NOTES ON THE MELITAEID BUTTERFLY EUPHYDRYAS PHAËTON (DRURY), WITH DESCRIPTIONS OF A NEW SUBSPECIES AND A NEW VARIETY

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INTRODUCTION

One of the most interesting of the common butterflies of eastern North America is *Euphydryas phaëton*. Its extreme localization, its abundance in the very restricted areas inhabited by it, its extreme sluggishness under ordinary conditions, and its most unusual tenacity of life combine to distinguish it from all other of our butterflies. In addition, there are the curious and rather frequent variations and aberrations to which, like all its close relatives, it is subject. Furthermore, the pupae and the caterpillars in all stages show features quite as interesting as those of the adults.

Casual experience with the early stages of this butterfly in the field showed that there was still much to be learned in regard to it, and accordingly during the autumn of 1925 and the spring of 1926 an intensive study covering all the stages was undertaken.

The actual work was largely carried out by Messrs. Austin B. J. Clark and Hugh U. Clark under my supervision. Many of the observations herein given were first made by them, and the present paper is to be regarded as a joint contribution by all three of us.

Most of our studies were on specimens from the vicinity of Washington. These we find to represent a different race from that represented by those with which we were previously familiar in New England; for this race we propose the name

EUPHYDRYAS PHAËTON SCHAUSI, new subspecies

Plate 1, figs. 5–8

Characters.—Closely resembling *Euphydryas phaëton phaëton* (pl. 1, figs. 1–4) from eastern Massachusetts, but with the ground color of the upper surface of the wings deep velvety black, usually, but not always, duller and more grayish in the females, instead of blackish brown, and the light markings white instead of light straw yellow; on the fore wings the orange spots in the middle and at the tip of the cell are usually much reduced and commonly (occasionally in the

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northern form) entirely absent; the eight orange spots along the margin of the wing are smaller, due to the broadening of the band of black scales along the veins between them and a rounding off of their outer angles by an invasion of black scales; they are frequently very much reduced in size, especially in the females, and may be almost wholly obliterated by black scales; in the northern form the three apical spots are usually noticeably larger than the others, extending inward between the veins for a greater distance, but in the southern form these spots may be all of the same size, as is usual in the females, or they may decrease regularly from the apex posteriorly, as is usual in the males; on the hind wings there is very seldom any trace of orange except for the submarginal row of spots, which are restricted by a broadening of the narrow black border of the wings and a heavier development of black scales along the veins, especially in the females; beneath, the marginal band of orange spots is narrower than in the northern form with a more deeply crenate inner margin, and the orange markings in the basal half of the hind wings are more or less reduced by a greater development of black along the veins and an invasion of black on all sides; the light markings on the under side are also purer white than in the northern form.

We take great pleasure in naming this form for our friend Dr. William Schaus, who first took it at Alexandria, Virginia, several years ago, and whose specimens we have been privileged to study in connection with our own.

Comparisons.—For comparison with our specimens from Cabin John, Maryland, we have before us a series of nine examples from Stoneham, Massachusetts, which were collected on June 27, 1926, and sent to us by our friend Mr. C. V. Blackburn; a female from Lincoln, Massachusetts, July 7, 1923; a female from Weston, Massachusetts, July 9, 1923 (pl. 1, figs. 3, 4); and three males from Newtonville, Massachusetts, July 11, 1923, and June, 1897, all taken by ourselves. Of the northern form we have also examined four males from Kendall, New York, three males and three females from New Jersey, and a male without locality. Of the southern form we have examined, in addition to our own series, five males and five females from Alexandria, Virginia, collected by Doctor Schaus.

We find no difficulty in distinguishing specimens from New Jersey and northward from those from the vicinity of Washington. Typical examples of each are very distinct, because of the deeper and more lustrous black of the latter, the brighter white of the light spots, and the restriction of the orange markings.

One of the specimens from Stoneham, Massachusetts, is nearly as deep black as the southern form; but it has the typical orange markings of the northern. Four of the specimens from Cabin John are

somewhat brownish; but the restriction of the submarginal orange spots, especially on the fore wings, easily distinguishes them. Three of these have both the orange spots in the cell of the fore wing present, though reduced, and the fourth has the outer present, rather broadly divided in the middle; one has faint indications of the two orange spots in the inner part of the hind wings.

Size.—We have measured the maximum expanse of 186 specimens.

The 116 males were found to range from 45.0 to 64.0 mm., averaging 52.7 mm.

The 70 females were found to range from 50.4 to 70.2 mm., averaging 60.4 mm.

There is no appreciable difference in size between northern and southern examples.

The 17 males from New Jersey and northward range from 49.4 to 60.0 mm., averaging 54.5 mm. The 99 males from the vicinity of Washington range from 45.0 to 64.0 mm., averaging 52.5 mm.

The 8 females from New Jersey and northward range from 54.0 to 69.8 mm., averaging 59.5 mm. The 61 females from the vicinity of Washington range from 50.4 to 67.8 mm., averaging 60.3 mm.

The two largest specimens are a female from Newtonville, Massachusetts (69.8 mm.) (pl. 2. figs. 13, 14), and another from Missouri (70.2 mm.).

In studying this butterfly one gets the impression that in the North there is less difference in size between the sexes than in the South, the males being larger and the females smaller; but the figures show very little difference.

In the South the extremes in size are slightly more in the males (a difference of 19.0 mm.) than in the females (17.4 mm.), while in the North the reverse would seem to be the case, the range in the females (15.8 mm.) being greater than that in the males (10.6 mm.); but our northern material is not sufficient to enable us to speak with any degree of certainty.

Frequency of different sizes in Euphydryas phaëton

Millimeters	Males		Females	
	Vicinity of Washington	New Jersey northward	Vicinity of Washington	New Jersey northward
45–47	6	0	0	0
48–50	23	1	1	0
51–53	34	4	1	1
54–56	28	9	9	2
57–59	5	2	11	0
60–62	2	1	19	2
63–65	1	0	15	2
66–68	0	0	5	1
69–71	0	0	1	1

Variation in the shape of the wings.—In the males the fore wings are more or less produced (pl. 1, figs. 1, 2, 5, 6; pl. 2, figs. 15, 16; pl. 3, figs. 19–22; pl. 4, figs. 25–32). From the apex the border runs backward and outward, curving broadly around at the third submarginal red spot and running thence in a straight (pl. 1, figs. 1, 2) or slightly concave (pl. 4, figs. 26, 27) line to the inner angle. The curve at the third red spot is usually well marked, and if the border beyond is concave it may even be somewhat abrupt. Occasionally this broad angulation of the fore wing is entirely lacking, and the border curves smoothly from the apex to the fourth red spot, thence running straight to the lower angle (pl. 3, fig. 23). Males of this last type, with the fore wings relatively short and broad, are inactive like the females from which they are not easy to distinguish either in the field or in the cabinet. The most active males are the smaller ones with the most produced fore wings (pl. 4, figs. 26, 27).

The shape of the hind wings in the males varies as much as that of the fore wings. When the fore wings are markedly produced the edge of the hind wings from the third red spot onward runs in a line which is only moderately convex to the well-marked anal angle (pl. 4, figs. 26, 27, 29). There are all gradations between this typical form and hind wings which are evenly and broadly rounded, indistinguishable in shape from those of typical females (pl. 3, fig. 23; pl. 4, fig. 31).

The fore wings of the females (pl. 1, figs. 3, 4, 7, 8; pl. 2, figs. 9–14; pl. 3, figs. 17, 18, 24; pl. 5, figs. 33–40) are relatively shorter than those of the males, and are more rounded. From the apex (pl. 1, figs. 3, 4, 7, 8) the margin runs backward and outward curving broadly around the fourth red spot and running in a slightly convex line to the inner angle. Rarely the margin of the fore wings curves regularly and evenly from the apex to the inner angle (pl. 5, figs. 33, 34). On the other hand, the fore wings of the females may be produced much as in the males (pl. 5, fig. 37), but in this case the maximum height of the convexity is at the fourth red spot instead of at the third, and the margin between it and the inner angle is very rarely concave.

The hind wings of the females (pl. 1, figs. 3, 4, 7, 8) have an evenly rounded border in the majority of cases, but rather frequently the border beyond the third red spot is much less convex than normal (pl. 5, fig. 33), so that the hind wings approach the form typical of that of the male.

In both sexes there is often a curious lack of correlation in the form of the fore and the hind wings. In the males broadly and evenly rounded hind wings are sometimes found with strongly produced fore wings (pl. 4, fig. 31), while in the females broadly

rounded fore wings may occur with hind wings of the shape found in the males (pl. 5, fig. 40).

While in the great majority of cases the shape of the wings enables the males and females to be differentiated at a glance, all possible gradations may be found between the extreme male and female types both of the fore and of the hind wings. Males occur with wings one would unhesitatingly pronounce female (pl. 3, fig. 23), and females occur with wings just as emphatically male.

On making routine determinations of the sex of our series of this butterfly we found that an unusually large specimen which on the wing form had been tentatively determined as a male was in reality a female, and we at first thought that we had found a female with male wings. Later a small specimen with typically female wings (pl. 3, fig. 23) turned out to be a male. We now believe that these represent normal, though rare, variants and can not be considered as gynandromorphs.

Variation in color.—The broader variations in the amount of red on the wings has already been considered. It may be further mentioned that occasionally the red spots on the under side of the hind wings, excepting the marginal, are so speckled with black scales as to appear a deep maroon, and that in one specimen on the under side of the hind wings the spot in the cell and the spots forming the submedian band, except for the hindmost, are dull yellow instead of red, the other red spots being normal.

In the males reduction of the white markings on the upper surface is very frequent (pl. 3, fig. 21; pl. 4, fig. 26). This reduction does not affect the outermost row of spots, just within the submarginal lunules, which thus become increasingly prominent. On the hind wings the lunules are sometimes so reduced that only the merest traces remain, while on the fore wings there are only vestiges of the lunules and of the spots in the row just within that adjacent to the lunules.

On the other hand there may be a very considerable increase in the number of the white spots. In one example (pl. 3, figs. 19, 20) the submarginal lunules on the hind wings are unusually large and strongly curved. On the fore wings the row of spots within that adjacent to the lunules is as well developed as the latter, while the four spots forming the fourth row, usually barely indicated, are large and sagittate with their apices inward. In the middle of the subcostal region of the fore wings is a large hourglass-shaped spot which, were the two red spots present, would fill the space between them. Below the position of the (missing) inner red spot there is on the left wing a white spot, and on the right wing a similar white spot with another below it near the inner margin.

Another specimen (pl. 4, fig. 30) is similar, but the markings on the fore wings within the row of spots adjacent to the lunules are not so heavy, and the hourglass-shaped spot is reduced to a trace of its lower portion. On the hind wings extending downward and slightly outward from the middle of the costal margin there is a row of four small white spots, with another in the lower portion of the cell just above the origin of M_1 and another below the cell just interior to M_1.

One male (pl. 2, figs. 15, 16) has the left fore wing above with the white spots slightly elongated between the veins. In the angles between M_3 and M_2 and M_2 and M_1 there is a thick sprinkling of white scales; between M_1 and SM the lunule is fused with the adjacent spot forming an oblong white patch divided by a hair line of black, and there are two elongated ill-defined spots of white extending from beneath the origin of M_1 nearly to the large outer spot. On the under side all the white markings are much enlarged, though not fused. The markings between M_1 and SM are larger and much more definite than above. The other three wings are normal.

The females are not so variable as the males. The chief variation is in the size and brightness of the white markings which in each individual are more nearly uniform in size than in the males. In the females the white markings are generally rather small, and as their wings are usually somewhat grayish they do not stand out in such sharp contrast as they do in the males. But in some females they are large and brilliantly white and tend to become confluent wherever they approach each other (pl. 5, fig. 35).

In some females (pl. 5, fig. 37) the hind wings show a row of four small white spots extending downward and somewhat outward from the middle of the costal border, with occasionally three more extending from the lower end of this row and at right angles to it to the inner end of the red spot within the anal angle; there are sometimes one or two small white spots in the cell over the large white spots on the under side. On the fore wings the fourth (innermost) row of white spots is sometimes well developed (pl. 5, fig. 34), and there is occasionally a white spot in the inner end of the cell, and one or two beneath the origin of M_1 (pl. 5, fig. 37).

All of these small white spots occasionally appear in northern specimens, though they are not mentioned in any of the published descriptions of the insect.

In one abnormal individual (pl. 3, figs. 17, 18) the upper radial vein in both hind wings terminates halfway from its point of origin to the margin. Beyond its termination the markings of the normally two interspaces are fused. The two marginal red spots have coalesced into one large one, there is a single Σ-shaped lunule, vestigial on the upper side, and within it a much enlarged oval white spot.

EUPHYDRYAS PHAËTON PHAËTON, var. SUPERBA Strecker

The variety *superba* of this butterfly appears to recur rather frequently, all of the specimens being very much alike. It is perhaps worth while to give a list of all the recorded captures of this interesting variety. These are the following:

Long Island, New York, 1875; male; Rev. George D. Hulst. The type specimen (Strecker, Butt. and Moths of North America, 1878, p. 125).

East Williamsburgh, just outside the city limits of Brooklyn, New York, June, 1879; Rev. George D. Hulst (Hulst, Bull. Brooklyn Ent. Soc., No. 3, 1880, p. 77).

Webster, New Hampshire, June 12, 1895; W. F. Fiske, (Fiske, Ent. News, vol. 7, March, 1896, p. 87).

Milton, Massachusetts; W. D. Denton; male (Newcombe, Psyche, vol. 14, No. 5, October, 1907, pl. 2, fig. 5, colored).

Milton, Massachusetts; H. H. Newcombe; male; from the same locality as the preceding and like it, but with the white more diffused and less distinct (Newcombe; see preceding reference).

Newtonville, Massachusetts, June, 1897; female; A. H. Clark (Clark, Proc. U. S. Nat. Mus., vol. 45, June 13, 1913, p. 363, pl. 32) (pl. 2, figs. 13, 14).

EUPHYDRYAS PHAËTON SCHAUSI, var. MAGNIFICA, new variety

If the southern form of this butterfly is recognized as distinct from the northern, the southern variety corresponding to the northern *superba* will require a new name. We suggest that it be called variety *magnifica*. We have secured two specimens of this variety, as follows:

Cabin John, Maryland, June 13, 1926; female; A. H. Clark (pl. 2, figs. 9, 10).

Cabin John, Maryland, June 27, 1926; female; A. B. J. Clark (pl. 2, figs. 11, 12). Type, Cat. No. 33131, U.S.N.M.

In the earlier capture (pl. 2, figs. 9, 10) the left wings were of the extreme type, but the right wings were not so much modified. The later capture (pl. 2, figs. 11, 12) was symmetrical.

Season.—The first butterflies were found on the wing on June 11, when 26 were captured in a short space of time, all perfectly fresh and evidently only very recently emerged. None of our pupae had up to this time hatched. On this date the caterpillars seemed to be as abundant as ever, and a mass of eggs was found indicating that this insect begins to lay very shortly after its emergence.

From this time on the butterflies were common; but after the 1st of July the numbers began to decrease, though fresh individuals still represented a large proportion of each catch.

On July 11 an intensive search resulted in the capture of only 3 specimens, 1 male and 2 small females, and none were found after that date.

By a curious coincidence our latest capture in Massachusetts was also on July 11, on which date we took a male at Newtonville. But they are known to fly a little later in the North.

Our observations about Washington indicate that this insect is on the wing for about a month, and this agrees with observations elsewhere.

As fresh individuals are emerging during practically all of the time the butterflies are flying and as very few of the specimens caught are badly damaged the natural inference is that the life of the individual adults is very short; but we have no direct evidence to offer on this point.

Habits.—There is a great difference in the habits of the two sexes of this butterfly, and apparently considerable diversity between different individuals of the same sex. The smaller females (pl. 3, fig. 24) are much more active than the larger ones (pl. 5, figs. 35, 38), and we have frequently found that an individual which we thought was a male proved on capture to be a small female. Similarly the larger males (pl. 4, fig. 25) are less active than the smaller ones (pl. 4, figs. 26, 27).

The large females we have never seen more than about 20 feet away from the food plant, but the small females occur throughout the range of the males. We are inclined to believe that these small females represent a specialized form the function of which is the dissemination of the species.

Both sexes seem to shun the food plant, and the only individuals we have seen upon or even very near it were large females engaged in oviposition.

But while the butterflies show a strong distaste for this plant, preferring to rest on almost any other, especially on grasses, they never voluntarily wander very far from it. They are most common in the grass from 10 to 50 feet from the patches of *Chelone*, and the males and smaller females are frequent up to about 100 feet away. Beyond that distance only rare stragglers are found.

In cloudy weather and on cool days the butterflies are very reluctant to take wing. Under these conditions we have industriously searched for them at the height of the season with the most discouraging results.

On bright hot days, however, the males, especially the smaller ones (pl. 4, figs. 26, 27), are very active. They fly rather swiftly for their size, with rather rapid wing beats and occasional glides after the manner of *Junonia*. Usually they keep near the grass tops, but occasionally they will dart rapidly upward in an erratic zigzag to a height of sometimes as much as 10 or 15 feet, soon coming down and perching on a grass blade. They will often go for a long distance without alighting, sometimes even out of sight. On a hot and sunny day these small males when they take wing are by no means easy butterflies to catch, though when resting they are singularly unsuspicious.

The large females (pl. 5, figs. 35, 38) always are inert, and when started usually fly only a yard or two, and seldom as much as 20 feet They fly only a few inches above the grass tops with a weak and tremulous flight. When resting they are wholly unsuspicious. Once seen, either on the wing or resting, they can invariably be caught.

Oviposition.—Three females were observed in the act of depositing their eggs. In all cases the plant chosen was a very vigorous one well within a dense growth of similar plants which at the time were about 6 inches in height. The more numerous smaller and more scattered plants seemed to be avoided.

The females all selected one of the largest and best developed leaves situated about halfway between the ground and the summit of the plant and extending outward horizontally from the stem. To the under side of this they clung transversely.

During oviposition all three females fanned the air slowly and constantly with their wings. It was the motion of the checkered under side of their wings that attracted attention to them. Had it not been for this they would have been almost invisible, deep down as they were in a mass of dark green foliage through the interstices of which appeared the blackish mud of the swamp.

The habit of this butterfly in crawling deep down into the denser portions of a vigorous colony of the food plant in order to find a suitable place for oviposition is noteworthy.

When engaged in placing their eggs the females are singularly unsuspicious.

All of the egg masses found extended from the midrib nearly or quite to the edge of the leaf, and varied from oval to almost circular in shape. All were incomplete, consisting of a single layer of eggs with sometimes part of a second.

Eggs.—A mass of clear light lemon yellow eggs collected on June 11, and which were probably laid on the same day, went through the various color changes described in detail by Mr. Scudder and hatched on June 27—that is, in 17 days.

Young caterpillars.—To one who is accustomed to gather butterflies mostly by means of a net, this seems to be a rather infrequent species. But in reality it exists in great numbers, although it is very local in its occurrence.

In order to appreciate the abundance of this insect in New England, it is only necessary to search for its food plant toward the middle of August when the conspicuous webs of the caterpillars, now at the summit of the stalks, are at their maximum size. These webs will be found in great profusion wherever the food plant grows.

In eastern Massachusetts we have found them wherever we have found the turtlehead, which here is common. Indeed, in a marshy spot in Prospect Hill Park, in Waltham, dozens of the webs may easily be seen from the road. We have sometimes been surprised to

find how small a colony of plants would support colonies of these caterpillars. The discovery of these very small isolated groups of plants certainly speaks well for the pioneering capabilities of this butterfly.

In a moist hillside south of Otis Street, in Newtonville, there is a small patch of turtlehead which certainly never consists of more than 20 plants. While fairly close together, these are more or less scattered in the long grass. For at least 29 years this little isolated group of plants has supported a colony or two of these insects.

About a hundred yards away down the hill there is another patch of the plants, a little larger. Here also there are always to be found a few colonies of this butterfly. The nearest colonies to these are a mile or more away.

We have often been surprised to find the webs on isolated plants growing by the roadside far from any others.

At the end of August, 1925, we made a search for webs in Essex, as we wished to bring some caterpillars back with us to Washington. But although we found the turtlehead in several places the few webs we found were torn and ragged ones, containing only a very few small and seemingly sickly caterpillars.

The mystery was solved by the eventual discovery of several webs quite different from the usual type of web found on the *Chelone* tops. These webs were small, dense, and opaque, roughly fusiform, and commonly about 4 inches long and an inch or so in thickness. They somewhat distantly suggested a large, loose, and irregular cecropia cocoon. Some were spun about several grass blades, one was on a stem of *Eupatorium purpureum*, and others were on various plants. They all agreed in being low down near the ground in the general mass of herbage and therefore very inconspicuous. Sometimes they were at the base of the *Chelone* stems, but often 2 or 3 feet or more away from the *Chelone* plants. Frequently strands of silk ran between these inhabited webs and the deserted webs on the summits of the stalks of turtlehead. Probably there is always a silken trail at first which, being delicate, soon gets destroyed.

Presumably these were webs especially constructed for hibernation after the caterpillars had finished feeding.

In the locality in Prospect Hill Park, in Waltham, in the previous year we had found the caterpillars prepared for hibernation in the feeding webs, a part of which, usually the lower part, they had thickened considerably. But this does not mean that there were not plenty of small dense webs in the grass or elsewhere which we overlooked.

One of the hibernating webs found at Essex was just below a feeding web to which it was broadly united by great numbers of silk threads,

so that it almost seemed to be part of it. This, therefore, represented a condition intermediate between hibernation in a part of the feeding web and the construction of a distant isolated web.

At Essex the *Chelone* was more or less scattered in rather thick grass nearly as tall as it. At Waltham it was in much larger patches and was taller than the surrounding herbage. It may have been that at Waltham the caterpillars did not have so much temptation to wander off the food plant.

It may be mentioned that the turtlehead is a singularly brittle plant and therefore much less safe a place for hibernating webs than grasses, *Eupatorium*, or the other plants on which we found them. We may also in this connection call attention to the somewhat curious fact that after hibernation the caterpillars will not remain upon the turtlehead except when actively engaged in feeding, and therefore are much more often found on other plants, especially dead leaves and twigs.

We found in the locality in Essex that the hibernating webs always contained caterpillars of very nearly the same size; the smaller and weaker ones apparently were left behind. The number in the webs was never very large, commonly less than 100.

While the feeding webs, large and loose and conspicuously situated at the summit of the *Chelone* stalks, are easy to see, the hibernating webs, much smaller and more compact, built nearer the ground, and usually more or less hidden by the grass, are difficult to find.

On our return to Washington early in September, 1925, we made a search for turtlehead, and found it growing abundantly in a field south of the Conduit Road just 2 miles beyond the Cabin John Bridge. In a moist hollow about midway between the road and the canal there was a large patch roughly 20 feet long and 15 feet broad, the plants in the wetter portion being exceedingly vigorous and close together, those in the drier portion smaller and more scattered. Beyond this moist hollow there runs an old drainage ditch parallel to the road, and all along this ditch are small patches of *Chelone*.

Certain that this insect was to be found here, we made a careful search for it on several different days; but we found not the slightest trace of webs, nor did any of the plants show any evidence of feeding.

Older caterpillars.—In the first week in September, 1925, we brought with us to Washington from Essex, Massachusetts, a number of caterpillars inclosed in a hibernating web.

These were kept outside until February 25, 1926, when they were brought into the house and supplied with succulent shoots of *Lonicera japonica* which had been forced in water. For nearly a week they wandered about without eating; then most of them attacked the plants and began to grow rapidly.

In feeding, the caterpillars always first attacked the terminal buds and then ate downward along the stem. The leaves were scarcely touched until after the first spring molt.

All of the caterpillars molted on March 8 and 9—that is, 11 or 12 days after having been brought from hibernation.

As the caterpillars increased in size they fed with avidity, consuming larger and larger leaves. But one by one they all died off. A single one suspended itself for pupation on April 2, but died without casting its larval skin.

This single northern caterpillar therefore molted once between hibernation and pupation, as described by Mr. Scudder.

On May 10 we visited the locality beyond the Cabin John Bridge, but could find no traces of caterpillars. On May 31, however, caterpillars of various sizes were found in great abundance on all the plants near the large patch of turtlehead, on ferns, grasses, ash, elder, *Viburnum*, willow, cat-tails, etc., but especially on the dead dry leaves and stalks of cat-tails and grasses and the dead last year's stems of various herbaceous plants. One hundred and eleven caterpillars were collected without apparently reducing their numbers.

The caterpillars varied very greatly in size. Many appeared to be fully grown, but a few were scarcely larger than the normal size after the first spring molt. Several were found suspended from a silken button preparatory to pupation; two of these cast the larval skin during the ride home.

The largest caterpillars were placed in four boxes of 25 each. About one-third pupated at once, but nearly all the pupae were at once attacked by the other caterpillars. In one box 10 out of 12 pupae were more or less bitten, usually in the anterior half of the ventral surface, and one was almost completely devoured, only a few empty abdominal segments remaining.

Much to our surprise, the caterpillars which did not pupate molted again. All of the caterpillars brought back were of approximately the same size, and were all, we thought, fully grown, as in the field a number were already suspended for pupation.

All of the butterflies from the caterpillars found suspended in the field as well as from those that pupated in the boxes were males.

We tried feeding the caterpillars on *Wisteria*, which they would not touch, and on *Lonicera japonica*, which they ate, though not with relish. *Chelone* they recognized at once and eagerly devoured.

In the field we have found the caterpillars on the leaves of ash and of *Viburnum* which they had eaten in their characteristic way by cutting in from about the middle of the side.

Our belief is that after hibernation, as well as before, these caterpillars normally feed only on *Chelone*. But they visit this plant only

to feed, after each meal wandering away and seeking any convenient support, preferably dried stalks and leaves of cat-tails and grasses and herbaceous annuals, on which to rest. After resting they retrace the silken thread they always spin wherever they go, wandering down from their supports and back to the *Chelone*. If their thread is broken and they can not find the *Chelone*, they will make a temporary meal of a large number of different kinds of plants. From our observations we believe that normally the turtlehead is their sole food, and other plants are eaten only through necessity.

We have seen large numbers of the caterpillars on the *Chelone*, and have observed that such caterpillars were always busily engaged in feeding. They seem to avoid remaining on this plant longer than is absolutely necessary. They attack mostly the larger leaves, eating inward from about the middle of the edge and thus excavating large rounded sectors. When feeding they are very conspicuous, and they make not the slightest attempt at concealment.

When on the *Chelone* the caterpillars are usually to be found in groups often of as many as a dozen or more. There seems to be no reason why they should concentrate on a few sprigs of the plant out of hundreds growing together. We believe that the apparent sociability of the nearly full-grown caterpillars is merely the result of their following up each others' silken trails if they happen to cross them in returning to the food plant.

The first act of the little caterpillar on leaving the egg is to spin a thread of silk, and all their lives they spin wherever they go. Small caterpillars after hibernation spin an astonishing amount of silk in going back and forth to their food plants, and if they are kept in small containers this has to be constantly cleaned out. This habit of spinning abundant silk is kept up until pupation.

From our observations we are led to believe that at all stages the caterpillars feed at any time of the day or night, provided only that the temperature is sufficiently high. Our small caterpillars in the heated house fed equally at all hours. At any given time, day or night, a few would be feeding and the majority resting as far away as they could get from the food plant. In the field we found the large caterpillars feeding at all times of the day, and the caterpillars we brought home fed ravenously at night.

But at any given time there are always many more caterpillars to be found resting on the surrounding herbage than feeding on the *Chelone*.

This habit probably results in a considerable wastage in caterpillars each year, and probably also accounts to some extent for the very great diversity in size, since not all of the smaller caterpillars are parasitized. It is likely that in many cases the silken trails from the

food plants to the resting places get broken from one cause or another so that many of the caterpillars, unusually active though they are, are unable again to find their normal food.

As has previously been remarked by others the caterpillars are singularly tenacious of life. Some in the last stage which we kept for 30 days without food still were active, though their size was much reduced.

Unlike the caterpillars of many other butterflies, these apparently will not pupate untill the full size is reached.

On June 11 about 100 additional caterpillars were bought in, and more on June 13 and June 20. The butterflies were now flying in abundance, and we noticed that the caterpillars were divisible into two size groups, a larger and a smaller, though there were many intermediates and some dwarfs due probably to lack of sufficient food and to parasitism.

The smaller caterpillars corresponded to those which we had first found which had pupated at once and emerged as male butterflies. The larger caterpillars, which were much larger and stouter, we assumed to correspond to those which instead of pupating had molted. The butterflies from these all proved to be females.

Although we have no conclusive evidence to offer we are strongly inclined to believe that after hibernation male caterpillars molt but once, while female caterpillars molt twice; that is, that male caterpillars molt four times and female caterpillars five times.

It is curious that the female caterpillars are much easier to raise than the males. Though the male caterpillars, like the male butterflies, appear to be much more numerous than the females, most of the butterflies that came through successfully were females.

On June 27 there were still many caterpillars feeding. As only one caterpillar was found suspended and there were very few on the surrounding herbage we thought it probable that the caterpillars still feeding were parasitized, more especially as none were very large.

On July 17 and 18 an exhaustive search was made for the butterflies, without result. The flight seemed to be entirely over for the season.

Four webs of conspicuous size were found which entirely surrounded the upper part of the *Chelone* stalks on which they were constructed. The caterpillars in them, which were busily engaged in enlarging and strengthening them, were still in the first stage, though apparently about ready to enter the second.

No last year's caterpillars were found in the field, but in our boxes in the house a few were still alive, all more or less surrounded by *Apanteles* cocoons.

In this butterfly, therefore, a few of the caterpillars of one year's brood live as caterpillars beyond the entire range of the adult life of

the butterflies of the same brood, and overlap by at least three weeks the caterpillars of the next year's brood. Throughout the entire year this insect is to be found in the caterpillar stage, and for at least three weeks the caterpillars of two successive broods exist together.

On August 3 there were about a dozen webs, which were of all sizes from very small ones 2 to 3 inches long involving only the summit of the *Chelone* and containing caterpillars in the early days of the first stage to very large ones over a foot long involving half a dozen or more plants and the intervening herbage and inhabited by caterpillars of hibernating size. Two of the largest were deserted, the caterpillars having apparently wandered off to form a hibernating web which we were unable to discover.

The very large straggling nests were formed by the coalescence of two, or in one case of three, adjoining nests.

Some of the nests were borne mostly by plants other than *Chelone*. *Eupatorium purpureum*, ferns and grasses were frequently incorporated. But we are sure that in all cases the caterpillars fed only on *Chelone*, though seeming to prefer to rest in that part of the nest supported by other plants.

One nest was found on *Mimulus ringens*, which here commonly grows among the turtlehead. But there was no evidence that the *Mimulus* was being used for food.

On August 7 there were two very small additional webs with very small caterpillars not long hatched. Two of the large webs were in process of being deserted by the caterpillars, which were gathered in a compact mass entirely outside of them below and to one side of their lower ends. The caterpillars were wholly exposed, but rested on a thick flooring of silk which was continuous with the lower end or one side of the web. Evidently these caterpillars were beginning the construction of the hibernating web.

On August 7 the caterpillars were in all stages from the early days of the first stage to the fully fed hibernating stage. Our observations would indicate that the caterpillars feed for about three weeks and then pass into the resting condition. The different egg masses hatch over a period of about a month corresponding to the month that the butterflies are on the wing, and similarly the caterpillars in the different nests enter the resting stage over a period of about a month, from the first to the last of August.

On August 28, after more than a week of showery days, all the webs had disappeared. Of the largest web there were still a few traces left in the form of a few ragged strands of silk with a large amount of frass entangled in it; but these were so inconspicuous that only a close examination revealed their presence. About 2 feet away from the place where this largest web had been there was a fresh hibernating web formed within a leaf of *Sagittaria*, which had been

curled around so that its edges overlapped for half an inch or more, forming a cylinder which had been lined with silk and the ends of which had been closed with silk.

Pupa.—We have searched very carefully for the pupa of this species, but we have never been able to find a single one, though we have found many caterpillars suspended from silken buttons preparatory to pupation. These were mostly on dead cat-tail leaves, dead leaves and stems of grasses, and dead stems of asters and other herbaceous plants.

We believe that the pupae of this butterfly after becoming hardened normally drop from their supports and lie upon the ground until the butterflies emerge. The pupae are weakly attached to the button, and the caterpillars are singularly careless in regard to the supports chosen for pupation. Caterpillars pulled from the button and forced to pupate lying on their side form pupae just as perfect as those which are formed suspended.

The duration of the pupal stage was 10 days for both sexes. A number of female caterpillars which were kept in an incubator at 80° for 4 days beginning just after suspension emerged in 7 days. Others which were placed on ice emerged in 10 days plus the length of time they were on the ice, whatever that was.

Exposure to heat.—Twenty-four female caterpillars ready for pupation were kept in an incubator at a constant temperature of 80° for 4 days. All the pupae formed in the incubator transformed to butterflies. The length of the pupal life was shortened to 7 days from the usual 10.

All the butterflies were perfect and showed no deviation from the normal except that in three the white spots on the upper surface were slightly enlarged and the two outer rows on the primaries tended to become confluent (pl. 5, figs. 34, 35, 38, 39).

Exposure to cold.—Twenty-four female caterpillars ready for pupation were kept at a temperature of 40° for varying periods of time. All the pupae formed transformed to butterflies. The pupal life was in all cases lengthened to 10 days plus the length of time spent in the cold chamber.

About one-quarter of the butterflies had one or more of the wings reduced in size, but there were no other deviations from the normal (pl. 5, figs. 33, 36).

Parasites.—On March 1 a single parasitic larva emerged from one of the caterpillars brought to Washington from Essex, Massachusetts, and formed a cocoon about half an inch away from its victim. This parasite was identified as *Apanteles clisiocampae* by Mr. R. A. Cushman.

On May 31 three dead caterpillars were found on dead cat-tail leaves surrounded by the cocoons of *Apanteles euphydryadis*. All of the cocoons were empty, the parasites having emerged.

On June 15 a number of *Apanteles* larvae emerged from a caterpillar which had been collected on May 31, and between June 22 and 25 larvae in greater or lesser numbers emerged from 15 more caterpillars which had been collected on June 13 and 20. The emergence continued; by June 30 larvae had emerged from 12 more, and by July 18 from 18 additional, making a total of 46 caterpillars out of about 250, about 18 per cent, victims of this parasite.

On June 30 a small tachinid pupa was found in one of the boxes by the side of a caterpillar from which evidently it had just emerged. Mr. Charles T. Greene very kindly identified this for us as *Tachina mella*.

About the middle of July another tachinid larva emerged from a caterpillar. Through the kindness of Dr. John M. Aldrich we are able to say that this was *Phorocera claripennis*.

EXPLANATION OF THE PLATES

Plate 1

Fig. 1. *Euphydryas phaëton phaëton*, male, Stoncham, Massachusetts, June 27, 1926; C. V. Blackburn.

2. The same specimen, under side.

3. *Euphydryas phaëton phaëton*, female, Weston, Massachusetts, July 9, 1923.

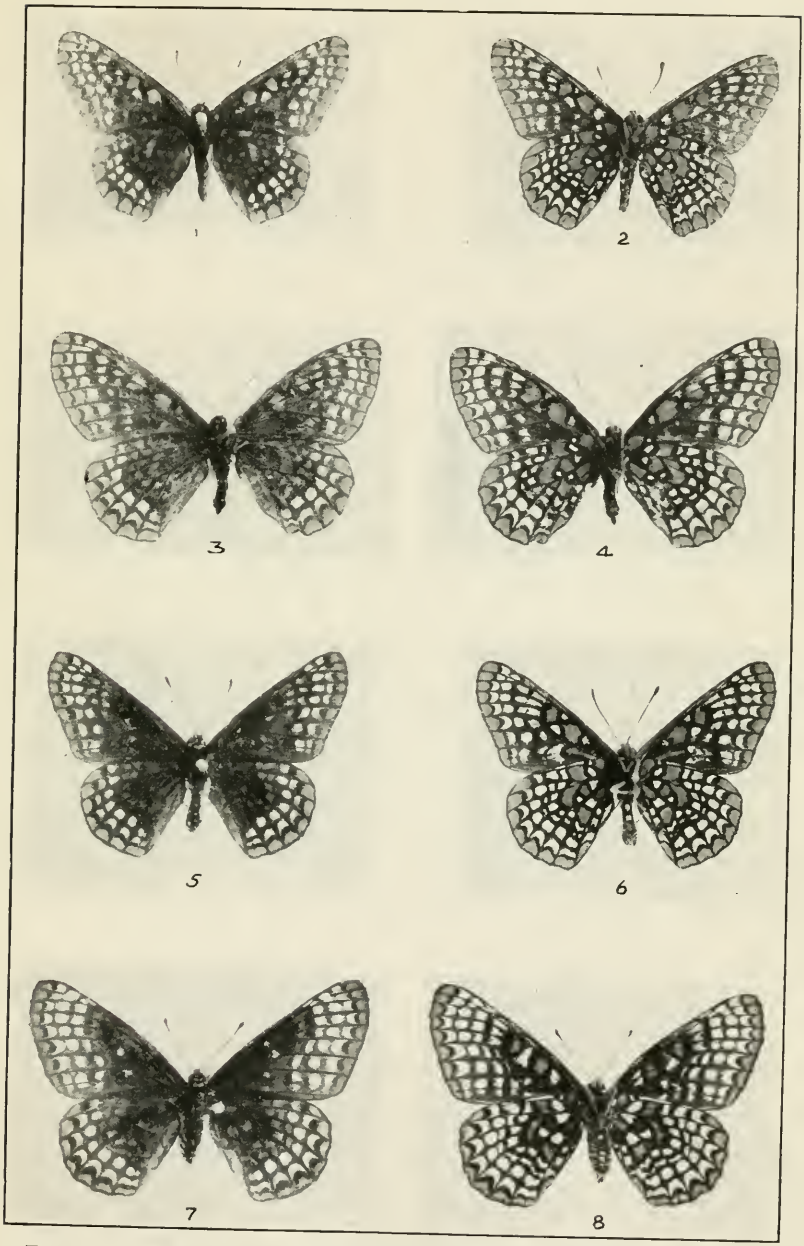
4. The same specimen, under side.

5. *Euphydryas phaëton schausi*, male, type; Cabin John, Maryland, June 13, 1926.

6. The same specimen, under side.

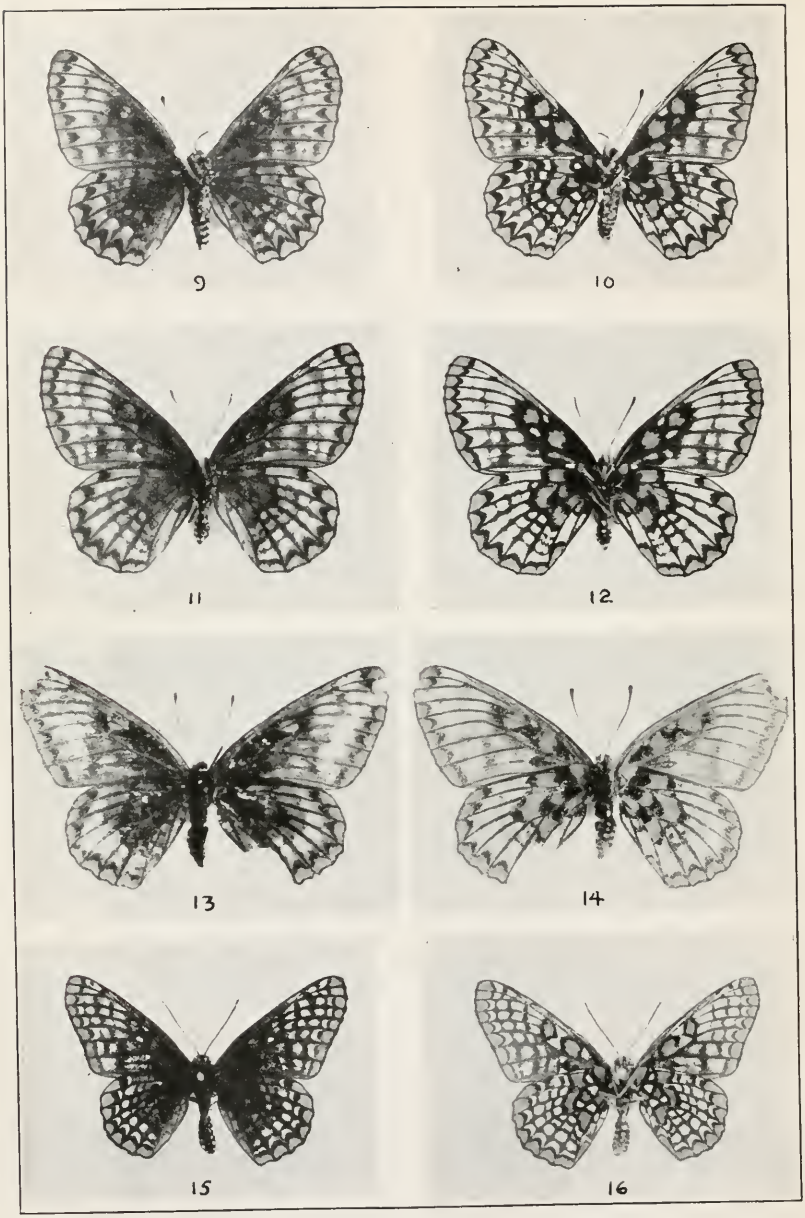
7. *Euphydryas phaëton schausi*, female, type; Cabin John, Maryland, June 22, 1926.

8. The same specimen, under side.



EUPHYDRYAS PHAËTON PHAËTON (FIGS. 1-4) AND EUPHYDRYAS PHAËTON SCHAUSI (FIGS. 5-8)

FOR DESCRIPTION OF PLATE SEE PAGE 18



EUPHYDRYAS PHAËTON SCHAUSI, VAR. MAGNIFICA (FIGS. 9, 12, 15, 16) AND EUPHYDRYAS PHAËTON PHAËTON, VAR. SUPERBA (FIGS. 13, 14)

FOR DESCRIPTION OF PLATE SEE PAGE 19

Plate 2

Fig. 9. *Euphydryas phaëton schausi*, var. *magnifica*, female; Cabin John, Maryland, June 13, 1926.

10. The same specimen, under side.

11. *Euphydryas phaëton schausi*, var. *magnifica*, female, type; Cabin John, Maryland, June 27, 1926.

12. The same specimen, under side.

13. *Euphydryas phaëton phaëton*, var. *superba*, female, Newtonville, Massachusetts, June, 1897.

14. The same specimen, under side.

15. *Euphydryas phaëton schausi*, male, with the left fore wing approaching the variety *magnifica*; Cabin John, Maryland, June 13, 1926.

16. The same specimen, under side.

Plate 3

All the figures represent *Euphydryas phaëton schausi* from Cabin John, Maryland

Fig. 17. Female with the upper radial vein in the hind wings only partially developed; June 20, 1926.

18. The same specimen, under side.

19. Male with an unusual development of the white markings; June 24, 1926.

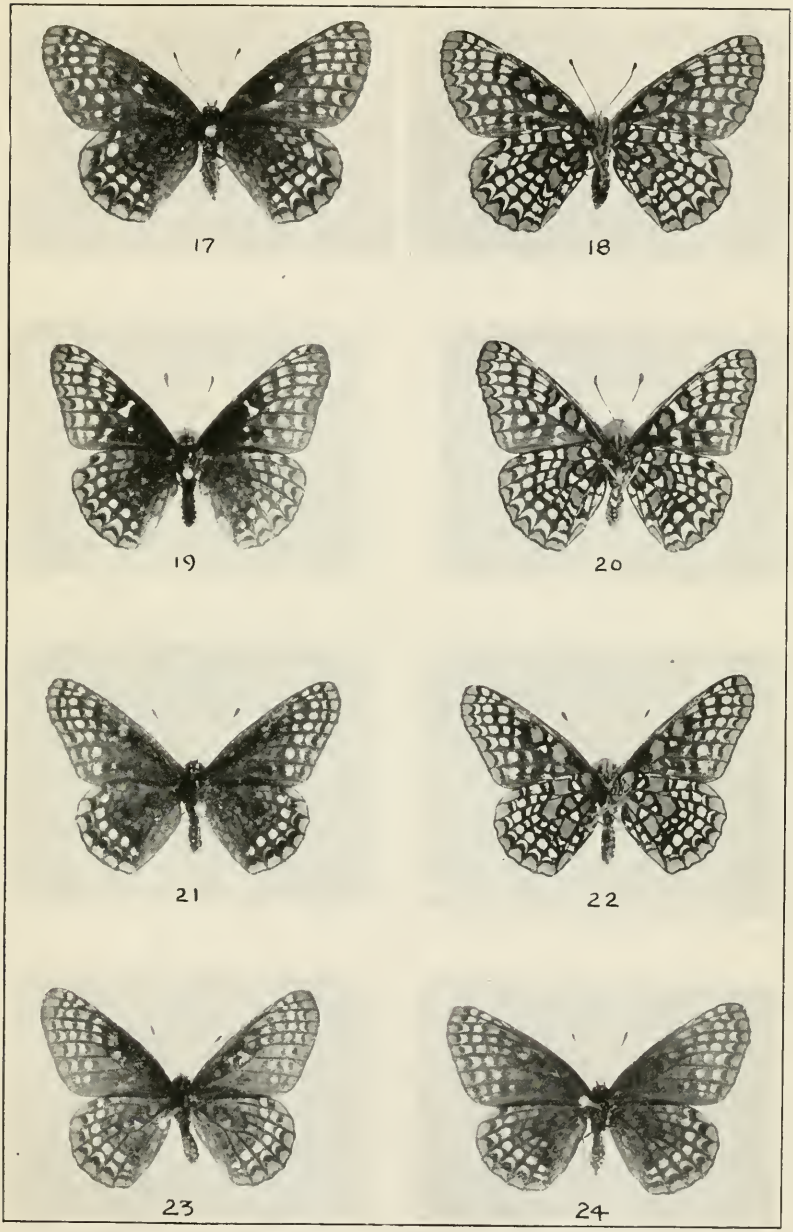
20. The same specimen, under side.

21. Male with the white markings restricted; June 20, 1926.

22. The same specimen, under side.

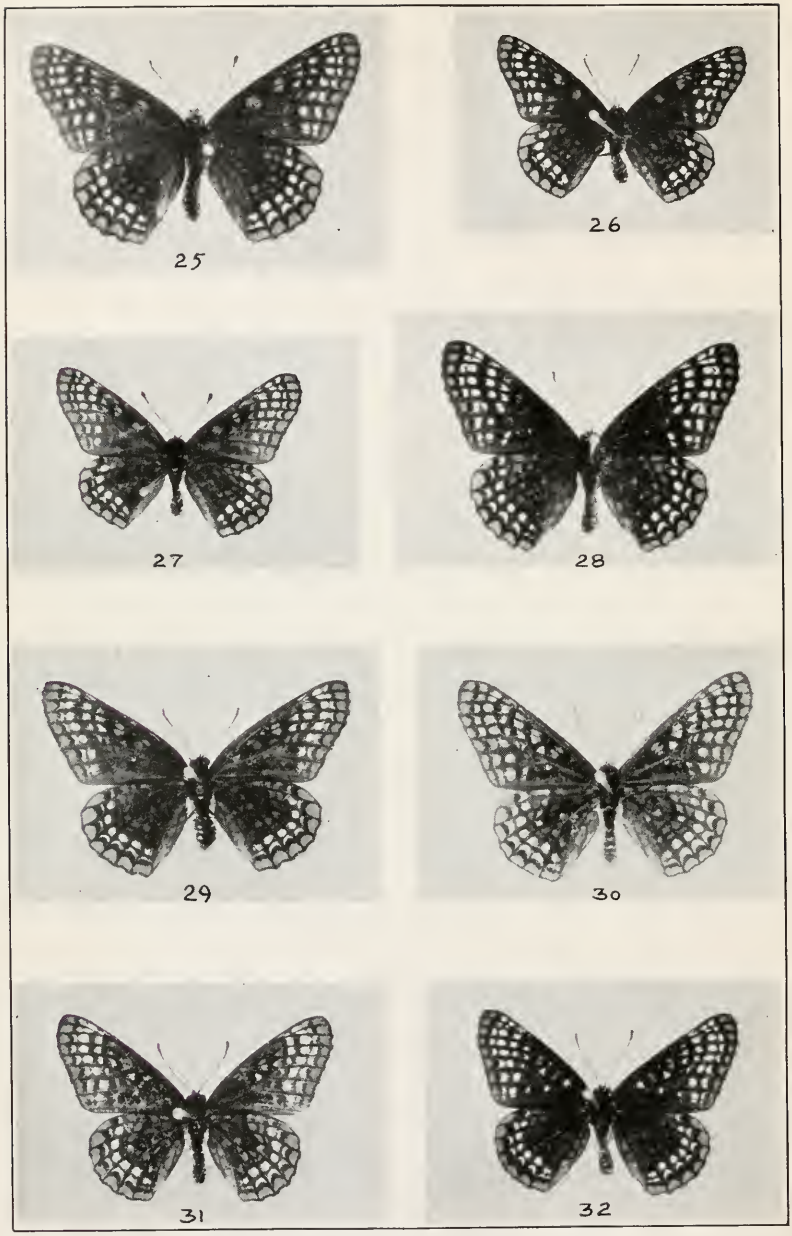
23. Male with the wings the shape and color of those of the female; July 3, 1926.

24. Small female, for comparison with the preceding.



EUPHYDRYAS PHAËTON SCHAUSI

FOR DESCRIPTION OF PLATE SEE PAGE 20



EUPHYDRYAS PHAËTON SCHAUSI, MALES

FOR DESCRIPTION OF PLATE SEE PAGE 21

PLATE 4

All the figures represent *Euphydryas phaëton schausi* from Cabin John, Maryland

FIG. 25. An unusually fine male; June 20, 1926.
26. An unusually small male, with the white markings much restricted; June 14, 1926.
27. A similar, but lighter colored, male; June 13, 1926.
28. Male; June 20, 1926.
29. Male, showing the typical shape of the male wings; June 27, 1926.
30. Male with an extensive development of white spots in the normally black portions of the wings; June 13, 1926.
31. Male with the hind wings shaped like those of the female (compare with figs. 27 and 29 above); June 13, 1926.
32. Male with the hind wings shaped like those of the female and the left fore wing shortened; June 14, 1926.

Plate 5

All the figures represent *Euphydryas phaëton schausi* from Cabin John, Maryland

Fig. 33. Female which for four days in the early stages of pupation was exposed to a temperature of 40°.

34. Female which for four days in the early stages of pupation was exposed to a temperature of 80°.

35. Female treated as that shown in Figure 34.

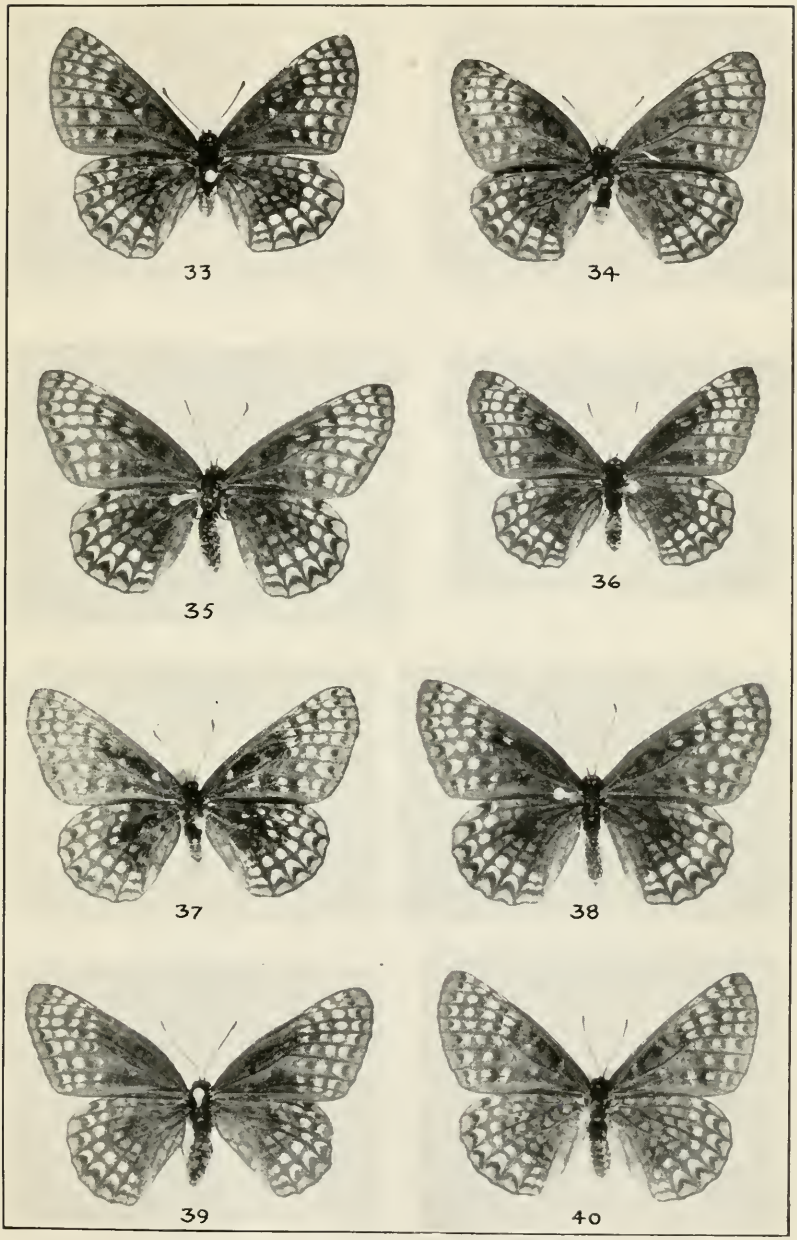
36. Female treated as that shown in Figure 33.

37. Female with an unusual development of white spots in the normally black area; June 11, 1926.

38. Female treated as that shown in Figure 34.

39. Female treated as that shown in Figure 34.

40. Female with the fore wings unusually short (see also figs. 9 and 10, pl. 2); June 11, 1926.



EUPHYDRYAS PHAËTON SCHAUSI, FEMALES

FOR DESCRIPTION OF PLATE SEE PAGE 22