
A	46	(8)	5.6	(14.2)	15.5	(24.8)
M	50	(10)	2.1	(5.3)	16.4	(26.2)
J	51	(10)	1.1	(2.8)	14.2	(22.7)
J	55	(13)	1.7	(4.3)	15.2	(24.3)
A	55	(13)	3.5	(8.9)	12.9	(20.6)
S	54	(12)	.8	(2.0)	13.8	(22.0)
O	52	(11)	5.7	(14.5)	14.9	(23.8)
N	51	(10)	8.3	(21.1)	15.8	(25.3)
D	48	(9)	9.5	(24.1)	21.8	(34.8)
YEARLY AVERAGE	50	(10)	74.8	(190.0)	16.3	(26.1)

* 3 year averages - Dept. of Commerce, NOAA

2 year averages - O.S.U. Atmospheric Science Dept.

Biological Description

Much has already been said of the general nature of the vegetation in the Rock Creek meadow, particularly as it relates to the effect of the salt-spray laden winds. A plant list made from the herbarium collection and notes of Heather A. Engelman, 1979, and expanded by McCorkle, 1980, is presented in

Appendix III, section A. Although numbers of the plants are introduced species reflecting use of the area as pasture in the past, the native species are still well represented. The dominant conifer in the nearby forest is Sitka spruce. The stunted forest near Ponsler State Park includes also shore pine, Pinus contorta, and western hemlock, Tsuga heterophylla. Red alder, Alnus rubra, is common along the streams and disturbed slopes inland.

The Tenmile Creek site is similar. Introduced grasses have crowded out the native plants to a much greater degree, however (see Plate XII, fig. 2). Another difference is the presence of a larger bog with standing water and probably containing some native plants missing at the Rock Creek meadow. (This bog is on private land.)

Lists of the vertebrate animals seen or likely to occur in the vicinity of Rock Creek are given in Appendix II, sections C and D. Zapus trinotatus, the Pacific jumping mouse, was seen twice. However, a live-trapping effort yielded only Peromyscus maniculatus, the deer mouse. Several birds were seen which the author could not identify. One was nesting in the meadow near Transect #1 (see habitat map) during June. Elk have a definite impact upon the meadows through grazing and occasionally breaking the sod with their hoofs. Where their activities are not too severe, they are probably beneficial to the meadow in the long run in that they shorten the heavy grass in places and open some soil for seedlings of meadow plants.

A complete list of the butterflies found in the Rock Creek - Big Creek area is given in Appendix III, section B. Most occur inland from the windswept meadow. The migrating species apparently use the coastline as a flight corridor, taking advantage of the flowering plants in sheltered places as a nectar source, even when further inland the herbaceous vegetation may be dried by the summer heat.

On each visit, a collection of moths was made at the Rock Creek campground lights. Various Coleoptera and other insects were acquired as opportunity arose. At present these all await the attention of qualified taxonomists for identification.

Notable among the Hymenoptera are the red and black mound-building ants whose colonies are scattered in the meadows. These may play an important role in distributing the seeds of *Viola adunca*, as ants are known to do for other *Viola* species (Meeuse, 1978). *V. adunca* is apparently diplochorous (shoots its seeds and entices ants to spread them). In at least one instance, *Viola adunca* plants were found concentrated around an ant mound. These ants have well-established tunnel-like runways that extend several meters from the nest so that it is hard to find an area in the meadow where ants from some nest are not foraging.

Biology of *Speyeria zerene hippolyta*

Imago Adaptation to the Coastal Environment

It is of particular interest that the Hippolyta Silverspot is characteristically darker and smaller than inland subspecies of the related *bremnerii* group (see fig. 4 and Plate IX). Evidence indicates that this is an adaptive condition responsive to the persistent wind and frequent fog characteristic of their breeding habitat during their flight period. Butterflies, being heterothermic, depend usually upon solar radiation to elevate their body temperature to a level sufficient to allow the flight which is necessary for their foraging, mate seeking, escape from predators, and oviposition activities. Rapid ovarian development is also thermodependent.

Douglas (1979) has determined that 30 to 39°C is the thoracic flight temperature most butterflies prefer. Below 30°C, flight is uncoordinated, whereas above 41°C thoracic temperature, butterflies overheat and cease flying. He has further shown that wings assist thoracic warming significantly during solar basking under stringent thermal conditions (Douglas, 1979, p. 45). Heat is transferred from the wings to the body primarily in the form of radiative heat (Douglas, p. 66). He states that dorsal basking, as opposed to lateral basking, is thermoregulatorily superior for rapid heat gain and that dark butterflies heat significantly faster and to a higher inflated temperature than their light-colored, size-matched equivalents (Douglas, p. 51). Furthermore, in experiments he conducted, he demonstrated that the basal third of the hindwings supplies most of the excess thoracic temperature radiated by the wings to the butterflies body (Douglas, p. 50). When basking, the basal third of both front and hind wings achieves a higher temperature than the body or the rest of the wings (Douglas, fig. 31), and the wings heat faster to their equilibrium temperature (30 seconds to 1 minute) than the body does (3.0 to 3.5 minutes), (Douglas, 1979, p. 46), thus contributing to their effiency in helping heat the body. Removing the scales from the wings reduces their heating ability by 10 to 15% (Douglas, p. 46 and fig. 34).

Douglas showed that basking small butterflies (c. 14 mm. wing length, right primary) heat up most quickly but reach the lowest inflated thoracic temperature, whereas large butterflies (c. 50 mm. wing length) heat the slowest but can attain the highest temperature. Medium-sized butterflies (c. 27 mm. wing length) enjoy the best of both -- quick warming to an adequately high thoracic temperature (Douglas, p. 43 and fig. 14).[1] He also points out that most arctic and alpine butterflies, whose flight activities must often occur under stringent thermal conditions, have wing lengths in the medium range (15.0 to 22.0 mm. with a mean of 20.0 mm. "costal length", Douglas, table II).

Douglas suggests two selective advantages to the medium-size range for butterflies living in such stringent thermal conditions where wind is frequent. First, the good basking efficiency must allow more frequent and extensive activity periods. The pubescent, medium-sized, dark butterfly heats rapidly to a high enough temperature and has sufficient mass (providing heat capacity) to stay warm long enough to allow at least periodic flight activity (Douglas, p. 130). Wind is a problem in maintaining the body temperature because heat is lost by forced convection from the body surface (Douglas, p. 69).

The second advantage to a smaller wingspan is that it allows flight closer to the ground where the wind velocity is less, due to the protective and insulative effects of plant growth (Douglas, p. 71). Here the butterfly encounters less form resistance and thus can maintain better flight control (Douglas, 1979, p. 132).

The Hippolyta Silverspot's darker color and smaller size, compared to the inland S. z. bremnerii (see fig. 4), fits Douglas' basking efficiency theory well. Inland bremnerii adults seldom encounter wind of significance nor fog during their activity periods. Although hippolyta adults do take advantage of such shelter from the wind as is available for part of their flight activity, it will be apparent below that those that can best endure the meadow winds have the reproductive advantage.

Footnotes

1) His experiments were done with different species. Using size variants of the same species might have better minimized the variables.

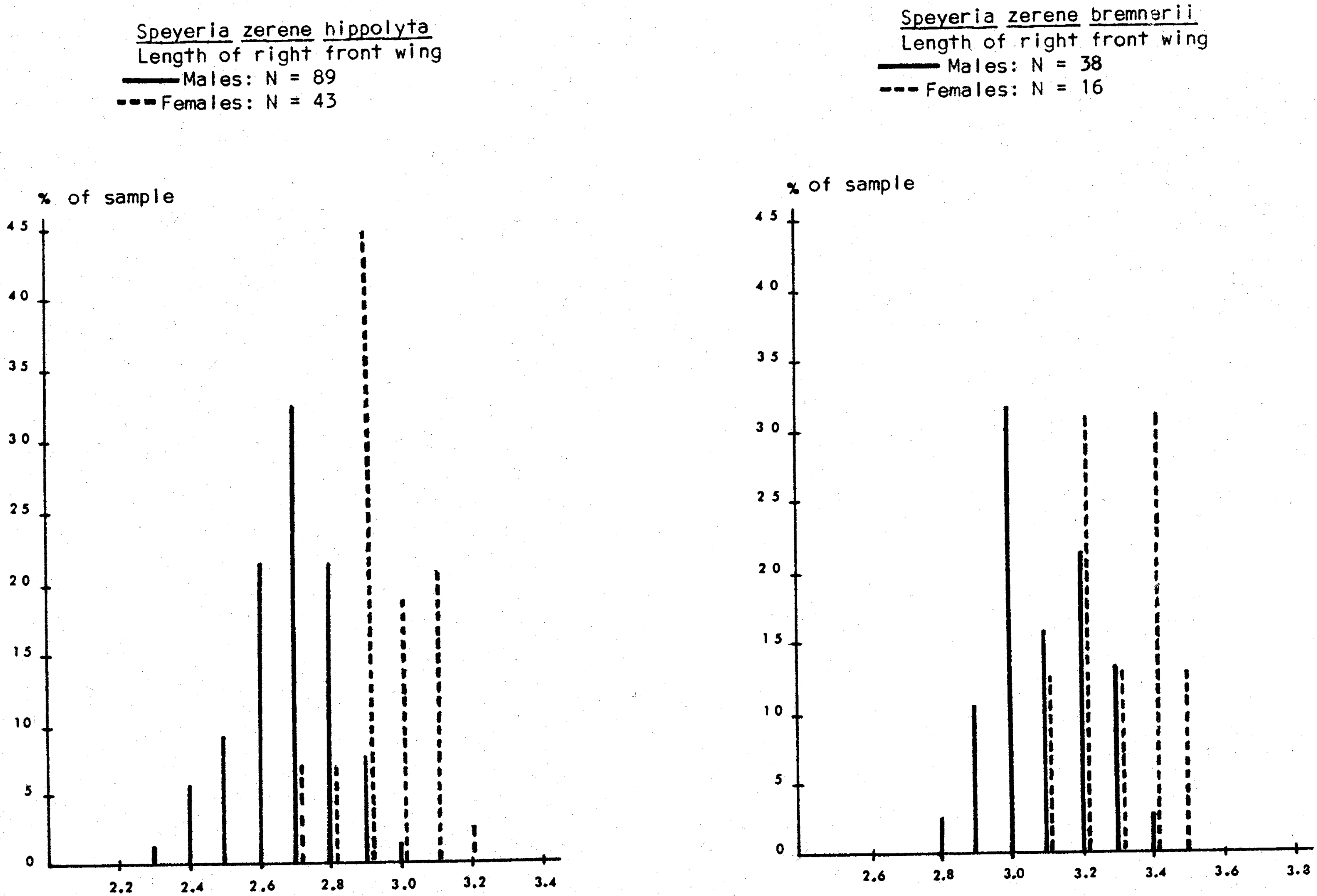


Figure 4. Winglengths of S. z. hippolyta and S. z. bremnerii compared. All data are from field-taken specimens.

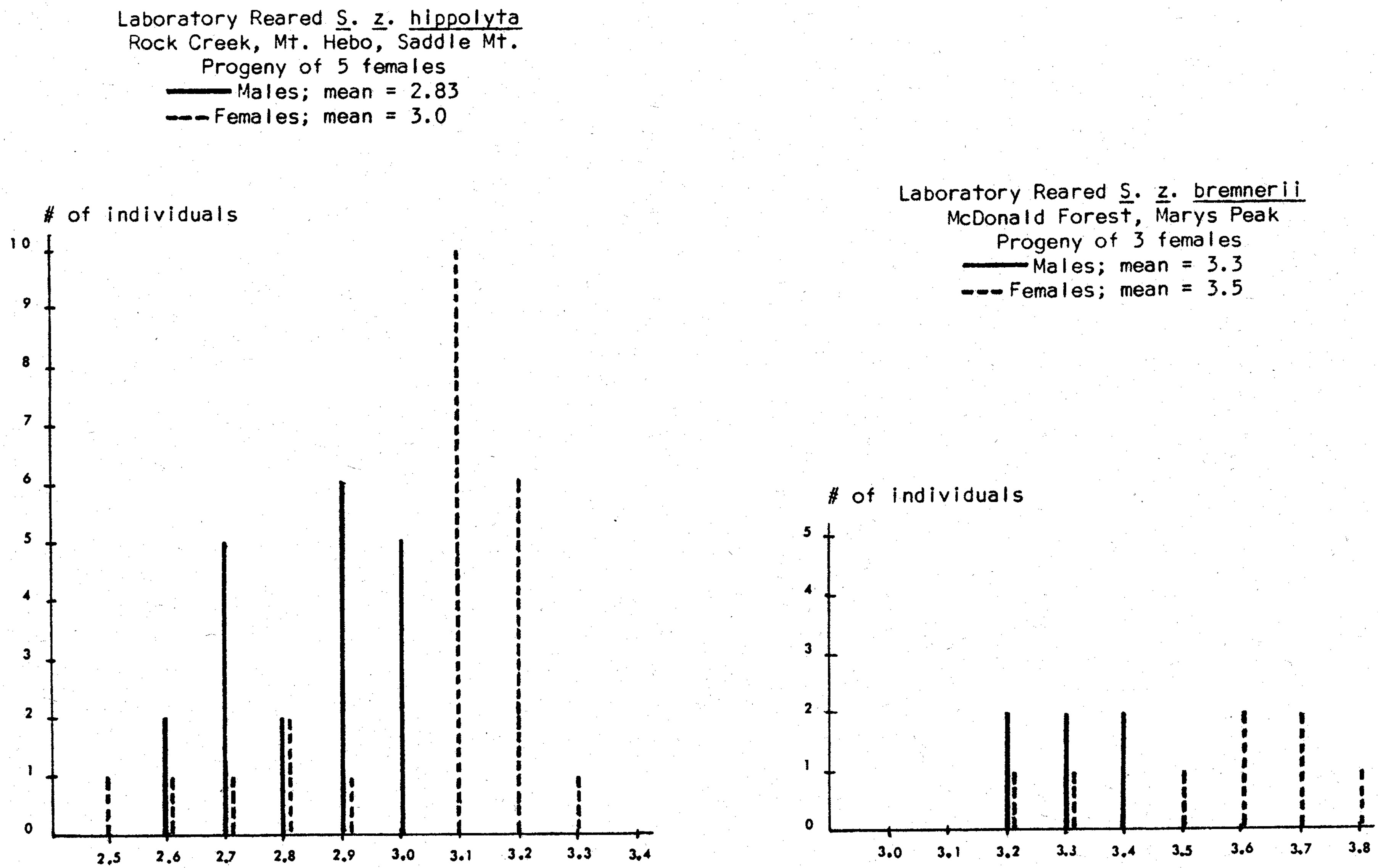


Figure 5. Right front winglengths of reared S. z. hippolyta and reared S. z. bremnerii. Note that, although reared in semi-standardized conditions, the characteristic size relationship is retained. Compare with Fig. 4.

Imago Ecology at the Rock Creek Site

Mark - Recapture Studies

Capture - recapture studies at the Rock Creek site during the 1980 season yielded many data of significance. These studies were done using the 1 - 2 - 4 - 7 marking system described by Cummins, et al, 1965 (adapted to Lepidoptera by Ehrlich and Davidson, 1961). A black, permanent ink, "Marks - A - Lot" brand broad tip marker pen was used to make the identifying dots on the ventral wing surface of the living butterflies. A short plastic ruler was inserted between the folded wings to provide a firm marking base. The length of the right primary from its base to apex was matched with the points of a precision divider, then the gap measured in mm. after the butterfly's release. The procedure was sufficiently efficient that an individual butterfly seldom was in custody as long as five minutes. In all cases, butterflies were released near, if not at, the point of their capture. The sex, wing length, general condition, time and place, and the type of activity at the time of capture were recorded in a field notebook. Place, time, activity and general condition were recorded for recaptured butterflies. Five females were retained for laboratory verification of their reproductive condition, etc.

In the discussion below, area numbers refer to those on the map in fig. 6, p. 29a.

The first male was taken at area 2 on July 5. (A nearly mature larva was also found on this date.) By early August, males were common (22 marked August 1 - 3) and females had begun to appear (2 marked during the same dates). Between August 20 - 22, 22 new males and 7 new females were taken and all but 2 females marked and released. Fresh females and a few fresh males were still present. On September 4, 15 new males and

(Footnotes for this section are on p. 36.)

16 new females were taken and nearly all marked and released. Five of the females were fresh. Three males were fairly fresh and one very fresh. It is thus apparent that in this colony, males eclose from early July at least until the end of August. The first females begin eclosing by the end of July and continue until the end of August or perhaps early September.

Data gained by the recapture of marked imagoes enables estimates of population size using the classic Lincoln index (Cummins, et al, 1965, p. 121; Lincoln, 1930). The product of the number of individuals marked and released previously and the total captured presently is divided by the number of individuals recovered to give the population size. The procedure assumes random mixing and no loss nor gain of individuals between the period of mark-release and recapture sampling. The sampling was done chronologically from site to site, due to personnel limitations. Recapture data used in the calculations are from one, or in some cases two, days following the release of the marked sample.

In the period August 1 to 3, 4 males were marked and released at site 1 (map, fig. 6; Plate VI, fig. 1). This site is up-slope from the main salt-spray meadow and near the spruce forest margin. Protection from the northwest winds is afforded by a hill immediately to the north and by the vegetation. A stand of goldenrod upon which the hippolyta would occasionally nectar, served as a focal point for sampling. The Lincoln index population estimate is 6 males for this vicinity at this time period (see fig. 7). No females were taken here.

During the same period (August 1 to 3), 15 males and 1 female were marked at sites 2 and 3. (These sites were eventually determined to be functionally a single unit.) This area is at the entrance to the Rock Creek campground at the first wind-protected site near the forest edge.

It is approximately 340 m. straight line distance from the beach, 435 m. upstream from the mouth of Rock Creek, but only 200 m. from the nearest Viola adunca stands (with feeding signs) on the hill west of Rocky Knoll. The nectar source here is principally yarrow growing along the roadside. Some false dandylion is also present.

The Lincoln index value for the male population here (site 2-3) is 21 to 24 (fig. 7). The one marked female was not recaptured. A Lincoln index value of 4 was obtained for the period August 21 to 22 at this site. A total of 4 males were "marked"[1] and released. No females were taken here at this time.

Site 2-3 was worked again on September 4; no hippolyta were seen. By this time, the coast wind has subsided substantially, especially early in the day.

Site 4 is a grassy meadow homestead remnent (lacking Viola adunca), lying at the north edge of Rock Creek .8 km. upstream from site 2 and separated by a solid forest canopy from any of the salt-spray meadow. Tansy ragwort and bull thistle are the principle potential nectar sources here. Hippolyta were observed only to nectar at the tansy. At this site 2 males and 1 female were taken and marked during August 1 to 3 (Lincoln index value = 2 males). The female was last seen flying up into the trees at the east end of the meadow about 5 to 10 minutes after her release on August 1. On August 21, 1 male only was found at site 4 (male number Im 80-36). This male was recovered two weeks later (September 4th) in the salt-spray meadow at site 12, 1.53 km. (.9 mi.) distant! This datum and a sighting of a hippolyta flying east through the forest canopy half-way between the Rock Creek campground and the site 4 meadow on August 3 at 2:18 P. M. constitute conclusive evidence that there is interchange between such inland, apparently temporary, adult assemblages and the seaside meadow populations.

On August 2, 1 male was marked and on August 21, 3 males were marked at a similar _Viola adunca_ - free grassy meadow .9 km. upstream from the U. S. Highway 101 bridge over Big Creek. This is marking site number 5. No Lincoln index estimates were made here because of lack of data. On August 21, clearings by the Big Creek road were checked for _hippolyta_ for several miles inland. No males were seen beyond site 5, but 1 fairly fresh fertile female was taken nectaring at a bull thistle along the road 2 km. (road distance) inland from U. S. Highway 101. She began ovipositing in the laboratory on September 1, indicating that her eggs were not mature at the time of her capture. On September 4, a female was seen flying west up over the trees at the west end of the site 5 meadow. The implications of this sex-dependent flight activity will be discussed below.

Toward the southern boundry of National Forest property and inland from U. S. Highway 101 there is a slope up which the northwest winds sweep, having first passed over the violet-rich meadow area west of the highway. At the top of this slope and over the rise is a flattened area containing a comparatively large stand of tansy ragwort and false dandy-lion. This area past the rise is fairly well protected from the up-slope wind. Butterflies concentrate here as they are blown up-slope from the meadow or as they test the wind in an attempt to return to it. Nearby there are fingers of the meadow that penetrate the forest and are thus well protected from the wind. Further east, in the lee of the hill, are the recently logged clear-cuts on Mr. Sherwood's property. From a distance it can be seen that there are presently strong stands of tansy and bull thistle throughout most of this clear-cut area. Because the study was limited to Forest Service lands in this area, sampling sites were chosen north and west of the property lines. These are sites 7, 8, and 8a on the map in fig. 6 (see also Plate III and Plate XII, fig. 1).

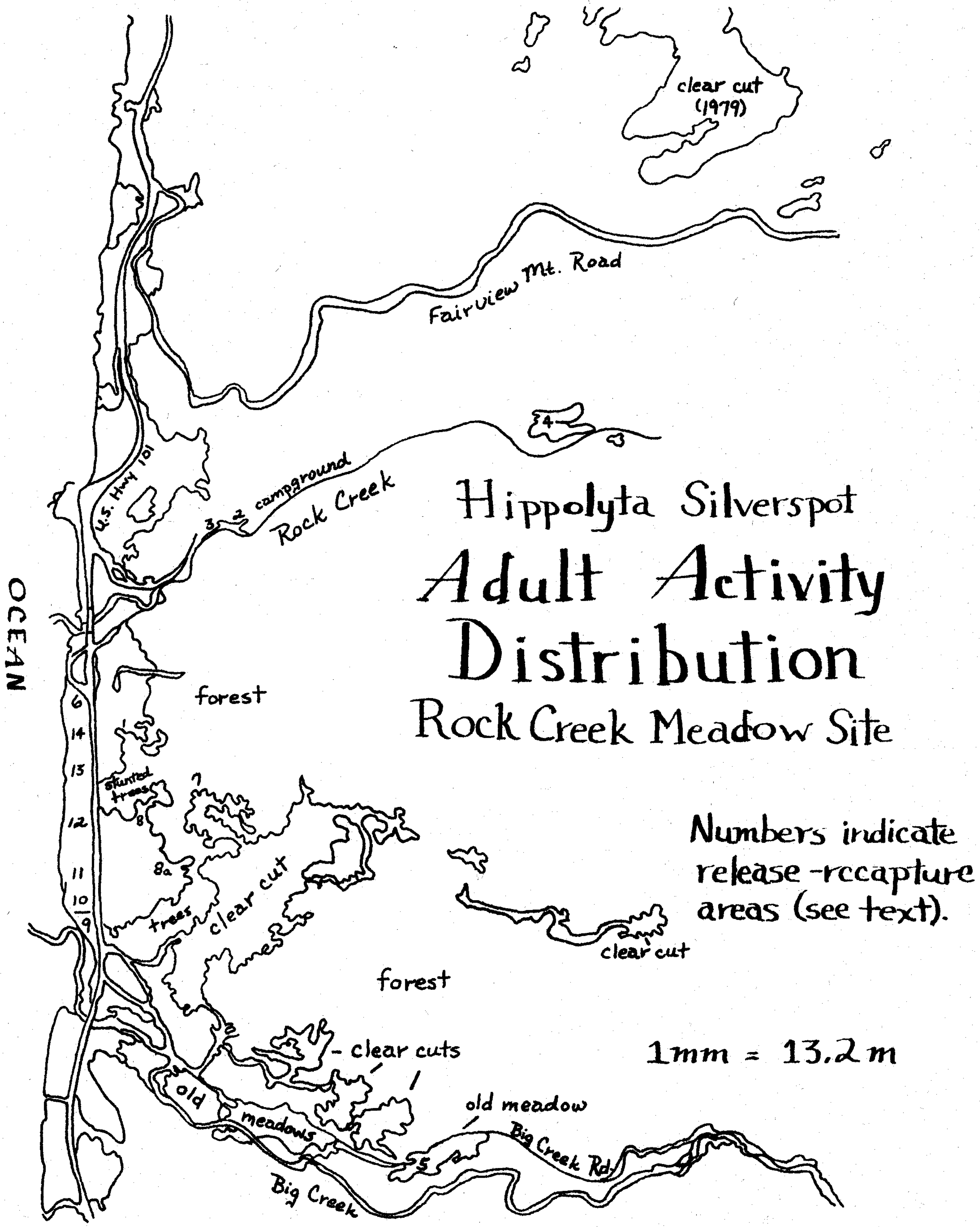

clear cut
(1979)
Fairview Mt. Road
4
3
U.S. Hwy 101
campground
3
2
Rock Creek
Hippolyta Silverspot
Adult Activity
Distribution
Rock Creek Meadow Site
OCEAN
forest
6
14
13
stunted trees
7
8
12
8a
11
10
9
trees
clear cut
Numbers indicate
release-recapture
areas (see text).
clear cut
forest
- clear cuts
1mm = 13.2m
old
meadows
old meadow
5
Big Creek Rd.
Big Creek

Figure 6.

Site	Date	Lincoln Index (all males)	Total Marked
1	Aug. 1-3	3 X 2 ÷ 1 = 6	4 males
2-3	Aug. 1-2	6 X 8 ÷ 2 = 24	- - -
2-3	Aug. 2-3	12 X 7 ÷ 4 = 21	15 males, 1 female
2-3	Aug. 21-22	4 X 1 ÷ 1 = 4	4 males
2-3	Sept. 4	- - - - - - -	0 seen
4	Aug. 1-3	1 X 2 ÷ 1 = 2	2 males, 1 female
4	Aug. 21	- - - - - - -	1 male
5	Aug. 2	- - - - - - -	1 male
5	Aug. 21	- - - - - - -	3 males
6	Aug. 20	- - - - - - -	1 female (teneral)
6	Sept. 4	- - - - - - -	1 male
7-8	Aug. 20-21	3 X 7 ÷ 1 = 21	- - -
7-8	Aug. 21-22	7 X 3 ÷ 1 = 21	10 males, 2 females
7-8	Sept. 4	- - - - - - -	5 males, 3 females
9	Aug. 21	- - - - - - -	1 male
9	Aug. 22	- - - - - - -	4 males, 1 female
12	Sept. 4	- - - - - - -	9 males, 13 females
14	Sept. 4	- - - - - - -	2 males

Fig. 7. Population estimate at several sites at the Rock Creek meadow.

The following two recapture records provide evidence that there is mixing of individuals in the 7, 8, and 8a areas, so that they are treated as a functional unit. Male Im 80-28 moved from area 7 to area 8 within one day (August 20 - 21). Male Im 80-38 moved from area 8 to area 8a within one day (August 21 - 22).

Lincoln index calculations made on data taken August 20 - 21 and 21 - 22 in these areas combined both predict a male population here of 21 (see fig. 7). Two females were marked and released, but neither recaptured, during this period.

On September 4, five males and three females were taken at this site. Most were marked and released. A fresh female proved fertile, first ovipositing in the laboratory on September 9.[2] A worn female did not oviposit after her capture, but died in the laboratory on September 12, still containing about 70 ova, all full-sized.

Area 9 is at the extreme southern end of the meadow seaward of U.S. Highway 101 and on the north bank of Big Creek (see map, fig. 6). Yarrow is the predominant nectar source here. The site is semi-protected from the northwest winds by a rise immediately to the north. In the period August 21 - 22, five males and one female were marked and released at this site. The female and at least some of the males appeared to be attempting to fly against the wind and into the meadow proper. Occasionally a male would nectar at the yarrow. The apparently gravid female (enlarged abdomen) was taken near the crest of the rise between areas 9 and 10. She was flying into the wind and very low amongst the vegetation. At least once she alighted to bask (in the protection of a salal bush).

A brief inspection of area 9 was made on September 4 when there was little wind. No *hippolyta* were seen.

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The salt-spray meadow proper (areas 10 through 14 and 6, see map, fig. 6) had been inspected for activity of adult _hippolyta_ on July 3 - 5, August 1 and 2, and August 20, all in 1980. During these inspections, a rather strong wind blew from the northwest. No adults were seen here on the July dates, although one male was taken at site 2 near the Rock Creek campground on July 5, a rather early record for _hippolyta_. On August 1 at 1:30 P.M. (Daylight Savings Time), a fresh female was flushed from the area at the west end of Transect #4 (marking area 13). The wind quickly blew her southeast and out of sight amongst the vegetation near the highway some 80 to 100 meters away. On August 2 at 12:45 P.M., a male was seen flying in a typical search pattern for females in area 6. At this time the sun was barely out and the wind had not yet reached full force. On the same date (August 2) at 1:10 P.M., a male was seen flying its search pattern near the east side of the highway below site 1. When it approached the highway, it turned back and flew easterly.

On August 20 at 10:00 A.M., a still somewhat teneral female was captured and marked (Im 80-25) in area 6. The air temperature was recorded at 15.5 to 16° C. The wind was just beginning to pick up. Upon its release the female basked for 11 minutes before flying up, whereupon the wind wafted her away to the southeast.

During the late morning on this same date (August 20), Dr. Milton Parsons and I walked the length of the meadow in this area in a brisk northwest wind looking intently for adults. None were seen until we reached the sheltered area 9 where several males were seen nectaring, basking and occasionally trying to fly upwind into the meadow. They seemed to have little success.

By contrast, on September 4, between 11:00 A.M. and 1:22 P.M. during which time only a mild northwest breeze blew, 9 males and 13 females were taken and most marked and released, predominantly in area 12. Of the males, 3 or 33% were fairly fresh, indicating that they had recently eclosed - perhaps within the week. Most were well worn, however. Seven or 54% of the females were very to fairly fresh. Unfortunately, due to contract time restrictions, no follow-up data collecting was done. Thus Lincoln index calculation of the population size is not possible.

The most striking result of the one day study was the recovery of male Im 80-36 which had been marked and released 14 days previously (August 21) in area 4, which is 1.53 km (.9 mi.) inland.

To test her oviposition readiness, a fresh female (80-5) was retained from those captured at this time. In the laboratory she began ovipositing on September 9,[2] indicating that her eggs were not quite mature at the time of her capture. Interestingly, the bulk of her eggs were laid in the first two days, 192, 105 of which were fertile. She did not oviposit in the period September 11 to 13, but between September 14 and 15 she laid 22 more eggs, most of which were fertile. By September 23 she had laid several more, so that her total production was in excess of 214. It seems likely that she had not oviposited prior to her capture. Thus this figure may be close to her potential. (Another female (f80-1) taken August 22 at area 8a, had laid 385 ova, 98% fertile by September 26, 1980.)

Although no field observations were made after September 4, 1980, seasonally later visits were made by McCorkle in previous years.

On September 15, 1979, no <u>hippolyta</u> were seen inland from the highway at the Rock Creek site (however, only the vicinity of area 1 was investigated), but several females were observed nectaring, some on aster - some on false dandylion, and ovipositing in area 6 (see map, fig. 6, p. 29a). Two of these were captured and kept in the laboratory for oviposition. Neither one did so. The only one autopsied (f79-2) contained about 50 fully-formed eggs.

After an unusual season of rainstorms during much of August and the first half of September, field checks were made both at Tenmile Creek and at Rock Creek on October 3, 1978. Although the weather conditions were ideal for hippolyta activity, no imagoes were seen.

As will be shown in the next section, it is significant that male hippolyta both translocate and remain for periods at certain sites. Evidence of this is given in tables 2a and 2b.

The data presented above serve as the basis for the theory developed in the next section. They also constitute the only quantitative basis for estimating the total population size of adult hippolyta at Rock Creek. The Lincoln index values obtained are only for local assemblages of males. Females were apparently too dispersed to provide sufficient recapture data for Lincoln index calculations. A total of 60 males and 25 females were captured during the mark-release study. The Lincoln index figures for the separate male populations added to the number of males actually captured in areas where Lincoln index data are unavailable total 94 for the season. However, there is overlap from one survey date to the next. Unavailability of data from Mr. Sherwood's clearcuts interjects a significant uncertainty factor. However, there must have been at least 100 males in the 1980 breeding population and an approximately equal number of females (the sex ratio is apparently close to 1:1). At this time, an estimate of the actual total is speculative as is the carrying capacity.

The high reproductive potential of _hippolyta_ (see p. 33) and other _Speyeria_ implies a basic _r_ selection, that is, a situation in which the population numbers are frequently below the ecological carrying capacity so that most of the time a large proportion of the offspring survive. During such times, those individuals with the greater reproductive capacity are likely to leave the most offspring in the next generation. Whenever the population reaches or exceeds the carrying capacity, selection should favor those individuals with a lower reproductive potential but whose offspring are better able to compete for the limited resources (_K_ selection). In _hippolyta_, this could mean females whose eggs are fewer but larger, or perhaps who are genetically programmed to put more energy into careful oviposition site selection at the expense of a higher egg number.

Indeed, it seems that _hippolyta_ is well-adapted to _r_ selection. This implies that disruptive conditions frequently occur which drastically reduce the population numbers. The adverse weather pattern during the flight period in 1978 is a likely example.

If the population has not already rebounded to near the carrying capacity, one would predict that it will do so by next year, barring the occurrence of renewed major disruptive phenomena. Assuming a reproductive population of 100 females and an average realized oviposition rate of 100 per female, some 10,000 ova would be distributed through the breeding habitat. Assuming a 70% fertility rate, 7,000 of these would be viable. All of these estimates are probably conservative.

This number of potential adults in the next generation will likely be reduced by the normal environmental resistance to near the carrying capacity. If indeed the population is already at carrying capacity, either it will exceed this level next year - if the environmental resistance, that is, parasitization, predation, etc., is not sufficient - or the survival rate will average the replacement level of two individuals per breeding female. Excessive environmental resistance, whatever the form, of course would again reduce the population to a level below the carrying capacity.

When the hippolyta population exceeds the carrying capacity, a depletion of its host plant, *Viola adunca*, could be expected. In effect, the excessive feeding activity of the hippolyta larvae would constitute excessive environmental resistance to the violet, in turn bringing its numbers below its carrying capacity. Larval food supply would then serve as the limiting factor to the hippolyta population size. Yearly monitoring of the violet densities and condition on the transects set up in this study should provide a measure of the impact of hippolyta. Correlation with current population size determinations could then provide a means of estimating the carrying capacity for hippolyta at this site.

Speyeria zerene hippolyta, 1980 Season at the Rock Creek Meadow

Study area (see map, fig. 6 p. 29a)	Number of Imagoes marked and released	Days to recapture (only recaptures at site of release are shown here)					
		<1	1	2		18	20
1	4m	1m		1m			
2-3	15m 1f	1m		2m		2m	1m
4	2m 1f			1m			
7-8	10m 2f	2m	2m	1m			
12	9m 13f	3m 1f					

f - female
m - male

Table 2a. Recapture Evidence of Staying.

Individual's identification number	Study area of mark and release	Study area of recapture	Days to recapture
Im 80-7 m	2 (Aug. 1)	8a	21
Im 80-36 m	4 (Aug. 21)	12	14

Table 2b. Recapture Evidence of Straying.

Footnotes

1) Actually, only one was newly marked. The other three had been marked during the August 1 - 3 period.

2) Females used for laboratory oviposition were kept in plasticized paper, gallon milk containers together with about three thin strips of paper towelling and one or two violet leaves. The containers were stacked in a horizontal orientation with the intended bottom close to and facing a west window. On sunny days, the containers were exposed to sunlight only in the late afternoon. Otherwise, they were kept at the ambient room temperature (c. 22°C). Once a day, but sometimes at irregular times, each female was removed from its container and allowed to feed for several minutes (until it recoiled its tongue) at a cotton wad soaked in a sucrose solution. Its legs were then dipped in tap water to prevent the build-up of a brittle sugar coating. Finally, each butterfly was returned to its identified container.

A Theory on the Strategy of Hippolyta Silverspot Imagine Behavior

Based upon the data described above, the following theory is formulated. At the Rock Creek area, Speyeria zerene hippolyta apparently breeds exclusively on Viola adunca growing in the beachside meadows which are subject to rather strong northwest winds during much of the butterfly's flight period. There is no evidence to the contrary, although two other species of violets occur in the nearby forest.[1] During July and most of August, these winds severely limit imagine activity in the meadows; yet, that is where eclosion occurs.[2]

The males tend to eclose first, as is characteristic for Speyeria species in general. They apparently require a period of maturation, dependent upon successful nectaring and thermal exposure. Furthermore, if a male is to successfully reproduce, he must both survive long enough and maximize his chances of encountering receptive females.[3] The longer a male takes to come to mating readiness, the greater the chance that he will perish before reproducing; thus, the better the thermal conditions and nectar supply, the greater the selective advantage to the male.

Having reached sexual maturity, a male's chance of successful mating involves both a time and a space dimension. Thus the longer his time of activity each day, and the closer he is to the eclosing females when he is mate searching, the greater his chance of successful competition for the females.

If a male is to remain in the windy meadows upon eclosion, his maturation rate would be seriously impaired, both by thermal insufficiency and by unsuccessful nectaring.[4] Furthermore, it would be difficult to patrol for females in the face of the wind. Thus it is not surprising that the males retreat to sheltered areas where convective heat loss is minimized and nectaring flights are unimpaired.[5]

(Footnotes for this section are on p. 43 - 45.)

However, the freshly eclosed females must leave the meadows as well, for similar reasons: thermal requirements for rapid egg development and nectaring flight. Thus the mature males concentrate in a fringe around the meadow at areas where the females are likely to pause as they exit. These are mostly at the first locations providing sufficient protection for efficient nectaring flights. Here the patrolling males intercept the virgin females leaving the windy meadows.[6] Marking areas 1, 2, 3, 8, 8a, and 9 are examples of such rendezvous sites (see map, fig. 6, p. 29a).

It happens that males are also found inland from the meadow fringe. Some of these may be immature sexually, but how does one explain the presence of individuals, apparently mature, performing the typical mate-seeking flight at these inland sites (e.g. 4 and 5) while most of the virgin females must be at the meadow fringe? Perhaps their behavior is mal-adapted, and their genetic traits destined to be selected out of the gene pool. This seems unlikely. Perhaps instead, there is a male population density level above which an unestablished male has a greater probability of mating with some of the few females that may chance to pass through the meadow-fringe zone of male concentration unmated, than if he were to remain in the zone where competition is keen.[7] Another factor may be that high concentrations of butterflies may act to induce predation by birds and perhaps other animals.

Some males move from one fringe area to another. Some move from inland locations back out to the meadow fringe. Many of the males move into the salt-spray meadow proper upon cessation of the summer winds.

It is of note that the male population at area 2 - 3 dwindled rather than maintaining a constant level (see fig. 7, p. 30). If the male concentration efficiency threshold hypothesis is true, this might be explained by simply a decrease in a sufficient supply of males, even with recruitment from inland, less optimum, sites. Or perhaps the flow of fresh females from the salt-spray meadows decreases, thus lowering the male concentration efficiency threshold value. There would still be a selective advantage to oversupply males to seek out any area where the male population is in undersupply, that is, below the male concentration efficiency threshold value which is determined at any given time by the concentration of receptive females.

Again, if the efficiency threshold hypothesis is accurate, it would be interesting to learn the mechanism which determines which males are established at a site and which are the oversupply. They do not seem to defend territories in the usual sense. And yet some individuals stay at a site over comparatively long periods of time while others stay only briefly, then move on (see Tables 2a and 2b).

Eclosing females likewise require a good nectar source and sufficient thermal exposure to reach a gravid state. But during this period of maturation, there is no advantage for them to remain at the meadow fringe, assuming they have successfully mated. Thus they wander over the forest canopy and down into flowered clearings, perhaps following the stream courses inland. They apparently range more than a mile inland. It may be that this scattering helps minimize predation. But this inland flight can only provide adaptive advantage if the females can successfully relocate the breeding meadows when they are ready to oviposit. Do they follow the scent of violets on the wind? What then of the woodland violets? Do they simply fly west until they encounter the ocean and then randomly search for the violet meadows? It seems apparent that the possession of a homing instinct would be of high adaptive value. One thing is certain, their flight is not random. If it were, the density in the meadow should decrease with time. This does not happen late in the flight period when the winds have died. Rather, the butterflies concentrate in the seaside meadows.

Unfortunately, no females marked inland were recovered back at the breeding meadow. But then, few were captured inland due to their wide dispersal and lack of concentration. That they must, indeed, move back to the seaside meadow is evidenced by their appearance there in numbers, including worn individuals, upon cessation of the winds during late August and September.

Those females eclosing late enough to escape the incapacitating winds need not disperse inland. The nectar supply is apparently adequate in the meadows. At this time, it is apparently to a male's reproductive advantage to be back in the salt-spray meadow on the chance that he may encounter a lately eclosed female. Hence, the return of males from their inland wanderings (e.g. male Im 80-36 from area 4 to area 12). This would explain the lack of males in areas 2 - 3 and 9 on September 4.

The flight period of S. z. hippolyta at Rock Creek is remarkably long. The first male was taken in 1980 on July 5. On September 4, there were still a few fairly fresh males and some 54% of the females were fresh (see p. 33).[8] The 1980 season was characterized by nearly continual good weather during the flight period. These eclosed butterflies should have been in flight daily and thus subjected to the factors which cause wearing: sun-caused fading of their color, loss of scales and wing tears due to flight amongst the vegetation, etc. Recapture evidence suggests that an individual's fresh appearance is lost at least by the end of a week of daily flight.

Although the maturation rate of larvae and pupae must vary depending upon the thermal conditions in the individual's microlocation, there may be a genetic factor as well, so that some individuals delay beginning to feed as larvae in the early spring, take longer to mature, and/or extend the pupal phase. In any event, it seems probable that the emergence span and consequent extended flight period is an adaptation characteristic of this subspecies, ensuring that some individuals will be in breeding readiness whenever suitable weather occurs during the summer and early fall.

In addition to selection for basking efficiency during the period of meadow escape following eclosion discussed above, similar selection must occur among males as they patrol the semi-windy "leading edges" of the meadow-fringe shelter zone in their attempt to intercept females fresh from the seaward meadow. Later, as the winds die, this zone must expand toward or even relocate in the meadow. Those males with the most efficient basking characteristics would be able to operate longer and deeper into the wind zone, thus increasing their mating competition effectiveness. Similarly, females with the best basking efficiency could re-enter the violet-rich meadows sooner and be active longer whenever weather conditions permit. This advantage would be especially significant during years when meadow access time is restricted by extended stormy periods such as in 1978.

As has been discussed above, there is evidence that birds prey upon the adult hippolyta (see also fig. 1, Plate XI). Although no direct evidence is known at present, it seems likely that lizards and spiders may also prey upon them by day, and perhaps tree mice by night if they roost in the forest, or meadow mice and shrews if they roost in the meadow vegetation.[9]

Another obvious hazard to adults at the Rock Creek site is the traffic-crowded highway separating the salt-spray breeding meadow from the sheltered areas inland. There can be little doubt that road kills are a significant factor. Fortunately, the reproductive potential of the survivors has been such that the population has been maintained during the nearly fifty years of the road's presence.

The number of _hippolyta_ taken by butterfly collecting at Rock Creek has been minimal - some 25 specimens in nine years prior to this season.

Footnotes

1) Apparently, Speyeria hydaspe (Plate X, fig. 1) holds the ecological niche which is based upon these violets (Viola sempervirens and perhaps V. glabella). On August 12, 1975, S. hydaspe were common along the Fairview Mountain Road just north of Rock Creek. A few S. zerene hippolyta were seen at about the same distance inland as the Rock Creek campground (area 2, map, fig. 6), but were notably absent further inland, including a small clearing supporting a population of Viola adunca some 5.5 road miles inland. On August 2, 1980, a similar survey was made. No Speyeria of any species were seen. On August 21, 1980, the Big Creek road was surveyed for Speyeria for several miles inland (as far as the Big Creek campground). One female hippolyta was taken 1.2 road miles inland from U.S. Highway 101. Otherwise, no Speyeria were seen inland of the meadow at area 5 (see map, fig. 6). Here, three hippolyta males were marked and released on that date.

The reason for the recent decline of S. hydaspe populations in the northern Oregon Coast Range has not been investigated. Most likely it is temporary, due to recent weather patterns. In any event, hydaspe's habitat is intact over large areas. One would not expect hippolyta to invade hydaspe breeding areas to any extent during a short term absence of hydaspe. Character displacement between the species is probably too well established.

2) If the butterflies all waited to eclose until the winds die in late August and September, during some years reproduction would be even less efficient than during the earlier windy period, due to extended stormy weather (e.g. 1978).

3) His reproductive success would be greatest if these females were previously unmated, one spermatophore being adequate to fertilize all of a female's eggs.

4) Although at present the introduced false dandylion and the native yarrow bloom in the meadows during this windy period, the butterflies are not able to efficiently nectar at them due to the wind. Interestingly, Aster chilensis, a native species perhaps more adapted to the immediate coast than yarrow, doesn't begin blooming appreciably until mid-August, about the average time that the winds slow.

5) However, both the males and the females must be able to attain an adequate thoracic temperature for sufficient flight to escape the meadow. This may well be the first phase of selection for basking efficiency. Once airborne, largely passive movement would carry butterflies inland to the southwest.

6) To what extent mating may occur in sheltered depressions in the forest canopy is unknown. The butterflies definately spend some time in the forest canopy. Several were observed to fly up into the canopy when released after marking in areas 2, 3, and 4. Recapture data indicate that they must at least traverse the canopy between flowered forest clearings. Although no in copulo pairs were observed, records of male mate-search flight activity is evidence of the potential mating areas. This activity was extensive at nectaring sites and in the salt-spray meadow when the weather permitted.

7) There is no evidence in support of the hypothesis that these inland assemblages of hippolyta breed endemically. No Viola adunca were seen at either areas 4 or 5 (see map, fig. 6). Such other violets that occur in the nearby woods must normally be used by S. hydaspe - which

species is apparently better adapted to this habitat. Even one meadow about 5.5 miles inland on the Fairview Mountain Road which contains Viola adunca lacks hippolyta as discussed above. If hippolyta could use the woodland violet habitat, it should not be limited to the vicinities of seaside meadows as apparently is the case.

8) Dr. Paul Hammond reports a few S. z. hippolyta still in flight as late as October 3 (1980) at the Mt. Hebo site. Unfortunately, time has not permitted late season checks at the Rock Creek site this year.

9) Unfortunately, little is known of this butterflies' roosting ecology. One observation made at Boiler Bay several years ago suggests that they may use salal brush in or near the salt-spray meadow, but this may be incidental rather than obligatory.

The Hippolyta Silverspot's Life History and Its Larval Ecology at the Rock Creek Site

George A. Hardy has published descriptions of the life history of *Speyeria zerene bremnerii*, a subspecies closely related to *S. z. hippolyta* (Hardy, 1958). He confined a female *bremnerii*, taken at Saanich on Vancouver Island, over a potted growing violet plant. She oviposited on the stems and leaves and in the surrounding moss. Upon hatching, the first instar larvae became dormant. Although they would bask in the sunshine on warm days, they did not feed. They were kept outdoors during the winter. By March 29, 1957, they had broken diapause and begun to feed. Hardy describes *bremnerii* as having five instars. This number is characteristic of many Nymphalid butterflies, but is in error for the *Speyeria*, in which genus the typical number of instars is six. If one calculates the per cent growth in length per instar that Hardy gives, it is evident that he missed either the 4th or the true 5th. His per cent growth increments are as follows: 1st instar 8%, 2nd instar 8%, 3rd instar 11%, his 4th instar 47%, and his 5th instar (actually the 6th) 26%. It is well established that the greatest growth occurs in the last instar in Lepidoptera. Further complicating the situation, Hardy apparently did not make his measurements coincident with the actual molts; thus, more growth may be attributed to the last instar than his measurement indicates.

As can be seen from a comparison of Hardy's description of the last instar of *bremnerii* with the last instar of *hippolyta* shown in fig. 1 of Plate VI, the larvae are very similar. The Hippolyta Silverspot larva is smaller at maturity, however, and perhaps somewhat darker in the black areas.

(Footnotes for this section are on p. 55.)

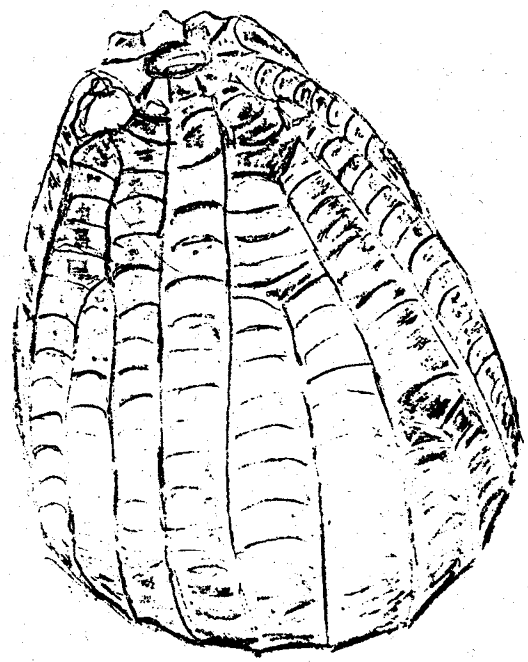


Figure 7a. Speyeria zerene hippolyta ovum. Actual size: .65 mm. X .8 mm.

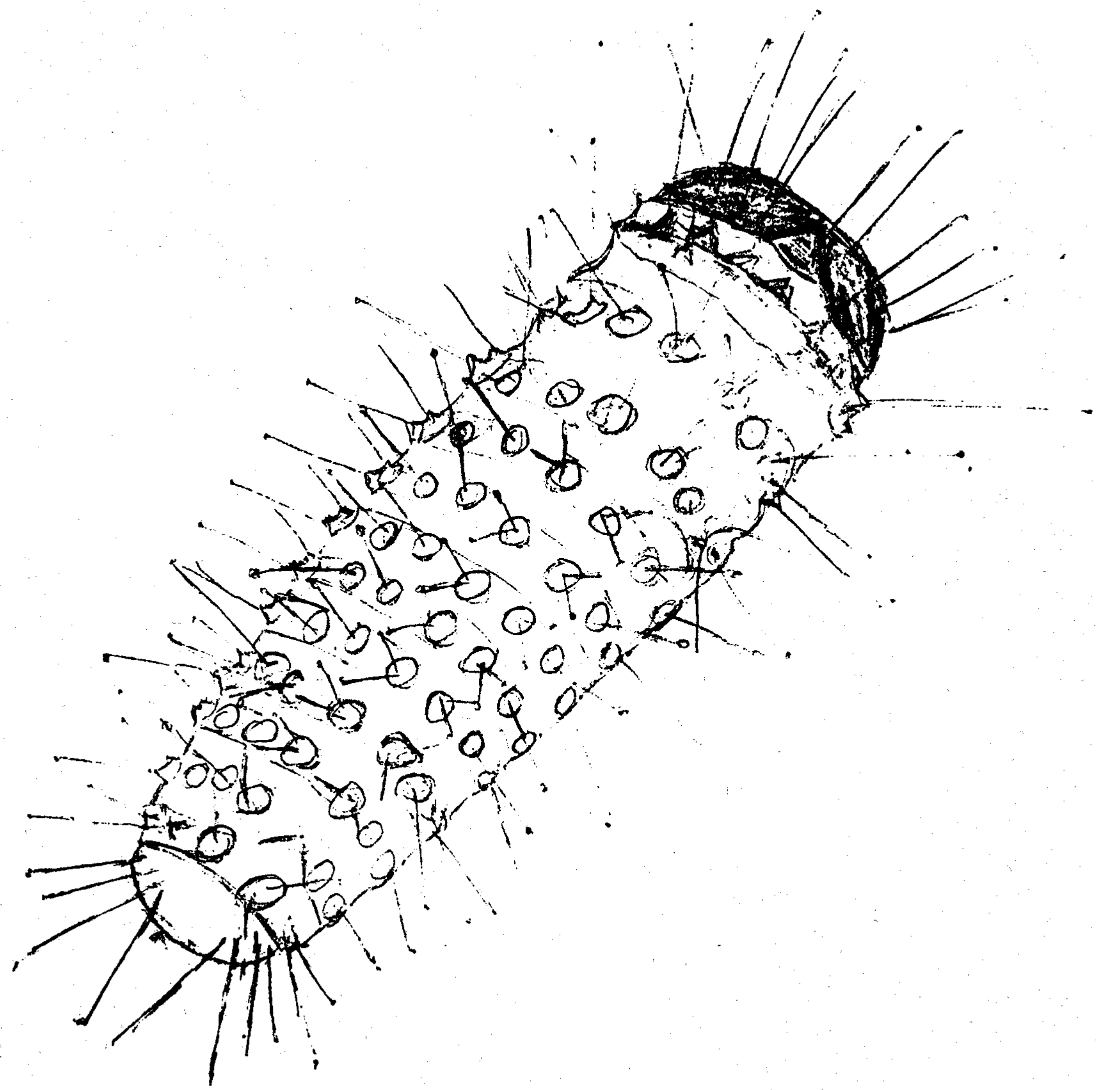


Figure 7b. Speyeria zerene hippolyta newly hatched larva. Actual length: 1.3 mm. This is the overwintering stage.

As Hardy states, the first instar larva possesses unbranched spines or hairs. Therafter, the larvae in the remaining instars bear branched spines. It is interesting to note that these spine branches are hinged so that they can fold up against the shaft when the larva withdraws from an entanglement; otherwise, the spine-branches lock into the outstretched position. At least in the larger larvae, these sharp spines provide a degree of protection from predators such as mice and perhaps shrews.

The following account of the Hippolyta Silverspot's life history and larval ecology is based upon observations made in the field, primarily during the 1980 season, and upon laboratory rearings done by the author in previous years.

The gravid females oviposit singly amongst the vegetation near the violet host plants. Even dried violet leaves provide sufficient stimulus to induce oviposition. Usually the females flutter low amongst the vegetation, working their way upwind. When violets are near, they pause to climb around in the meadow vegetation, probing with curved abdomen until a suitable oviposition site is contacted and an egg deposited. They are apparently sufficiently stimulated to oviposit by some "volatile" compound eminating from the violets, even at a distance of several inches. They seem to favor sites that have good sun exposure, usually avoiding north slopes of the steeper meadow rises.

The eggs are cream-colored when first laid, but, if fertile, darken to pinkish-tan by the second day under laboratory conditions. Likewise,under laboratory conditions with ambient room temperature varying from 22 to 25°C, the eggs of one female (80-1) required 16 days to hatch. (Hardy's <u>bremnerii</u> took 12 days under unstated conditions.)

The newly hatched larvae may wander short distances. Upon selecting a suitable site, they spin a thin silk mat upon which they normally will rest until the following spring. Considering the volume to surface ratio of these small larvae, their resistance to dessication is truly amazing. Under laboratory conditions, they are able to survive for a month or more without moisture, but of course this amount of stress may weaken them so that their survival rate by spring may be diminished. Thus, in years with delayed fall rains, the earliest hatched larvae may be at a disadvantage. When moisture is available, laboratory larvae can be seen to touch their mouths to the wet surface and imbibe. They apparently continue to drink water as needed during the rest of their diapause period.

The diapausing larvae can survive the rain-drenching of winter storms and the sub-freezing temperatures of clear winter nights. In the laboratory, the diapausing larvae are best kept at near-freezing, but can revive even after being embedded in ice.

At the Rock Creek meadow there were distinct feeding signs on some violets by April 15, 1980. Most likely the larvae begin to feed by late March in most years. Temperature in the microhabitat is most likely an important factor in ending diapause. The role of photoperiod, if any, has not been demonstrated. Laboratory-kept larvae usually commence feeding within a few hours of removal from a refrigerator in which they have been kept cold and in nearly continual darkness for up to a year.

Typically, these newly-warmed larvae crawl around the container to which they have been transferred before settling in a resting place. From this location, at intervals they subsequently visit nearby violet leaves to feed.

Larva #	1980 date	Time	Instar	Location found	Sky condition	Air temp.*	Resting site temp.
♀ L80-1	Jun 14	1:30 PM	early 6th	--- **	overcast	16.0°C	19.0°C
Nearby test sites lacking larva for comparison	Jun 14	1:40 PM	---	In ditch-poor sun exposure	overcast	16.0°C	16.0°C
	Jun 14	1:40	---	Grass cover appears similar to L80-1 site	overcast	16.0°C	17.0°C
♂ L80-2	Jun 14	3:15 PM	5th	.8 cm from nearest violet **	thinly overcast	20.0°C	23.0°C
♂ L80-3	Jun 14	---	6th	<1 cm from violet (but by fecal pile) **	---	---	---
♀ L80-4	Jun 14	5:45 PM	4th	12 cm from violet under 10 cm of grass cover ***	overcast	16.2°C	19.0°C
♀ L80-5	Jul 5	---	mid-6th	--- ** ?	---	---	---

* Thermometer bulb dry and protected from breeze.
** Shelter site under red fescue mat or clump.
*** Grass species unknown, but not red fescue.

Table 3. Conditions of the larval microhabitat of S. z. hippolyta.

Nothing is known of the parasites and predators that may attack these small larvae in nature. Very likely, predaceous ground beetles (Carabidae) and small spiders are included among their enemies. In any event, it seems likely that a large share of the normal environmental resistance is realized during this period. Food supply does not appear to be the normal population limiting factor.

Surviving larvae pass through five molts as they grow to maturity. As they increase their size, they may become suitable as prey or hosts to new predators and parasites. These may include shrews, birds, and perhaps mice among the former and perhaps some species of Tachinid fly similar to the one which parasitizes the nettle-feeding larvae of the red admiral butterfly in nearby wet forest clearings (see fig. 2, Plate XV). However, of the six or more half-grown to nearly mature larvae of hippolyta so far field collected, none have been parasitized.[1]

As is characteristic of most Speyeria, the older larvae of hippolyta retreat to shelter sites sometimes several centimeters from the violets upon which they feed (see Table 3). The shelter sites in which hippolyta larvae survive apparently provide thermal advantage as well as cover from predators (see Plate V and note the temperature discrepancies between the air at the vegetation layer surface and the larval shelter sites given in Table 3). Violets in areas with scant graas cover tend to be very small (see p. 15 and fig. 8, p. 53) and characteristically lack larval feeding signs. Medium grass cover such as is provided by the native grass, red fescue, apparently provides the optimum shelter-cover for the larvae (see figs. 8 and 9).

However, they also utilize areas with somewhat heavier grass cover, such as provided by bent grass (see Appendix II B, and the larval habitat map which is under separate cover). The reason that hippolyta larvae do not occur on violets in the woods may well relate to the need for sun exposure of the larval shelter sites. The larvae will feed on these violets in the heated laboratory. They especially do well on Viola glabella.[2]

There is some debate as to the timing of larval feeding among the Speyeria. Some species may be mainly nocturnal (Dornfeld, 1980, p. 75).[3] Although none of the hippolyta larvae found during daytime in the present study were feeding, laboratory reared hippolyta and other Speyeria feed both night and day. Their feeding is typically very rapid so that they are exposed from cover only briefly.

In the constantly heated laboratory, hippolyta larvae must grow considerably more rapidly than in nature. Their growth rate must be especially delayed by the cooler spring weather. In the laboratory, they require about one month to mature and pupate and spend about two weeks in the pupal stage.

Because this study was begun in June, by which time the larvae had long been active in nature, it has not been possible to accurately determine the individual larval time span. As noted above, larval feeding signs were evident on violets observed on a brief visit to the Rock Creek meadow on April 15, 1980, indicating that at least some were well into their feeding activity. On July 5, 1980, one mid-6th instar larva was found and several violets had fresh feeding signs, indicating that at least some larvae were still active. However, on the same date the first adult male was taken. Thus, the minimum natural larval feeding span would last from mid-April to mid-June - some two months. It may be that a few larvae continue feeding well into August, producing the fresh adults present in early September.

The length of the pupal stage in nature likewise has not been determined; indeed, no wild *hippolyta* pupae have yet been located. The larvae apparently disperse widely from their feeding sites before pupating and select well-hidden shelter sites in which to construct their pupal chamber (see Plate VII). Undoubtedly the duration of the pupal stage is influenced by temperature and its control may vary genetically. In the laboratory, *hippolyta* spends about two weeks in the pupal stage.

The newly eclosed adult quickly crawls from the pupal chamber and ascends some support at least high enough to provide space for its limp, expanding wings. After the wings and other body parts have hardened (a chemical process, not merely drying), the butterfly apparently basks long enough to elevate its body temperature sufficient for the flight that will enable it to escape the meadow.

The ecology of the adult stage is treated in the previous section.

Figure 8

Xerographs of _Viola adunca_ from the Rock Creek meadow.

Subfigure 1. Violets from an area lacking grass cover (Class 3a).*

Subfigure 2. Violet plant found growing in an area with relatively tall grass cover (Class 2b).* Note larval feeding signs.

Subfigure 3. Violet found in medium grass cover (Class 1a).* Note larval feeding signs.

* See Appendix II B and habitat map (under separate cover).

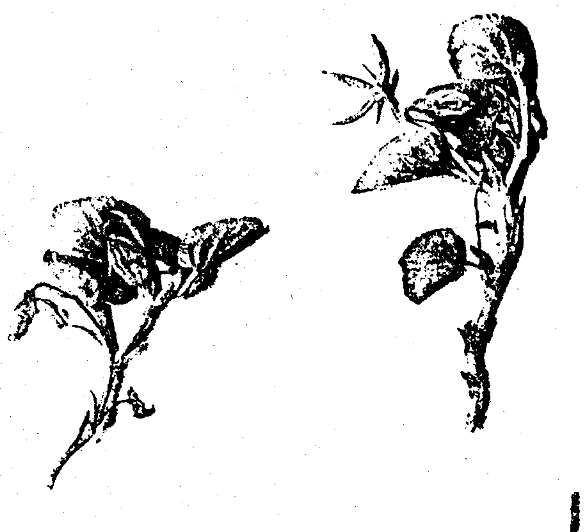


Fig. 1

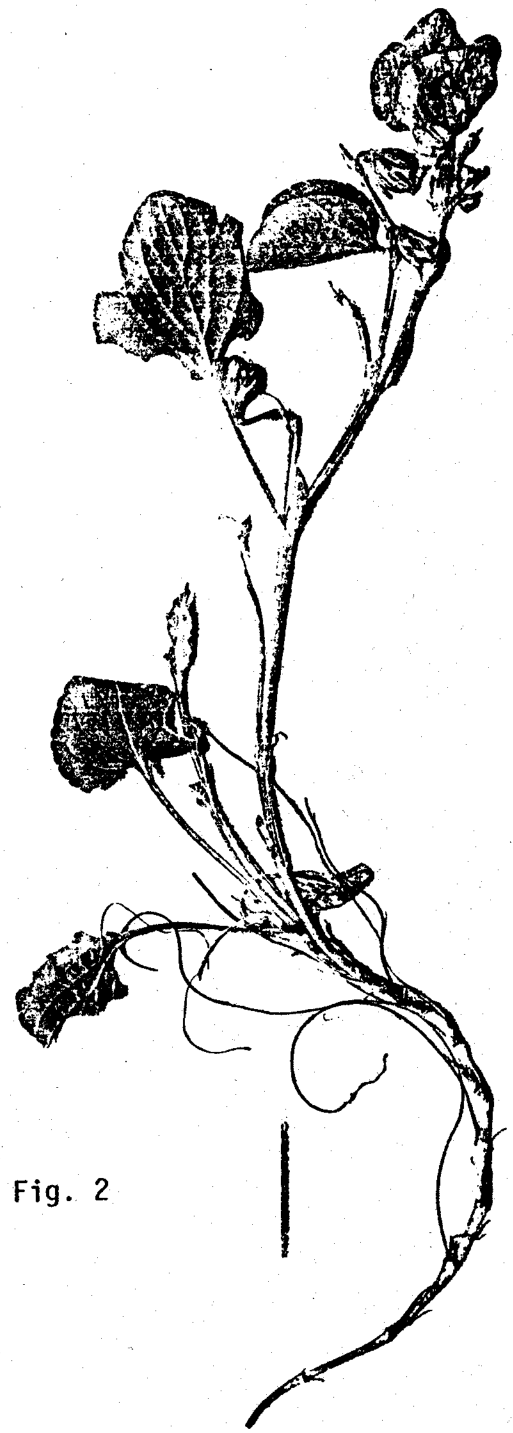
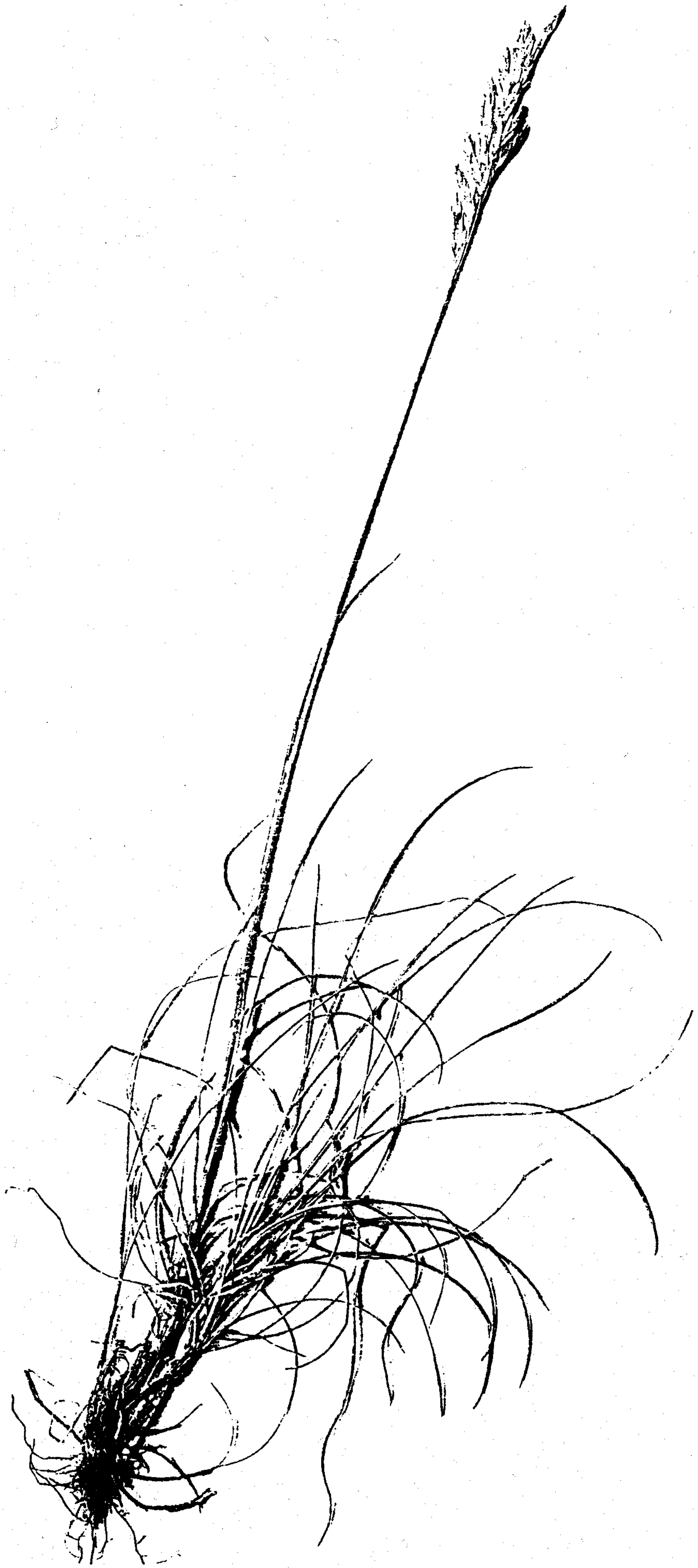


Fig. 2

Fig. 3

Figure 9

Xerograph of red fescue, Festuca rubra, from the Rock Creek meadow. The wiry leaf-blades of this native grass form an ideal shelter layer for the larvae of the Hippolyta Silverspot.



Reasons for the Decline of Speyeria zerene hippolyta

At the turn of the century, the Hippolyta Silverspot apparently occupied a range beginning at least as far north as the old sand dunes near Westport, Washington, and extending south to the vicinity of Big Creek in Lane County, Oregon.[1] Its greatest numbers were apparently in the old Clatsop dunes between the present towns of Warrenton and Seaside in Clatsop County, Oregon. According to Mr. Stanley Jewett, Sr., at one time they apparently ranged inland here at least as far as Astoria. These may have been wanderers coming from the violet beds nearer the coast or perhaps they represented population clines grading into the inland subspecies, S. z. bremnerii. This may still occur in southwestern Washington between the vicinity of the coast and the rocky prairies near Tenino below the southern end of Puget Sound. Further south along the Oregon coast they established inland on at least two Coast Range mountains: Saddle Mountain in Clatsop County and Mt. Hebo in Tillamook County.

Today the only known strongholds this butterfly has are at the Rock Creek - Big Creek meadows in Lane County, Oregon, and on Mt. Hebo. What is the cause of this decline?

It is rather clear that the basic reason is the interference of modern man. Seaside meadows make ideal building sites for summer homes and tourist-catering businesses.[2] The use of public parkland for access to the scenic beaches has too often disregarded the values of the natural coastal biotic communities. Seaside meadow was converted into manicured lawns and asphalt parking lots[3] and in some areas the natural vegetation was damaged by excessive use of off-road vehicles or overgrazing.[4] And

if man didn't destroy the *hippolyta* habitat, he introduced exotic grasses which crowded out the natural meadow vegetation[5] or prevented fires which allowed wind-swept meadow habitat to progress in succession to brushfield and stunted woodland.[6]

That the primary butterfly population loss has not been due simply to killing of the adults is amply illustrated at the Rock Creek meadow. Here, in spite of U.S. Highway 101 bisecting the habitat and undoubtedly accounting for many *hippolyta* roadkills each season, the population remains strong where the habitat is intact and extensive.[7] Fortunately, the Hippolyta Silverspot has a high reproductive potential, but it must have suitable habitat in which to realize this potential.

Although habitat reduction is certainly the primary cause of the Hippolyta Silverspot's demise, the death knell to colonies of reduced size and restricted genetic variability may have come in recent years by weather stress (e.g. the 1978 summer rainstorms) and could conceivably occur through overcollecting or by road kills.

Considering the magnitude of adversity, classification of the Hippolyta Silverspot as a threatened species comes at a most appropriate time.

Footnotes

1) Five larvae were found in 1980, the rest in 1977.

2) As pointed out earlier, woodland violets sun-exposed in forest clearings in the Oregon Coast Range are apparently dominated by _Speyeria hydaspe_.

3) Warmer daytime temperatures should produce a higher body temperature and thus allow more efficient feeding activity. However, larvae would likely be more subject to avian predators.

Footnotes

1) But see also p. 4.

2) Long Beach Peninsula, Washington; Clatsop old sand dune and deflation plain area in part; Seaside, Boiler Bay vicinity, Newport, Yachats, and Tenmile Creek, Oregon.

3) Boiler Bay State Park, and Cape Meares lighthouse, Oregon.

4) The Westport, Washington old sand dune population may have been lost due to vehicle and pedestrian impact. (This area needs more field investigation, however.) The Clatsop plain area in part.

5) Orchard grass at Tenmile Creek.

6) Ponsler State Park area south of Big Creek, Oregon is a good example. To a lesser degree, this has happened at the Boiler Bay site and is presently occurring in parts of the Rock Creek meadow itself. The Squaw Creek hippolyta record (see p. 7) may have been a stray from the nearby Tenmile Creek or Rock Creek colonies, or this area too may have succeeded from meadows. Erosion by the sea is another natural loss of habitat, e.g. Cape Meares and Rock Creek meadow.

7) Increased traffic on this highway could, however, be a problem in the future.

Further Research Needs

Although the present study has clarified many facets of the biology of *Speyeria zerene hippolyta* and this butterfly's threatened status, there remain many aspects yet uninvestigated.

More information is needed on the ecology of the immature stages, especially the instars present during the period from early spring to mid-June. What predators and parasites, if any, constitute a significant component of the environmental resistance to *hippolyta* during this period? Will this explain why the *hippolyta* larvae usually don't exterminate their own host plant through overpopulation? If not, then what is the population limiting factor?

An autecological study of *Viola adunca* would be quite significant. What role do the mound ants, or others, play in its seed distribution? If they are important, what is their autecology? What is the distance to which individual seeds can spread under natural conditions? What is their longevity? What conditions are optimal for germination and seedling survival? How does *V. adunca* respond to fire or other brush control techniques? To what extent do introduced weeds, such as false dandylion, crowd out the violets? What determines the density of violet stands? Under what conditions might *hippolyta* larvae over-impact their violet host? Which grass species, besides red fescue, are most compatible with the violets? What is the competitive relationship between native grasses such as red fescue and introduced grasses here in the salt-spray meadow?

Any management scheme should ultimately utilize natural phenomena in enhancing and maintaining *hippolyta* habitat. In the long run, it must be less expensive, and most likely more successful.

A clarification of the impact of the traffic on U.S. Highway 101 upon the adult population of the Hippolyta Silverspot would be of interest. Is the impact sufficiently significant biologically to warrant a reduced speed limit in the meadow area?

A study on hippolyta's nectaring ecology would be of significance. What are the comparative nutritional values of the flowers presently utilized? To what degree do the introduced tansy ragwort and false dandylion compete (for the butterfly pollinators) with native flower species such as *Aster chilensis*? What other pollinators compete with hippolyta for the nectar supply? To what degree has the introduction of tansy ragwort enhanced the nectar supply to hippolyta adults? Should it be exterminated? If not artificially restrained, will tansy ragwort eventually dominate the salt-spray meadow to the exclusion of important meadow species? Or will natural phenomena such as the action of the salt-spray winds and of the Indian thistle stem borer[1] keep it sufficiently in check? What is the relationship of disturbances in the meadow such as by elk, and perhaps even brush-burning, to the spread of tansy ragwort? Has the introduction of tansy ragwort and other weed species significantly altered the potential ecological succession in these meadows so that fire will no longer serve its old role of native meadow restoration?

What is the roosting ecology of hippolyta adults when in the forest and when in the salt-spray meadow? Are certain forest trees best suited for protection during summer rain storms? What role does salal and other meadow vegetation play as an adult roosting shelter in the meadows? What intensity of night lighting constitutes a hazard to butterflies disturbed from their roosting on warm nights?

Additional data on the ecologies of the late instar larvae, the pupae, and the imagoes or adults would, of course, be useful in the further refining of theory developed in the present study.

Innumerable research opportunities are open on the Rock Creek meadow's ecology and the biology of its many components. The limited range of the *hippolyta* colony at Rock Creek make it ideally suited to research on general aspects of *Speyeria* biology. For instance, although much work has been done on directional flight and homing instinct in bees, little is known of this phenomenon in butterflies. The present study suggests that the Hippolyta Silverspot has this ability.

Lastly, there is a need to further explore certain stretches of coastline and perhaps inland grass balds, especially in Washington, for *hippolyta* populations yet unknown. Unfortunately, the probability of finding any is low (see p. 56).

It can be expected that a new layer of research opportunities will be revealed as progress is made on those suggested above. Nature is seldom simple when all things are considered. Unfortunately, to destroy its product is much easier than to construct it.

Footnotes

1) The author first discovered this apparently native lepidopteron attacking both the native Indian thistle, *Cirsium edule*, and the recently introduced tansy ragwort at Cascade Head in about 1973. Its activity was called to the attention of individuals in the tansy ragwort control program. In the 1980 study, its presence was confirmed at the Rock Creek meadow.

Some Management and Habitat Enhancement Suggestions

Because of the complexities of the ecology of the habitat used by the Hippolyta Silverspot in its several stages, it seems necessary to begin management on an experimental basis. Small plot burns and/or other removal might be tried in brushfields near established salt-spray meadow sites. Natural succession could be monitored in some; in others, manipulated plantings of species of known importance to <u>hippolyta</u> could be made and the subsequent utilization by <u>hippolyta</u> monitored. The sites chosen for these experiments should encompass a range of sun and wind exposures and soil moisture levels and types. However, they could emphasize locations having potential conditions similar to those suggested to be optimal in the present study.

In areas where the type of grass cover is unsuitable for good <u>Viola adunca</u> growth and consequent <u>hippolyta</u> usage (class 3b areas - see Appendix II B), different types of disturbances such as vegetation cutting (or elk grazing intensification) and earth mounding could be tried (at first on a limited basis) as possible habitat enhancement procedures. This could be done at the Rock Creek site, especially in 3b areas inland from the highway (see habitat map under separate cover). It might also be done in the grassy basin between Rocky Knoll and the Fairview Mountain Road intersection. A successful expansion of the Rock Creek colony here might offset eventual loss of habitat on private land near Big Creek.

It is evident that the success of all of these management measures is tentative. Thus, it seems wise that all natural components of the meadow ecosystem at Rock Creek be retained - at least to a degree that will ensure

(Footnotes for this section are on p. 71.)

their perpetuation. In any event, *hippolyta*'s dependence upon some factors may not yet be recognized. Nothing is to say that the Hippolyta Silverspot is the only native species of organism biologically important at Rock Creek!

Some types of activity would likely have a negative impact potential on important meadow community species, and thus should be avoided. Obviously indiscriminate herbiciding of the salt-spray meadows should be prevented. That is not to suggest that controlled, spot spraying of limited brush stands would be unacceptable as a management tool - assuming that short-lived herbicides are used and no toxic by-products accumulate in the meadow ecosystem. One notes that the salt-spray acts as a natural herbicide on exposed new growth.

Fortunately, mosquitoes seem to be no problem at the Rock Creek campground. In any event, insecticides should never be used in the meadows and should not be used in brushy or forested areas within the declared critical habitat zone during the flight period of the adults: July to mid-October.

No fixed lighting of excessive magnitude should be used in the vicinity of the roosting butterflies until it is determined if such lighting constitutes a hazard. Experimental lighting would be an exception, of course. The meadow area may be particularly sensitive to excessive lighting such as street lights along U.S. Highway 101. Such lighting may cause photoperiod disturbances to important meadow plants and perhaps to the diapausing or active *hippolyta* larvae in addition to the possible hazard to adults disturbed from their roosting.

No non-native plants whose impact is untested should be introduced within the critical habitat zone. The introduction of orchard grass, *Dactylis glomerata*, should specifically be prevented.

Excessive foot traffic in the meadow undoubtedly has a negative impact as evidenced by the worn footpaths and other class 4d and 4dr areas at the north end of the Rock Creek meadow (see habitat map under separate cover). It would be unfortunate to have to close the meadows to pedestrian access. Perhaps passage to the beach could be directed so that its impact would be minimized. This could be accomplished in part by proper location of parking and highway pull-off areas. None should be developed along the stretch of highway passing through the meadow proper. Such parking would be hazardous and would encourage unnecessary pedestrian traffic in the meadows.

Consideration should be given to the feasibility of closing the present highway pull-offs near Transect #1 (see habitat map under separate cover). Observations made during the field work this season indicate rather heavy usage of these two pull-offs. Most of those observed appeared to be primarily interested in beach access or viewing. Beach access could better be done from the Rock Creek campground road where pull-offs might be developed. A much safer and less disruptive beach viewing opportunity is already provided at Ocean Beach park near the Fairview Mountain Road intersection.

Off-road vehicles should not be permitted in the Rock Creek meadow. The present barricades have been reasonably successful in preventing their access which had been a serious problem at the north end of the meadow. One vehicle did get in the meadow in area 6 (see p. 29a) during the 1980 season; tracks were left in the meadow.

Camping in the meadow proper should be discouraged, if not prohibited. Area 6 had apparently been used by some unauthorized campers for years, according to one passer-by interviewed. Since the barricading of the meadow access points here, most of this traffic seems to have relocated on private property just south of Big Creek. Some bikers and hikers still use the Rock Creek meadow at various points. This camping activity becomes a problem as its concentration and frequency increases, especially if fire rings are used. On each visit during the 1980 field work, the author removed unused firewood, seating logs, and fire ring rocks that had appeared in the meadow since his previous visit. This camping activity occurs primarily in area 6, near the highway pull-offs and where bank-cuts allow beach access. Perhaps if these bank-cuts were shored up and filled with soil, and the pull-offs blocked off, it would not be necessary to post the area. Such site identification may have a negative effect.

Conceivably the Rock Creek meadow may eventually serve as a repository for native coastal meadow plants and perhaps animals as their last stands disappear elsewhere! In most cases, their introduction may be quite compatible with the hippolyta habitat.[1] Some, such as crowberry (Empetrum nigrum), may be of questionable compatibility. This species forms dense, brushy mats in some areas such as near Port Orford. Counsel on the usefulness for native plant enrichment at the Rock Creek site should be invited of qualified botanists before such actions are undertaken.

Meadow alterations should avoid diminishing its ecological diversity.

Disruption to the habitat of the glossy blue butterfly, Plebejus saepiolus, should be minimized (see Plate X, fig. 2).

Construction of fences or any other obstacles to the action of the salt-spray winds could be expected to encourage the growth of brush and trees at the expense of the meadow habitat, and therefore should be minimized.

What is the point at which the Hippolyta Silverspot can be considered safe and therefore be removed from the threatened species list? It may be as difficult to set such a level as it is to predict the magnitude of future negative disturbances upon the _hippolyta_ populations. However, certain goals seem evident.

First, as has been discussed above, the strength and permanence of the Rock Creek meadow populations should be insured. This should likewise be done for the Mt. Hebo population.

Secondly, as suggested on p. 61, exploration for yet undiscovered colonies should be continued. In the past, this has been accomplished through the cooperation of non-commercial butterfly collectors. Foremost of the incentives for their activities for the most part has been the scientific contribution such specimen accumulation provides. Indeed, an awareness of the Hippolyta Silverspot's threatened status, as well as significant portions of the present study, would not have been possible without the fruits of their efforts. And yet the total number of specimens of this butterfly that they have removed from nature during the 100 years it has been known is probably less than 200 (see fig. 1, p. 30) - well below the reproductive potential of a single female (see p. 33).

The cooperation of non-commercial collectors is still needed, both to continue the exploration for new _hippolyta_ colonies and to monitor the yearly condition of known ones. Therefore, it is strongly recommended that requests for non-commercial collecting permits from qualified lepidopterists be honored with the understanding that restraints on numbers taken will be self-imposed during years of low population or where the colonies are critically small. Coordination of their effort could be achieved by the issue of regional permits. Compilation of data from their annual reports could well serve as a basis for monitoring the condition of _hippolyta_ throughout its range and thus help in determining the point at which its threatened status has ended.

A third goal in a rehabilitation program would be to re-introduce hippolyta into areas of re-established habitat. Due to the limits in application of the threatened species law, this would most easily be done on federal lands. Cooperation by state agencies would make state lands available. Private lands could be used if they were dedicated to such a purpose or to the extent that developers would utilize hippolyta habitat components in landscaping open areas.

Because of the complexities of re-constituting balanced ecosystems once they have been destroyed, priority in selection of re-introduction sites should be given to those sites with habitat remnants which could serve as nuclei for expansion in the rehabilitation process. Sites with at least some habitat components, such as the presence of Viola adunca, would constitute a second priority.

Unfortunately, except for the National Forest land just north of Rock Creek discussed above as a potential site for habitat expansion, there is nowhere within the Hippolyta Silverspot's geographic range in Oregon additional federal beachside land with hippolyta habitat remnants. However, two low priority sites are possibilities for habitat establishment. One is the grassland on the bluff north of Hart Cove on Cascade Head and the other is the sand dune area near Sand Lake in Tillamook County.

The former lacks any Viola adunca at present, but does have good nectar sources and forest-fringe cover for the adults. Access to this area is by trail only.

The Sand Lake area would probably require a massive application of topsoil to stabilize the sand sufficiently to allow establishment of Viola adunca and other hippolyta habitat plants. The rehabilitated area would likely require protection from the invasion of any remaining sand dunes and from unrestricted public access. All in all, such actions would seem impractical.

It may not be possible to increase the Hippolyta Silverspot's numbers sufficiently to warrant removal from the threatened list without either the cooperation of state land managing agencies and private land owners or the acquisition of additional land by federal agencies. With the cooperation of the State of Oregon, the small amount of habitat remaining on state land at Tenmile Creek might be improved sufficiently to preserve the remnants of this hippolyta colony. Unfortunately, the construction of buildings on private land to the north not only acts to destroy the habitat on the building sites (see Plate XII, fig. 2), but also may serve as a windbreak to much of the state property, thus changing its nature as a salt-spray meadow.

The following are additional actions upon state lands that could be expected to increase the hippolyta population in strength.

The Ponsler State Park brushfields could be burned off, re-establishing meadow as it occurred early in the century.

The lawn at Boiler Bay State Park could be cultivated and returned to salt-spray meadow habitat.[2] State park land east of the highway at this site could be protected from overgrazing by horses.

If some of the brush were removed and part of the lawn area restored to native meadow at Cape Meares, perhaps a small colony of hippolyta could be re-established here.

Grassland within the state park at Neahkahnie Mountain in Tillamook County already harbors Viola adunca. Only Speyeria hydaspe has been seen here to date, but perhaps habitat adjustments could be made which would favor the establishment of the Hippolyta Silverspot.

Hippolyta habitat could be established on other parklands, county and perhaps city, as well as highway right-of-way lands if traffic is not a hazard to the adults. The public's sympathy would need to be gained to achieve such a goal. This would require preparation and distribution of educational materials.

In my judgment, the following private lands have potential for support of *hippolyta* populations. The grassland near Pray Point, just north of Tenmile Creek, is now without violets, but perhaps with their establishment, could be managed to support *hippolyta*.

Nature Conservancy land on Cascade Head and grassland on the headland south of the mouth of the Salmon River already support populations of *Viola adunca*. To date, only *Speyeria hydaspe* has been seen here, but perhaps, with habitat modification, *hippolyta* would establish.

The Clatsop plains area should be carefully explored for breeding habitat. If any high quality areas remain, perhaps land could be acquired[3] and the habitat area expanded sufficiently to support a re-established or, hopefully, remnant population. A similar action is recommended for the Long Beach Peninsula in Washington. Here the established habitat is essentially all presently under private ownership. If some of this land cannot be acquired, a last resort effort would be to enhance the small area of habitat at the public ocean beach access near Cullaby Lake and to attempt to artificially establish *hippolyta* habitat in Leadbetter Point State Park. At present, this area contains sand dunes of insufficient age to support the violet's meadow successional stage. Perhaps with the addition of topsoil, or in some other way, violet meadow could be constructed. Whatever is done here should be done quickly or the remaining *hippolyta* gene pool will be lost.

State parks and other public lands further north in Washington should also be investigated for their potential as sites for hippolyta establishment.

The above suggested sites are all ones subjected to the environmental conditions to which the Hippolyta Silverspot is adapted. Establishment at inland sites might serve to temporarily save certain gene pool remnants, but in the long run would likely result in the loss of hippolyta by re-adaptation to the different conditions - probably producing a form similar to bremnerii.

Establishing laboratory cultures of hippolyta could also serve only a temporary function. It is very difficult to maintain genetic diversity within the usual limits of laboratory culturing. Because the butterfly's parasites are not yet discovered, it is not known if they could also be cultured for eventual introduction to new areas along with the butterfly host. Indeed, it is not known if they are necessary at all as a population control factor in nature.

One recognizes two routes to the removal of Speyeria zerene hippolyta from the threatened species list. One is its rehabilitation, the other - its extinction. One may be difficult to achieve, the other requires no effort in the modern momentum of nature exploitation. Perhaps we could afford to lose another butterfly, but where, then will the line be drawn? How ironical, if some day our own species were threatened due to our unwillingness to revere the natural system that has given us existence.

Footnotes

1) E.g. staff gentian, Gentiana sceptrum, has not been recorded here but is in the Boiler Bay meadow and was at Tenmile Creek. It probably could do well in some of the wet areas (class 4a) at the Rock Creek meadow if transplanted.

2) The design and management of Cape Blanco State Park by the Oregon State Park and Recreation Division illustrates that the maintenance of natural habitat can be compatible with public use. Here Speyeria zerene behrensii (Plate XI, fig. 1) breeds in patches of native meadow left between the campsite driveways. The wild flowers are beautiful in season, and lawn mowing and watering is unnecessary.

3) The Nature Conservancy has expressed an interest in cooperating in the perpetuating of the Hippolyta Silverspot.

PLATES

Plate II

Ventral surface of a hind wing of the Hippolyta Silverspot showing the spots, bright silver in life, from which the butterfly takes its name. As in all lepidoptera, the wing pattern is produced by the aggregate effect of millions of separate colored scales, each produced by a single cell as the wing developes during the pupal stage.

Plate III

Oblique aerial view of the Rock Creek meadow, *Speyeria zerene hippolyta* critical habitat. (After Forest Service photo L30159 5-60 taken July 14, 1973.)

Plate IV

Figure 1

Salt-spray wind-pruned vegetation on hill inland from Rocky Knoll. Looking southwest. Speyeria zerene hippolyta breeds on violets amongst the grass shown in upper right-hand area. Taken August 3, 1980.

Figure 2

View of S. z. hippolyta habitat near west end of Transect #1 (see Appendix IIA) taken on June 14, 1980. Larva L80-2 (a male) was taken in its fifth instar (of six) near the base of the stake on this date. The dominant grass here is the native red fescue (Festuca rubra). Flowers include Indian thistle (Circium edule), seaside daisy (Erigeron glaucus), and the introduced false dandylion (Hypochaeris radicata).

The area near the stake is classed as habitat type la to 2a, the salal stand near the fence as 4b. (See Appendix IIB). Figure 1 Plate XV is a view of the exposed soil profile below the loose terminal fence post. In 1971, this fence post was erect and still encased in soil at its base.

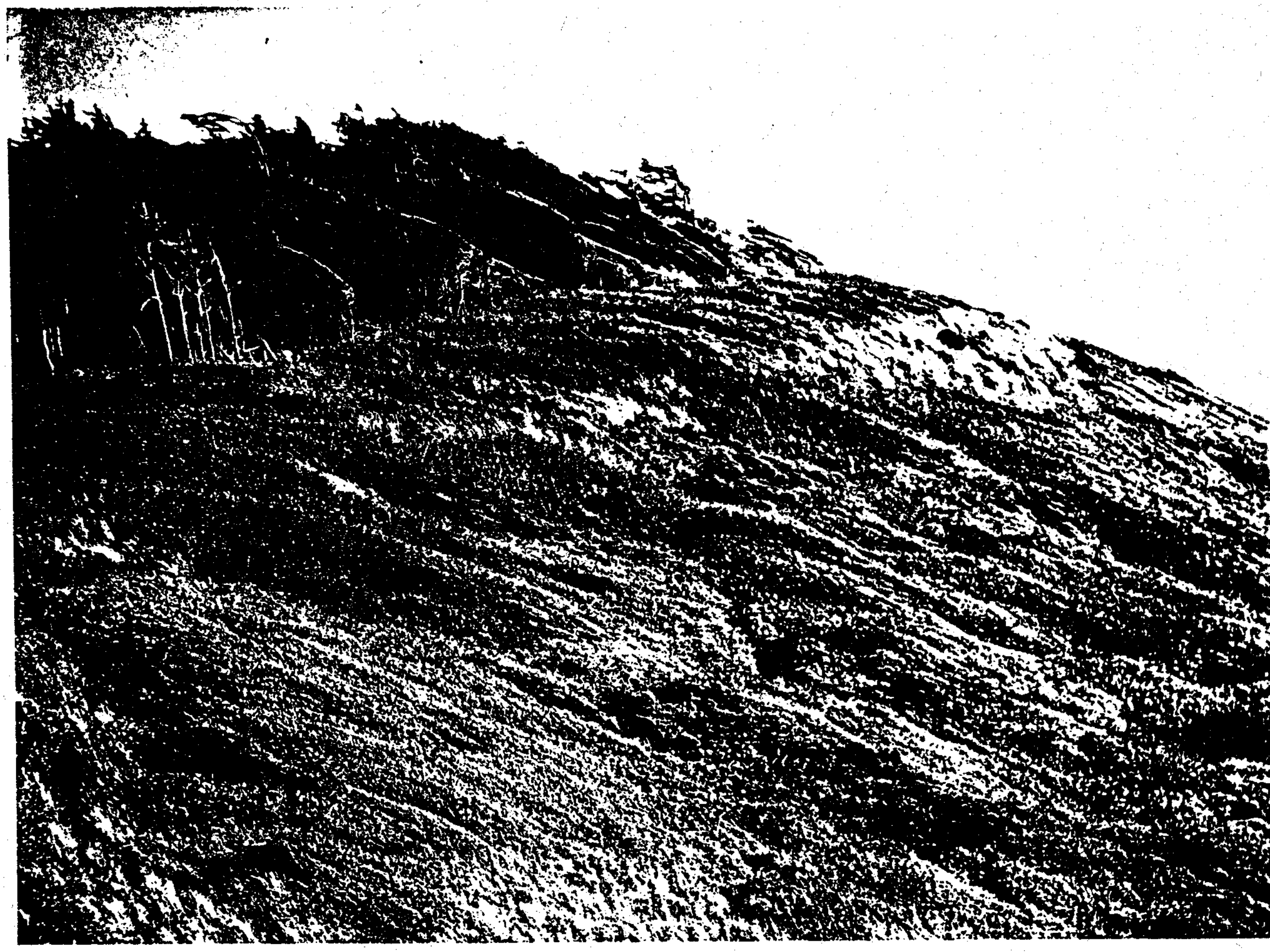


Plate V

Microhabitat of the Hippolyta Silverspot larva. Larva L80-2 was found on June 14, 1980 at 3:15 P.M. Daylight Savings Time, concealed beneath the vegetation where the thermometer is here inserted. The rather oval leaves to the left center are those of *Viola adunca*, the violet upon which the larva of this species feeds in nature. The wiry-leaved grass at the base of which the larva was hiding is red fescue, *Festuca rubra*, a native species. The temperature at the point where the larva rested was 23°C. The air temperature at the surface of the vegetation layer was 20°C. The sky was somewhat thinly clouded.

Also dominant in the picture are the tri-lobed, serrated leaves of the coast strawberry, *Fragaria chiloensis*.

Plate VI

Figure 1

Speyeria zerene hippolyta larva L80-5 (a female) in its last (6th) instar, posed with leaves of Viola adunca its foodplant and Festuca rubra (red fescue), a native grass amongst whose dead leaves it takes refuge when not feeding. Note the color match of the light stripes and spines with that of the dead grass blades.

Figure 2

Butterfly marking site number 1 (see map, fig. 6 and data, fig. 7). Goldenrod (Solidago sp.) is S. z. hippolyta's nectar source here. Early in the flight period, males patrol this sheltered area searching for unmated females moving up from the wind-swept, violet-rich meadow showing in the distance to the left. Stunted trees are Sitka spruce and red alder. Western bracken fern is common here. The foreground area is classed 3b (see Appendix IIB).

Plate VII

Pupa of Speyeria zerene hippolyta. When fully fed, the mature larva spins silk with which it constructs a shelter amongst the meadow vegetation and in which it then pupates. This one, partially torn open for the photograph, was made of violet and red fescue leaves provided in the laboratory. Indoors, the pupal stage of the field-taken larvae lasted 14 to 18 days. The next stage is the imago or adult. (See the Frontispiece, Plate I.)

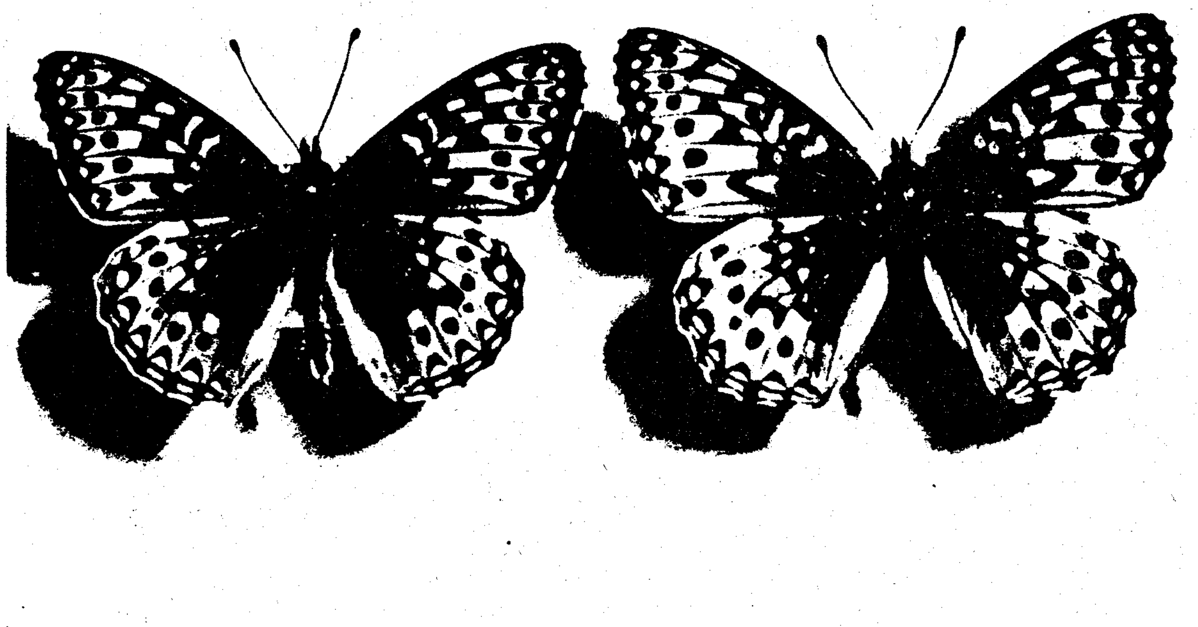
Plate VIII

Figure 1

Speyeria zerene hippolyta, dorsal view. The left specimen is a male, the right a female. These specimens were laboratory reared - the offspring of a female taken at the Rock Creek meadow on September 8, 1971. The specimens are shown enlarged.

Figure 2

Ventral view of the same specimens shown in fig.1.



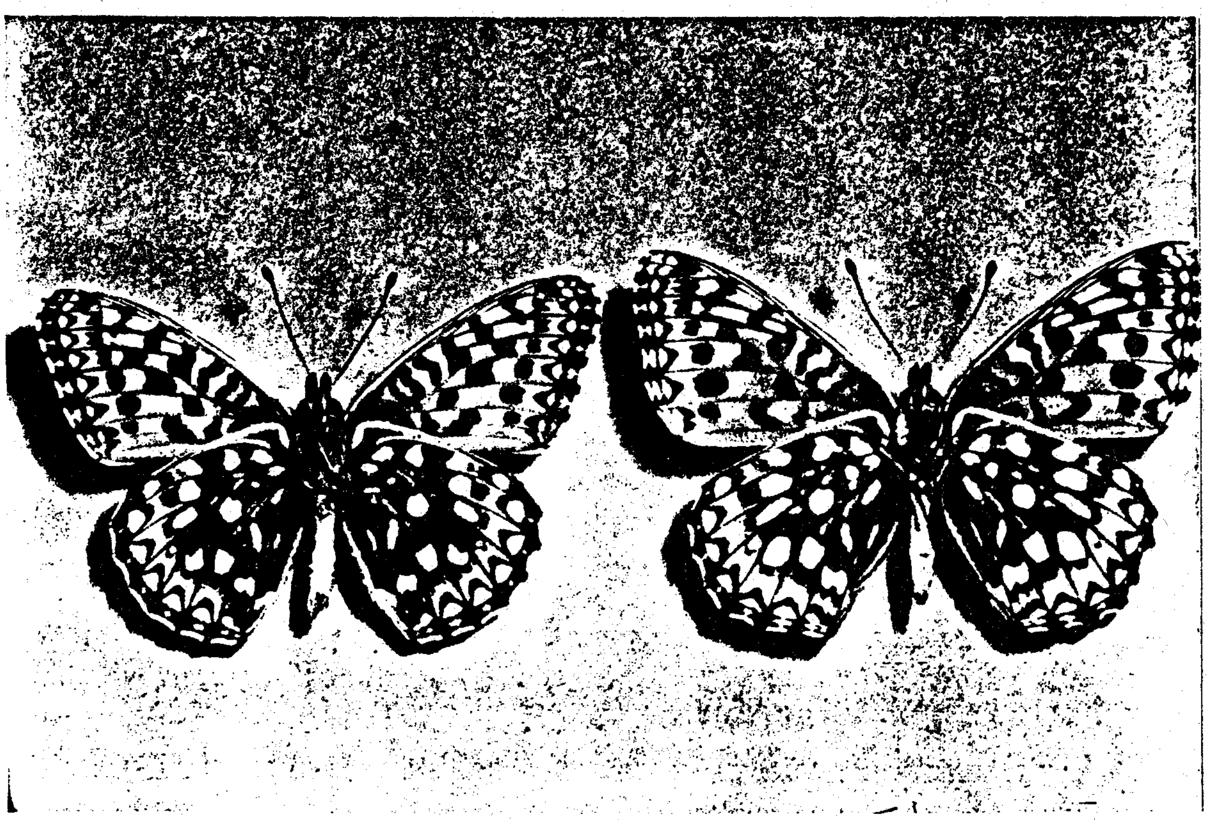


Plate IX

Speyeria zerene males compared. On the left is *S. z. hippolyta* (the same specimen as shown in Plate VIII). The right specimen is *S. z. bremnerii* taken on August 10, 1968 on Marys Peak, Benton County, Oregon. Note the difference in size of the specimens and of the density of melanic scaling in the basal third of the wings. Such seemingly minor differences have been proved to be of major adaptive significance to a butterfly's ecology (see pp. 23 - 25).

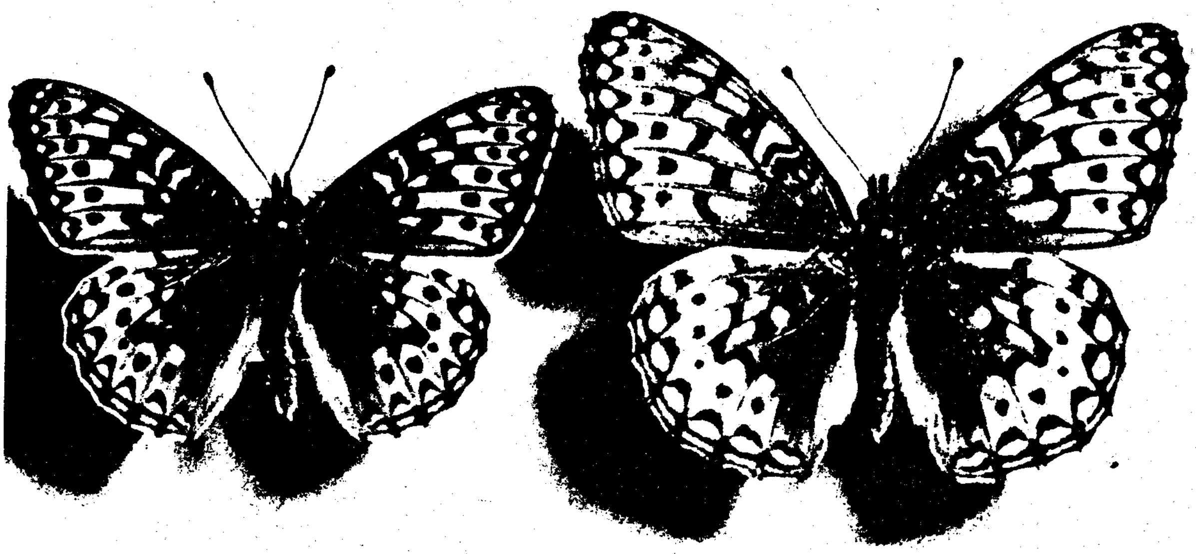


Plate X

Figure 1

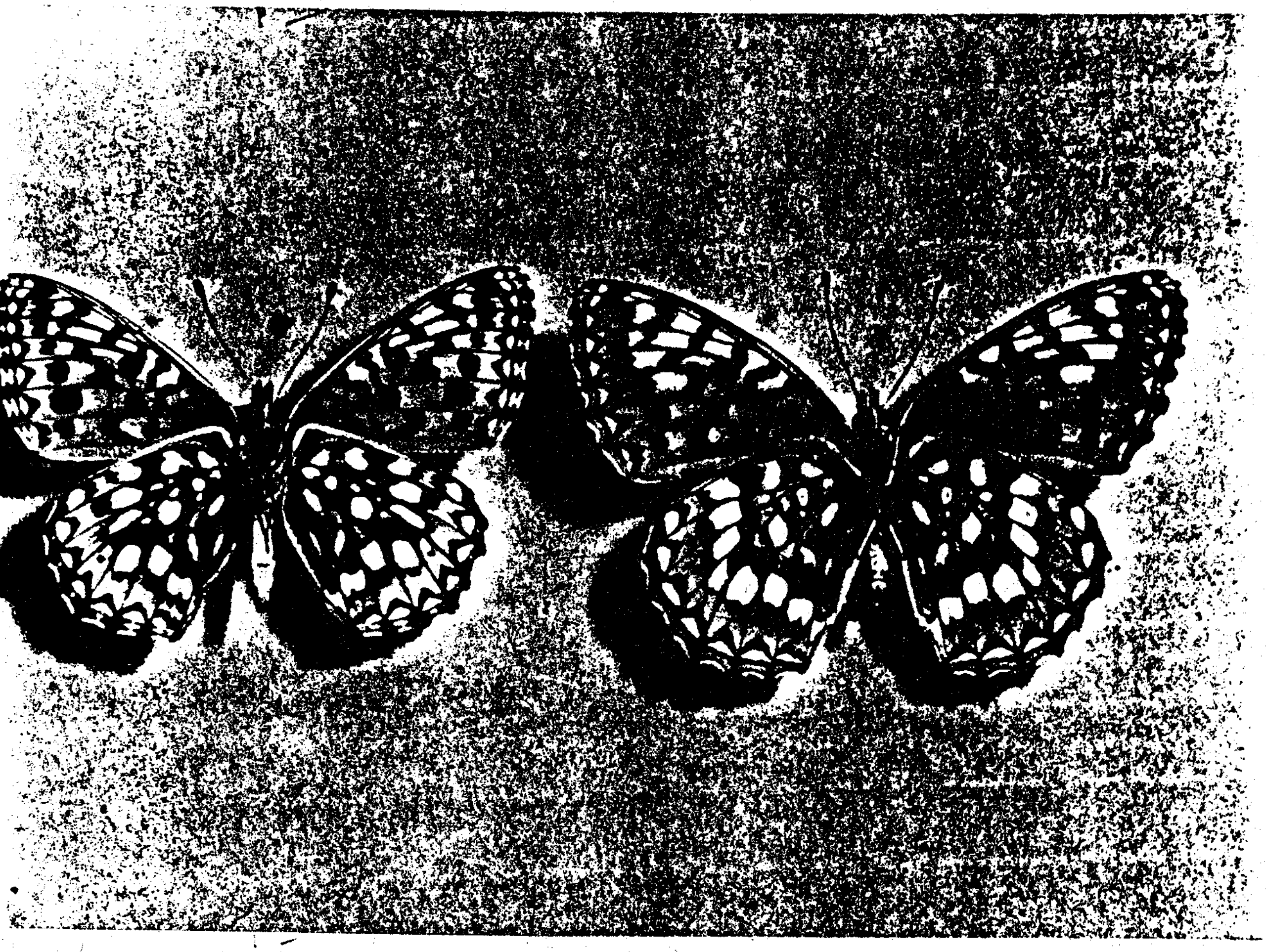
Undersurfaces of Speyeria zerene hippolyta (left) and S. hydaspe compared. Note that the bright silver spots of hippolyta are replaced by pale cream-colored spots in hydaspe and that hydaspe is larger. S. hydaspe is a common species widespread in the Oregon Coast Range. Some years it may be found in forest clearings and roadsides just inland from the Rock Creek salt-spray meadows, the home of hippolyta.

Figure 2

Other butterflies recorded from the vicinity of the Rock Creek meadow. They are, beginning at the left, top row: Vanessa annabella, the western lady, V. cardui, the painted lady or thistle butterfly, and V. virginiensis, the Virginia lady. None of these three overwinter in Oregon but immigrate during the late spring or early summer of most years.

Second row: Vanessa atalanta, the red admiral, and Limenitis lorquini, Lorquin's admiral. V. atalanta is also a migrating species. L. lorquini overwinters as a diapausing larva. Both species are common in Oregon.

The glossy blue, Plebejus saepiolus, shown at the bottom, is established in the Rock Creek meadow where its larvae apparently feed upon spring-bank clover. It is recorded from only one other locality on the Oregon coast. However, the inland forms are well represented at numerous localities mostly in the Cascade mountains or eastward.



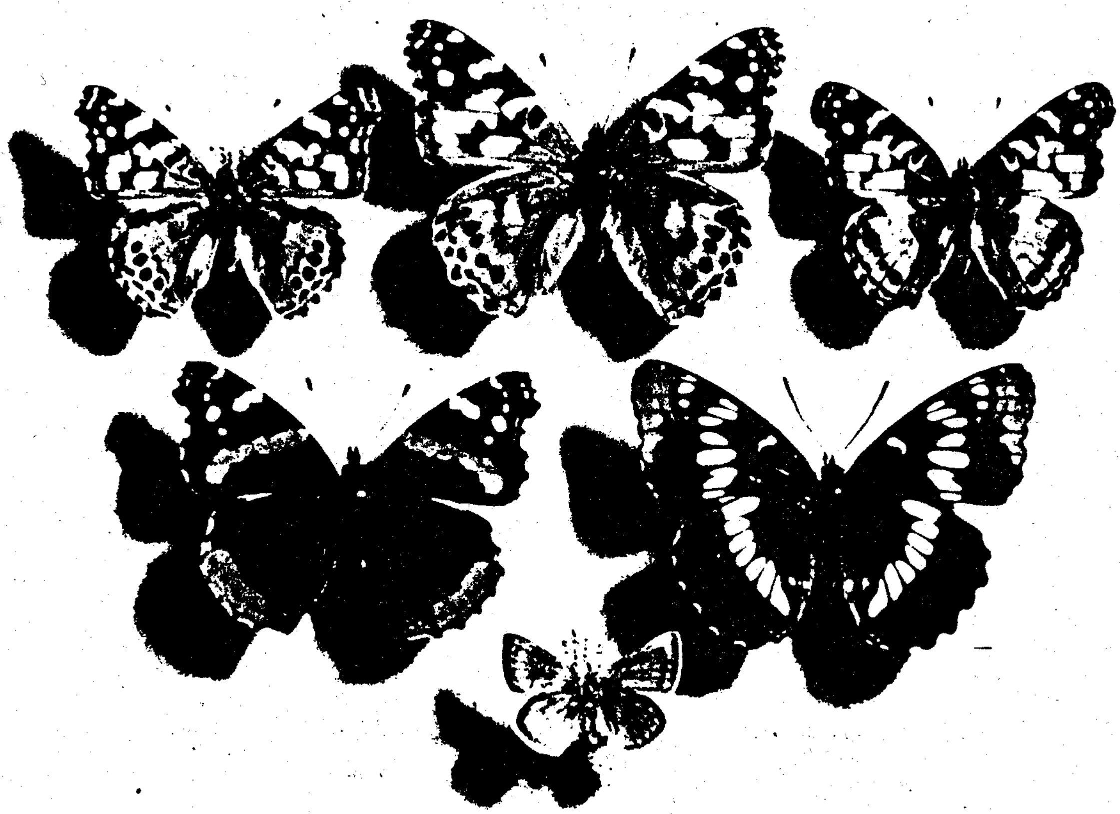


Plate XI

Figure 1

Evidence of avian predation. The specimen on the right is a male Speyeria zerene hippolyta taken in flight at the Rock Creek site, area 8a, at 1:40 P.M., August 22, 1980. Two other males with freshly damaged wings were also taken (and released) within a 15 minute period. This suggests that one bird or more (species unknown), had acquired a search image for hippolyta at this site where the male butterflies were concentrated. Damage of this severity was otherwise not encountered in the present study.

The female on the right is a Speyeria zerene near behrensii taken at Cape Blanco in Curry County, Oregon on August 31, 1973. A mark left by a bird's beak is evident on the right front wing.

The butterflies are shown enlarged.

Figure 2

A comparison of size and degree of melanism of the wing bases (basal suffusion). The upper two females are topotypical Speyeria zerene bremnerii taken on San Juan Island, Washington on August 13 and 9, respectively, in 1960. They illustrate the range of variation in basal suffusion in this population. Willamette Valley populations of bremnerii (now thought extinct) virtually lacked individuals with developed basal suffusion. By contrast, the smaller hippolyta, this one (at the bottom) from Big Creek, Lane County, Oregon are essentially all with well developed basal suffusion. The significance of this comparison is discussed beginning on p. 23.

The butterflies here are somewhat less enlarged than those in fig. 1.

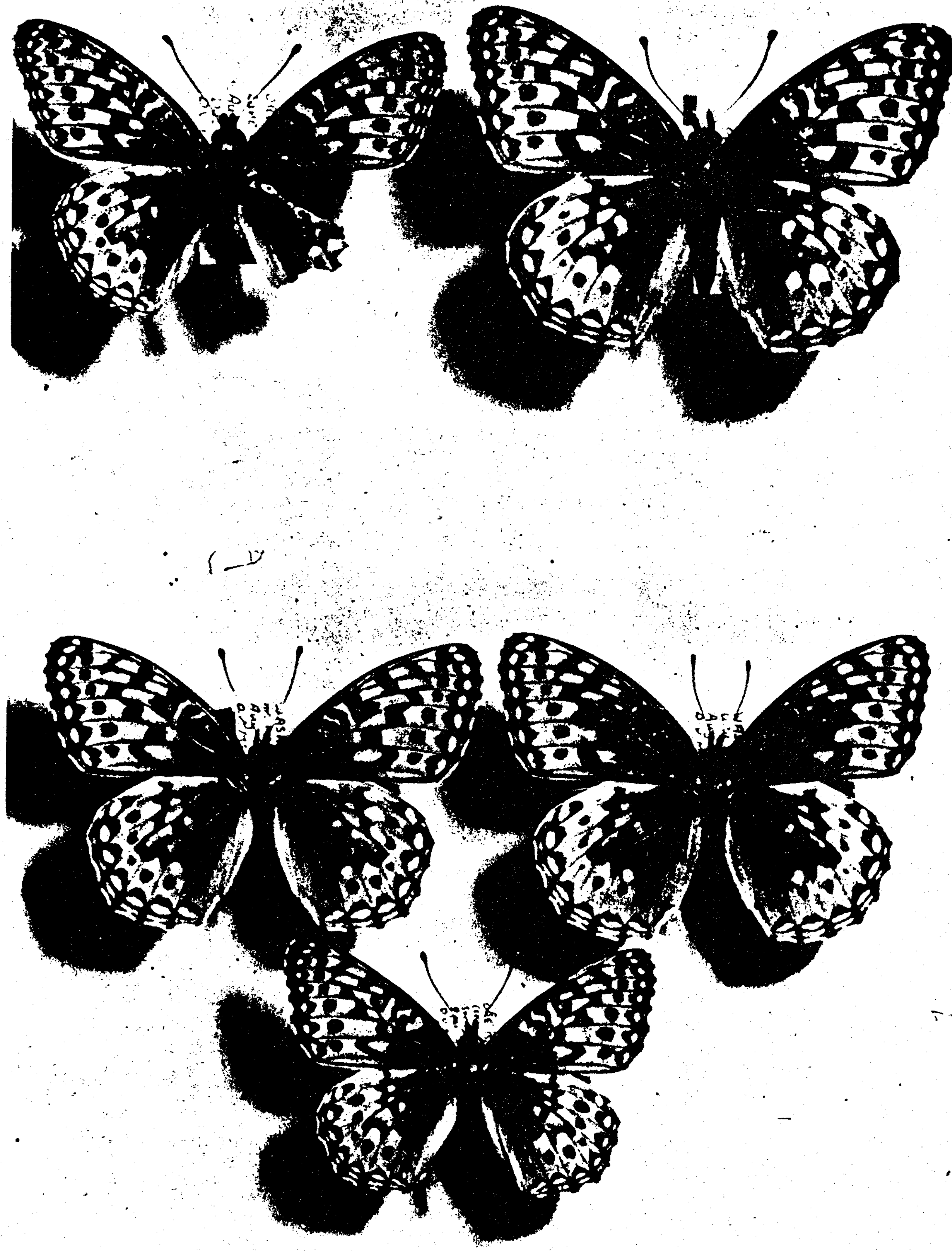


Plate XII

Figure 1

View looking NNE from near Ponsler State Wayside. The top of the Big Creek bridge is just visible above the foreground brushline on the left. The slope up to marking areas 8 and 8a (see map, text fig. 6) appears in the left distance and the recent clearcut, on private land, in the right distance. Early in the century, the whole of the land in this view had been cleared or burned and was used for pasture. Apparently, the salt-wind-swept distant meadows and the brushfield in the foreground have had as much time to undergo succession as has the 70 year-old forest on the lee side of the hill.

Figure 2

The Tenmile Creek meadow, August 22, 1980. The dominant grass in the field in the background is the introduced orchard grass, Dactylis glomerata L. This species appears to crowd out the native grasses and herbs, including Viola adunca, forming virtually pure stands. In the foreground, one of the few surviving patches of bentgrass, Agrostis sp., still containing V. adunca, is disrupted by the installation of a well in preparation for house construction. Although there is some of the meadow at this site in public ownership (state), most is private and apparently soon to be developed.

Speyeria zerene hippolyta was common at this site as late as 1975, but none were seen on August 2 and only three, all males, were seen on August 22, in 1980.

Plate XIII

Figure 1

Differential herbicidal effect of salt-spray winds. Salal is resistant. The exposed bracken ferns have browned.

View, taken on August 20, 1980, is looking west from south of Transect #1 near the old fence (see Rock Creek meadow habitat map). This is in the southern portion of marking area 6 (see map, fig. 6).

Figure 2

Evidence of herbicidal effect of salt-spray winds upon red alder. Note the dead leaders which had grown up during the spring before the northwest winds commenced.

This picture was taken just north of Ponsler State Park on August 2, 1980, in an area that apparently was meadow prior to the 1950's.

Plate XIV

Soil profile as exposed at the beach near Ponsler State Wayside, just south of Big Creek. Note the dark surface stratum, constituting the topsoil, and the presumed filled root channels (fossil) protruding below this layer, most evident on the right. This constitutes evidence that this site was forested in the past, perhaps with wind-stunted trees as it is now.

Compare this view with that in Plate XV, fig. 1. This picture was taken in August, 1980.

Plate XV

Figure 1

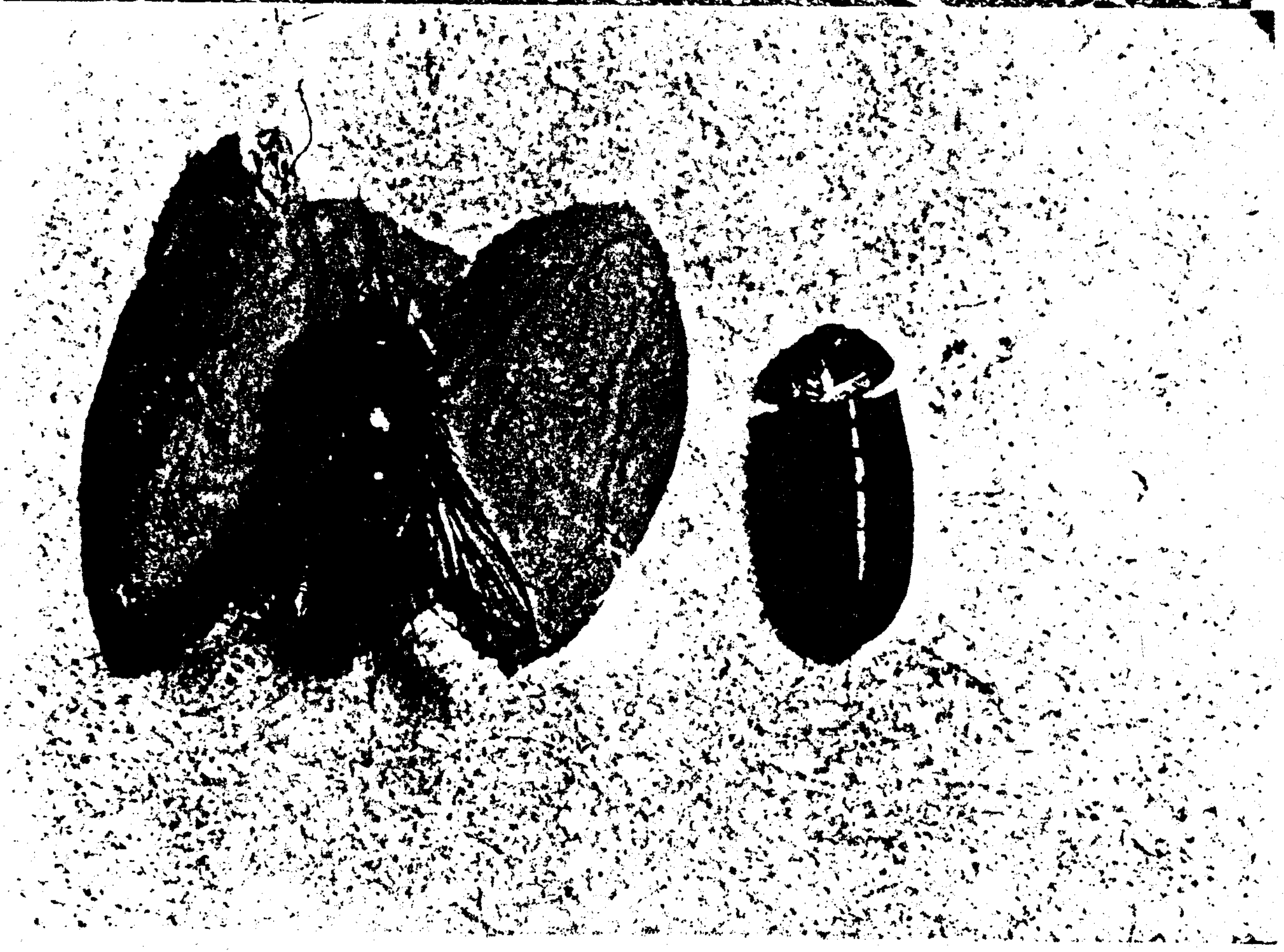
Soil profile as exposed at the beach at the Rock Creek meadow near area 6 (see map, text fig. 6). Leaching from the layer of black meadow topsoil has stained the substrate. Recent cracks are evident, but there are essentially no filled deep root channels as shown in Plate XIV. This is considered evidence that this site has never been forested.

Indian midden artifacts, evident just north of Big Creek, are confined to the dark layer of topsoil.

The fence post was still encased in soil in 1971. This picture was taken in August, 1980.

Figure 2

An unidentified Dipteran parasite of *Vanessa atalanta* larvae taken on nettle along Big Creek road on August 2, 1980 just inland from U.S. Highway 101. Only one larva of 6 taken was not eventually killed by this parasite. By contrast, none of 5 nearly mature *Speyeria zerene hippolyta* larvae taken in the Rock Creek meadow were parasitized. If indeed a comparable Dipteran parasite does attack *hippolyta* larvae, it is likely to be a different species, probably undescribed taxonomically.



APPENDICES

Appendix I

Taxonomy of *Speyeria zerene hippolyta*

by Dr. Paul Hammond

Introduction

The butterflies of the genus *Speyeria* belong to the subfamily Argynninae of the family Nymphalidae. The group includes the thirteen species of *Speyeria* in North America, and fifteen related species of *Argynnis* and *Fabriciana* in Eurasia. The larvae of all these species feed exclusively upon violets (*Viola*). A single Eurasian species, *Fabriciana aglaja*, appears to be the immediate ancestor of the genus *Speyeria* in North America. In turn, the genus *Speyeria* appears to represent an adaptive radiation in North America very similar to the classical example of Darwin's finches in the Galapagos Islands. Beginning with the single ancestral species, there has been a progressive multiplication of species that have divided up the available food resources into various ecological niches based upon habitat differences. Up to eight different species of *Speyeria* are able to co-exist together sympatrically in the mountains of the western United States. Each species occupies a different habitat so that interspecific competition for the larval foodplant is avoided.

In addition to this primary speciation of *Speyeria*, most of the species also exhibit a tremendous amount of secondary differentiation into numerous geographical races or subspecies. Western North America, with its many mountain ranges separated by desert lowlands, has been particularly conducive to this differentiation process. As a result, most of the *Speyeria* are very complex, polytypic species consisting of distinctly different subspecies in each local mountain range.

The Geographic Racial Structure of *Speyeria zerene*

Speyeria zerene is a prime example of a complex, polytypic species. It consists of some fifteen subspecies that may be divided into five major subspecies groups. These include the *S. zerene bremnerii* group, the *S. zerene zerene* group, the *S. zerene carolae* group, the *S. zerene garretti* group, and the *S. zerene gunderi* group. Each of these groups is so divergent in wing color and pattern that it is not immediately obvious that they belong to the same species. However, the existence of intermediate clinal populations that form intergradation between the groups serves to demonstrate the conspecific relationships of these subspecies. The morphological characteristics and distribution of each subspecies group will now be described in some detail. However, since *S. zerene hippolyta* belongs to the *bremnerii* group, this last group will be described in greater detail than the other groups. This discussion is based upon the study by Hammond (1978).

The *S. zerene carolae* group. This group consists of some four distinct subspecies or populations that are distributed along the eastern slope of the Sierra Nevada Range in California, the Spring Mountains near Las Vegas, Nevada, and in the mountains of southern California and Sonora, Mexico. These butterflies are dark ruddy orange on the dorsal wing surfaces, but have little dark basal suffusion and thin light veins in the male dorsal forewing. On the ventral hindwing, they have a reddish-brown disc, small to large silver median spots, and a narrow yellow to brownish submarginal band.

The *S. zerene zerene* group. This group consists of about three subspecies distributed along the western slope of the Sierra Nevada Range in California, the southern Cascade and Warner ranges of southern Oregon and northern California, and in the Siskiyou and Coast Ranges of southern Oregon and northern California. This group is similar to the *carolae* group on the dorsal wing surfaces, with dark ruddy orange color, little dark basal suffusion, and thin veins in the male forewing. However, the ventral hindwing has a purple-brown to purple-red disc, a lavender submarginal band, and small silver or white, unsilvered spots.

The *S. zerene garretti* group. This group consists of four subspecies distributed along the eastern slope of the Cascade Range in the Pacific Northwest, in the various ranges of the Intermountain region, and through the Rocky Mountains from Alberta to New Mexico. This group is similar to the *carolae* and *zerene* groups on the dorsal wing surfaces with little dark basal suffusion and thin veins in the male forewing, but the color is usually a light yellow-orange. On the ventral hindwing, the *garretti* group has a reddish-brown or greenish-brown disc, very large silver spots, and a distinct yellow submarginal band.

The *S. zerene gunderi* group. This group consists only of the single subspecies. It is a highly specialized form adapted to the arid desert mountains of the Great Basin. This distribution includes the various mountain ranges of Nevada, southwestern Idaho, and southeastern Oregon. *Gunderi* is similar to the *garretti* group, but is very pale in color.

The entire ventral hindwing is yellow, with a lemon-yellow disc, a wide yellow submarginal band, and very large silver spots.

The S. zerene bremnerii group. This group consists of four subspecies distributed in the cool, wet coastal regions of the West Coast from British Columbia south to northern California. In sharp contrast to the previous groups, this group is medium orange on the dorsal wing surfaces with moderate to extensive dark basal suffusion and with thick, dark veins in the male dorsal forewing. On the ventral hindwing, the bremnerii group has a dark reddish-brown disc, small silver spots, and a narrow yellow submarginal band. The typical bremnerii subspecies is an inland form distributed in British Columbia and western Washington west of the Cascade Range. It was formerly found in Columbia, Yamhill, Marion, Polk, and Benton Counties of western Oregon, but is apparently extinct in Oregon today. However, bremnerii is still fairly common in western Washington[1] and probably on Vancouver Island today. There is direct intergradation between bremnerii and the garretti group across the Cascades in the Lake Chelan region of Washington and in British Columbia. The typical bremnerii is fairly large with a forewing length of 28 - 33 mm. in the male and 30 - 34 mm. in the female.

The hippolyta subspecies is almost identical to bremnerii in wing pattern and color, but most individuals have extensive basal suffusion[2] on the dorsal wing surfaces. Also it is much smaller, with a forewing length range of 23 to 31 mm. (average 27 mm.) in the male and 26 to 31 mm. (average 29.4 mm.) in the female (see fig. 4). Laboratory rearing studies have shown that this small size is apparently under genetic control[3], and is not merely a phenotypic modification as a result of the harsh environmental conditions of its habitat. Hippolyta is completely restricted to the immediate vicinity of the Pacific Ocean from British Columbia south to extreme northern California in Del Norte County. It is rarely found more than a few miles inland from the ocean. There is intergradation with the typical bremnerii in coastal Washington, particularly on the Olympic Peninsula, and the inland bremnerii populations around Tenino, Washington also show some hippolyta influence in the size of a few specimens.

A third member of the bremnerii group is S. zerene behrensii. This form replaces hippolyta in the Coast Range from Curry County, Oregon to Mendocino County, California. It is similar to the other forms in coloration, and is relitively large in size like bremnerii. Unlike hippolyta, behrensii is more commonly found away from the ocean in the higher coastal mountains. A particularly large population is found in the Rogue River Valley of Curry County, Oregon on the Siskiyou National Forest. There is direct intergradation between behrensii and S. zerene zerene in the Coast and Siskiyou ranges of both southern Oregon and northern California.

The fourth member of the bremnerii group is S. zerene myrtlae. This form is quite similar to hippolyta[4], and is also largely restricted to the immediate vicinity of the Pacific Ocean in Sonoma, Marin, and San Mateo Counties. However, myrtlae is larger in size and lighter in color than hippolyta, and it has a bright yellow cast over the ventral hindwing and rather long, pointed forewings. Myrtlae is now extinct in San Mateo county due to suburban growth south of San Francisco, but a large population in Marin County is now protected at the Point Reyes National Seashore.

The Speciation of *Speyeria zerene*

Speyeria zerene belongs to a complex of six closely related species. These include *S. atlantis*, *S. zerene*, *S. egleis*, *S. callippe*, *S. coronis*, and *S. hydaspe*. Hammond (1978) has developed an interpretation of the speciation and past evolutionary history of the group. *Speyeria atlantis* appears to be the original parental species of the complex, while *S. zerene*, *S. egleis*, *S. callippe*, and *S. hydaspe* appear to be sister species, each independently derived from *S. atlantis*. *Speyeria coronis* is a daughter species derived from *S. zerene* in turn, and is closely allied to the *S. zerene carolae* subspecies group.

The evidence of morphology, distributions, geographic variation, and ecology strongly suggests that the ancestral *S. atlantis* has passed through three distinct phases of evolution, and the various daughter species originated at different times during these three phases. The most primitive form appears to be *S. atlantis atlantis*. This subspecies is presently distributed in the taiga spruce forests across central Canada, at the higher elevations in the Appalachians, and in a few isolated, relict populations in the Rocky Mountains. *Speyeria callippe* is apparently the oldest daughter species. It is probably a West Coast derivative of *S. atlantis atlantis* that originated in the California Coast Range.

The second evolutionary phase in *S. atlantis* is represented by *S. atlantis nikias* and its relatives in the southern Rocky Mountains and Southwest. It is from this group of *S. atlantis* that *S. egleis* and *S. zerene* are probably derived. *Speyeria egleis* speciated in the northern Rocky Mountain and Intermountain region, while the speciation of *S. zerene* took place along the

West Coast. Even today, S. zerene bremnerii is still extremely similar to S. atlantis nikias, and is clearly the most primitive form of S. zerene.

The third and most recent evolutionary phase in S. atlantis originated in the Rocky Mountain Front Range of Colorado, and consists of the hesperis-dodgei series of subspecies. These forms of S. atlantis eventually spread northward and westward from Colorado to the Cascade and Sierra Nevada ranges along the West Coast. The most recent daughter species, S. hydaspe, is apparently derived from an isolate of S. atlantis dodgei in the Sierra Nevada Range, possibly during the last Pleistocene interglacial period. In turn, S. hydaspe eventually spread northward along the West Coast and eastward through the Rocky Mountains.

At the time of the S. hydaspe speciation, it is thought that S. atlantis occupied forest habitats at the higher elevations in the mountains, while S. zerene occupied the forests at lower elevations. Even today, these two species exhibit these ecological characteristics in the mountains of the Great Basin and Southwest outside of the range of S. hydaspe. However, S. hydaspe has acquired superior competitive abilities that have given it complete ecological dominance over the other forest dwelling Speyeria. As a result, the sympatric S. atlantis dodgei has been replaced in the forest habitat by S. hydaspe, and is largely confined to open meadow habitats at higher elevations in the mountains today. Likewise, S. zerene is largely confined to open, dry pine forests at the lower elevations east of the Cascades when S. hydaspe is present.

West of the Cascades, S. zerene bremnerii has been largely replaced in the forest habitat by S. hydaspe. As a result, the largest populations of S. zerene are now found in open meadow habitats where they avoid the competition from S. hydaspe. Thus, the meadow and field habitats of S. zerene hippolyta along the Pacific Ocean represent a type of refugia habitat away from the forest habitat formerly occupied by S. zerene. The gradual replacement of S. zerene bremnerii by S. hydaspe was probably taking place when the White Man first appeared upon the scene, and later activities of Man have served to accelerate this process. Thus, the various subspecies of the S. zerene bremnerii group are basically old relicts that are threatened with extinction due to a combination of both natural and human-caused factors.

Appendix II A

Transect Descriptions

The following are the data taken on transects run at the Rock Creek and Tenmile Creek meadows. Marker stakes made of rebar and painted bright red at the exposed end were placed at either end of each transect. Each transect description provides additional landmark features to assist in the location of at least one end of the transect.

Transect 1 was run on June 14 and Transects 2 - 10 were run on July 4 and 5, 1980. Transect 4b and those at Tenmile Creek were run on August 2 and 3, 1980.

Transect measurements were made by overland pacing and thus are approximate. In all cases they are made from the starting point. Plant heights, etc., were measured with a metric rule. The width of each transect line is approximately .5 m.

In all cases the common name "violets" refers to Viola adunca.

It is assumed that the user of the following descriptions will refer to the Hippolyta habitat maps for the Rock Creek and Tenmile Creek sites which are under separate cover.

Rock Creek Meadow Transects

#1 Diagonal to highway on west side (240° compass bearing); c. 70 m. in length.

Begin at north end of meadow at brink 14 m. north of old fence (see Plate IV, fig. 2).

End at corner where old driveway intersects highway.

Violet plants located: .4 m., 4m (very small), 16.5 m., 18 m., 18.5 m., 25 m., 28 m., 30 m., 33 m. (6), 63 m., 63.6 m.

Average .23 violet plants per m. Feeding sign on 7 of 16 plants (44%).

#2 Right angle to highway on west side; c. 57 m. in length.

Begin at highway on line about 7 m. north of second telephone pole south of the Rock Creek campground sign.

End at brink at "jog" as marked.

Violets: 7 m., 13 m., 23 m., 23.5 m., 31 m. (3), 37 m., 48 m. (4), 56 m., 56.3 m.

Average .25 violets per m. Feeding sign on 7 of 14 plants (50%).

Other features of note: Ant mound at 53 m. with a tunnel outlet at 48 m; spring-bank clover prominent at 23 m. to 35 m., 42 m. to 47 m.; manroot plants at 13 m. and 46 m.

#3 Right angle to highway on west side; c. 61 m. in length.

Begin at old wooden fence post on west side of highway and just north of the first drainage channel south of the north end of the meadow.

End at brink about half-way between "notch" of Transect #2 and drainage channel to the south, as marked.

Violets: 18 m. (5+), 18.6 m. (6), 42 m., 49 m., 49.5 m., 56.5 m.

Average .25 violets per m. Feeding sign on 2 of 15 plants (13%).

Other features of note: Asters prominent at 29 m. and 43 m.; spring-bank clover prominent at 29 m., 42 m., and 56.5 m.; small manroot at 29 m. Tall grass, some clover and aster, damp at 29 to 42 m. Violet 28 cm. tall in grass layer 30 cm. thick at 49 m.

#4 Right angle to highway on west side; c. 59 m. in length.

Begin at white road sign marked "SHRW", etc. See transect marker at its base.

End at brink in a small grassy area surrounded by brush.

Violets: 8 m. (2), 19 m. (3), 42.5 m., 43 m. (2), 45.8 m., 47.7 m., 48 m., 50 m. (3), 57 m.

Average .25 violets per m. Feeding sign on 9 of 15 violet plants (60%).

Other features of note: Spruce at 45.8 m. (4 dm. high, 1 m. and .6 m. wide); brush (salal, bracken fern, small spruce) at 15 to 17 m., 21 to 42 m., 6.5 m.; spring-bank clover at 8 m. and aster at 6.5 m.

#4b Right angle to highway on west side; c. 68 m. in length.

Begin near highway at southern end of sedge marsh and in line with the first fence post north of a thick salmonberry patch. Transect marker at west edge of the marsh tip.

End at brink as marked.

Violets: 4 m. (2), 4.5 m., 5 m., 6 m., 9 m. (2), 9.5 m (2), 11 m. (2), 12 m., 12.5 m., 13 m., 14 m. (3), 15 m., 16.5 m., 20 m., 21 m. (2), 22.5 m., 23 m., 23.5 m. (2), 36 m., 37 m., 38.5 m., 39.5 m. (2), 40 m., 41 m., 44 m., 48 m., and 54 m.

Average .53 violets per m. Feeding sign on 23 of 36 violet plants (64%).

Other features of note: Aster prominent at 26 m., 41 to 50 m., and 59 to 62 m.; salal at 59 to 62 m.

#5 Right angle to highway on west side; c. 84 m. in length.

Begin near highway at north end of road cut at "trail" between two fence posts (marker at fence line).

End at brink as marked.

Violets: 3 m., 16 m. (3), 17 m. (2), 22 m., 23 m., 24 m., 26 m., 28 m., and 42 m.

Average .14 violet plants per m. Feeding sign on 5 of 12 violets (42%).

Other features of note: Manroot at 19 to 20 m.; ant mound with surrounding lush plant growth including at least 2 violet plants at 24 m.; tall grass with some aster and spring-bank clover at 50 to 84 m.

#6 Right angle to highway on west side; c. 80 m. in length.

Begin near highway approximately at National Forest property line (marker at base of widest of several fence posts).

End at brink c. 25 m. north of drainage channel as marked.

Violets: 10 m., 22 m., and 46 m.

Average .04 violet plants per m. Feeding sign on none of 3 plants (0%).

Other features of note: Nearly pure bent grass stand at 30 to 80 m.

#7 Right angle to highway on east side; c. 125 m. in length.

Begin near highway at old fence post near small spruce tree south of Rock Creek campground sign (marker at base of said fence post).

End at edge of forest (marker at base of small alder).

Violets: 56 m. (on a mound).

Average .008 violet plants per m. Feeding sign on none of one violet (0%).

#8 Nearly parallel to highway on east side in clearing amongst small spruce trees on hill (see habitat map under separate cover). Markers placed at edges of clearing. Transect c. 24 m. in length.

Begin at south edge of clearing.

End at north edge.

Violets: 1 m., 2 m.,(2), 2.4 m., 3 m. (2), 8 m., 10 m.

Average .33 plants per m. Feeding sign on 4 of 8 violet plants (50%).

Other features of note: Rocky mound with red fescue at 7 m.; several violet plants small, apparently seedlings. Some growing in old elk tracks.

#9 Near right angle to highway on east side; c. 65 m. in length.

Begin near highway near crest of ridge near National Forest south property line (marker at base of old fence post).

End on knoll above shallow crater beneath middle wire of power line as marked.

Violets: 6 m., 12 m., 16 m., 17 m., 17.7 m., 18 m. (2), 19 m. (3), 20 m.

Average .17 violet plants per m. Feeding sign on 2 of 11 violet plants (18%).

Other features of note: Small spruce tree at 53 m.; some asters and manroot between 20 and 65 m. This transect is mostly on a north slope, thus its violets do not have good solar exposure.

#10 Near right angle to highway on west side; c. 90 m. in length.

Begin near highway, on roadcut, at "double" fence posts (marker at base of south one).

End at brink as marked.

Violets: 21 m., 47 m., 57 m., 81.5 m. (trail edge) (2), 83.5 m., 86 m., 87.2 m.

Average .09 violet plants per m. Feeding sign on 4 of 8 plants (50%).

Other features of note: Large mound to north at 78 to 79 m.; tall grass at 21 m. (layer 6 dm. thick).

Other Habitat Descriptions: Vicinity of Rock Creek Meadow

Area between Big Creek and Ponsler State Wayside, west of U.S. Highway 101

July 2, 1980

Very little suitable meadow remains here. Brush has encroached most of the area. An old fence just north of the remains of a cabin has obviously acted as a windbreak. At present, dense salal stands in front (north) of the fence grade into stunted spruce wind-pruned even with the top of the fence. Behind the fence, the wind-prune surface continues at the same slope allowing spruce, and in their lee, shore pine and hemlock to attain increasingly greater height.

Several meters north of this old fence and near the highway is a marshy meadow area (class 4a).

Further north the brushfields are well-developed over much of the area. Near the brink to the west, however, there is a strip heavily disturbed due to vehicle access and camping activity. _Plantago maritima_ and coast strawberry act as colonizers of the bare soil here. False dandylion is well-established in the few remaining grassy areas. No violets were found. In 1971, _hippolyta_ adults were observed to be active in this area in then-remaining patches of meadow.

Rocky Knoll

July 2, 1980

Most of the salt-spray meadow present is on a north slope apparently exposed to the full force of the summer northwest winds. For the most part, the vegetation is very short here with very small violet plants and no grass cover (class 3a). However, there is a narrow zone of taller meadow vegetation grading into the surrounding brush. A very few larger violet plants were located in this gradation zone, but none showed signs of _hippolyta_ larva feeding.

Near the top of the knoll is a small patch of meadow with several prominent patches of Indian paint brush (Castilleja sp.) and a few Viola adunca plants, none with feeding sign.

Hill east of Rocky Knoll across U.S. Highway 101 (see Plate X, fig.1).
August 3, 1980

A moderately-sized (25 - 30 m. diameter) grassy opening in the brush and wind-stunted trees. Bracken fern and false dandylion are prominent. The meadow showed heavy elk use, their trails leading from the forest cover on the lee side of the hill. At least one ant mound occurs in the opening. Viola adunca is found in clusters mostly around the meadow fringes. Two sizeable clusters examined showed good larval feeding sign. At the northwest edge of the meadow where the wind impacts the most is a rocky out-crop with red fescue and violets. These showed heavy feeding sign.

Tenmile Creek Transects

#1 Approximately at right angle to highway on west side; c. 62 m. in length.

Begin at braced fence post (marker at base) east of old roadway near beach. A small holly tree is nearby.

End at edge of dense salal and alder thicket mixed with shore pine, etc. Marker at base of hemlock sapling.

Violets: 25.5 m. (small plant), 49 m. (miniature plant), 50 m. (2 - both miniature), 57 m. (very small).

Average .08 violets per m. Feeding sign on 0 of 5 plants (0%).

Other features of note: 0 - 10 m. is boysenberry patch; dewberry patch at 11 - 20 m.; tall grass at 20 - 23 m.; alder patch at 23 - 25 m.; heavy grass cover at 25 - 36 m.; alder at 36 m.; recently established driveway at 37 - 42 m.; spruce thicket at 45 - 48 m.; low grass and wild strawberry at 48 - 50 m.; spruce at 50.5 m.; hole left by shrub digger at 51 m.; exotic berry bushes at 51 - 54 m.

#2 Approximately at right angle to highway on west side; c. 205 m. in length. Follows property line as indicated on Tenmile Creek habitat map.

Begin at brink.

End at fence by highway.

Violets: 128 m.

Average .005 violets per meter. Feeding sign on 1 of 1 plants (100%).

Other features of note: Property boundary post at 3 m.; disturbed, white clover and trail at 3 - 5 m.; old overgrown log at 9 - 10 m.; good cover but no violets at 5 - 10 m.; aster and wild strawberry at 10 - 18 m.; yarrow and tall grass at 18 - 21 m.; aster and tall grass at 21 - 29 m.; aster and tall orchard grass at

29 - 34 m.; aster and bent grass but too thick for violets at 34 - 37 m.; old road (class 4dr) at 37 - 41 m.; heavy grass with asters at 41 - 52 m.; heavy orchard grass cover at 52 - 116 m.; trampled area, vicinity of well installation 116 - 127 m.; patch of bent grass, good cover but trampled at 127 - 130 m.; trampled orchard grass at 130 - 134 m.; heavy stand of orchard grass at 134 - 147 m.; evergreen huckleberry bush (patch of bentgrass with some violets to south of transect) at 141 m.; salal patch at 147 - 150 m.; heavy stands of orchard grass mixed with blackberry vines at 150 - 205 m.

Appendix II B

Speyeria zerene hippolyta Larval Habitat Classification

Class 1 Optimum (Frequent sign of larval feeding)

a) Good violet growth, moderate grass cover mostly in clumps.

b) Good violet growth, grass cover somewhat excessive.

Class 2 Fair (Some sign of larval feeding)

a) Violets in numbers but mostly too small, grass cover sparse or mostly too short to provide larval cover.

b) Grass cover and other vegetation somewhat too dense, violets sparse.

Class 3 Marginal (Sign of larval feeding questionable or absent)

a) Violets all too small, no grass cover of sufficient density and size.

b) Grass and other vegetation too dense, violets nearly absent.

c) Violets present and showing good growth, but larvae apparently absent (too damp, wrong sun exposure, etc.).

Class 4 Non-Habitat (Violets completely missing)

a) Wet meadow or marsh.

b) Dense brush cover (salal, etc.).

c) Tree cover (spruce, etc.).

d) Too disturbed (roadways, pathways, etc.).

dr)Recovering from excessive disturbance, no violets yet.

Appendix III

Biota Lists

List A

Tentative List of Plants

in Rock Creek Salt-Spray Meadow

Family	Scientific Name	Common Name
Caprifoliaceae	Lonicera involucrata	Twin berry, bush honey-suckle
Compositae	Achillea millefolium	Yarrow
	Anaphalis margaritacea	Pearly everlasting
	Aster chilensis	California aster
	Cirsium edule#	Indian thistle
	Erigeron glaucus	Seaside daisy
	Gnaphalium purpureum	Purple cudweed
	Hypochaeris radicata	False dandylion, hairy cat's ear, gosmore
	Solidago sp.	Goldenrod
Cucurbitaceae	Marah oreganus	Manroot, bigroot
Cyperaceae	Carex obnupta	Slough sedge
Ericaceae	Gaultheria shallon	Salal
	Vaccinium ovatum	Evergreen huckleberry
Equisetaceae	Equisetum palustre	Horsetail, scouring rush
Gramineae	Agrostis aequivalvis	Alas bentgrass
	Agrostis hallii#	Hall's bentgrass
	Agrostis longiligula#	Pacific bentgrass
	Agrostis pallens#	Seashore bentgrass
	Agrostis sp.	Bentgrass
	Aira praecox#	Early hairgrass
	Ammophila arenaria	European beachgrass
	Calamagrostis canadensis#	Bluejoint reedgrass
	Calamagrostis nutkaensis#	Pacific reedgrass
	Deschampsia cespitosa#	Tufted hairgrass
	Festuca rubra	Red fescue
	Poa palustris#	Meadow-grass
	Poa trivialis#	Roughstalk bluegrass
	Puccinellia nutkaensis#	Alkaligrass
Iridaceae	Sisyrinchium angustifolium#	Blue-eyed grass, blue star, eye-bright
	Sisyrinchium californicum#	Golden-eyed grass
Juncaceae	Juncus bufonius#	Toad rush
	Juncus effusus#	Common rush
	Juncus ensifolius	Dagger-leaf rush

Labiatae	Prunella vulgaris	Heal-all
	Stachys mexicana	Hedge-nettle
Leguminosae	Lotus corniculatus	Deervetch
	Lupinus littoralis	Seashore lupine
	Trifolium wormskjoldii	Spring-bank clover
	Vicia gigantea	Giant vetch
Liliaceae	Malanthemum bifolium var. kamtschaticum	False lilly of valley
Myricaceae	Murica californica	Wax myrtle
Onagraceae	Epilobium watsonii	Willow-herb
Ophioglossaceae	Botrychium multifidum	Leathery grape fern
Orchidaceae	Habenaria greenei#	Bog-orchid, rein-orchid
	Spiranthes romanzoffiana#	Twisted orchids, pearl-twist, hooded ladies' tresses
Pinaceae	Picea sitchensis	Sitka spruce
Plantaginaceae	Plantago hirtella	Tall coast plantain
	Plantago lanceolata	English plantain
	Plantago maritima	Seaside plantain
Polygonaceae	Rumex acetosella	Sourweed
	Rumex conglomeratus	Green dock
	Rumex occidentalis#	Western dock
	Rumex salicifolius#	Willow dock, narrow-leafed dock
Polypodiaceae	Blechnum spicant	Deer fern
	Polystichum munitum var. munitum	Sword fern
	Pteridium aquilinum	Western bracken
Rosaceae	Fragaria chiloensis	Coast strawberry
	Potenti lla pacifica	Pacific silverweed
Salicaceae	Salix hookeriana	Coast willow
Scrophulariaceae	Castilleja (prob. litoralis)	Pacific paintbrush
	Mimulus guttatus subsp. littobalis	Common monkey flower
Umbelliferae	Angelica hendersonii	Angelica
Violaceae	Viola adunca	Western blue violet

Voucher specimen not obtained.

List B

Butterflies of the Rock Creek Meadow Vicinity

Arrangement according to Hinchliff, et al, 1980

Recorded Species

Family	Scientific Name	Common Name
Hesperidae	Ochlodes sylvanoides (Boisduval), 1852	Woodland skipper
Papilionidae	Papilio rutulus Lucus, 1852	Tiger swallowtail
Pieridae	Neophasia menapia tau (Scudder), 1861	Pine white
	Artogeia napi (Linnaeus), 1761 marginalis (Scudder), 1861	Grey vein white
	Artogeia rapae (Linnaeus), 1758	Cabbage butterfly
	Colias eurytheme Boisduval, 1852	Orange sulfur
Lycaenidae	Epidemia helloides (Boisduval), 1852	Purplish copper
	Plebejus saepiolus (Boisduval), 1852	Glossy blue
Nymphalidae subf. Nymphalinae	Vanessa virginiensis (Drury), 1773	Virginia lady
	Vanessa cardui (Linnaeus), 1758	Painted lady, Thistle butterfly
	Vanessa annabella (Field), 1971	Western lady, Hollyhock butterfly
	Vanessa atalanta rubria (Fruhstorfer), 1909	Red admiral

Nymphalidae		
subf. Argynninae	Speyeria zerene (Boisduval), 1852 hippolyta (Edwards), 1879	Hippolyta fritillary
	Speyeria hydaspe (Boisduval), 1869 nr. rhodope (Edwards), 1874	Hydaspe fritillary
subf. Melitaeinae	Phyciodes mylitta mylitta (Edwards), 1861	Mylitta crescent
subf. Limenitidinae	Limenitis lorquini (Boisduval), 1852 burrisonii Maynard, 1891	Lorquin's admiral
Danaidae	Danaus plexippus (Linnaeus), 1758	Monarch

Also Likely

Lycaenidae	Incisalia augustinus iroides (Boisduval), 1852	Brown elfin
	Celastrina argiolus (Cramer), 1780 echo (Edwards), 1864	Echo blue, Spring azure
Nymphalidae	Nymphalis californica (Boisduval), 1852	California tortoise-shell
	Nymphalis milberti furcillata (Say), 1825	Milbert's tortoise-shell
	Polygonia satyrus neomarsyas dos Passos, 1969	Satyr anglewing
Satyridae	Coenonympha tullia Edwards, 1871 eunomia Dornfeld, 1967	Tullia ringlet
	Cercyonis pegala (Fabricius) boopis (Behr), 1864	Large woodnymph

List C

Tentative List of Non-Avian Terrestrial Vertebrates

in the Rock Creek Meadow and Adjacent Woodland

This list is modified from one prepared by Chris Maser for the proposed Blacklock Point Natural Area Preserve (State Land Board).[1]

Order	Scientific Name	Common Name
	CLASS AMPHIBIA	
Salientia	*Hyla regilla*	Pacific treefrog
Caudata	*Aneides ferreus*	Clouded salamander
	Ensatina eschscholtzii	Oregon salamander
	Taricha granulosa	Rough-skinned newt
	CLASS REPTILIA	
Squamata	*Gerrhonotus coeruleus**	Northern alligator lizard
Serpentes	*Thamnophis ordinoides*	Northwestern garter snake
	CLASS MAMMALIA	
Insectivora	*Neurotrichus gibbsii*	Shrew-mole
	*Scapanus orarius**2	Coast mole
	Sorex pacificus	Pacific shrew
	Sorex trowbridgii	Trowbridge shrew
	Sorex vagrans	Wandering shrew
Chiroptera	*Eptesicus fuscus*	Big brown bat
	Lasionycteris noctivagans	Silver-haired bat
	Lasiurus cinereus	Hoary bat
	Myotis californicus	California myotis
	Myotis evotis	Long-eared myotis
	Myotis lucifugus	Little brown myotis
	Myotis thysanodes	Fringed myotis
	Myotis volans	Long-legged myotis
	Myotis yumanensis	Yuma myotis
	Plecotus townsendi	Townsend big-eared bat
Lagomorpha	*Sylvilagus bachmani**	Brush rabbit

Rodentia	Aplodontia rufa	Mountain beaver
	Clethrionomys californicus	California red-backed vole
	Erethizon dorsatum*	Porcupine
	Eutamias townsendi*	Townsend chipmunk
	Microtus oregoni	Oregon vole
	Peromyscus maniculatus*	Deer mouse
	Phenacomys sp.	Tree mouse
	Spermophilus beecheyi*	California ground squirrel
	Tamiasciurus douglasii*	Chickaree
	Thomomys monticola niger	Black pocket gopher
	Zapus trinotatus*	Pacific jumping mouse
Carnivora	Lynx rufus	Bobcat
	Mephitis mephitis	Striped skunk
	Mustela erminea	Short-tailed weasel
	Mustela frenata	Long-tailed weasel
	Procyon lotor	Raccoon
	Spilogale putorius	Spotted skunk
	Urocyon cinereoargenteus	Gray fox
Artiodactyla	Cervus canadensis*	Roosevelt elk, wapiti
	Odocoileus hemionus columbianus*	Black-tailed deer

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* Occurrence verified in the Rock Creek meadow or adjacent woods.

Footnotes

1) See Martin and Frenkel, 1978. The proposed Blacklock Point Natural Area Preserve also includes salt-spray meadows.

2) Evidenced by fresh earthen mounds.

List D

Tentative List of Birds

at Rock Creek Meadow, Lane County

This list is modified from one prepared by Chris Maser for Blacklock Point.

Order	Scientific Name	Common Name
Falconiformes	Accipter cooperi	Cooper's hawk
	Buteo jamaicensis	Red-tailed hawk
	Cathartes aura	Turkey vulture
Strigiformes	Aegolius acadicus	Saw-whet owl
	Bubo virginianus	Great horned owl
Apodiformes	Selasphorus rufus	Rufous hummingbird
Piciformes	Colaptes cafer*	Red-shafted flicker
	Dendrocopos pubescens	Downy woodpecker
	Dendrocopos villosus	Hairy woodpecker
	Dryocopus pileatus	Pileated woodpecker
Passeriformes	Certhia familiaris	Brown creeper
	Chamaea fasciata	Wrentit
	Chordeiles minor	Common nighthawk
	Corvus brachyrynchos*	Common crow
	Cyanocitta stelleri*	Steller's jay
	Hylocichla guttata	Hermit thrush
	Hylocichla ustulata	Swainson's thrush
	Ixoreus naevius	Varied thrush
	Junco oregonus	Oregon junco
	Melospiza melodia	Song sparrow
	Nuttallornis borealis	Olive-sided flycatcher
	Parus rufescens*	Chestnut-backed chickadee
	Petrochelidon pyrrhonota*?	Cliff swallow
	Sitta canadensis	Red-breasted nuthatch
	Tachycineta thalassina	Violet-green swallow
	Troglodytes troglodytes	Winter wren
	Turdus migratorius	Robin

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* Occurrence verified in the Rock Creek meadow.

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Interviews

Stephen D. Beckham
History Dept., Lewis and Clark College
Portland, Oregon
September 2, 1980

Mrs. John G. Cameron (Elizabeth Starker)
Big Creek property owner
Corvallis, Oregon
September 13, 1980

Stanley Jewett, Jr.
Entomologist
Portland, Oregon
August 18, 1980

Herman Larsen
Son of Big Creek area homesteader
nr. Alvadore, Oregon
September 4, 1980

Hugh M. Sherwood
Big Creek area property owner
Discussion at Newport Public Information Meeting
April 15, 1980

Specimen Identification

Kenton L. Chambers
Herbarium Curator, OSU
Corvallis, Oregon

Heather Engelman
1979 contractor with Waldport Ranger District of Siuslaw National Forest

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INDEX ADDENDA