

A REVISION OF THE GEOMETRID  
MOTHS FORMERLY ASSIGNED  
TO *DREPANULATRIX*  
(LEPIDOPTERA)

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FORMERLY ASSIGNED TO *DREPANU-  
LATRIX* (LEPIDOPTERA)

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## INTRODUCTION

OF ALL THE GENERA of the subfamily Ennominae, the group of moths heretofore included in recent check lists (Barnes and McDunnough, 1917; McDunnough, 1938) under the generic name of *Drepanulatrix* Gumpfenberg is one of the least understood. The combination of general structural similarity of the various species with a rather remarkable degree of variation in color, maculation, wing shape, and, to a lesser extent, size, within the species has served as an effective barrier to accurate identification. It has been felt for some time that this group of species was not homogeneous when considered on the basis of characters believed to indicate natural affinity. It is the purpose of this paper to try to reevaluate this group of moths, to answer some of the questions pertaining to its phylogeny, distribution, and taxonomy, and to propose a more satisfactory systematic arrangement of the species.

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of Berkeley, California. Finally, thanks are given to Professor H. J. Reinhard of the Agricultural and Mechanical College of Texas and to Mr. C. F. W. Muesebeck of the United States National Museum for the identification of parasites obtained in the course of life history studies.

The genitalic drawings and distributional maps were prepared by Miss Alice Gray of the American Museum of Natural History under the author's direction.

### HISTORICAL BACKGROUND

One of the major problems in this group of moths is the multitude of names that have been applied; to date 39 specific or intraspecific names have been used in combination with 18 different generic names. In the latter category only two of the 18 generic names have any bearing on the problem today, since they were the only ones actually based upon species that fall within the group as here defined.

The earlier of these is *Drepanulatrix*, erected by C. F. von Gumpfenberg in his "Systema geometrarum zonae temperationis septentrionalis" (1887). In this work the use of wing venational characters, accepted by earlier workers and which provide today the primary characters for the division of the Geometridae, was repudiated. Instead, Gumpfenberg proposed an entirely new classification of the family based almost entirely on wing form; he used *falcataria*, described by Packard in 1873, as the single included species, on the basis of the strongly falcate nature of the forewings. Yet, by the date of his publication, at least 11 other specific names had been applied to species assignable to the group as now understood. Four of these species were treated by him under a variety of other generic headings, while the remainder were not included in his work.

Following the proposal of *Drepanulatrix*, the genus remained unrecognized in this country for many years. Consequently, G. D. Hulst in his "Classification of the Geometrina of North America" (1896), when faced with the problem of placing *falcataria* in his scheme of classification, unfortunately added some more synonyms to the literature. He

listed *falcataria* under *Deilinia* Hübner, then redescribed this species as *electa* and placed it in a new monobasic genus *Aethyctera*, largely on the basis of the falcate forewings. Hulst followed the subfamily classification of Lederer and Meyrick and, due to the fact that the hind wings have seven instead of eight veins, placed his new genus in the Ennominae (Selidosemidae of Meyrick), where it appears in today's lists.

Not until 1916 did the name *Drepanulatrix* reappear in the North American literature, at which time Barnes and McDunnough in volume 3 of their "Contributions to the natural history of the Lepidoptera of North America" used it in its present sense. These same authors, in their "Check list" (1917), listed the species essentially as they stand today, and the McDunnough "Check list" (1938) made but few additional changes.

#### MATERIALS AND METHODS

**MATERIALS STUDIED:** This revision is based on a study of the specimens in some of the major eastern and western museums and the private collections of several individuals; these have been referred to specifically under the section on acknowledgments. Nearly all the type specimens in this country have been examined; the only types not studied were those of Guenée (*monicaria*, *unicararia*), Walker (*liberaria*, *integraria*), and Warren (*erubescens*, *carneata*), which are in Europe or England, and those of Hulst (*behrensaria*), Strecker (*mercedulata*), and McDunnough (*columbiaria*) in this country and Canada. More than 4000 specimens have been studied. Over 300 genitalic slides have been prepared by the author, mainly from specimens in his own collection, and 156 additional slides have been examined at the United States National Museum and the Museum of Comparative Zoölogy, making a total of over 456 slides, which include those of nearly all the types. In addition, venational and larval slides have been prepared. A number of Dyar's inflated larvae at the United States National Museum and a considerable quantity of eggs, larvae of all instars, and pupae preserved in alcohol from the author's collection have been studied.

**FIELD WORK:** Adult moths of this group have been collected throughout the state of

California since 1938 by the author. An unsuccessful attempt to collect them in the Rocky Mountain states was made in the summer of 1948 with the assistance of the author's wife. The adults were collected almost exclusively at lights during the hours of darkness. Three general types of light collecting have been employed involving (1) ordinary electric lights and neon signs in towns, (2) electric light traps utilizing blue light (described and illustrated by Herms, 1947, pp. 360-362), and (3) gasoline lanterns with a large white background to serve as a reflecting surface. Sugaring has not proved successful in the few trials attempted, but more work with this method would be desirable. Occasionally the adults may be disturbed from vegetation during the day and captured while flying.

Larvae had been obtained by beating *Ceanothus* bushes in the early spring and fall months in the San Francisco Bay area. For this work, beating over a large inverted umbrella held underneath the bush has proved satisfactory.

**LARVAL REARINGS IN THE LABORATORY:** The caterpillars, often representing all instars, collected in the field were brought into the entomological laboratories of the University of California and reared to adult moths. Temperature and humidity conditions were those of the room except as modified by the organisms and food plant within the rearing cages. Small larvae were placed in 4-inch, glass petri dishes together with a quantity of food plant, stems of the latter being in a small vial with water in order to maintain freshness as long as possible. In this way the larvae were easily accessible at all times for observations, measurements, etc. The caterpillars proved to be easy to rear, with no evidence of cannibalism, so that relatively large numbers could be kept in the same container. The life history was either entirely completed in the petri dishes, or the larger larvae were transferred to wire-enclosed breeding cages of the author's design. These cages were 11½ inches high by 4 inches in diameter and included a well for water to keep the food plant fresh and a quantity of dirt for pupation.

To obtain eggs, adults, after emerging from their pupal cases, were confined in the wire



breeding cages together with their food plant. In nearly every case fertile eggs were obtained; these were usually laid on the wire screen, especially on the top, with only a relatively few being deposited on the leaves. These eggs were transferred before hatching to the 4-inch petri dishes and placed either on fresh leaves of the food plant or on the glass bottom of the dishes.

**DESCRIPTIONS:** Owing to the variations in color and maculation of the wings of these moths, the descriptions of the various species are of necessity rather long and generalized. However, the same basic pattern has been followed throughout this paper for all specific descriptions. All species are characterized by a detailed description of the adult male with short comparative notes on the female. The genitalia of both sexes are described fully, and notes on the early stages are given whenever possible.

A binocular dissecting microscope has been used throughout when describing the adults, genitalia, and early stages. All measurements for the length of antennal pectinations in the adult males, for the genitalia of both sexes, and for the early stages were first made with an eyepiece micrometer and then converted to millimeters.

**VARIATION:** As has been mentioned above, the range of variation of the imago in color, maculation, wing shape, and size both within the species and in the group as a whole is rather extensive. This has undoubtedly been a major factor in the large number of names that have been proposed. There is a tendency in several of the species, especially *monicaria*, *baueraria*, and *liberaria*, for the median area of the forewings of the males to become partially or wholly suffused with black. These suffused forms, where they have been named, have been described as distinct species. However, breeding experiments with *monicaria* have shown that both the suffused and normal forms can come from one batch of eggs from a single female and that the progeny through the  $F_2$  generation is completely interfertile. This tendency towards suffusion is present to a lesser degree in the females of the above species, where the suffusion is likely to be with dark reddish or brown scales rather than with black; it may be present in this rather intermediate form in some of the other

species as well.

There is apparently another much less common tendency for both sexes to have very lightly colored and lightly marked specimens. This fact should be kept in mind when unusually light-colored specimens are being identified.

**TERMINOLOGY:** The terms used in the descriptions and discussions are those that are used throughout the lepidopterous literature. The terminology of the genitalia of both sexes is taken from Pierce (1914), where the various organs and their relationships are defined and discussed.

With regard to the terminology used for the early stages, Heinrich has been followed for naming the setae of the larval heads, while arabic numbers are used to designate the setae of the thorax and abdomen, following Peterson (1948); the latter (pp. 63–65) gives a section on discussion of terminology. For the pupal nomenclature, Mosher has been used as the basis for terminology.

**DISTRIBUTIONAL RECORDS:** The distribution or range of each species or subspecies is briefly summarized under each name, and distributional maps have been prepared to show known details as accurately as possible. The data have been obtained from an examination of all specimens available in the collections above mentioned. For the sake of brevity, the complete distributional data (locality, date, collector, and institution) for each species are not listed in full; it is felt that these would add too much length to the paper without a corresponding increase in value.

#### GEOGRAPHICAL DISTRIBUTION

All the known species of this group of moths are confined to continental North America; with one exception they are found in the western half of the continent in the area between the northern boundary of Mexico and southern Alaska. The single exception occurs in the eastern United States and Canada from Georgia to Ontario and from the Atlantic coast to Wisconsin. As yet no species are known from Mexico, but careful collecting in that country, especially in the northern mountains, may reveal the presence of some species or subspecies. In the United States the greatest number of known species, in fact every one that occurs anywhere in the

west, is found in California. The other Pacific coast states follow in having the next largest number of species. The Rocky Mountain region has representatives of most of the species, but to date the number of specimens collected from that area is small in comparison with the west coast region. When the Rocky Mountain area is as intensively collected and as well known as the Pacific

it can be seen that the group is represented in most of the so-called life zones in the west.

As far as is known this group of moths is primarily restricted in larval feeding to members of the genus *Ceanothus* (Rhamnaceae). Therefore, any discussion of the distribution of this group of moths, if they are truly restricted to this genus of plants, must be correlated with a study of the distribution of

TABLE 1  
DISTRIBUTION IN WESTERN NORTH AMERICA\*

	California	Oregon	Washington	British Columbia	Alaska	Idaho	Montana	Wyoming	Colorado	Utah	Arizona	Nevada	New Mexico	Texas
<i>rectifascia rectifascia</i>	x	x	x	x	—	x	—	—	—	—	—	—	—	—
<i>rectifascia erubescens</i>	—	—	—	—	—	—	—	—	x	x	x	—	—	—
<i>unicararia</i>	x	x	x	x	—	x	x	—	x	x	x	x	x	—
<i>hulstii hulstii</i>	x	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>hulstii carneolata</i>	—	—	—	—	—	—	—	—	—	—	x	—	—	—
<i>hulstii verdiaria</i>	x	x	—	—	—	—	—	—	—	—	—	x	—	—
<i>bifilata bifilata</i>	x	—	—	—	—	—	—	—	x	—	x	x	x	x
<i>bifilata ruthiaria</i>	x	—	—	—	—	—	—	—	—	x	—	x	—	—
<i>quadraria quadraria</i>	x	—	—	—	—	—	—	—	x	x	—	—	—	—
<i>quadraria usta</i>	x	x	—	—	—	—	—	—	—	—	—	—	—	—
<i>foeminaria</i>	x	*	x	x	—	x	—	—	—	x	—	x	—	—
<i>nevadaria</i>	x	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>carnearia carnearia</i>	x	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>carnearia columbiaria</i>	x	x	*	x	—	x	—	—	?	—	—	x	—	—
<i>falcataria</i>	x	x	x	x	—	x	—	—	x	x	—	x	—	—
<i>secundaria</i>	x	x	x	x	—	x	—	—	—	—	—	—	—	—
<i>baueraria</i>	x	x	x	—	—	—	—	—	—	—	—	—	—	—
<i>monicaria</i>	x	*	x	*	x	—	—	—	—	—	—	—	—	—
<i>litaria</i>	x	x	x	x	—	x	—	—	x	x	x	—	—	—

\* The symbols signify the following: —, no known records; x, specimens examined; \*, no records but probably occurs; ?, doubtful record.

coast, several changes will undoubtedly have to be made in the present distributional and taxonomic picture of this group. See table 1 for the known distribution of the species that occur in the west.

The range of elevations at which the species occur is similarly large. Quite a few of the species are found practically at sea level along the Pacific coast. From there they go up into the mountains along the coast, and then up into the Sierra Nevada and Cascade mountain ranges as high as 8000 feet. Hence

those plants. This latter field is discussed by McMinn (Van Rensselaer and McMinn, 1942, pp. 136-144), who states that this genus of plants is restricted to continental North America, ranging from Guatemala to southern Canada and from the Pacific to the Atlantic coasts, and, further, that its greatest development has occurred on the Pacific coast of the United States and, more particularly, in California. This latter corresponds exactly with the distribution of the *Drepanulatrix* complex as it is known today.



The single eastern species, *liberaria*, is apparently confined to *Ceanothus americanus* Linnaeus. The distribution of the moth and this species of plant correspond well in the eastern and northern portions of their range, but the plant extends down the Mississippi Valley and into Texas where the moth is unknown. Probably some limiting factor or factors other than the food plant must be operating in this part of the range, if the distribution of the moth as now known is correct. With the information available at present, it is impossible to state what this factor or factors are.

In the west the picture is not so clear, at least with our present knowledge. In those species (*monicaria*, *baueraria*, *carnearia*) reared by the author, it has been found that the caterpillars occur in nature on at least two species of *Ceanothus* in the same area, and that these moths and their larvae will transfer apparently without any difficulty from one to the other of the host plants. Hence, in some of the species at least, the distribution of a single species of food plant is not the critical factor. This would be complicated too by the rather extensive hybridization that occurs in nature between the various species of *Ceanothus*. If the distribution of the moths is not correlated with the food plant, other factors (such as temperature, humidity, elevation, etc.) must be of importance. However, what role these factors play, either singly or in combination with one another, in determining the distribution of the different species of moths is not known.

#### BIOLOGY

Descriptions of the early stages of some of the species have been published by Dyar. Unfortunately, however, his application of specific names was often erroneous, as he apparently had several species confused. In later publications he rectified some of these mistakes; the remainder apparently have gone without published correction until now. The published descriptions, together with those provided by the author, give data on the early stages of two-thirds of the species in this group.

**EGGS:** The eggs are elongate and flattened, somewhat wedge shaped with one end truncate, the other bluntly or broadly rounded;

the surface is covered with a number of longitudinal ribs with fainter cross striations running between. When first laid the eggs are a unicolorous, pale, shining, greenish white; often they change in coloration to a mottled bright orange red as they mature. They are laid singly, rarely in pairs, lightly glued to the surface. Individual females in captivity have been found to lay from 25 to 200 eggs, averaging about 75 eggs each.

Oviposition may take place on leaves; the eggs that were found in the field were usually laid on the under surface, and, in the laboratory breeding cages, eggs were laid on either the upper or under surfaces. However, an even more common site of oviposition in the wire laboratory breeding cages was on the wire mesh itself; of the surfaces available, the top was preferred to the sides. This might indicate that in nature oviposition would take place elsewhere than on leaves; perhaps the rougher stems or trunk of the host plants or shrubs would be selected.

**LARVAE:** As with most geometrids, this group has five larval instars (although only four were reported for *foeminaria* by Dyar) and are of the normal "looper" type. The young larvae emerge from the truncate end of the egg, which comes off like the end of a barrel. The end is apparently eaten and the remainder of the egg shell left intact. The mature larvae are largely nocturnal in habits, although larvae of all instars may frequently be obtained by beating *Ceanothus* early in the day before the temperature rises.

The larvae are apparently of two main color types in nearly every species known, and it may prove to be the case in every species when their biologies are completely worked out. One of these is the green form, which often closely approximates the color of the leaves upon which the larvae are feeding, while the second is a brown. This latter may be quite variable, ranging from a green brown to a red-, orange- or even gray-brown, more or less approximating in color the twigs or branches of the host plant. Usually the green form is the more common of the two, although the number of brown forms may vary from 5 per cent to as high as 50 per cent of the larvae in the progeny of different females. The brown form sometimes becomes recognizable as early as the first instar, although it

is not common until succeeding instars.

**PUPAE:** Pupation may occur either between leaves in a slight silken cocoon or on the surface of or in the ground. When no dirt is available pupation will still normally occur. When reared in glass petri dishes, the larvae apparently pupate without difficulty as a naked chrysalis on the surface of the dish.

species. Those living at low elevations and in temperate climates apparently have a continuous succession of generations throughout the year (*bifilata bifilata*, *quadraria usta*, *baueraria*, *monicaria*), while those of high altitudes or more rigorous climates have but a single generation (*secundaria*, *nevadaria*, *liberaria*). The remaining species are intermediate be-

TABLE 2  
FLIGHT PERIODS OF ADULT MOTHS<sup>a</sup>

	January	February	March	April	May	June	July	August	September	October	November	December
<i>rectifascia rectifascia</i>	—	—	x	x	x	x	x	x	x	—	x	—
<i>rectifascia erubescens</i>	—	—	—	—	x	x	x	x	x	—	—	—
<i>unicalcararia</i>	—	—	x	x	x	x	x	x	x	x	—	—
<i>hulstii hulstii</i>	—	x	x	x	x	x	x	x	x	x	x	x
<i>hulstii carneolata</i>	—	—	x	x	—	x	x	x	x	x	—	—
<i>hulstii verdiaria</i>	—	—	—	—	x	x	x	x	—	—	—	—
<i>bifilata bifilata</i>	x	x	x	x	x	x	x	x	x	x	x	x
<i>bifilata ruthiaria</i>	—	—	—	—	x	x	x	x	—	—	—	—
<i>quadraria quadraria</i>	—	—	—	x	—	x	x	x	—	—	—	—
<i>quadraria usta</i>	x	x	x	x	x	x	x	x	x	x	x	x
<i>foeminaria</i>	—	—	x	x	x	x	x	x	x	—	—	—
<i>nevadaria</i>	—	—	—	—	—	x	x	—	—	—	—	—
<i>carnearia carnearia</i>	—	—	—	—	x	x	x	x	—	x	—	—
<i>carnearia columbiaria</i>	—	—	—	x	x	x	x	x	—	—	—	—
<i>falcataria</i>	x	x	x	x	x	x	x	x	—	—	—	x
<i>secundaria</i>	—	—	—	—	—	x	x	—	—	—	—	—
<i>baueraria</i>	x	x	x	x	x	x	x	x	x	x	x	x
<i>monicaria</i>	x	x	x	x	x	x	x	x	x	x	x	x
<i>litaria</i>	—	—	—	—	x	x	—	x	x	x	x	—
<i>liberaria</i>	—	—	—	—	—	x	—	x	x	x	—	—

<sup>a</sup> The symbols signify the following: —, no known records; x, specimens examined.

These pupae when first formed may be greenish; dark brown after they harden.

**ADULTS:** The adults of some species may be captured any month of the year in temperate localities, while others are on the wing for only a brief period in midsummer. The seasonal occurrence data are summarized in table 2 for the species treated in this paper.

Nothing is known about the longevity of the adults in nature. A few records have been kept in laboratory breeding cages, and these form the basis of the figures in table 3.

**GENERATIONS PER YEAR:** The number of generations per year varies from species to

tween these two extremes. Very little is known about the method of overwintering. It is believed that the eastern species (*liberaria*) accomplishes this in the egg stage, and it may be that the other species do likewise.

**LENGTH OF LIFE CYCLE:** The duration of the life cycle also varies in the different species, ranging from those that have but a single annual generation in which it is almost a year in length to from five to eight weeks in those species that have a succession of broods per year. Summarized in table 3 are some data on three species that fall into this latter category, reared by the author under labo-



ratory conditions. Of these species, *monicaria* and *baueraria* normally fly throughout the year. *Carnearia* usually flies in midsummer, but under laboratory conditions, with the temperatures higher than those encountered outdoors during the winter months, this species will continue to breed. Under these conditions, the period from egg deposition to emergence of adult may be as short as 36 days.

PARASITES: Field-collected larvae of *monicaria*, *baueraria*, and *carnearia* have produced a small number of parasites belonging to the families Larvaevoridae (Diptera) and

is undoubtedly also some loss every year on forage plants and those used for erosion control, but here also no data are available. In view of the relatively low economic value of the host plants, it is doubtful whether much damage of economic importance does occur.

#### PHYLOGENY

Apparently but few fossil Geometridae are known; Handlirsch (1906, p. 924) reports five species from the Oligocene and Miocene. Outside of these fragmentary specimens, not much else is known, so the paleontological evidence is not of much assistance in trying to reconstruct the past history of this family or, more particularly, this group of moths.

The *Drepanulatrix* complex is rather closely related to the genus *Deilinia* Hübner (*Cabera* Treitschke). This latter genus is small but widespread, being Palearctic, Indo-Australian, and North American in distribution (Prout, 1915, p. 317). To this distributional picture Janse (1932, p. 123) adds four species from South Africa; however, these are quite different in appearance and possibly do not belong in *Deilinia*, *sensu stricto*.

*Deilinia* as known today is perhaps the remnant of a once larger group of moths that at one time was more or less world-wide in distribution. This is suggested by the fact that the genus has only about 15 species and that these are widely scattered throughout the world—one in the Indo-Australian region, two in Europe, five in Asia, and seven in North America—and by the considerable number of closely related genera that occur throughout the world and that have probably been derived from this stock. It is a well-known fact that the Indo-Australian region has a great number of primitive genera of the family Geometridae. It is possible that an ancestral form, which later gave rise to *Deilinia*, arose in this general area and some time later migrated northward, spreading into Europe and Asia, and eventually reaching North America via Alaska. On this continent they spread across the northern portion from the Atlantic to the Pacific where they are found today. A few were able to extend southward along the Pacific coast into northern California and along the Rocky Mountains as far south as northern Arizona. As far as is known today, they are restricted in feeding

TABLE 3

DURATION, IN DAYS, OF VARIOUS STAGES IN THE LIFE HISTORY OF THREE SPECIES OF *Drepanulatrix*

	<i>monicaria</i>	<i>baueraria</i>	<i>carnearia</i>
Egg	7- 9	7-10	7- 9
Larvae 1st instar	5- 6	7- 8	6- 7
Larvae 2d instar	2- 4	2- 3	4- 5
Larvae 3d instar	3- 4	4- 5	4- 5
Larvae 4th instar	3- 4	4- 5	4- 5
Larvae 5th instar	4- 6	7- 8	5- 8
Pupae	13-24	22-28	16-18
Adults	8-15	7-15	5-19
Total time from egg deposition to emergence of adults	36-48	48-56	46-53

Braconidae (Hymenoptera). These are listed under the above species in the body of the text and constitute the sum of our knowledge of the parasites.

#### ECONOMIC IMPORTANCE

Since this group of moths is apparently confined almost entirely to the genus *Ceanothus*, the question of economic importance is therefore dependent upon the importance of that genus of plants. The uses of the latter are primarily limited to cultivated ornamentals, forage plants, and for erosion control (Van Rensselaer and McMinn, 1942, p. 162). It is possible that some damage of economic importance might result from larval feeding, particularly on cultivated ornamentals where it would be more likely to be noticed. There

to willow and poplar. Thus a shift in food plant is one of the basic changes required for the transition from the *Deilinia* group to the *Drepanulatrix* complex.

According to Mason (*in* Van Rensselaer and McMinn, 1942, pp. 281-303), *Ceanothus* is a group of southern origin, the earliest known forms arising from the Caribbean flora of Cretaceous time. This flora migrated northward in the early Tertiary through Mexico into the mountainous regions of the western United States, at least to the present distributional periphery of the genus. The genus, or its ancestral type, began to split up and proliferate during the Eocene and Oligocene and forms the basis for the distribution of the group as known today. This was followed in the late Oligocene or early Miocene by climatic changes that caused a reversal of migration trends, followed by a southward movement of the Pacific coast coniferous forests during the later Tertiary.

Hence it can be seen that some *Ceanothus* was present in the northern Rocky Mountain area by mid-Tertiary times or earlier. There is no way of ascertaining when the *Deilinia* group reached this area; however, the *Ceanothus* may have preceded it. The change in food plant, a prerequisite for the shift from the supposedly ancestral *Deilinia* type to the *Drepanulatrix* group, having been accomplished, it would have been possible for the latter to migrate southward, utilizing the increasing numbers of species of *Ceanothus*, and to proliferate accordingly.

The problem of the single eastern species of moth (*liberaria*) is perhaps correlated with the distributional problem of its host plant, *Ceanothus americanus* Linnaeus. The migrational history of this plant is somewhat obscure (Mason, *op. cit.*, p. 290), but a route to the east via the Ozark plateau is suggested. It is possible that this was also followed by the moths in question, leaving the closely related *litaria* behind in the west. In more recent times the Ozark plateau and Mississippi Valley have apparently become uninhabitable for the moths, although the host plant still remains.

#### TAXONOMY

As Capps (1943, p. 117) has pointed out, "the variability in the shape of the wings and

venation, particularly of the fore wing, prevents extensive use of such characters as the origin of the veins, degree of anastomosis, stalking, or size and shape of the areoles for separating genera of the Ennominae. Hence, as has proved useful to other workers seeking a more natural classification of difficult groups, the employment of genitalic structures for the restriction of genera when other characters were unsatisfactory appears to be adoptable to the development of a more desirable rearrangement of the species of this subfamily. . . ."

With this statement in mind, an external examination of the moths of the *Drepanulatrix* complex was undertaken. The results showed that only minor variations occur in the venation, while in wing shape there was more variation but nothing sufficiently constant to be of supraspecific value. By maculation alone the group could be roughly subdivided, but this by itself certainly cannot be used as a basis for generic or subgeneric categories. Consequently a study of both male and female genitalia was undertaken. This proved fruitful since these structures are subject to much less variability within the species than are color, maculation, and shape of wings. Also, there are large differences between the species, and, further, the group is divisible into three genera on these characters. Significantly, the three groups thus separated correspond with the divisions set up on the basis of maculation.

This group of moths has the following characters in common, and they are presented here to avoid repetition in the generic descriptions: Front flattened or smoothly rounded, scales appressed; eyes large, round; antennae of male bipectinate, plumose, pectinations terminating before apex, of female simple; tongue present; labial palpi slender, moderate, basal and middle joints subequal, heavily scaled, terminal joint small, sometimes partially hidden. Thorax without tufts; legs without hair pencils, fore tibia with moderate process, hind tibia not dilated with two pairs of spurs. Abdomen without tufts. Forewings broad, projecting at vein  $M_2$ , outer margin falcate or not; 12 veins, no areoles;  $Sc$  and  $R_1$  may or may not anastomose, if so, both separate to costa;  $R_1$  from top of cell;  $R_2$  to  $R_5$  stalked, from top near upper angle,  $R_5$  from

stalk before  $R_2$ ;  $M_1$  from upper angle;  $M_2$  from just above middle of DC, which is erect, usually approximate with  $Cu_1$ , at base;  $Cu_2$  from well before outer angle; fovea absent. Hind wings broad; frenulum strong in both sexes; outer margin slightly produced at  $M_3$ , usually slightly concave between veins, particularly adjacent to  $M_3$ ; Sc approximate to  $R_s$  near base for one-fourth distance;  $R_s$  and  $M_1$  approximate, from cell, the latter from upper angle; DC oblique;  $M_3$  from angle, usually approximate with  $Cu_1$  at base;  $Cu_2$  from well before outer angle.

Owing to the nature of the differences in the genitalia alluded to above, a summary of those characters is given under the different generic headings.

The following keys can be used to separate the genera. When the key to adults is used, the great variability in the maculation and color of wings must be kept in mind, as this may possibly lead to error; in case of doubt, the genitalic keys should be used.

#### KEY TO ADULTS

1. Hind wings above concolorous with forewings, with antemedian, postmedian, and/or subterminal lines prominent and with outer margin usually scalloped . . . . . *Apodrepanulatrix*  
Hind wings above not concolorous with forewings, or if so, without antemedian and subterminal lines; outer margin of hind wings not scalloped . . . . . 2
2. Wings above with single, straight, usually complete postmedian cross line; hind wings concolorous with forewings . . . . . *Eudrepanulatrix*  
Forewings above often with four cross lines, these sometimes rudimentary in varying degrees, never as above; hind wings usually not concolorous with forewings; if so, without complete postmedian line . . . . . *Drepanulatrix*

#### KEY TO MALE GENITALIA

1. Valves very narrow and long, tubular, extending to or beyond tip of uncus; gnathos absent; anellus in form of calcar . . . . . *Eudrepanulatrix*

- Valves broad, normal; gnathos present; anellus simple . . . . . 2
2. Uncus with small spine at apex; gnathos wide, often reduced or absent anteriorly; valves with or without costal arm; when present, in form of short blunt process . . . . . *Drepanulatrix*  
Uncus without small spine at apex; gnathos strongly developed, complete; valves with pointed triangular costal arm. . . . . *Apodrepanulatrix*

#### KEY TO FEMALE GENITALIA

1. Posterior margin of venter of eighth abdominal segment with wide sclerotized band . . . . . *Eudrepanulatrix*  
Eighth abdominal segment without sclerotized band . . . . . 2
2. Ostium without sclerotized band; operculum present or absent; if present, small and inconspicuous; ductus bursae sclerotized, at least in part . . . . . *Drepanulatrix*  
Ostium with sclerotized band anteriorly; operculum large, subtriangular; ductus bursae membranous . . . . . *Apodrepanulatrix*

#### KEY TO MATURE LARVAE

1. Second adfrontal setae located at or above branching of epicranial suture; first ocellar setae located dorsad of first anterior setae . . . . . 2  
Second adfrontal setae located below branching of epicranial suture; first ocellar setae located on horizontal level with first anterior setae . . . . . *Apodrepanulatrix*
2. Second anterior setae situated above or even with ocellus one; five ocelli on lateral surface of head capsule, sixth one on ventral surface . . . . . *Drepanulatrix*  
Second anterior setae on horizontal level with ocellus three; all six ocelli on lateral surface of head capsule . . . . . *Eudrepanulatrix*

#### KEY TO KNOWN PUPAE<sup>1</sup>

1. Dorsum of abdomen with furrow between segments IX and X; mesothoracic spiracle with small, straight, raised ridge, this latter sometimes rudimentary . . . . . *Drepanulatrix*  
Dorsum of abdomen without furrow between segments IX and X; mesothoracic spiracle with prominent, raised, kidney-shaped ridge . . . . . *Apodrepanulatrix*

No material available for *Eudrepanulatrix*.

## SYSTEMATIC DESCRIPTIONS

### **EUDREPANULATRIX**, NEW GENUS

**ADULT:** In addition to the characters noted for the group: Antennal pectinations of male arising in terminal half of segments, terminal 15 per cent of antennae simple. Forewings with outer margin straight to vein  $M_3$ ;  $M_3$  and  $Cu_1$  approximate at base. Forewings and hind wings concolorous, with single postmedian cross line on upper surface, although this sometimes reduced or rudimentary; discal dots present on all wings; intervenular dots usually present on upper surface of all wings although sometimes reduced or rudimentary.

**MALE GENITALIA:** Uncus long, simple, enlarged terminally, hook-like, heavily haired, apex with small spine; socius fairly strong, with from 20 to 30 hairs; gnathos absent; valves simple, sclerotized, very long and tubular, extending beyond tip of uncus, lightly haired but with very long lateral fringe on terminal half; transtilla strong; cristae present; anellus strong, elongate, in form of calcar; furca absent; saccus projecting short distance beyond base of valves, narrow, rounded, longer than uncus; aedeagus very long, slender, cylindrical, vesica armed with two or three heavy spines located in posterior half of aedeagus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Ostium simple; operculum absent; ductus bursae sclerotized, membranous at junction with bursa copulatrix, widest posteriorly, ranging from two to two and one-half times length of ovipositor rods; ductus seminalis from posterior extension of bursa copulatrix; bursa copulatrix large, slightly shorter than ductus bursae, region of junction with ductus bursae sclerotized, curving anteriorly and enlarging into elongate to oval membranous area, signum absent, ornamentation of bursa in form of small number of sclerotized lines with inwardly projecting teeth in area of junction of sclerotized and membranous areas, sometimes with teeth alone in sclerotized area. Ventral and lateral surfaces of sixth abdominal segment with wide sclerotized ring on posterior margin.

**EARLY STAGES:** These have been described in part for the nominate subspecies. Some of

the larvae reared by Dyar have been inflated and are in the United States National Museum; the following setal descriptions are based on these specimens. When fresh larval material becomes available it may be necessary to amend the following and to add more details.

**EGGS:** Described by Dyar.

**LARVAE, FIFTH INSTAR:** Head: First adfrontal seta ( $Adf_1$ ) above middle of clypeus, second adfrontal ( $Adf_2$ ) shortly above branching of epicranial suture; first posterior seta ( $P_1$ ) on horizontal level with  $Adf_2$ , second posterior seta ( $P_2$ ) vertically above  $P_1$ , these three setae forming a right angle; lateral seta ( $L_1$ ) slightly below  $P_1$ ; first anterior seta ( $A_1$ ) below ocellus three, second anterior seta ( $A_2$ ) on a level with ocellus three, third anterior seta ( $A_3$ ) level with  $Adf_1$ , the three anterior setae forming an acute angle; all six ocelli well developed, located on lateral surface of head; first and second ocellar setae ( $O_1$ ,  $O_2$ ) on the same horizontal plane, third ocellar seta ( $O_3$ ) ventrad, the three forming a right angle; subocellar seta ( $SO_2$ ) above lowest ocellus.

Thorax: Prothorax with setae 1a, 1b, and 2a, 2b well separated; seta 3 double, above spiracle; seta 4 on level with lower rim of spiracle; seta 5 approximate; setae 6 and 7 approximate. Mesothorax, seta 2b ventrad of seta 1a; seta 3 between 1a and 1b in a vertical plane, above 4 horizontally; seta 5 anterior and approximate to 4; seta 6 below 3. Metathorax, setae 2a, 2b more anterior than on mesothorax; seta 3 between 2a and 2b in a vertical plane; setae 4 and 5 more caudad and ventral than on mesothorax.

Abdomen: Segment I, seta 1 above spiracle; seta 2 posterior and slightly ventrad of 1; seta 3 above and slightly anterior to spiracle; seta 4 on level with and posterior to spiracle; seta 5 anterior to and farther from spiracle than 3 and 4; seta 6 ventrad of 3; seta 7 on level with 6, below 2. Segments II to VI, seta 1 anterior to spiracle; seta 2 posterior; seta 3 below 1 and higher than spiracle; seta 4 on level with lower rim of spiracle or slightly ventral thereof; seta 5 below or slightly posterior to 1; setae 3, 4, and 5 approximately equidistant from spiracle; seta 6 ventrally between 5 and spiracle; seta 7 ven-



trally between 4 and 2. Segment VII similar except seta 1 above spiracle; seta 6 ventrally posterior to spiracle. Segment VIII similar to segment VII, except setae 3 and 5 nearer anterior rim of spiracle and in a vertical plane; setae 6 and 7 posterior, between setae 4 and 2.

PUPAE: Undescribed.

GENOTYPE: *Diastictis rectifascia* Hulst.

The single species of this genus has been associated with *Drepanulatrix* for some time, but may be distinguished from that genus by the wings above being concolorous and having but a single cross line, and even more readily by the nature of both male and female genitalia.

The male genitalia are very distinct in the narrow and sclerotized nature of the tegumen, saccus, and valves, the absence of the gnathos and the presence of the calcar. The single species falling herein is easily recognized by the very long valves extending beyond the tip of the uncus.

The females of this genus can be separated readily by the sclerotized band on the sixth abdominal segment. This can often be recognized in dried specimens without making a genitalic mount, as the lateral extensions of this band extend as two points above the dorsal surface of the abdomen when it shrinks upon drying.

#### ***Eudrepanulatrix rectifascia* (Hulst)**

*Diastictis rectifascia* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 333.

MALE: Head, vertex cream white, often shaded with brown or gray, concolorous with thorax; white band laterad of antennal bases; front light pink or brown; palpi cream colored with brown shadings. Thorax and legs concolorous with wings. Abdomen concolorous with thorax or lighter in color.

UPPER SURFACE OF WINGS: Forewings, ground color cream white, more or less evenly strigate or overlain with pink, gray, or brown scales, or with combinations of the above so that wings range in color from cream white through pinkish, pinkish brown to gray, sometimes slightly darker subterminally; basal, antemedian, and median lines lacking; discal dot round, dark, prominent; postmedian line gray brown, usually prominent, sometimes reduced or rudimentary, leaving costa at two-thirds distance from base at right angle, then

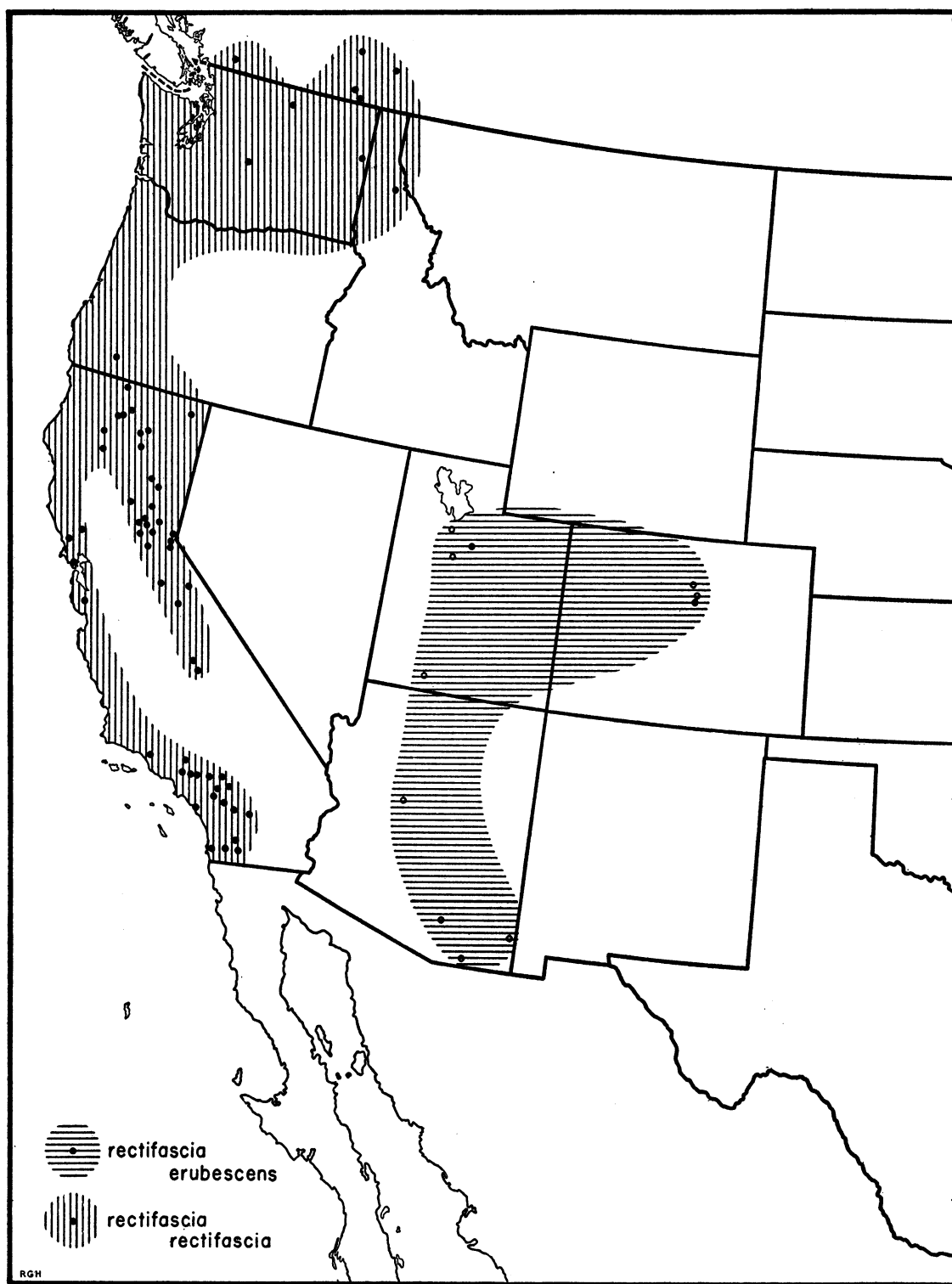
bending and running straight to inner margin at two-thirds, quite thin at costa, widening at bend and subequal in width for remainder of distance; intervenular dots dark, usually present although sometimes reduced or rudimentary; fringes concolorous. Hind wings concolorous with primaries although somewhat lighter along costal margin; discal dot dark, usually prominent; postmedian cross line present, appearing as continuation of line on primaries, reduced or absent in costal portion, running straight across wing to inner angle at two-thirds distance from base; intervenular dots dark, somewhat reduced or rudimentary, often absent near anal angle; fringe concolorous.

UNDER SURFACE OF WINGS: Ground color cream white, lightly shaded with darker scales as above, more glistening, apex of primaries slightly darker; discal dots present on all wings, not so heavy as on upper surface; postmedian line absent or showing through very faintly on all wings from upper surface; intervenular dots weak, present or absent; fringes as above, slightly darker than wings beneath. Expanse: 25 to 30 mm.

FEMALE: Like male; less heavily overlain with gray scales with pink more common; postmedian line less prominent, sometimes weak. Expanse: 22 to 27 mm.

MALE GENITALIA: Uncus with terminal half swollen, thickly beset with large number of hairs longer than width of uncus at widest point, lightly haired on narrow basal half; valves very long, thin, somewhat curved and recurved, apex pointed, the whole about four to five times length of uncus; transtilla extending posteriorly, somewhat reduced medially; cristae consisting of approximately two dozen long hairs; anellus in form of calcar, subequal to or longer than uncus; saccus as long as wide; aedeagus very slightly S-shaped, ratio of length to width varying from 10:1 to 14:1, vesica armed with two, rarely three, spines ranging in length from shorter than to one and one-half times length of uncus.

FEMALE GENITALIA: Ductus bursae elongate, ostium three to four times as wide as narrowest part of ductus, maximum width of ductus near ostium four to five times as wide as narrowest point, lateral margins apparently folded over, sclerotized surface punctate; bursa copulatrix somewhat variable in extent



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FIG. 1. Distribution of *Eudrepanulatrix rectifascia* (Hulst.).

and shape of membranous area (perhaps due to mounting technique), elongate, usually rather narrow but ranging to broadly oval, ornamentation rather variable in number and extent of sclerotized lines and teeth, the latter sometimes present in sclerotized area without the former.

The early stages have been described for the typical subspecies by Dyar.

RANGE: Western United States. (See fig. 1.)

REMARKS: The species is separable into two geographical subspecies. Some specimens may be a bit difficult to place accurately in one or the other subspecies on the basis of maculation alone, but with the aid of the genitalia, too much difficulty should not be encountered.

There is some variation in total size of the male genitalia, those from the Pacific coast being larger, although the spines in the aedeagus are shorter (*rectifascia rectifascia*), while those from the Rocky Mountains are somewhat smaller but with larger aedeagal spines (*rectifascia erubescens*).

There is also some variation in size and proportions of the parts of the female genitalia, apparently paralleling the male in this respect, as the Pacific coast specimens appear to have larger genitalia than the Rocky Mountain ones.

#### KEY TO SUBSPECIES

1. Wings dusted with dark scales, producing a somewhat finely speckled appearance; cross lines often prominent; Pacific coast states, British Columbia, and Idaho to California . . . . . *rectifascia rectifascia*
- Wings with fewer dark scales, having a smoother appearance; cross lines tending to be absent; Colorado, Utah, Arizona . . . . . *rectifascia erubescens*

#### *Eudrepanulatrix rectifascia rectifascia* (Hulst)

Figure 12A

*Diastictis rectifascia* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 333.

*Cymatophora rectifascia*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 314.

*Deilinia rectifascia*, DYAR, 1903, Psyche, vol. 10, p. 200 (life history); 1904, Proc. U. S. Natl. Mus., vol. 27, p. 905.

*Drepanulatrix rectifascia*, BARNES AND McDUNNOUGH, 1917, Check list, p. 111. McDUNNOUGH, 1927, Canadian Ent., vol. 59, p. 244.

MALE: Wings usually rather heavily irrorate, with darker scales giving a rough, speckled appearance; postmedian line usually prominent on all wings, sometimes reduced or absent; intervenular dots usually fairly strong on upper surfaces, usually represented on under surfaces.

FEMALE: Like male, but less heavily irrorate, with darker scales and with postmedian line less prominent.

MALE GENITALIA: Length of uncus ranging from 0.76 to 0.86 mm.; valves ranging from 3.3 to 3.7 mm. in length; aedeagus from 2.8 to 3.7 mm. in length, from 0.20 to 0.26 mm. in width, with spines ranging from 0.50 to 0.68 mm. in length.

FEMALE GENITALIA: Ductus bursae 2.5 to 2.7 mm. in length, ratio of maximum to minimum width from 4.5:1 to 5:1; ornamentation of bursa copulatrix consisting of both transverse and some longitudinal sclerotized lines, rarely with teeth in sclerotized area.

EARLY STAGES: Described by Dyar, with the exception of the pupa.

TYPE: According to the original description there was but a single female type. Two such specimens from the type locality are in existence, one in the Hulst collection at Rutgers University and the other in the United States National Museum, type no. 3909. The latter was labeled by Hulst as the type, so this specimen should be so considered.

TYPE LOCALITY: Easton, Washington.

RANGE: Pacific coast states, from British Columbia and Idaho to southern California (see fig. 1). On the wing from March through November.

FOOD PLANT: *Ceanothus* (Dyar, 1903); reared by Claude Smith from *Ceanothus* species in Los Angeles County, California.

REMARKS: Three hundred and ninety specimens examined. This subspecies is rather variable in color and in the extent to which the wings are shaded with dark gray scales, with the cross line usually prominent.

#### *Eudrepanulatrix rectifascia erubescens* (Warren)

*Lozogamma erubescens* WARREN, 1904, Novitates Zool., vol. 11, p. 561.

*Drepanulatrix rectifascia erubescens*, BARNES AND McDUNNOUGH, 1917, Check list, p. 111.

MALE: Wings usually rather lightly sprinkled with darker scales giving a smoother,

more even appearance; postmedian line usually rather weak on all wings, sometimes absent; intervenular dots usually present on upper surface, usually absent on under surface.

**FEMALE:** Like male, with postmedian line usually very weak or absent.

**MALE GENITALIA:** Length of uncus 0.70 to 0.81 mm.; valves ranging from 2.7 to 3.2 mm. in length; aedeagus from 2.6 to 2.9 mm. in length, from 0.23 to 0.30 mm. in width, with spines ranging from 0.73 to 1.60 mm. in length.

**FEMALE GENITALIA:** Ductus bursae 2.0 to 2.3 mm. in length, ratio of maximum to minimum width from 3:1 to 4:1; ornamentation of bursa copulatrix consisting of nearly all transverse sclerotized lines, often with quite a few teeth in sclerotized area.

**EARLY STAGES:** Unknown.

**TYPE:** In British Museum (Natural History) (?); described from a single female.

**TYPE LOCALITY:** Chimney Gulch, Colorado.

**RANGE:** Rocky Mountain states, from Colorado and Utah to Arizona (see fig. 1). On the wing from May through September.

**FOOD PLANT:** Unknown.

**REMARKS:** Thirty-nine specimens examined. This name is being retained for those specimens of this species occurring in the southern Rocky Mountains. Typically, this is a larger, smoother appearing, pinker moth than occurs on the Pacific coast. However, specimens from the more southern parts of its range are apt to be quite similar in appearance to the Pacific coast ones and thus not easily recognized. A study of the genitalia of these more southerly forms shows a closer relationship with the Colorado material than with specimens from California, so they are retained here.

#### GENUS *DREPANULATRIX* GUMPPENBERG

*Drepanulatrix* GUMPPENBERG, 1887, Nova Acta Deutschen Akad. Naturf., Halle, vol. 49, p. 330; 1895, *ibid.*, vol. 64, p. 454. BARNES AND McDUNNOUGH, 1917, Check list, p. 111.

*Aethyctera* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 339.

**ADULT:** In addition to the characters noted for the group: Antennal pectinations of male arising in terminal half of segments, terminal 10 per cent to 25 per cent of antennae simple.

Forewings with outer margin concave, straight or convex to vein  $M_3$ ;  $Sc$  and  $R_1$  may or may not anastomose, rarely both conditions present in same insect;  $M_3$  and  $Cu_1$  approximate at base. Forewings and hind wings rarely concolorous; primaries with four cross lines present in varying degrees, sometimes reduced or absent; discal dots present on forewings, usually present on hind wings, rarely absent; terminal intervenular dots present or absent.

**MALE GENITALIA:** Uncus long, simple, strong, hook-like, lightly haired, apex with small spine; socius weak, with from five to 24 hairs; gnathos a large wide ring, often reduced or absent anteriorly; valves broad, either simple, heavily haired, rarely with terminal spines, costal arm heavily haired at apex, small when present or absent, or valves with costal region sclerotized for length of valves terminally swollen into broad projecting arm; transtilla well developed, thin or reduced medially; cristae usually present, sometimes wanting; anellus a simple, shield-like structure; furca absent; saccus projecting well beyond base of valves, bluntly rounded or pointed, about twice length of uncus; aedeagus cylindrical, often with both ends strongly oblique, with sides convergent, sometimes curved with bulbous base, varying from relatively short and thick to long and slender, vesica variously armed with from one to 14 spines in one or two groups, or unarmed. Ventral surface of eighth abdominal segment rarely with plate, usually without.

**FEMALE GENITALIA:** Ostium simple; operculum present as small subtriangular to oval plate, reduced or absent; ductus bursae membranous, partially or completely sclerotized, ranging in length from shorter than, to four times as long as, ovipositor rods; ductus seminalis from bursa copulatrix; bursa copulatrix small to very large, ranging in length from subequal to ovipositor rods to length of abdomen, variously shaped suboval to attenuate, signum absent, ornamentation consisting of sclerotized areas or inwardly pointing teeth, the latter often more or less arranged in longitudinal rows.

**EARLY STAGES:** The following generic descriptions are based primarily on material of *monicaria*, *baueraria*, and *carnearia carnearia* reared by the author. However, Dyar



has described the immature stages in part for several of the species; some of his inflated larvae are in the United States National Museum and these specimens have been used to corroborate the descriptions.

**EGGS:** Elliptical, with one end truncate, the other rounded, dorsoventrally flattened, sometimes slightly wedge shaped, being thicker at truncate end; surface with numerous longitudinal ridges, with less prominent transverse ridges between these, forming rectangular cells; truncate end with distinct ridge around edge, indented below this with central area convex. Color white, yellow, or light green when first laid, usually becoming mottled with orange red or red before hatching.

**LARVAE, FIFTH INSTAR:** Head: First adfrontal seta ( $Adf_1$ ) above middle of clypeus, second adfrontal ( $Adf_2$ ) above branching of epicranial suture; first posterior seta ( $P_1$ ) on a level with or below  $Adf_2$ , second posterior seta ( $P_2$ ) vertically above  $P_1$ , sometimes slightly laterad, these three setae forming a slight acute to obtuse angle; lateral seta ( $L_1$ ) below  $P_1$ ; first anterior seta ( $A_1$ ) on level with lower margin of ocellus three, second anterior seta ( $A_2$ ) on level with or above ocellus one, third anterior seta ( $A_3$ ) above  $Adf_1$  in horizontal plane, the three anterior setae forming a right or an obtuse angle; six ocelli usually well developed, sometimes median one reduced, upper five ocelli on lateral surface of head capsule, sixth one on or partially on ventral surface; second ocellar seta ( $O_2$ ) higher than ocellus one, third ocellar seta ( $O_3$ ) posterior to ocelli three or four, the three ocellar setae forming an acute angle; subocellar setae ( $SO_2$ ) above lowest ocellus.

**Thorax:** Prothorax with seta 1a, 1b and 2a, 2b fairly well separated; setae 3 double, above spiracle; seta 4 on level with lower rim of spiracle or shortly below same; seta 5 approximate; setae 6 and 7 approximate. Mesothorax, setae 2a and 2b ventrad of 1a and 1b; seta 3 posterior to 1a, 2a, slightly above or on horizontal plane with 4; seta 5 ventral and approximate to 4; seta 6 ventrad of 1 and 2. Metathorax similar to mesothorax except setae 2a and 2b may be either as on mesothorax or more anterior with the four setae of 1 and 2 approximating a straight line.

**Abdomen:** Segment I, seta 1 caudad to or

dorsally above spiracle; seta 2 posterior to, and slightly ventrad of, 1; seta 3 above and slightly or moderately anterior to spiracle; seta 4 on level with top of spiracle; seta 5 anterior to 3 and below spiracle; seta 6 below spiracle; seta 7 on level with 6, posterior or ventral to 2. Segments II to VI, seta 1 anterior to spiracle; seta 2 posterior; seta 3 below or posterior to 1 and higher than spiracle; seta 4 below spiracle or on level with lower rim thereof; seta 5 slightly posterior to 1; seta 6 ventrally below or anterior to spiracle; seta 7 ventrally posterior to 2. Segment VII similar except seta 1 closer in vertical plane to spiracle; seta 6 ventrally posterior to spiracle. Segment VIII similar to segment VII except setae 6 and 7 in a vertical plane near posterior margin of segment.

**PUPAE:** Shiny brown, naked or in a slight, loose cocoon. Head, epicranial suture absent; antennae extending caudad of other appendages, subequal in length to wing cases; labial palpi small, triangular; maxillae slightly shorter than wing cases. Thorax, metathorax about one-fourth length of mesothorax on dorsal surface; mesothoracic spiracle with small, straight, raised ridge on posterior margin; mesothoracic wings extending to posterior portion, sometimes as far as posterior margin, of fourth abdominal segment; metathoracic wings narrowly exposed ventrally to anterior portion of fourth abdominal segment; prothoracic legs approximately three-fourths length of maxillae, femora shortly exposed; mesothoracic legs subequal in length to maxillae; metathoracic legs usually exposed for short distance caudad of maxillae, subequal in length to antennae, sometimes not visible. Abdomen, spiracles without furrows; dorsum with distinct furrow between segments IX and X, irregularly toothed or scalloped on posterior margin; with furrow on lateral surface of segment X; cremaster of eight recurved spines, the terminal two thicker and slightly longer than remainder.

**GENOTYPE:** *Tephrosia falcataria* Packard (first included species).

The species of this genus as now restricted may be separated from those of related genera by the fact that the forewings and hind wings above are not concolorous, or only very rarely so, by the presence of four cross lines on the forewings, although these are often reduced

or absent in part or completely, and that the wings do not have any complete cross lines. The genitalia are, however, a more reliable criteria for both generic and specific levels.

The male genitalia of this genus can be distinguished by the uncus' having a small terminal spine, by the gnathos' being present as a wide broad ring, often reduced or absent anteriorly, by the costal arm, when present, in the form of a short blunt process, and by the anellus' being a simple, shield-like structure. *Deilinia* Hübner (*Cabera* Treitschke), with which this genus was often confused in earlier days, is quite distinctive in the reduced gnathos, the spining of the valves, which is very heavy at the apex and often at the base, and in the short saccus.

With regard to the female genitalia, the species as a whole are rather variable and quite distinct from one another; hence the genitalia can be used with ease to separate the species. Owing to this considerable variability it is difficult to give any one character that makes the genus recognizable from the female genitalia alone. However, the following may be used to separate them: abdomen without ventral sclerotized ring on sixth segment, ostium without sclerotized band, operculum reduced or absent, and ductus seminalis arising from the bursa copulatrix.

The adults of this genus show an amazing amount of variability within the species in regard to maculation and color of the forewings. Consequently specific identification is often a rather hazardous procedure unless one is familiar with the genus. Even so, it may be necessary to prepare genitalic mounts to make the identification perfectly certain. The genitalia offer the most accurate means of identification as they show less variation within the species, and the differences between most of the species are quite large; this holds true for either sex. With the above in mind, the following keys can be utilized; the one based on maculation should, however, be used only with considerable caution.

#### KEY TO ADULTS

1. Terminal intervenular black dots present on all wings, although these sometimes weakly represented on hind wings . . . 2
- Terminal intervenular black dots absent from all wings . . . . . 9

- 2 (1). Male antennae with pectinations subequal in length to length of eye; forewings above pale ocher shaded with orange, rose, or even purplish, transverse anterior and median lines absent or indistinct, transverse posterior line prominent in costal half of wing and with purple area between transverse posterior line and outer margin . . . . . *nevadaria*  
Male antennae with pectinations at least one and one-half times length of eye; forewings not as above . . . . . 3
- 3 (2). Forewings strongly concave below apex; hind wings white, often lightly dusted with darker scales, and with wide pinkish fringe . . . . . *falcataria*  
Forewings weakly concave to convex; hind wings more or less concolorous with forewings . . . . . 4
- 4 (3). Forewings above pale ocher shaded with orange, rose, or even purplish, with transverse anterior, median and transverse posterior cross lines usually heavy, distinct, sometimes lacking in various degrees, with terminal smoky, purple, or pinkish area present in various degrees, and with subterminal scalloped line absent . . . . . 5  
Forewings above various shades of brown, yellow brown, or gray, without above combination of markings, and with subterminal line present, scalloped, usually the most prominent cross line . . . . . 6
- 5 (4). Cross lines variable, ranging from three dots on costa with lines absent to three heavy, more or less complete lines, thickest on costa, purple or red purple . . . . . *carnearia carnearia*  
Cross lines three in number, narrow, distinct, reddish or purple . . . . . *carnearia columbiaria*
- 6 (4). Forewings above dark brown, gray brown, or red brown irrorate with darker scales, rarely shaded with orange, with maculation rather indistinct . . . . . 7  
Forewings above buff or yellow brown, not as above . . . . . 8
- 7 (6). Forewings above gray brown or red brown irrorate with darker scales, rarely shaded with orange, with maculation indistinct, cross lines usually lacking or very faintly indicated and with subterminal line distinct to absent, rarely median field wholly or partly black, and with discal dot black not encircled by white scales; hind wings light gray, usually

- heavily dusted with darker scales to give a more or less concolorous appearance; under side of forewings without black bar near apex . . . . . *monicaria*
- Forewings above dark brown, heavily irrorate with darker scales, with all cross lines black, distinct or indistinct, with discal dot black surrounded by white scales; hind wings concolorous; under surface of forewings with black bar near apex . . . . . *foeminaria*
- 8 (6). Forewings above buff to yellow brown, usually only lightly dusted with dark scales, with transverse anterior, median and transverse posterior lines distinct to absent, with subterminal line prominent, narrowly shaded outwardly with white, rarely median field wholly or partly black; hind wings slightly lighter than forewings or concolorous, sometimes with indications of cross lines at inner margin . . . . . *baueraria*
- Forewings above pale orange ocher, dusted with dark scales, with transverse anterior, median and transverse posterior lines indistinct to absent, with subterminal line somewhat indistinct and with median field never shaded with black; hind wings whitish, lighter than forewings, irrorate with darker scales but without any traces of cross lines at inner margin . . . . . *secundaria*
- 9 (1). Forewings above with subterminal line represented by a series of black inter-venular dots, varying in intensity, sometimes absent, going straight across the wing, with transverse anterior and transverse posterior lines rather indistinct, with enclosed median area sometimes slightly darker than remaining areas of wing; discal dot of forewings large, dark, often elongate . . . . . 10
- Forewings above with subterminal line complete, represented by a few dots or absent, sharply indented between veins  $M_2$  and  $M_3$ , and with median area never darker than remaining areas of wings . . . . . 12
- 10 (9). Forewings above pale fawn, with subterminal line represented by few dots near apex or absent, with transverse anterior and transverse posterior lines usually absent, with median area seldom darker than remainder of wing, and with discal dot on forewings often the most prominent mark; mountains of southern Arizona . *hulstii carneolata*
- Forewings above varying in color from gray brown, yellow brown, red brown to pink, with cross lines usually more or less distinct, with median area often darkened, and with discal dot not so prominent due to these other markings; California, Nevada, Oregon. . . . 11
- 11(10). Forewings above varying in color from pink, red brown, yellow brown to gray brown, with cross lines usually rather indistinct, with subterminal line the most distinct, and with median area seldom darker than remainder of wing; southern California, extending up coast to central and northern California . . . . . *hulstii hulstii*
- Forewings above gray brown to red brown, with cross lines usually distinct, and with median area often darkened; Sierra Nevada, Cascade, and adjacent mountain areas of California, Oregon, and Nevada . . . . . *hulstii verdiaria*
- 12 (9). Costa of forewings with prominent dots at one-third and two-thirds distance from base, marking inception of two prominent, straight, cross lines, the latter sometimes rudimentary; discal dots of hind wings usually absent . . . . . 13
- Costa of forewings without dots and lines as above; discal dots on hind wings black, usually present . . . . . 14
- 13(12). Forewings above pink, ocher, or red brown, with distinct cross lines . . . . . *bifilata bifilata*
- Forewings above gray brown to buff, with cross lines indistinct . *bifilata ruthiaria*
- 14(12). Forewings above with transverse posterior line absent, with subterminal line broad, yellow to orange, outwardly bordered with black triangles or shading; expanse, 28 to 36 mm. . . . . *unicararia*
- Forewings above with transverse posterior line present, sometimes represented on costa only, with subterminal line indicated by black scallops; expanse, 22 to 29 mm. . . . . 15
- 15(14). Forewings above light to dark gray, with transverse anterior line indistinct, and with transverse posterior and subterminal lines prominent; Rocky Mountains, Sierra Nevada Range. . . . . *quadraria quadraria*
- Forewings above rose brown to gray, with transverse anterior line usually distinct, and with transverse posterior and subterminal lines weak; coastal regions of California and Oregon . *quadraria usta*

## KEY TO MALE GENITALIA

1. Ventral surface of eighth abdominal segment with W-shaped plate . . . *foeminaria*  
Ventral surface of eighth abdominal segment without plate . . . . . 2
- 2(1). Aedeagus with cornuti . . . . . 3  
Aedeagus without cornuti . . . . . 10
- 3(2). Cornuti in form of single elongate sclerotized rod extending length of aedeagus . . . . . *hulstii*  
Cornuti not as above . . . . . 4
- 4(3). Valves with costal region sclerotized for length of valves, terminally swollen into broad projecting arm, costal margin with projecting sclerotized blunt teeth, mesiad of these very heavily spined . . . . . *unicararia*  
Valves simple, not as above . . . . . 5
- 5(4). Cornuti in one group, one to many . . . 6  
Two large cornuti, one medial, one terminal . . . . . 9
- 6(5). Cornuti capitate, located in basal half of aedeagus . . . . . *secundaria*  
Cornuti pointed, located medially . . . . 7
- 7(6). Tip of saccus narrow, pointed; valves widest near base, narrowed distally, or with heavy spines distally . . . . . 8  
Tip of saccus broad, rounded; valves subequal in width, without heavy spines distally . . . . . *falcata*
- 8(7). Valves with heavy spines at distal end; uncus slightly bulbous . . . . . *quadraria*  
Valves without heavy spines distally; uncus parallel sided (in ventral view) . . . . . *biflata*
- 9(5). Uncus clavate; cristae consisting of 10 or more hairs . . . . . *nevadaria*  
Uncus with terminal third bulbous; cristae of six or less hairs . . . . . *carnearia*
- 10(2). One side of aedeagus modified into long, thin, sclerotized blade about one-third length of aedeagus . . . . . *monicaria*  
Aedeagus without this elongate blade . . . . . *baueraria*

## KEY TO FEMALE GENITALIA

1. Bursa copulatrix sclerotized, very long, with large membranous sac on anterior end . . . . . 2  
Bursa not shaped as above . . . . . 3
- 2(1). Bursa copulatrix largest posteriorly, evenly tapering to narrow junction with anterior membranous sac . . . . . *hulstii*  
Bursa copulatrix subequal in width, not tapering to broad junction with anterior membranous sac . . . . . *unicararia*
- 3(1). Bursa copulatrix with large, smooth,

- sclerotized area occupying approximately one-half total surface . . . . . *quadraria*  
Bursa variously ornamented, not as above . . . . . 4
- 4(3). Surface of bursa copulatrix with many heavy folds or teeth, these not connected to form lines; ductus bursae longer than bursa copulatrix . . . . . *falcata*  
Bursa variously ornamented, not as above . . . . . 5
- 5(4). Anterior half of bursa copulatrix membranous; posterior half dorsally with numerous longitudinal sclerotized strips, ventrally with narrow, horseshoe-shaped, sclerotized band . . . . . *biflata*  
Bursa variously shaped, not as above . . 6
- 6(5). Bursa copulatrix semicircular, small, subequal in length to ovipositor rods, broadly joined to short ductus bursae . . . . . *monicaria*  
Bursa not as above, larger . . . . . 7
- 7(6). Ductus bursae one and one-half times as long as bursa copulatrix . . . . . *secundaria*  
Ductus bursae shorter than bursa copulatrix . . . . . 8
- 8(7). Bursa copulatrix with numerous sclerotized, inwardly projecting teeth or longitudinal toothed lines in central sclerotized area . . . . . 9  
Bursa variously ornamented, not as above . . . . . 10
- 9(8). Bursa copulatrix with large, posterior, recurved, membranous sac . . . . . *foeminaria*  
Bursa membranous at posterior end but without recurved sac . . . . . *carnearia*
- 10(8). Bursa copulatrix with large posterior membranous sac arising from lightly sclerotized base; ductus bursae largely sclerotized . . . . . *nevadaria*  
Bursa without sac; ductus bursae lightly sclerotized at ostium only . . . *baueraria*

## TENTATIVE KEY TO SOME FIFTH INSTAR LARVAE

1. Ocellus six much smaller than remaining five ocelli; setae 1 and 3 of abdominal segments I to VI located approximately halfway between spiracle and anterior margin of segments . . . . . *carnearia carnearia*  
All six ocelli of same size; setae 1 and 3 of abdominal segments I to VI located vertically above anterior rim of spiracle . . . . . 2
2. Setae 2a, 2b of metathorax anterior to setae 1a, 1b; setae 4 and 5 of second abdominal segment at same height, both ventral to spiracle . . . . . *baueraria*  
Setae 2a, 2b of metathorax ventrally below



setae 1a, 1b; setae 4 and 5 of second abdominal segment not at same height, 4 being higher and at level of lower rim of spiracle . . . . . *monicaria*

#### KEY TO KNOWN PUPAE

1. Distance between ends of prothoracic legs and maxillae about 1.6 mm. in length . . . . . *monicaria*  
Distance between ends of prothoracic legs and maxillae about 1.2 mm. in length . . . . . 2
2. Tips of metathoracic legs exposed; exposed portion of prothoracic femora about 0.75 mm. in length . . . . . *carnearia carnearia*  
Tips of metathoracic legs usually not exposed; exposed portion of prothoracic femora about 0.50 mm. in length . . . . . *baueraria*

#### *Drepanulatrix unicalcararia* (Guenée)

##### Figure 12B

*Tephрина unicalcararia* GUENÉE, 1857, Histoire naturelle des insectes, vol. 10, p. 100. OBERTHÜR, 1923, Études de lépidoptérologie comparée, vol. 20, p. 249.

*Deilinia unicalcararia*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix unicalcararia*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112. McDUNNOUGH, 1927, Canadian Ent., vol. 59, p. 244.

*Aspilates behrensaria* HULST, 1887, Ent. Amer., vol. 2, p. 210. BEUTENMÜLLER, 1892, Bull. Amer. Mus. Nat. Hist., vol. 4, p. 194.

*Tephрина unicalcararia behrensaria*, HULST, 1895, Ent. News, vol. 6, p. 15.

*Deilinia behrensaria*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306; 1903, Psyche, vol. 10, p. 197 (life history); 1904, Proc. U. S. Natl. Mus., vol. 27, p. 904. HOLLAND, 1903, Moth book, p. 339, pl. 43, fig. 38.

*Drepanulatrix behrensaria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179; 1917, Check list, p. 112.

*Deilinia behrensaria cervinicolor* HULST, 1898, Canadian Ent., vol. 30, p. 161. BLACKMORE, 1918, Proc. Ent. Soc. British Columbia, vol. 8, p. 17. (New synonymy.)

*Drepanulatrix unicalcararia cervinicolor*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Diastictis ella* HULST, 1898, Trans. Amer. Ent. Soc., vol. 23, p. 332. BARNES AND McDUNNOUGH, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 182. (New synonymy.)

*Cymatophora ella*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 213; 1904, Proc. Ent. Soc. Washington, vol. 6, p. 224.

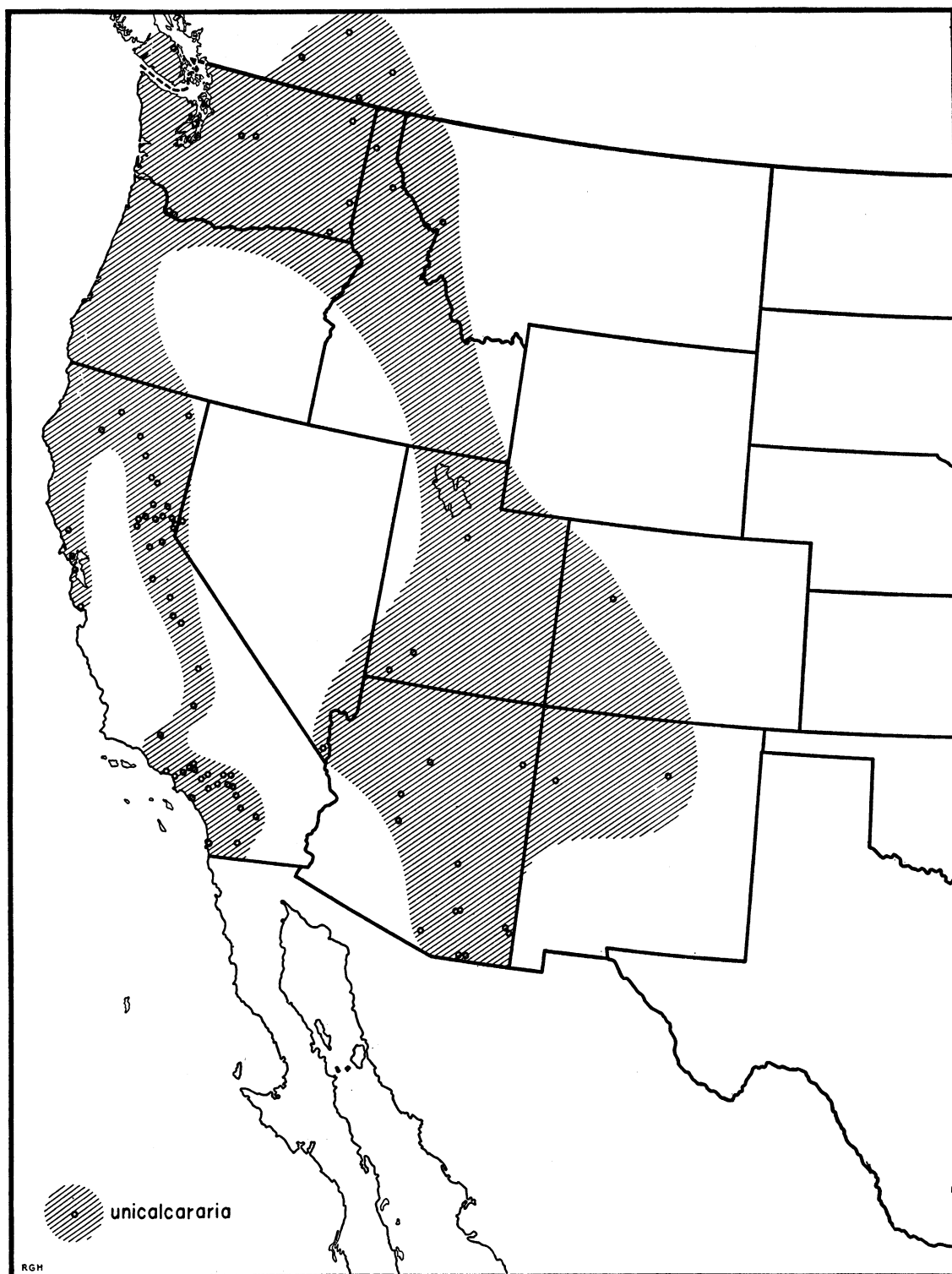
*Drepanulatrix ella*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Caripeta ida* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 341. DYAR, 1904, Proc. Ent. Soc. Washington, vol. 6, p. 225. (New synonymy.)

*Drepanulatrix ida*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

**MALE:** Head, vertex with light gray scales, these often brown in middle; front usually gray brown, somewhat darker than vertex; palpi concolorous with or slightly browner than front; antennal pectinations almost twice length of eye, terminal 10 per cent of antenna simple. Thorax dorsally concolorous with forewings, ventrally somewhat lighter; legs concolorous, somewhat tinged with brown or smoky. Abdomen grayish white with darker scales, concolorous with hind wings.

**UPPER SURFACE OF WINGS:** Forewings ranging in color from light or dark gray to light yellow or orange brown, more or less heavily speckled with black scales; cross lines, with exception of subterminal one, usually absent or weak; transverse anterior line, when present, black, indistinct on costa, going towards anal angle in cell two-fifths distance from base of wing, turning sharply on cubital vein and going to inner margin at one-third distance from base with outward projection on vanal vein; median line absent, rarely indicated by indistinct diffuse brown shade going straight across wing from basad of discal dot to inner margin at one-half distance from base; discal dot black, prominent, rather large; transverse posterior line absent; subterminal line usually complete, well marked, most prominent line on wing, orange brown or yellowish, leaving costa at about five-sixths distance from base parallel with outer margin to about vein  $M_1$ , curved sharply basad to vein  $M_3$ , then to inner margin with outward bend above vanal vein at about three-fourths distance from base, sometimes inwardly edged with narrow dark line, outwardly edged with two or three black triangular marks below apex and with from two to four black marks below cell, any of these sometimes narrowly margined distally with light gray or white; terminal area and fringe concolorous with remainder of wing; outer margin convex between apex and vein  $M_3$ ; no terminal inter-venular dots. Hind wings white, more or less



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FIG. 2. Distribution of *Drepanulatrix unicalcararia* (Guenée).

heavily dusted with dark gray or black brown scales except along costal margin; discal dots present, sometimes reduced, dark, smaller than those on forewings; cross lines absent, rarely postmedian line faintly indicated on inner margin, going for short distance before disappearing; terminal intervenular dots absent; fringe concolorous, sometimes appearing lighter than heavily dusted posterior portion of wing.

**UNDER SURFACE OF WINGS:** Yellowish white, sparsely marked with dark scales along costa and apically on forewings, posteriorly on hind wings; cell of primaries sometimes tinged with smoky; no cross lines or terminal intervenular dots on any wings; discal dots present on all wings, dark; fringes concolorous. Expanse: 29 to 36 mm.

**FEMALE:** Like male; forewings tending to be more variable in color, ranging from gray black to light gray, through yellow brown and orange brown to orange red; cross lines as in male, or even more reduced; subterminal line usually prominent, sometimes reduced, indicated by outward dark shadings and lightening of ground color; terminal area concolorous or sometimes rather heavily and evenly shaded with black scales. Expanse: 28 to 34 mm.

**MALE GENITALIA:** Uncus tapering, with terminal half of equal width (in ventral view) or swollen (in lateral view), hairs ranging in length from subequal to twice width of uncus at base of hairs; valves thick-set, heavily haired and spined, especially in costal region; anellus elongate, broadest anteriorly, pointed posteriorly, with median anterior cleft, almost twice as long as wide; saccus sharply constricted distad of middle, longer than wide; aedeagus ratio of length to width 7:1 or 8:1, vesica armed with five to nine heavy pointed spines located medially, ranging in length from one-third to longer than uncus, plus two or three very long, thin, pointed, sclerotized rods about two and one-half times length of uncus and extending from basad of heavy spines to apex of aedeagus.

**FEMALE GENITALIA:** Ductus bursae somewhat longer than broad, lateral margins folded over, posterior margin with median indentation, width of posterior end two to three times as wide as width of anterior end; bursa copulatrix sclerotized, broadly swollen

on left side (in ventral view), running straight to membranous sac, on right side going straight to membranous sac, dorsal swelling at posterior end sometimes projecting on right side as shoulder, constriction between sclerotized area and membranous sac ranging from subequal to wider than maximum width of ductus bursae, the whole bursa ranging from four to five times length of ductus.

**EARLY STAGES:** Described by Dyar, with the exception of the pupa.

**TYPES:** *Unicalcararia*, reported as lost (Oberthür); described from a single male. *Behrensaria*, Illinois Natural History Survey collection; designated by Barnes and McDunnough (1916). *Cervinicolor*, Rutgers University collection; a male labeled "Col." is hereby designated as lectotype. *Ella*, *ida*, Rutgers University collection; both were described from single females.

**TYPE LOCALITIES:** "Californie" (*unicalcararia*); Soda Springs, California (*behrensaria*); "Col." (*cervinicolor*); "Was. T." (*ella*); Colorado (*ida*).

**RANGE:** Western United States, from California and Arizona north through the coastal and Rocky Mountain states to British Columbia. (See fig. 2.) On the wing from March through October.

**FOOD PLANT:** *Ceanothus* (Dyar, 1903); reared by Claude Smith from *Ceanothus* species in Los Angeles County, California.

**REMARKS:** Two hundred and ninety-one specimens examined. A variable and widespread species, apparently not divisible into subspecies. Some of the Rocky Mountain specimens have a broader orange subterminal line with the row of definite black outward points beyond the cell reduced, but this is not a constant feature. Some of the British Columbia examples are a darker gray than those from more southern localities, but this is by no means a constant feature either. The name *cervinicolor* was applied by Hulst in 1898 to the gray form of this species, although at an earlier date (1895) he had realized that his *behrensaria* was a synonym of *unicalcararia* and then applied the latter name to the cervinus form. In any case, a varietal name is not warranted, as pointed out by Dyar (1903), as there is a complete integradation from the light brown to the dark gray colors.

***Drepanulatrix hultii* (Dyar)**

*Catopyrrha hultii* DYAR, 1903, Proc. Ent. Soc. Washington, vol. 6, p. 226.

**MALE:** Head, vertex light brown, dark or light gray, or a mixture of these; front and palpi similar, either lighter or darker; antennal pectinations one and one-half times length of eye, terminal 12 per cent of antennae simple. Thorax dorsally concolorous with forewings, ventrally lighter, as are legs. Abdomen light brown with darker scales, concolorous with secondaries.

**UPPER SURFACE OF WINGS:** Forewings variable in color, ranging from light or dark gray, tan, cream, fawn, pinkish, or red brown, more or less irrorate with orange brown, dark brown, or black scales; transverse anterior line present or absent, when present, leaving costa one-third to one-fourth out from base, blackish, broad, diffuse, more or less bent outward in cell and on veins, meeting inner margin at one-third; median field between cross lines often somewhat more heavily set with darker scales, especially between discal dot and transverse posterior line, sometimes not differentiated; discal dot present, black or dark, conspicuous; median line absent; transverse posterior line usually present, sometimes lacking, leaving costa at two-thirds distance from base in large, dark, indefinite mark, going outward opposite cell and above inner margin, concave between, blackish, broad, diffuse; area between transverse posterior and subterminal lines of ground color, sometimes slightly lighter in color; subterminal line prominent to rudimentary, consisting of black intervenular dots almost straight in course, often outwardly shaded with white or light gray; terminal area concolorous with basal part of wing; outer margin straight, rarely slightly concave, to vein  $M_3$ ; terminal intervenular dots absent; fringe concolorous. Hind wings dull white, more or less heavily covered with dark brown or black scales, especially along inner and outer margins and anal angle; antemedian line absent; discal dot often absent, usually weak when present; postmedian line present on inner margin, diffuse, absent on anterior half of wing; faint indications of subterminal dots at anal angle in some specimens; terminal intervenular dots absent; fringe as on primaries, sometimes

appearing darker or pinker than secondaries.

**UNDER SURFACE OF WINGS:** Ground color dull white with pale yellow or smoky cast, sparsely irrorate with dark scales along costa of primaries and on secondaries; secondaries somewhat lighter than primaries; discal dots weak or absent; cross lines, intervenular terminal dots absent; fringe concolorous.

**FEMALE:** Like male; wings tending to be more evenly colored with fewer markings, sometimes immaculate with exception of discal dot.

**MALE GENITALIA:** Uncus somewhat variable in shape, usually bulbous, apex broadly rounded, heavily covered with hairs about twice width of uncus at base of hairs; socius with from 12 to 24 hairs; gnathos complete, reduced anteriorly; valves long, widest at two-thirds distance from base, apical one-third evenly tapered to blunt point, costal portion apically with long heavy spines, costal arm absent; cristae long, numerous, approximately 14 to 24 in number; anellus broadly triangular, ovoid, or subrectangular, as wide as long, broadest anteriorly, median anterior and/or posterior clefts present or absent; saccus elongate, more or less constricted about, or just distad of, middle, apex broadly rounded to bluntly pointed; aedeagus very long, one and one-fourth times as long as distance from tip of uncus to end of saccus, straight, with anterior one-fourth bent at angle, ratio of length to width approximately 10:1, vesica armed with single, very long, sclerotized rod extending practically entire length of aedeagus, widest anteriorly, tapering posteriorly. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum absent; ductus bursae subequal in width, posterior half sclerotized, anterior half membranous, broadly joined ventrally to bursa, the whole subequal in length to ovipositor rods; ductus seminalis from ventral side of bursa near anterior end of junction with ductus; bursa copulatrix very long, subequal in length to length of entire abdomen, sclerotized, widest at posterior end, evenly tapering anteriorly to narrow neck, then enlarged into rounded membranous sac, attenuated sclerotized portion with many longitudinal rows with elongate sclerotized teeth except ventrally.

Apparently nothing is known of the early





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FIG. 3. Distribution of *Drepanulatrix hulsii* (Dyar).

stages or food plant of any of the subspecies of this species.

RANGE: Arizona and California to Oregon and Nevada. (See fig. 3.)

REMARKS: The male genitalia are quite distinctive in the very long aedeagus with the sclerotized rod extending the length thereof. Closest to *quadraria* but immediately distinguishable by the above characters.

This species is unique in having the very long, attenuated bursa copulatrix in the female genitalia with the small membranous sac on the anterior end.

This species can be divided into three subspecies. There is a considerable range of variation within these races, so accurate determinations of these subspecies may at times be difficult. In this case, the genitalia are not of much assistance as an aid in separating the subspecies.

***Drepanulatrix hulstii hulstii* (Dyar)**

Figure 12C

*Catopyrrha hulstii* DYAR, 1903, Proc. Ent. Soc. Washington, vol. 6, p. 226.

*Deilinia hulstii*, GROSSBECK, 1912, Jour. New York Ent. Soc., vol. 20, p. 289.

*Drepanulatrix hulsti*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179, pl. 13, fig. 13.

*Deilinia lenitaria* GROSSBECK, 1912, Jour. New York Ent. Soc., vol. 20, p. 284.

*Drepanulatrix lenitaria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179.

MALE: Forewings above varying in color from light to dark gray, sometimes with brown shadings; cross lines usually weak, represented on costa by dark blotches, often showing only by contrast in color between darkened median and lighter subterminal areas; subterminal row of black dots usually prominent, sometimes reduced. Expanse: 27 to 38 mm.

FEMALE: Forewings above varying in color from bright pink to pale brown pink through light to dark gray; median area sometimes showing darker; cross lines weak or absent; subterminal row of black dots usually weak, often reduced or absent; discal dot often most prominent mark. Expanse: 25 to 35 mm.

MALE GENITALIA: Entire genitalia rela-

tively small, the over-all distance from tip of uncus to apex of saccus being from 2.5 to 2.6 mm.; uncus usually bulbous; valves relatively small and broad, averaging approximately 1.9 mm. long by 0.43 mm. maximum width.

FEMALE GENITALIA: Ratio of maximum length to maximum width of sclerotized portion of bursa copulatrix 3.5:1; maximum length of teeth in bursa 0.10 to 0.18 mm., longitudinal rows of teeth quite numerous, about 0.3 mm. apart.

EARLY STAGES: Unknown.

TYPES: *Hulstii*, United States National Museum, type no. 9803; a male, by original designation. *Lenitaria*, the American Museum of Natural History; both male and female types designated by Grossbeck.

TYPE LOCALITIES: Los Angeles County, California (*hulstii*); San Diego, California (*lenitaria*).

RANGE: California, extending from the mountains and coastal regions of the southern portion up the coast to near the northern border, and at low elevations on the western side of the Sierra Nevada Range. (See fig. 3.) On the wing from February through December.

FOOD PLANT: Unknown.

REMARKS: Three hundred and nineteen specimens examined. Typically distinguished from the other subspecies by the pinkish cast of the primaries, with rather indistinct cross lines, although this varies considerably; the color of the forewings ranges from yellow brown to red brown gray brown. It apparently intergrades into *hulstii verdiaria* in the Sierra Nevada Range, although the typical subspecies apparently occurs at lower elevations on the western side, while the latter occurs at higher elevations and to the east.

***Drepanulatrix hulstii carneolata***

Barnes and McDunnough

*Drepanulatrix hulsti carneolata* BARNES AND McDUNNOUGH, 1917, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 233, pl. 28, figs. 5, 6.

MALE: Forewings above varying in color from light fawn to flesh color; median area not darkened; cross lines absent or rudimentary, as is subterminal row of spots; discal dot only prominent mark. Expanse: 28 to 38 mm.

**FEMALE:** Like male, but even more immaculate. Expanse: 28 to 39 mm.

**MALE GENITALIA:** Too little material available for accurate comparisons, but apparently very similar to the above.

**FEMALE GENITALIA:** Too little material available for accurate comparisons, but apparently similar to *verdiaria* in structure of bursa ornamentation.

**EARLY STAGES:** Unknown.

**TYPE:** United States National Museum; by original designation; illustrated with original description.

**TYPE LOCALITY:** Redington, Arizona.

**RANGE:** Arizona. (See fig. 3.) On the wing from March through October.

**FOOD PLANT:** Unknown.

**REMARKS:** Forty-four specimens examined. Distinguished from the other subspecies by the light fawn or cream-colored forewings that are very lightly marked, often without markings except for discal dot. Typically from the mountains of southern Arizona, although other Arizonan specimens are included here also. Some examples from southern California (Bouquet Canyon, Mint Canyon, both Los Angeles County, August and September) are practically indistinguishable from southern Arizonan examples; however, other moths from these areas agree with typical *hulstii*. With more specimens and information on the life histories of typical *hulstii* and *hulstii carneolata*, it may be necessary to revise the status and distributional picture of these forms.

***Drepanulatrix hulstii verdiaria*** (Grossbeck),  
new status

*Deilinia verdiaria* GROSSBECK, 1912, Jour. New York Ent. Soc., vol. 20, p. 285.

*Drepanulatrix verdiaria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Drepanulatrix rindgearia* SPERRY, 1948, Bull. Southern California Acad. Sci., vol. 47, p. 9. (New synonymy.)

**MALE:** Forewings above varying in color from dark gray to tan or red brown; median area often darkened; cross lines usually distinct, complete; subterminal row of black dots sometimes complete, often reduced and incomplete towards anal angle. Expanse: 27 to 43 mm.

**FEMALE:** Forewings above varying in color from pinkish brown through tan to dark

gray; median field sometimes showing darker; cross lines strong to weak; subterminal row of black dots weak, complete to absent. Expanse: 30 to 44 mm.

**MALE GENITALIA:** Entire genitalia relatively larger, the over-all distance from tip of uncus to apex of saccus being from 2.6 to 2.7 mm.; uncus often bulbous, sometimes of subequal width throughout; valves longer and narrower, averaging 2.2 mm. long by 0.55 mm. maximum width.

**FEMALE GENITALIA:** Ratio of maximum length to maximum width of sclerotized portion of bursa copulatrix 3:1; maximum length of teeth in bursa 0.16 to 2.00 mm., longitudinal rows of spines less numerous, about 0.3 to 1.0 mm. apart.

**EARLY STAGES:** Unknown.

**TYPES:** *Verdaria*, the American Museum of Natural History, labeled lectoholotype and lectoallotype by Grossbeck. *Rindgearia*, Los Angeles County Museum.

**TYPE LOCALITIES:** Verdi, Nevada (*verdiaria*); Round Valley, Inyo County, California (*rindgearia*).

**RANGE:** Sierra Nevada and Cascade Mountains of California, north into Oregon, east into Nevada. (See fig. 3.) On the wing from May through August.

**FOOD PLANT:** Unknown.

**REMARKS:** Sixty-six specimens examined. This apparently is a higher altitude and Great Basin form and can usually be recognized by the brownish forewings with more or less definite cross lines and the median area sometimes darkened. The specimens also tend to be slightly larger than the other subspecies.

*Drepanulatrix rindgearia* is apparently indistinguishable from, and conspecific with, true *verdiaria*. The male genitalia of *rindgearia* are seemingly inseparable from *verdiaria*; the armature of the vesica is too variable to be used for even subspecific differentiation. The female genitalia of a single paratype *rindgearia* in the author's collection are somewhat intermediate between those of *hulstii* and of *hulstii verdiaria*, the size ratio agreeing with the latter but the teeth and rows thereof approaching the former, although this latter character is a rather variable one and can be matched by other *verdiaria*.

***Drepanulatrix biflata* (Hulst)**

*Lozogamma biflata* HULST, 1880, Bull. Brooklyn Ent. Soc., vol. 3, p. 44.

**MALE:** Head, vertex cream to buff; front and palpi slightly darker; antennal pectination twice length of eye, terminal 12 per cent simple. Thorax and legs cream or buff, sometimes reddish brown, concolorous with wings. Abdomen cream to buff, concolorous with secondaries.

**UPPER SURFACE OF WINGS:** Forewings, ground color cream to buff, lightly or heavily covered with dark brown or black scales; transverse anterior line prominent to weak, arising from heavy, often squarish, dark spot on costa one-third distance from base, sometimes slightly bent outwardly in cell, running straight to inner margin, orange brown to black in color; discal dot small, black, prominent; transverse posterior line prominent to weak or absent, arising from heavy dark spot on costa two-thirds distance from base, running straight to inner margin, paralleling or converging on transverse anterior line, orange brown to black in color; subterminal line more or less complete, usually prominent, indicated by series of black, often triangular spots, often inwardly shaded with orange brown, outwardly with white, leaving costa between inception of transverse posterior line and apex curving inward across cell and approaching transverse posterior line, separating off just before inner angle; area between this line and outer margin somewhat darkened owing to heavier accumulation of dark-colored scales; apex often with dark dash; outer margin slightly concave or straight to vein  $M_3$ ; no intervenular terminal dots; fringe concolorous. Hind wings dull white, lightly dusted with dark brown or grayish scales, especially near anal angle and to a lesser degree along outer and inner margins; ante-median line and discal dot absent; postmedian line often present, sometimes weak or absent, arising two-thirds out on inner margin running straight across wing, fading out in center; intervenular terminal dots absent; fringe concolorous, sometimes slightly darker.

**UNDER SURFACE OF WINGS:** Ground color silken white, lightly dusted with dark brown scales; no maculation; terminal intervenular dots absent; discal dots usually present on

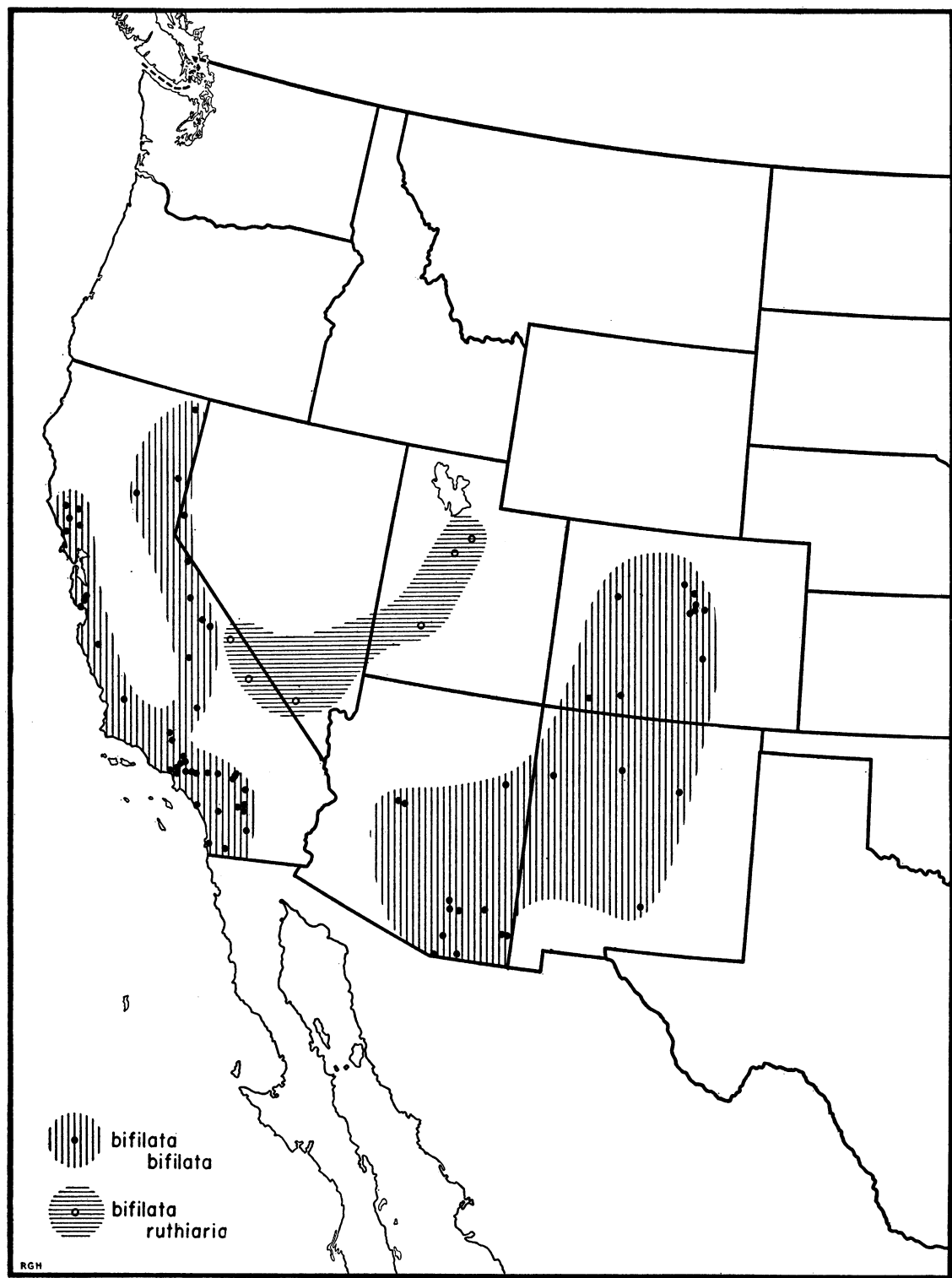
all wings, sometimes weakly represented or absent; fringes concolorous.

**FEMALE:** Like male; coloration of forewings tending more towards pink, orange, red, or darker gray; maculation similar, subterminal line often absent; discal dot reduced, sometimes absent. Hind wings dusted with red brown or black brown scales; fringe concolorous or reddish.

**MALE GENITALIA:** Uncus with terminal two-thirds of equal width or very slightly swollen, bluntly pointed, sparsely haired, with maximum length of hairs being subequal to width of uncus at base of hairs; socius with from 10 to 20 hairs; gnathos complete, reduced anteriorly; valves broadly widened in costal portion about one-third distance from origin of transtilla to base, distally narrowed and curved posteriorly with apex bluntly pointed, costal arm absent; cristae consisting of from three to 12 hairs; anellus subrectangular, rounded, with anterior median cleft, longer than wide, widest near anterior end; saccus elongate, constricted medially or subterminally with apex bluntly pointed or rounded; aedeagus straight, slightly swollen distally, ratio of length to width approximately 10:1, vesica armed with three or four, rarely one to six, pointed spines located medially in one group and ranging in length from one-third to two-thirds length of uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum rudimentary or absent; ductus bursae sclerotized, posterior end with corners lightly sclerotized and with central area projecting as sclerotized process, decreasing in width anteriorly, lateral margins apparently doubled over, short membranous area at attachment to bursa, the whole slightly longer than ovipositor rods; ductus seminalis arising from ventral surface anterior to junction of ductus bursae and bursa; bursa copulatrix roughly oval, anterior half membranous, posterior half sclerotized dorsally and laterally with longitudinal rows of small rudimentary sclerotized teeth, ventrally largely membranous but with flattened U- or horseshoe-shaped sclerotized band with small or reduced teeth, the bursa being almost twice as long as ductus bursae.

The early stages have not been described.



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FIG. 4. Distribution of *Drepanulatrix bifilata* (Hulst).

RANGE: Southern Rocky Mountain states and western Texas to California. (See fig. 4.)

REMARKS: On the basis of the structure of the male genitalia closest to *quadraria*, but distinguished from that species by the broad valves without the presence of heavy spines distally and by smaller number of cornuti in the aedeagus.

The ornamentation of the bursa, with the horseshoe-shaped sclerotized band, is distinctive and cannot be confused with any other species. Divisible into two geographical subspecies that are usually fairly easy to distinguish and are practically identical in genitalia.

***Drepanulatrix biflata biflata* (Hulst)**

Figure 12D

*Lozogamma biflata* HULST, 1880, Bull. Brooklyn Ent. Soc., vol. 3, p. 44.

*Apacasia biflata*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 340.

*Deilinia biflata*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306; 1903, Proc. Ent. Soc. Washington, vol. 5, p. 226.

*Drepanulatrix biflata*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Thamnonoma perpallidaria* GROTE, 1882, Canadian Ent., vol. 14, p. 185; 1883, Canadian Ent., vol. 15, p. 25.

*Deilinia perpallidaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix perpallidaria*, BARNES AND McDUNNOUGH, 1917, Check List, p. 112.

*Lozogamma carneata* WARREN, 1904, Novitates Zool., vol. 11, p. 561.

*Drepanulatrix carneata*, BARNES AND McDUNNOUGH, 1917, Check List, p. 112.

MALE: Forewings above varying in color from cream to buff, overlain with darker scales; transverse anterior and transverse posterior lines usually prominent; subterminal line complete to almost reduced; terminal area slightly darker than remainder of wing. Expanse: 24 to 30 mm.

FEMALE: Forewings above varying in color from cream to orange, pink, or reddish; transverse anterior and transverse posterior lines narrow, orange, sometimes brownish, arising from smaller orange brown or dark brown costal spots; area between transverse posterior and subterminal lines, when latter present, often deep orange. Hind wings dusted with red brown scales; fringe often pinkish. Expanse: 24 to 31 mm.

MALE GENITALIA: Cristae of five to 12 hairs; aedeagus with vesica armed with from three or four, rarely one to six, spines. See remarks under *biflata ruthiaria* for discussion of further characters.

FEMALE GENITALIA: As above.

EARLY STAGES: Undescribed.

TYPES: *Biflata*, female specimen in the United States National Museum labeled "Col.," with genitalia mounted on slide 2924 J.F.G.C., is hereby designated as lectotype. The type series, according to the original description, consisted of three females from Colorado. One of these is referred to above and is in excellent condition, a second is in the Rutgers University collection and lacks the abdomen, while the location of the third specimen is unknown. The United States National Museum also has the following under this name: type no. 3876, from Havilah, California, and no. 34205 from "Ariz.," both are labeled by Hulst as types, but these must be considered as spurious. *Perpallidaria*, United States National Museum, type no. 34206; apparently described from a single male. *Carneata*, British Museum (Natural History) (?), described from a single female.

TYPE LOCALITIES: "Col." (*biflata*); near Hot Springs, Las Vegas, New Mexico, 7000 feet, August, 1882 (*perpallidaria*); San Juan Mountains, Colorado (*carneata*).

RANGE: Southern Rocky Mountain states and western Texas to California. (See fig. 4.) A single female labeled "The Basin, Big Bend Nat. Park, Texas, el. 5500 ft., April 14, 1949, R. R. McElvare" is the only Texan specimen seen; this locality is not indicated on the distribution map. On the wing every month of the year in temperate regions.

FOOD PLANT: A male and a female in the Los Angeles County Museum labeled as having been reared from *Cercocarpus* by Dr. John A. Comstock.

REMARKS: Four hundred and one specimens examined. This subspecies is distinguished by the forewings' being pink, ocher, or red brown with distinct cross lines. Typically from the Rocky Mountains; specimens from there can be matched with many specimens from California. Some of the Californian material becomes a darker brown or reddish with more distinct markings. However, there is a complete gradation between the



two, so these dark forms have not been named.

***Drepanulatrix bifilata ruthiaria* Sperry,**  
new status

*Drepanulatrix ruthiaria* SPERRY, 1948, Bull. Southern California Acad. Sci., vol. 47, p. 8.

MALE: Forewings above buff, overlain with darker scales; transverse anterior and transverse posterior lines reduced or absent; subterminal line usually reduced, sometimes complete; terminal area sometimes darkened. Expanse: 25 to 29 mm.

FEMALE: Forewings above buff, more or less heavily overlain with darker gray or blackish scales; transverse anterior and transverse posterior lines broad, diffuse, dark gray. Hind wings dusted with black brown scales, appearing somewhat concolorous with primaries; fringe concolorous. Expanse: 24 to 28 mm.

MALE GENITALIA: Cristae of from three to eight hairs; aedeagus with vesica armed with from two to four spines.

FEMALE GENITALIA: As above, apparently indistinguishable from those of *bifilata bifilata*. In some specimens the anterior end of the bursa copulatrix appears somewhat constricted or reduced, but this may be owing to the mounting technique; more fresh material is needed to settle this point.

EARLY STAGES: Unknown.

TYPE: Los Angeles County Museum.

TYPE LOCALITY: Charleston Mountains, Nevada, May 14, 1934 (Dr. John A. Comstock).

RANGE: Utah, Nevada, and eastern desert portions of California. (See fig. 4.) On the wing from May through August.

FOOD PLANT: Unknown.

REMARKS: Forty-six specimens examined. Distinguished by the gray brown or buff forewings with indistinct cross lines, sometimes almost without markings except on costa. Apparently this is more a desert or Great Basin subspecies than is the typical one.

The following discussion applies to those characters of the male genitalia mentioned by Sperry in the original description, the measurements being taken from nine specimens of *bifilata bifilata* and from five specimens of *bifilata ruthiaria*. (1) For armature of the vesica, see above. (2) The average over-all

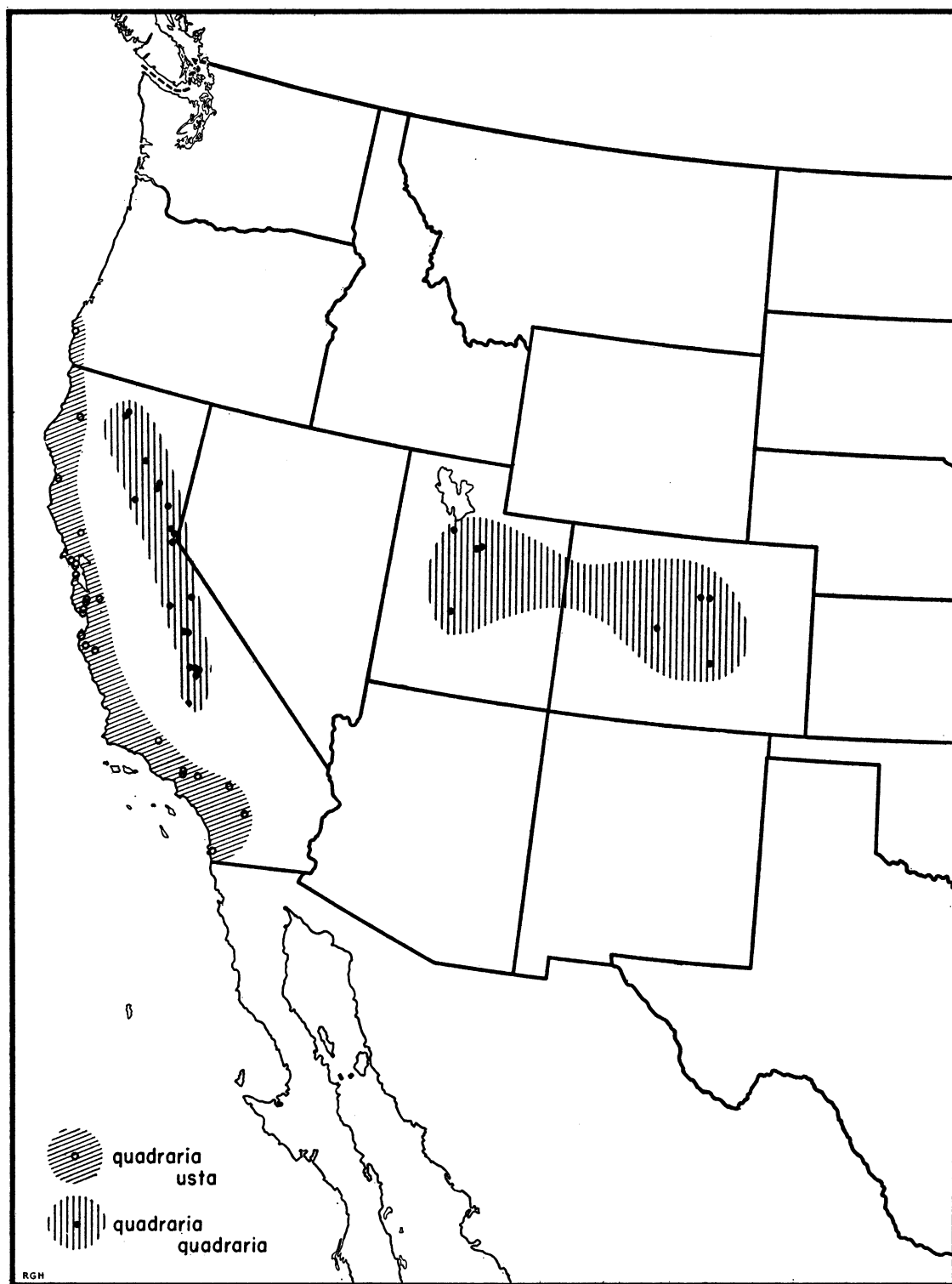
length compared with the average maximum width of valves is 15.33 by 3.40 mm. for *bifilata bifilata*, and 14.80 by 3.46 mm. for *bifilata ruthiaria*. (3) The average total length compared with maximum width of saccus is 1.05 by 0.75 mm. for *bifilata bifilata*, and 1.00 by 0.69 mm. for *bifilata ruthiaria*, with a larger constriction present in one out of the nine *bifilata bifilata* as compared to two out of five specimens of *bifilata ruthiaria*. Hence it can be seen that the characters mentioned by Sperry may be applicable but should be used only with considerable caution.

***Drepanulatrix quadraria* (Grote)**

*Thamnonoma quadraria* GROTE, 1882, Canadian Ent., vol. 14, p. 185.

MALE: Head, vertex and thorax above gray brown, sometimes pinkish, concolorous with forewings; front and palpi darker brown, sometimes shaded with rose; antennal pectinations about twice length of eye, terminal 15 per cent simple. Thorax ventrally lighter than above, legs brownish or pink. Abdomen dull white or light gray, more or less heavily dotted with dark gray or black scales, sometimes with pinkish or orange cast instead, appearing concolorous with or darker than hind wings.

UPPER SURFACE OF WINGS: Forewings broad, light to dark gray, light orange to rose brown, more or less sprinkled with black scales; cross lines in basal half of wing indistinct, more prominent in outer half; transverse anterior line weak, sometimes absent, dark, arising on costa about one-fifth distance from base at right or obtuse angle to radial vein, outwardly produced thereon, then to inner margin at one-third distance from base with outward projections on cubital and vanal veins; median line, when present, weaker than transverse anterior line, dark, arising on costa basad of one-half distance from base, going to radial vein, curved outward to black, prominent discal dot in cell, then to inner margin at one-half distance from base with strong outward bend between cubital and vanal veins; transverse posterior line usually prominent, black, arising on costa about two-thirds distance from base at right angle to vein  $R_4$  or  $M_1$ , turning posteriorly, sometimes with slight inward bow across cell going straight across wing to inner



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FIG. 5. Distribution of *Drepanulatrix quadraria* (Grote).

margin at four-fifths distance from base, decreasing in width and strength posteriorly; area between transverse posterior and subterminal lines often shaded with orange brown or pinkish scales, especially next to subterminal line, standing out in contrast with remainder of wing, sometimes undifferentiated; subterminal line usually prominent, sometimes reduced or rudimentary, leaving costa about 2 mm. from apex, in form of black, outwardly pointing projections, three in number below apex, then sharply indented below cell, meeting transverse posterior line with two or three smaller scallops decreasing in size and intensity towards inner margin; terminal area concolorous with remainder of wing, sometimes somewhat darker; outer margin straight between apex and vein  $M_2$ ; terminal intervenular dots absent; fringe concolorous. Hind wings lighter than forewings, white or pale gray, more or less sprinkled with black scales; discal dot black, usually prominent, sometimes reduced; no cross lines; terminal intervenular dots absent; fringe concolorous or sometimes pinkish.

**UNDER SURFACE OF WINGS:** Pale gray, often rather heavily sprinkled with black scales, on forewings along costa and terminally, usually with smoky or faint pinkish tinge, on hind wings evenly distributed; discal dots present on all wings, black, more prominent than on upper surface; no cross lines or intervenular terminal dots; fringe concolorous or slightly pinkish.

**FEMALE:** Like male; forewings variable in shape, broad as in male or considerably narrowed; cross lines indistinct, subterminal line reduced, usually without black projecting teeth, more or less indicated by orange brown or pinkish brown coloration in area basad.

**MALE GENITALIA:** Uncus more or less constricted in center, distal half somewhat bulbous, apex bluntly pointed with small reduced hook, sparsely haired, with hairs being shorter than width of uncus at base of hairs; gnathos complete, weakly sclerotized; valves subequal in width, sometimes slightly swollen in costal portion, anterior margin angled and curved posteriorly, apex narrowed, bluntly pointed, costal arm absent, whole organ, especially terminally, with long heavy spines; transtilla narrowed medially; cristae reduced, from zero to three hairs; anellus subrectangu-

lar, anterior median cleft absent or present, longer than wide; saccus elongate, constricted either basally or distally of middle, apex bluntly rounded; aedeagus straight, subequal to distance from tip of uncus to apex of saccus, ratio of length to width approximately 10:1, vesica armed with eight to 16 pointed spines located medially in one group and ranging in length from one-fourth to equal to length of uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum small, transversely elongate oval; ductus bursae elongate, lightly sclerotized at both ends, posterior end in form of subrectangular plate four times as long as wide, anterior end in form of triangular plate, two sides of which go up sides of bursa, medially membranous and constricted, the whole more than twice length of ovipositor rods; bursa copulatrix roughly oval in shape, membranous with large, smoothly sclerotized area ventrally, ventral posterior region extended in form of broad, membranous, conical structure continued posteriorly as ductus seminalis, the bursa being shorter than length of ductus bursae.

The early stages of the nominate subspecies have been described.

**RANGE:** Rocky Mountain states; California and Oregon. (See fig. 5.)

**REMARKS:** The male genitalia appear closest to *bifilata*, but are distinguishable by the valves' being subequal in width rather than broadly widened costally and by having heavy spines distally; also by the armature of the vesica, there being eight to 16 spines in *quadraria* while in *bifilata* the number ranges from one to six.

The female genitalia are quite distinct in possessing the large, smooth, sclerotized area in the bursa. The large, membranous, conical structure giving rise to the ductus seminalis is a noteworthy feature but is shared with *nevadaria* and, to a lesser degree, *carnearia*.

This species is at present divided into two geographical subspecies. The adults are fairly variable but relatively easy to recognize; they are quite distinct genitally. There is considerable variation in wing shape in the females, which may cause some difficulties; however, genitalic preparations will quickly settle the determination.

***Drepanulatrix quadraria quadraria* (Grote)**

*Thamnonoma quadraria* GROTE, 1882, Canadian Ent., vol. 14, p. 185.

*Deilinia quadraria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix quadraria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Deilinia carnearia* DYAR (not Hulst), 1902, Psyche, vol. 9, p. 419 (life history).

**MALE:** Forewings varying in color from light to dark gray; transverse anterior line usually indistinct; median line usually absent, only faintly indicated by indistinct darker shade when present; transverse posterior line usually prominent, distinct, especially in anterior half of wing; area between transverse posterior and subterminal lines often shaded with orange brown or dark brown outwardly; subterminal line quite prominent, black. Hind wings usually rather heavily dusted with dark scales. Expanse: 25 to 29 mm.

**FEMALE:** Like male; wings sometimes shaded with light orange brown; subterminal line weaker than in male, not black and prominent, often showing by contrast in color between subterminal and terminal areas. Expanse: 23 to 26 mm.

**MALE GENITALIA:** Uncus relatively long with noticeable constriction, being about 0.46 mm. in length, ratio of narrowest point of constriction to total length 1:9, of widest portion of terminal bulb to total length 1:7; sacculus two and one-half times length of uncus, constricted in basal half; aedeagus five times length of uncus.

**FEMALE GENITALIA:** As above.

**EARLY STAGES:** Dyar (1902, Psyche, vol. 9, p. 383) described a life history under the name of *Deilinia quadraria*. Later (1903, Proc. Ent. Soc. Washington, vol. 6, p. 226) he corrected this to read *Ixala desperaria* (Hulst), which is apparently where the description belongs. Dyar also described a life history under the name of *Deilinia carnearia* (Hulst), which is referable to this subspecies; as far as can be told, the neotype and neallotype are reared specimens from this material. As mentioned above, Dyar had many of his identifications in this group incorrect; it is also possible that he had more than one species at hand when he wrote his notes on this species.

**TYPE:** Apparently destroyed; all that remains is a large pin with the label "Thamnonoma Quadraria Grote Male Type" in the United States National Museum. In the same collection is a male with Dyar's no. 17258 (Golden, Colorado, foothills, July 6, 1901), Dyar and Caudell, that is hereby designated as neotype; a female with the same data, no. 17259, is designated as neallotype. These two specimens are in good condition and are conspecific with a specimen from Stockton, Utah, that was compared by Dr. J. H. McDunnough with the type of *quadraria* when it was in the Brooklyn Institute collection.

**TYPE LOCALITY:** Colorado.

**RANGE:** Colorado, Utah, Sierra Nevada and Cascade mountain ranges in California. (See fig. 5.) On the wing from April through August.

**FOOD PLANT:** *Ceanothus* (Dyar, *loc. cit.*, in Colorado); a specimen in the United States National Museum is labeled "Placer Co., Cal. Larva on *Ceanothus cordulatus*."

**REMARKS:** One hundred and thirty-three specimens examined; the great majority of these are from California, with only 11 specimens from the Rocky Mountains. When more and better Rocky Mountain material becomes available, it may be necessary to separate off the specimens from the Sierra Nevada and Cascade ranges as another subspecies. The descriptions given above were compiled almost entirely from Californian specimens. The Rocky Mountain specimens appear to be slightly smaller and more brightly colored than the Californian material. A long series of specimens will be needed to show whether or not these characters are constant and of any value and what other differences occur.

***Drepanulatrix quadraria usta*, new subspecies**

Figure 12E

**MALE:** Forewings rose brown; transverse anterior line rather prominent, especially on costa; median line weak but present; transverse posterior line prominent at costa, dark, weaker posterior of cell red brown in color; area between transverse posterior and subterminal lines shaded completely with orange; subterminal line showing primarily by change in color between subterminal and terminal areas, narrowly black on tips of scallops,

faintly edged with white. Hind wings only lightly dusted with dark scales.

**FEMALE:** Like male; forewings pinker, cross lines weakly showing; very indistinct indications of orange red subterminal area. Hind wings with discal dot absent.

**MALE GENITALIA:** Uncus shorter and less constricted, length 0.44 mm., ratio of narrowest point of constriction to total length 1:6, of widest portion of terminal bulb to total length 1:5; saccus twice length of uncus, constricted in distal half; aedeagus four and one-half times length of uncus.

**FEMALE GENITALIA:** As above, apparently indistinguishable from those of *quadraria*.

**EARLY STAGES:** Unknown.

**TYPES:** Holotype, male, Inverness, Marin County, California, July 2, 1940 (W. R. Bauer), no. 6120, California Academy of Sciences, Entomology; allotype, female, Inverness, Marin County, California, June 10, 1940 (W. R. Bauer), no. 6121, California Academy of Sciences, Entomology. Paratypes, 31 males and 14 females: Inverness, Marin County, California, 14 specimens (W. R. Bauer) with the following range of dates: March 5–July 2, 1940, April 12–July 16, 1947; Westport, Mendocino County, California, June 20, 1940 (W. R. Bauer); Mill Valley, Marin County, California, five specimens (E. P. Van Duzee), March 12, 1920, April 12, May 14, 29, 1924, and April 22, 1926; Alma, Santa Clara County, California, four specimens (G. E. Pollard), May 6–September 2, 1944, March 31, 1945; Carmel, Monterey County, California, March 3, 1926 (L. S. Slevin); San Antonio Ranger Station, Santa Clara County, California, April 15, 1948 (R. van den Bosch); San Diego, San Diego County, California, 19 specimens (L. E. Ricksecker), with the following range of dates: March 10–December 3, 1910, April 6–November 19, 1911.

Paratypes to be distributed as follows: California Academy of Sciences; California Insect Survey collection at the University of California, Berkeley; Los Angeles County Museum; United States National Museum; Museum of Comparative Zoölogy, Harvard University; the American Museum of Natural History; Canadian National Collection; the collections of John L. Sperry of Riverside,

California, William R. Bauer of Petaluma, California, and the author.

**RANGE:** Coastal regions of California and Oregon. (See fig. 5.) On the wing every month of the year.

**FOOD PLANT:** Unknown.

**REMARKS:** One hundred and seventy-nine specimens examined. This subspecies, as are the other species and subspecies in this genus, is rather variable. The males vary in the color of the forewings from rose brown through gray brown to dark gray, with the transverse anterior line usually more distinct than in typical *quadraria*, and with the transverse posterior and subterminal lines less distinct; the area between the transverse posterior and subterminal lines is usually not distinctly marked, often being concolorous with remainder of wing; the hind wings are usually less heavily dusted with dark scales, and the discal dots are weak to absent. Expanse: 22 to 29 mm. The females vary in color of the forewings from rose brown through gray brown to an almost purple brown, with all lines indistinct, rarely the wing appearing unicolorous and without maculation except for discal dot; subterminal area often shaded with orange or red brown, sometimes extending to inner margin; discal dots of secondaries absent or weakly represented. Expanse: 23 to 29 mm.

### *Drepanulatrix foeminaria* (Guenée)

#### Figure 13A

*Selidosema foeminaria* GUENÉE, 1857, Histoire naturelle des insectes, vol. 10, p. 149. WALKER, 1862, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 24, p. 1029. HULST, 1896, Ent. News, vol. 6, p. 104. OBERTHÜR, 1920, Études de lépidoptérologie comparée, vol. 17, p. 23, pl. DVII, fig. 4236; 1923, *op. cit.*, vol. 20, p. 267.

*Deilinia foeminaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix foeminaria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Deilinia pulveraria* HULST, 1898, Canadian Ent., vol. 30, p. 161. DYAR, 1903, Psyche, vol. 10, p. 196 (life history); 1904, Proc. U. S. Natl. Mus., vol. 52, p. 306. (New synonymy.)

*Drepanulatrix pulveraria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

**MALE:** Head, vertex reddish brown concol-

orous with thorax; front slightly darker than vertex; antennal pectinations two to two and one-half times length of eye, terminal 12 per cent of antennae simple. Thorax dorsally concolorous with wings, ventrally lighter brown, legs light brown with darker scales on all segments except tarsi. Abdomen light brown with darker scales, concolorous with secondaries.

**UPPER SURFACE OF WINGS:** Forewings, ground color dark orange brown heavily covered with black brown scales more or less completely obscuring ground color except for band beyond discal spot; basal part of wing to transverse posterior line usually unicolorous dark brown; occasionally with dark transverse anterior line showing indistinctly, leaving costa at about one-fourth distance from base at angle, turning and going straight to inner margin with outwardly projecting teeth at veins SC, R, and Cu; median cross line usually indistinct or absent; when present, dark, leaving costa between one-third and one-half distance from base at angle, turning before reaching discal dot and going straight to inner margin; discal dot black, in white field; dark transverse posterior line often present, leaving costa at about two-thirds distance from base at right angle or even less, going straight to vein  $M_2$ , turning basally as far as vein  $M_3$ , then running somewhat bowed outwardly to inner margin at two-thirds, this line often indistinct or lacking in center of wing; area between transverse posterior and subterminal lines of ground color usually standing out in contrast to remainder of wing; subterminal line leaving costa near apex, dark, overlain with scalloped white line, the two paralleling transverse posterior line; terminal area rather broad, concolorous with basal portion of wing, area between apex and inception of subterminal line sometimes darkened; black intervenular dots present; fringe concolorous. Hind wings dull white, more or less heavily covered with dark brown and orange brown scales so that wings appear lighter than primaries; antemedian line absent; discal dot round, dark; median line rather indistinct, going straight across wing, passing either around or just distad of discal dot; postmedian line very faint or absent; when present, showing near anal angle only; intervenular

dots present; fringe concolorous or slightly darker than wing.

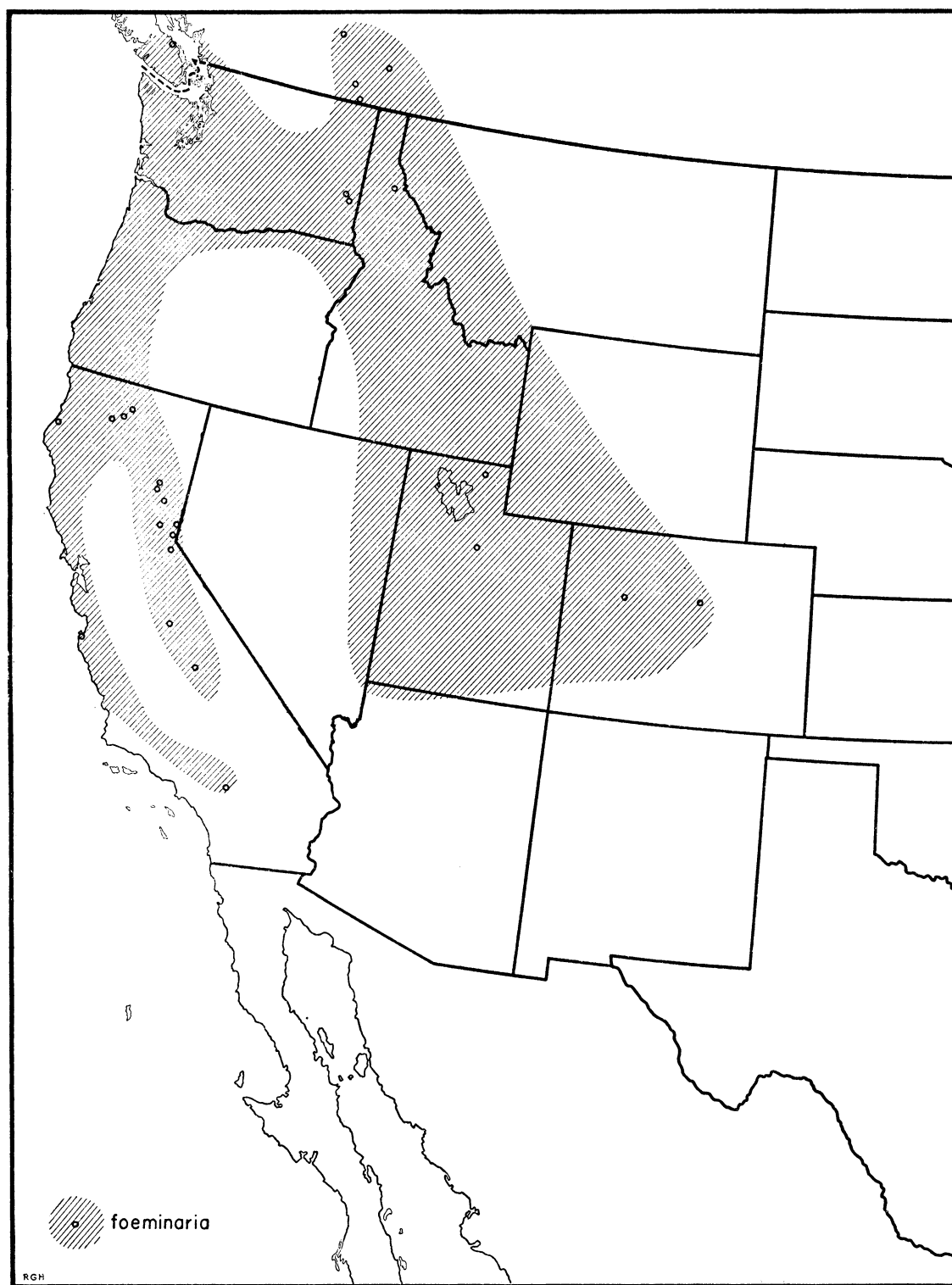
**UNDER SURFACE OF WINGS:** Forewings, ground color dull white, irrorate with dark brown scales, especially along costa and apically, also with some orange brown scales; veins lightly shaded with orange; cross lines absent; discal dot dark, elongate; apex with large dark marking sometimes surrounded by orange brown; intervenular black dots present; fringe darker than wing. Hind wings colored as primaries; cross lines absent; discal dot dark, prominent; wide indistinct dark band usually crossing wing between discal dot and outer margin; intervenular dots present, sometimes weakly represented; fringe somewhat darker than wing. Expanse: 24 to 32 mm.

**FEMALE:** Like male; cross lines usually indistinct; area between transverse posterior and subterminal lines not standing out so brightly. Expanse: 25 to 29 mm.

**MALE GENITALIA:** Uncus constricted medially, terminal portion bulbous, apex bluntly pointed; valves with apex bluntly rounded, costa swollen, slightly projecting; transtilla thick, tapering towards center line where apparently the arms are separate; cristae apparently absent; anellus almost twice as long as wide; saccus elongate, approximately one and one-half times as long as wide; aedeagus slender, ratio of length to width approximately 10:1, with anterior one-sixth bent at angle, cornuti ranging from four to nine in number, gradually decreasing in size posteriorly. Venter of eighth abdominal segment with W-shaped plate.

**FEMALE GENITALIA:** Operculum small; ductus bursae sclerotized, slightly constricted medially, slightly shorter than ovipositor rods, point of attachment to bursa membranous, constricted, on left side (in ventral view); ductus seminalis arising ventrally from near point of juncture of ductus bursae with bursa; bursa copulatrix suboval to somewhat barrel shaped, right side posteriorly broadly extended as large recurved membranous sac extending anteriorly for about one-half length of bursa, central area broadly sclerotized with well-defined longitudinal rows of heavy teeth, anterior end membranous, broadly rounded, the bursa being subequal to, or slightly longer than, length of ductus bursae.





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FIG. 6. Distribution of *Drepanulatrix foeminaria* (Guenée).

**EARLY STAGES:** Described by Dyar, with the exception of the pupa; only four larval instars reported.

**TYPES:** *Foeminaria*, United States National Museum. This species was described from a single female. The specimen in the United States National Museum collection, as usual with most of Guenée's species, was not labeled as type by the author but apparently may be accepted as the type as it fits the original description, is from Guenée's collection, and is labeled as the one figured in the "Études." *Pulveraria*, United States National Museum, type no. 3901, is hereby designated as lectotype; it is labeled "Rossland, B. A. May 9 Danby" and "male genitalia mounted on slide April 23, 1940 J.F.G.C. No. 2927." This species was described from several specimens; one male, just referred to, in very good condition, is in the United States National Museum collection, while two more males are in the collection of Rutgers University, and these are hereby designated as lectoparatypes.

**TYPE LOCALITIES:** "Californie" (*foeminaria*); "Rossland, B. A." (*pulveraria*).

**RANGE:** Pacific coast states from California to British Columbia and Idaho; Utah. (See fig. 6.) On the wing from March through September.

**FOOD PLANT:** *Ceanothus* (Dyar, 1903); *C. thyrsiflorus* Eschscholtz, reared by the author from Kings Mountain, San Mateo County, California.

**REMARKS:** One hundred and seventy-eight specimens examined. A rather widespread species, somewhat variable in maculation as would be expected. Specimens from British Columbia tend to be more contrastingly marked than those from more southern localities, but every type of integradation is present.

Judging by the male genitalia, this species appears rather intermediate between typical *Drepanulatrix*, as represented by *quadraria* to which it is most closely related, and the *liberaria-litaria* group. The well-formed gnathos is quite similar to that of *litaria*, but it falls well within *Drepanulatrix* on general appearance as well as specific characters. It can be distinguished from all other *Drepanulatrix* by the presence of the well-defined, W-shaped ventral plate on the eighth abdominal segment. It may be further distin-

guished from *quadraria* by the better defined gnathos, the wider valves, and shorter aedeagus, with the spines extending from medial area almost to apex instead of being only mediad as in *quadraria*.

The female genitalia appear closest to *carnearia* in general appearance and structure but are distinguished from those of that species by the presence of the large recurved membranous sac on the right side posteriorly. The ornamentation of the bursa is also different, consisting of 15 to 20 well-defined longitudinal rows with large teeth in *foeminaria*, and of many more poorly defined rows with smaller teeth in *carnearia*.

#### *Drepanulatrix nevadaria* (Hulst)

Figure 13B

*Tephrosia nevadaria* HULST, 1888, Ent. Amer., vol. 3, p. 217.

*Deilinia nevadaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix nevadaria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

**MALE:** Head, vertex, front, and thorax above concolorous with forewings, ranging in color from light orange brown to pink; palpi concolorous or shaded with gray; antennal pectinations subequal to, or shorter than, length of eyes, terminal 25 per cent simple. Thorax ventrally dirty white, legs concolorous or very light tan, sometimes with some dark scales. Abdomen silken white with light gray scales shaded anteriorly with pink or orange.

**UPPER SURFACE OF WINGS:** Forewings ranging in color from cream white to orange, pink or purple gray, often heavily overlain with these colors, especially in outer portions of wing; transverse anterior line absent, sometimes very slightly indicated on costa at one-fourth distance from base as diffuse, slightly darker blotch; median line similar, somewhat stronger than transverse anterior line, arising at one-half distance from base, rarely going to inner margin basad of discal dot, very diffuse and indistinct; discal dot black, prominent, rounded to slightly elongate; transverse posterior line present, prominent at least in costal portion of wing, arising at three-quarters distance from base at right angle, broad, diffuse, reddish purple, going across cell, then curving slightly concavely to inner

margin, decreasing in width and intensity posteriorly, often absent in posterior one-third of wing; subterminal line absent; area between transverse posterior line and outer margin reddish purple except for triangular area of pinkish or orange between apex and inception of transverse posterior line and smaller subtriangular area near anal angle adjacent to transverse posterior line; outer margin straight between apex and vein  $M_3$ ; terminal intervenular marks present, not prominent, elongate, purple black, sometimes shaded inwardly by narrow strip of ground color; fringe reddish purple, concolorous with terminal area. Hind wings white, lightest basally, shaded or irrorate outwardly with gray black; terminal intervenular dots present, as on forewings, rather weak; fringe pink, somewhat shaded with purple.

**UNDER SURFACE OF WINGS:** Forewings white, sparsely marked or irrorate with brown black scales except along inner margin; discal dot dark, rounded; cross lines absent except for prominent subterminal line, in same position and same color as on upper surface, broad, going one-third distance across wing, then disappearing; between subterminal line and apex shaded with orange and red purple; terminal intervenular dots present, elongate as on upper surface, or as dots; fringe purple or reddish purple. Hind wings similar to forewings, evenly marked with darker scales; discal dot dark, prominent; outer one-third of wing sometimes lightly shaded with orange or pink beyond very faint trace of postmedian cross line in anterior portion of wing; terminal intervenular dots and fringe as on upper surface of secondaries. Expanse: 23 to 28 mm.

**FEMALE:** Like male; coloration of forewings as above, often shaded prominently with orange; suffused terminal area duller purple than in male. Expanse: 22 to 26 mm.

**MALE GENITALIA:** Uncus thin, clavate, about 0.6 mm. in length, hairs subequal in length to width of uncus at base of hairs; socius with from five to 10 hairs; gnathos weakly developed, reduced to absent anteriorly; valves somewhat curved posteriorly, widest basally, slightly tapering to broadly rounded apex, costal arm present with height subequal to width; transtilla constricted medially; cristae 12 to 16 in number; anellus

subrectangular, longer than wide, somewhat concave anteriorly; saccus elongate; constricted medially, apex broadly rounded; aedeagus straight, ratio of length to width approximately 6:1, vesica armed with two heavy, pointed spines located medially and apically, the former being slightly longer than uncus, the latter slightly shorter than uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum absent; ductus bursae elongate, posterior region slightly less than one-half total length, sclerotized, in form of broad plate tapering anteriorly, both ends truncate, anterior one-fourth also sclerotized, broadest at junction with bursa, which is median, tapering posteriorly, median region between sclerotized ends membranous, somewhat narrowed, the ductus being more than twice length of ovipositor rods; bursa copulatrix elongate oval, membranous, anterior end rounded, median area with lightly sclerotized longitudinal rows of minute teeth, the latter also occurring generally between the rows, posterior end ventral to junction of bursa and ductus extended as large, broad, conical process arising from lightly sclerotized basal band and terminating in ductus seminalis, dorsal posterior portion in form of lightly sclerotized plate, between this and junction of ductus bursae a small membranous sac, the bursa being approximately one and one-half times as long as ductus bursae.

**EARLY STAGES:** Undescribed.

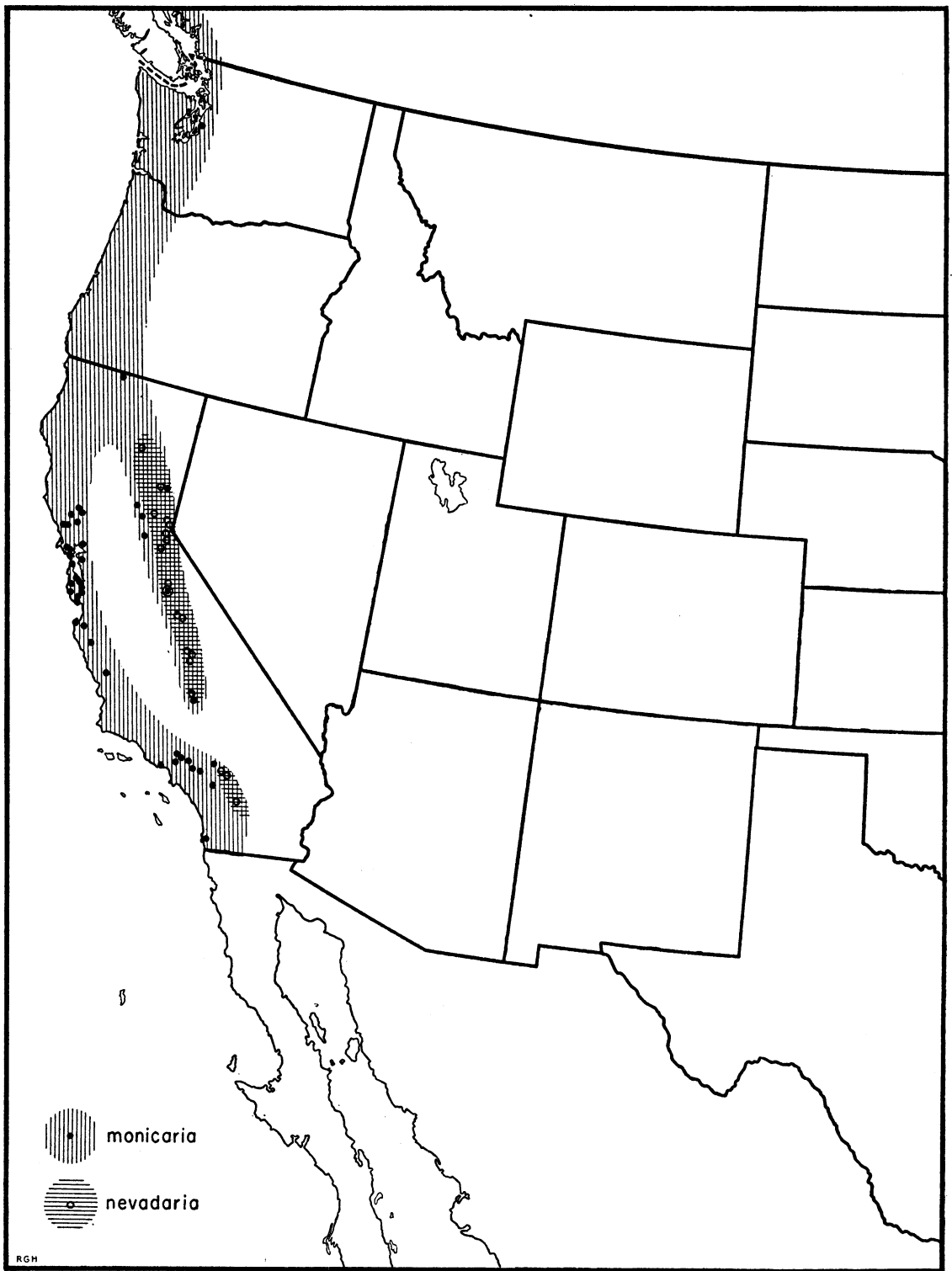
**TYPE:** Rutgers University collection; described from a single male specimen.

**TYPE LOCALITY:** "Sierra Nev. Cal."

**RANGE:** Restricted to inland mountain ranges of California. (See fig. 7.) On the wing in June and July.

**FOOD PLANT:** A specimen in the United States National Museum labeled "Placer Co., Cal. Larva on *Ceanothus cordulatus*."

**REMARKS:** Ninety-two specimens examined. There has been some confusion as to what species this name should be given. The species is easily separable from all others in the genus by the very short antennal pectinations in the male, these being subequal to, or shorter than, the length of the eye, with the terminal one-fourth of the antennae being simple. The maculation and genitalia are dis-



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FIG. 7. Distribution of *Drepanulatrix nevadaria* (Hulst) and *monicaria* (Guenée).

tinctive also; refer to the species key for their diagnostic characters.

The female genitalia appear closest to those of *carnearia* but are distinguishable by the longer, narrower clavate uncus and the larger number of cristae.

This species has the greatest development of the conical process giving rise to the ductus seminalis in the female genitalia; it is also present in *quadraria* and, to a much lesser degree, in *carnearia*. The above, plus the chiefly membranous nature of the bursa as a whole, distinguish this species.

***Drepanulatrix carnearia* (Hulst)**

*Tephrosia carnearia* HULST, 1888, Ent. Amer., vol. 3, p. 216.

MALE: Head, vertex, and thorax above concolorous with forewings, ranging in color from buff, orange brown to rose; front deep rose, sometimes light brown; palpi concolorous or shaded with gray; antennal pectinations about twice length of eye, terminal 15 per cent simple. Thorax ventrally lighter, legs concolorous or tinged with rose. Abdomen silken white tinged with pink, concolorous with hind wings.

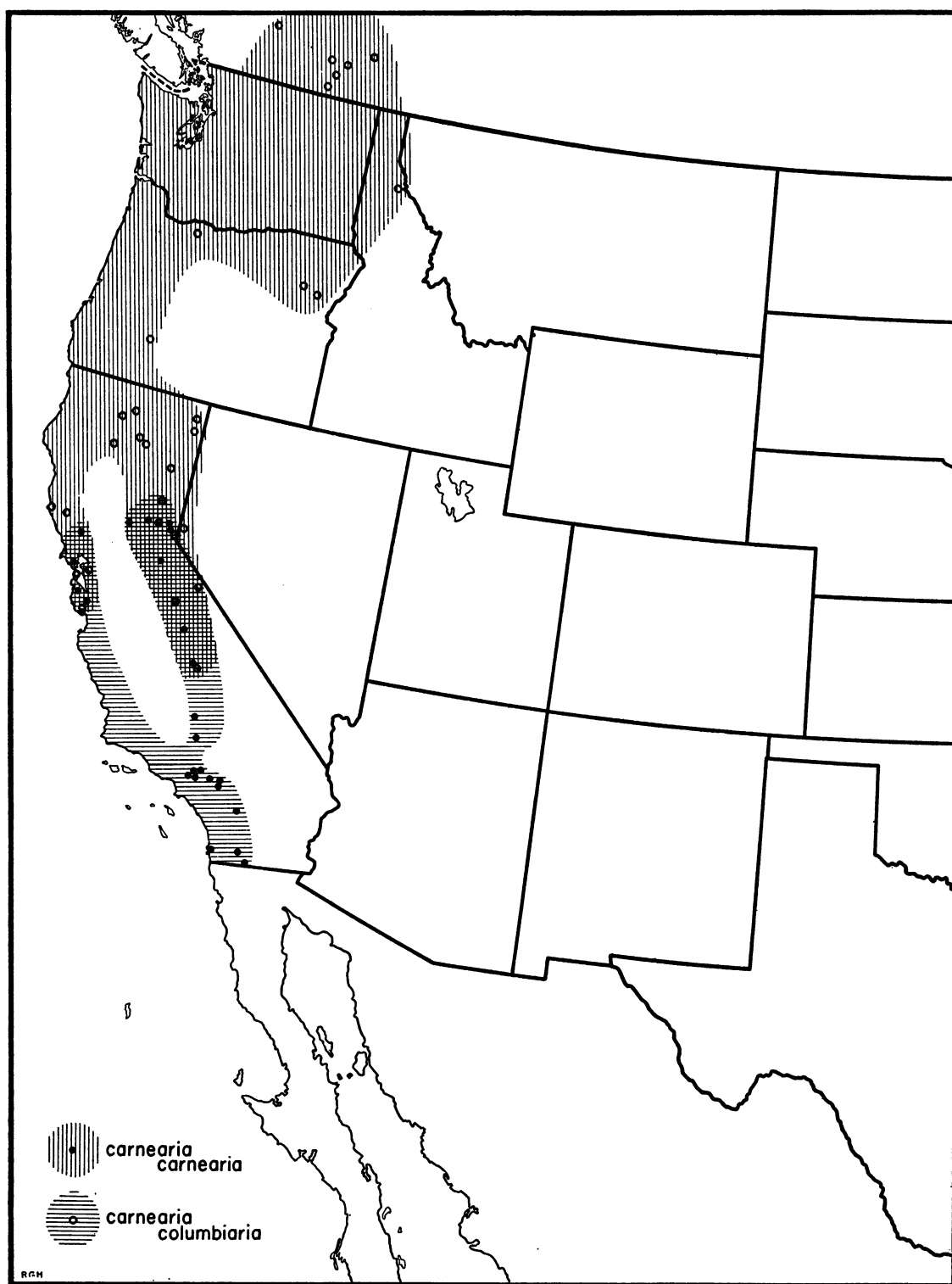
UPPER SURFACE OF WINGS: Forewings ranging in color from buff to orange yellow, more or less broadly suffused with pink, rose, purple, or blackish scales; rarely basal portion of wing from base to median line suffused with purple; cross lines distinct, sometimes rudimentary, rose to purple in color; transverse anterior line narrow, arising on costa at about one-fourth distance from base, curved to cell, then straight to inner margin; median line narrow or somewhat diffuse, arising on costa at one-half distance from base, passing either basad of or touching black prominent discal dot, going straight across wing to inner margin; transverse posterior line usually broadly marked on costa, complete or incomplete, arising just basad of three-fourths distance from base, curving inward below cell, then roughly paralleling median line to inner margin; subterminal line absent; area between transverse posterior line and outer margin more or less broadly suffused with pink, purple, or blackish scales except for area between apex and inception of transverse posterior line; outer margin slightly concave or straight from apex to vein  $M_3$ ;

terminal intervenular dots present; fringe concolorous or darker than adjacent portion of wing. Hind wings white, more or less sprinkled or irrorate with dark scales, often with broad light orange, pink, or reddish purple suffusion over most of wings; discal dot dark, prominent; antemedian and postmedian cross lines usually indicated on inner margin, going one-third or one-half distance across wing before disappearing; terminal intervenular dots present, weaker than on forewings; fringe concolorous to pink.

UNDER SURFACE OF WINGS: Ground color cream, more or less dotted or irrorate with darker scales. Forewings broadly suffused with orange, pink, or purple in cell, costally and along outer margin; discal dot present, dark; transverse posterior line only cross line showing, broad, diffuse, in same position and of same color as on upper surface, going about one-third distance across wing before disappearing; terminal area below apex often broadly suffused with rose or purple; terminal intervenular dots present, sometimes weakly represented; fringe concolorous or darker, being rose or purple in color. Hind wings sometimes weakly suffused with orange or pink outwardly; prominent dark discal dots present; rarely with faint postmedian cross line weakly showing; terminal intervenular dots present; fringe concolorous, sometimes pinker than wing.

FEMALE: Like male; forewing as above, or tending to be broadly suffused with orange; cross lines tending to be reduced or even absent; terminal area more lightly shaded with dark scales or concolorous with remainder of wing. Hind wings as in male, rarely appearing almost concolorous with primaries.

MALE GENITALIA: Uncus with terminal half bulbous, from 0.4 to 0.5 mm. in length, hairs subequal in length to width of uncus at base of hairs; socius with from eight to 10 hairs; gnathos weakly developed, reduced or absent anteriorly; valves widest basally, then narrowed with terminal one-third more or less subequal in width with rounded apex, costal arm present, variable in shape, being higher than wide or with height subequal to width; transtilla subequal in width, sometimes somewhat narrowed medially; cristae from one to six in number; anellus semicircular, length subequal to width, rarely with



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FIG. 8. Distribution of *Drepanulatrix carnearia* (Hulst).



anterior median cleft; saccus elongate, constricted medially, apex broadly rounded; aedeagus straight, ratio of length to width 6:1 or 7:1, vesica armed with two heavy, pointed spines located medially and apically, the former subequal to, or longer than, uncus, the latter slightly shorter than uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum absent; ductus bursae sclerotized, tapering anteriorly, lateral margins apparently folded over, region of attachment to bursa membranous, the ductus being slightly longer than one and one-half times length of ovipositor rods; bursa copulatrix roughly barrel shaped, anterior end usually of somewhat greater circumference than posterior end, both ends convex, membranous, median area completely covered with numerous longitudinal sclerotized rows of inwardly projecting teeth, posterior region ventral to juncture of bursa and ductus giving rise to small, conical, membranous sac and terminating in ductus seminalis, the bursa being approximately twice length of ductus bursae.

The early stages for the typical subspecies are described under that heading.

**RANGE:** California to British Columbia and Idaho; Colorado (?). (See fig. 8.)

**REMARKS:** This species is divisible into two geographic subspecies. These are quite distinct at the north and south ends of their range, but there is a broad region of overlap in central California, being in the vicinity of the San Francisco Bay area on the coast and in the northern part of the Sierra Nevada Range. In rearing experiments by the author, it has been shown that the progeny from a single female moth from the San Francisco Bay area may include specimens that can be classified as typical dark *carnearia*, the light *lutearia*, and the sharply banded *columbiaria*.

Closest to *nevadaria* according to the male genitalia, both species having the vesica armed with two heavy medial and apical spines, but separable from the latter by the shorter bulbous uncus and the reduced number of cristae.

The male genitalia of this species are somewhat variable in size. In respect to this character, *lutearia* usually is the smallest (apparently correlated with small imaginal size) but it

runs into *columbiaria*, which in turn ranges in size from somewhat intermediate to as large as typical *carnearia*. There are apparently no characters that will hold to separate the three names, although the shape of the valves may sometimes be of value (however, this character will vary within one population).

The female genitalia of this species can be distinguished by the somewhat barrel-like shape of the bursa copulatrix with the large number of sclerotized rows of teeth, and by the small membranous conical sac that gives rise to the ductus seminalis.

Slide material shows the bursa as being rather variable in shape (probably owing to the mounting technique) and in the extent of the sclerotized rows of teeth, but the species is still easily recognized. Apparently these variations are not of subspecific value, as no character or characters have been found to separate the subspecies successfully.

#### *Drepanulatrix carnearia carnearia* (Hulst)

Figure 13C

*Tephrosia carnearia* HULST, 1888, Ent. Amer., vol. 3, p. 216. BEUTENMÜLLER, 1892, Bull. Amer. Mus. Nat. Hist., vol. 4, p. 194.

*Deilinia carnearia*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix carnearia*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Drepanulatrix lutearia* BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 25, pl. 2, figs. 5, 6. (New synonymy.)

**MALE:** Forewings often heavily marked, with cross lines tending to be broad, diffuse, rose or red purple, arising on costa as large dark blotches, sometimes reduced or partially absent, usually enlarged on inner margin; terminal area variable in extent of markings, ranging from almost completely suffused with rose purple or purple black to suffusion present as one or two small clouds in middle of wing along transverse posterior line. Expanse: 19 to 25 mm.

**FEMALE:** Forewings broadly suffused with orange or yellowish; cross lines indistinct, sometimes absent; terminal area concolorous with remainder of wing or lightly suffused with purple. Expanse: 20 to 24 mm.

**MALE GENITALIA:** Valves usually broad-

ened basally, rarely subequal in width. See discussion above.

**FEMALE GENITALIA:** As above.

**EARLY STAGES:** Eggs: Longitudinal and transverse ridges not prominent, the intervening cells being quite shallow; approximately 20 longitudinal ridges at truncate end. Color light greenish white when first laid, becoming mottled with dark orange red. Size: 0.63–0.66 mm. long, 0.43–0.46 mm. wide, 0.36–0.40 mm. high.

**LARVAE, FIRST INSTAR:** Head, shiny pale yellowish, ocelli black; mouth parts edged with darker brown. Body unicolorous, pale translucent greenish white, with pale pink on abdominal segments I to V when freshly emerged, losing this in a day; setae on head and body long, prominent, dark, arising from black tubercles. Head width: 0.30 mm.

**SECOND INSTAR:** Head pale greenish white to pearly white. Body slightly tinged with buff over light greenish white when freshly moulted, turning pale green, with thorax concolorous with head; subdorsal and spiracular stripes represented by interrupted white spots not forming definite complete lines; setae as before; all legs translucent, concolorous with head. Head width: 0.46 mm.

**THIRD INSTAR:** Head light green. Entire body unicolorous, light yellow green with lateral stripes as above; spiracles small, inconspicuous; posterior margins of segments greenish white. Head width: 0.70 mm.

**FOURTH INSTAR:** Head pale green; terminal segments of antennae and palpi black, otherwise concolorous with head. Body light green, practically concolorous with head; lateral lines similar to previous instars; dorsal vessel outlined laterally by interrupted line of white dashes; subdorsal line most prominent; supraspiracular and spiracular lines faint. Head width: 1.04 mm.

**FIFTH INSTAR:** Head light green; antennae whitish green, terminal segment shaded with gray brown; ocellus six much smaller than remaining five ocelli. Metathorax with seta 2a ventrally below 1a, 2b slightly anterior thereof; abdominal segment I with setae 1 and 3 located approximately halfway between spiracle and anterior margin of segment; abdominal segment II with seta 4 higher than 5, on level with lower rim of spiracle. Body unicolorous light green as before, with longitudi-

nal incomplete white lines more prominent, giving the larva a whitish striate appearance; posterior margins of segments light yellow green; rarely with red or carmine dorsal spots; longitudinal lines as follows: (1) a few whitish spots along dorsum; (2) lateral margins of dorsal vessel outlined; (3) a heavy line along setae 1 and 2; (4) a very broken one below this; (5) another faint one above seta 3; (6) below this everything quite indistinct and not forming definite bands, consisting of isolated spots; all setae light, arising from prominent black tubercles; spiracles light yellow brown with dark brown rims; legs concolorous, somewhat translucent. Head width: 1.40 mm.

**PUPAE:** Mesothoracic spiracle with small ridge on posterior margin; mesothoracic wings extending almost to posterior margin of fourth abdominal segment; distance between ends of prothoracic legs and maxillae about 1.2 mm.; prothoracic femora exposed for approximately 0.75 mm.; tips of metathoracic legs exposed.

**TYPES:** *Carnearia*, according to the original description, was described from two males and two females from California. One of the males is in the American Museum of Natural History, labeled "Havilah, California. No. 12899 Collection Hy. Edwards," and is the dark, heavily marked variety; this is hereby designated as lectotype. The second male is in the Hulst collection at Rutgers University and is labeled "2847 Sierra Nev. Cal."; this is the "reddish ochre" form mentioned in the original description and corresponds with *lutearia*. One of the females is in the United States National Museum, type no. 34204, labeled "California"; this specimen is not conspecific with the two males but is what was described as *ferruginosaria* Packard (= *monicaria* Guenée). The second female is in the American Museum of Natural History and is labeled like the lectotype; this is also *monicaria*. Further, the United States National Museum, type no. 3889, has a specimen labeled "Colo. Bruce. *Tephrosia carnearia* Hulst Type" which corresponds to *columbiaria*; however, this specimen must be considered as a spurious type.

*Lutearia*, United States National Museum, labeled "*Drepanulatrix luteata* B. & Mc D." (*sic!*), as are all specimens in the type series,

consists of one male and five females. The single male, with "genitalia on slide July 25, 1938 J.F.G.C. No. 1921" is the type mentioned above, and is illustrated by the authors (*op. cit.*), plate 2, figure 5. No female was specified as allotype; the specimen figured on plate 2, figure 6 (*op. cit.*), is hereby designated as lectoallotype; it bears the date July 8-15. The remaining paratype females are dated June 24-30, July 1-7 (two specimens), and July 16-23.

**TYPE LOCALITIES:** Havilah, California (*carnearia*); Camp Baldy, San Bernardino Mountains, California (*lutearia*).

**RANGE:** Southern and central California. (See fig. 8.) On the wing from May through October.

**FOOD PLANT:** Specimens in the United States National Museum collection and the American Museum of Natural History are labeled "Placer Co., Cal. Larva on *Ceanothus cordulatus*." Other specimens also reared by the author from *C. thyrsiflorus* Eschscholtz and *C. sorediatus* Hooker and Arnott from San Mateo County, California, and by Claude Smith from *Ceanothus* species in Los Angeles County, California.

**PARASITE:** *Apanteles* species, apparently undescribed (Branconidae).

**REMARKS:** One hundred and twenty-eight specimens examined. A very variable subspecies, ranging from the typically dark, heavily marked form with broad diffuse cross lines to the quite lightly marked, sometimes almost immaculate, type (*lutearia*). Both the light and dark forms occur in the mountains of southern California; in the Sierra Nevada Range the moths appear to run somewhat darker than those from the coast ranges. However, from the progeny of a single female there may be a complete range of variation between the two.

***Drepanulatrix carnearia columbiaria***

McDunnough, new status

*Drepanulatrix lutearia* McDUNNOUGH (not Barnes and McDunnough), 1927, Canadian Ent., vol. 59, p. 244.

*Drepanulatrix columbiaria* McDUNNOUGH, 1939, Canadian Ent., vol. 71, p. 252.

**MALE:** Forewings more lightly marked, with all three cross lines tending to be more sharply defined, narrow, rose or purple in

color, not marked on costa or inner margin by swollen blotches, going completely across wing; terminal area lightly and evenly suffused with rose or purple. Expanse: 23 to 27 mm.

**FEMALE:** Forewings suffused with orange or pinkish; cross lines usually distinct, complete, as in male, sometimes reduced; terminal area as in male, sometimes concolorous with remainder of wing, rarely strongly suffused. Expanse: 21 to 25 mm.

**MALE GENITALIA:** Valves usually subequal in width, rarely enlarged basally. See discussion above.

**FEMALE GENITALIA:** As above.

**EARLY STAGES:** Undescribed.

**TYPE:** Canadian National Collection, No. 4929.

**TYPE LOCALITY:** Peachland, British Columbia.

**RANGE:** British Columbia south to central California. (See fig. 8.) Two specimens labeled "Colo. Bruce" are the only representatives seen from that part of the Rocky Mountains. There is a possibility that these might be incorrectly labeled and so are considered as doubtful records. On the wing from April through August.

**FOOD PLANT:** A male in the United States National Museum collection labeled "Placer Co., Cal. Larva on *Ceanothus cordulatus*" is apparently referable here; however, see Remarks under the species heading.

**REMARKS:** Ninety-eight specimens examined. Less variable than the typical subspecies; recognizable by the more sharply defined and narrow cross lines of the forewings. In central California, both in coastal regions and in the Sierra Nevada Range, a complete series of intergradations will be found between this and the typical subspecies.

***Drepanulatrix falcataria* (Packard)**

Figure 13D

*Tephrosia falcataria* PACKARD, 1873, Proc. Boston Soc. Nat. Hist., vol. 16, p. 32; 1876, A monograph of the geometrid moths . . . of the United States, p. 423, pl. 9, fig. 67.

*Drepanulatrix falcataria*, GUMPPENBERG, 1895, Nova Acta Deutschen Akad. Naturf., Halle, vol. 64, p. 454. BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Deilinia falcatoria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Aethycta electa* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 339. GROSSBECK, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 341.

*Deilinia litaria* DYAR (not Hulst), 1903, Psyche, vol. 10, p. 199 (life history); 1904, Proc. U. S. Natl. Mus., vol. 27, p. 905. TAYLOR, 1908, Canadian Ent., vol. 40, p. 100.

**MALE:** Head, vertex, front, and palpi yellow brown, orange brown, or red brown, concolorous with thorax; antennal pectinations almost twice length of eye, terminal 12 per cent of antennae simple. Thorax dorsally concolorous with forewings, ventrally dirty white to light brown; legs concolorous, fore legs tinged with brown or pink. Abdomen dull white with darker scales, concolorous with hind wings.

**UPPER SURFACE OF WINGS:** Forewings rather variable in color, ranging from light brown, orange brown to darker red brown, overlain with black brown, orange, and/or pink scales; veins often faintly marked with orange scales; all cross lines usually present, diffuse and somewhat indistinct, dark; transverse anterior line arising on costa at about one-fifth distance from base at right angle or sometimes even greater angle, running to cell, turning rather sharply and going to inner margin; median line arising on costa just basad of one-half distance from base, going with slight outward bow directly to inner margin, passing basad of discal dot; discal dot black brown, rounded to slightly elongate, usually prominent; transverse posterior line arising on costa two-thirds distance from base, going roughly parallel to outer margin with outward bend opposite cell and just before reaching inner margin; subterminal line arising on costa midway between transverse posterior line and apex, in form of dark intervenular blotches, often indistinct in posterior portion of wing, going straight across wing in direction of junction of transverse posterior line with inner margin; outer margin strongly concave between apex and vein  $M_3$ ; terminal intervenular dots present, black; fringe concolorous, sometimes darker in anterior half of wing, tinged with pink posteriorly. Hind wings white, lightly marked with brown black scales along inner margin; discal dot dark, usually prominent; cross lines

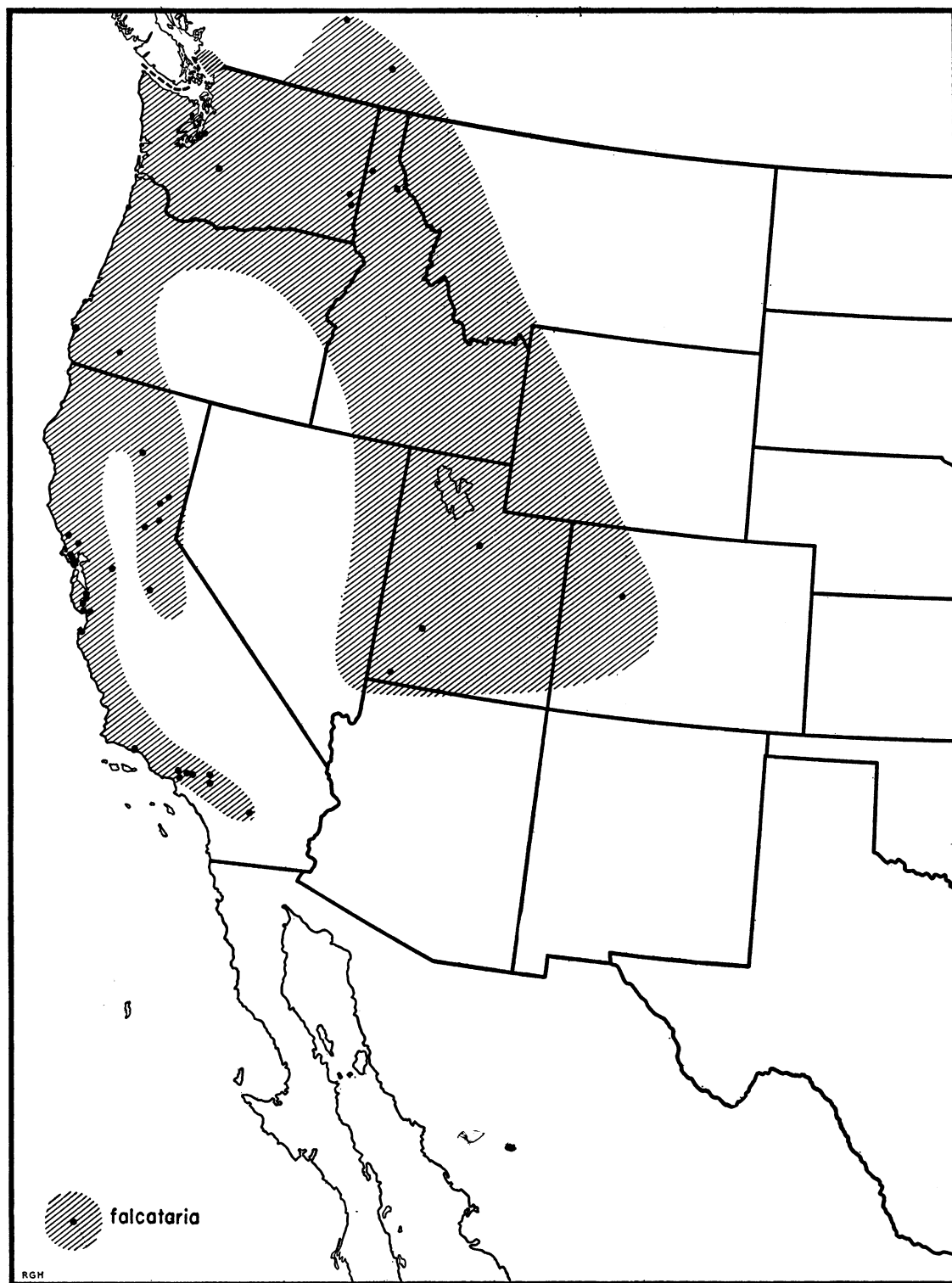
usually absent, postmedial rarely indicated by small gathering of dark scales at inner margin going for about 1 mm. then disappearing; terminal intervenular dots present or absent; fringe concolorous to bright pink.

**UNDER SURFACE OF WINGS:** Forewings, ground color dull white, with brown black scales, these sometimes grouped in cell producing smoky cast, along costa and apically often with orange or pink tinge; cross lines variable, ranging from faintly showing through from upper surface to being rather prominent; when present, location and direction as on upper surface; discal dot present, dark; terminal intervenular dots present; fringe concolorous to darker, being largely shaded with brown black on anterior half of wing, pink on posterior half. Hind wings similar to primaries, appearing whiter, lightly and evenly speckled with dark brown scales, sometimes with pink or orange tinge on outer portion; discal dot large, dark, more prominent than on upper surface; no cross lines; terminal intervenular dots present, sometimes weak; fringe concolorous or pink. Expanse: 28 to 32 mm.

**FEMALE:** Similar to male; forewings tending to be more pink or orange brown, usually only lightly shaded with black brown; cross lines reduced, often rather indistinct or rudimentary, subterminal line usually absent; discal dot often reduced or weak. Expanse: 25 to 30 mm.

**MALE GENITALIA:** Uncus enlarged distally, slightly bulbous, apex bluntly pointed, heavily clothed with hairs about twice width of uncus at base of hairs; socius with six to 10 hairs; gnathos complete, reduced anteriorly; valves long, thin, subequal in width, slightly tapering to rounded apex, costal arm present, wider than high; cristae three to five in number; anellus semicircular without anterior median cleft; saccus elongate, constricted just distad of middle, apex broadly rounded; aedeagus straight, ratio of length to width ranging from 9:1 to 13:1, vesica armed with six to nine pointed spines located in one group medially, ranging in length from one-half to longer than uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum absent; ductus bursae elongate, posterior two-thirds sclerotized, in form of broad plate rounded



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FIG. 9. Distribution of *Drepanulatrix falcatoria* (Packard).

posteriorly, tapering to rounded point anteriorly, anterior one-third narrow, membranous, entering bursa on left side (in ventral view) posteriorly or somewhat laterally, the ductus being two to three times longer than ovipositor rods; ductus seminalis arising at junction of ductus bursae and bursa on left side and attached to ductus for short distance before becoming separated; bursa copulatrix ovoid to rounded, membranous, sometimes with anterior swelling, entire surface with exception of anterior swelling covered with large, inwardly pointing, sclerotized teeth not arranged in definite rows, the bursa shorter than length of ductus bursae.

**EARLY STAGES:** Described by Dyar, with the exception of the pupa.

**TYPES:** *Falcataria*, Museum of Comparative Zoölogy, Harvard University; described from a single male. A second specimen in this collection, a female from "S. Nevada," is also labeled as type, but this must be considered as spurious. *Electa*, Rutgers University collection; apparently described from a single male.

**TYPE LOCALITIES:** California (*falcataria*); Siskiyou County, California (*electa*).

**RANGE:** California to British Columbia and Idaho; Colorado and Utah. (See fig. 9.) On the wing from December through August.

**FOOD PLANT:** *Ceanothus* (Dyar, 1903).

**REMARKS:** Two hundred and six specimens examined. Quite variable in the maculation of the forewings, ranging from practically immaculate to heavily marked with black, but with the outer margin strongly concave below the apex, and with the hind wings usually white, contrasting with the primaries, often with a pink fringe. When in doubt as to the determination of the adult, the genitalia offer many good differentiating characters.

Judging by the male genitalia, the closest relationship appears to be with *secundaria*, but the two are easily separated by the nature of the aedeagal spines, which are pointed and located medially in *falcataria*, capitate and located basally in *secundaria*. Several other noticeable differences include the slightly bulbous uncus, the subequal width of the valves, and the distal constriction of the saccus in *falcataria* as compared with the tapering uncus and valves and the basal constriction of the saccus in *secundaria*.

The ornamentation of the bursa is quite distinctive, and the female genitalia of this species may be recognized on this point alone.

***Drepanulatrix secundaria* Barnes and McDunnough**

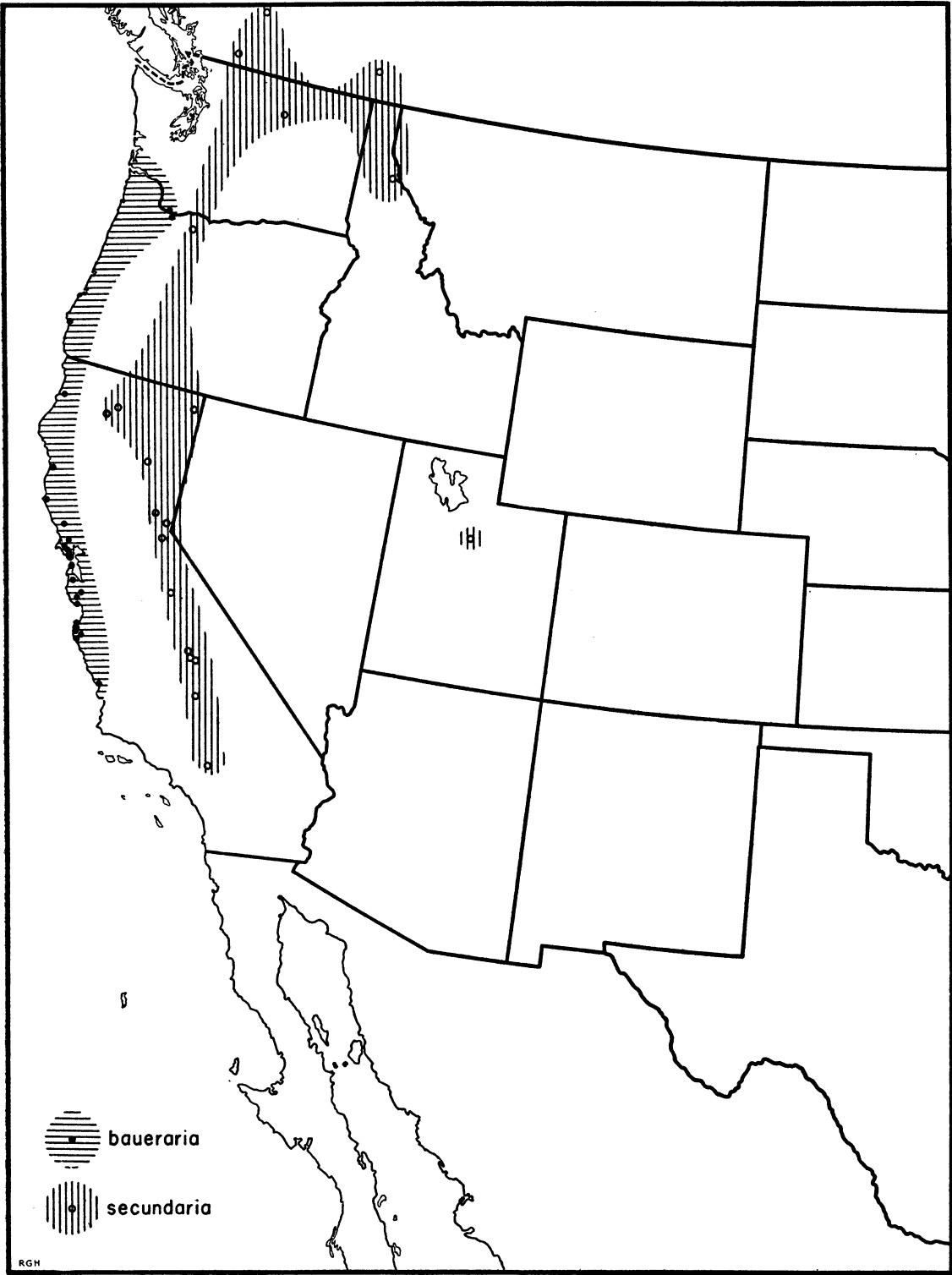
Figure 14A

*Drepanulatrix secundaria* BARNES AND MCDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 25, pl. 2, figs. 11, 12. MCDUNNOUGH, 1927, Canadian Ent., vol. 59, p. 244.

**MALE:** Head, vertex, front, and thorax above concolorous with forewings, ranging in color from dark cream with orange brown suffusion to pinkish cinnamon; palpi concolorous or shaded with gray brown; antennal pectinations between one and one-half and twice as long as length of eye, terminal 17 per cent simple. Thorax ventrally lighter, legs concolorous, fore legs tinged with gray or light orange. Abdomen silken white, concolorous with hind wings.

**UPPER SURFACE OF WINGS:** Forewings dark cream with orange brown suffusion to pinkish cinnamon, more or less sprinkled with orange brown and black scales; median area of wings always concolorous with other parts; cross lines indistinct to absent except subterminal line which is most prominent mark; transverse anterior line, when present, arising on costa about one-fourth distance from base at right angle, going to cell, turning posteriorly, going straight to inner margin; median line, when present, arising on costa about one-third distance from base, going straight across wing, passing at least 1 mm. basad of discal dot; discal dot black, prominent, rounded; transverse posterior line, when present, arising on costa about two-thirds distance from base, going across cell, curved broadly towards base below cell, then straight to inner margin; area between transverse posterior line and subterminal line concolorous with remainder of wing, sometimes shaded with orange brown scales next to subterminal line; subterminal line usually complete, sometimes rudimentary below cell and at inner margin, often only line showing on wing, arising on costa between transverse posterior line and apex, indented below cell, then roughly parallel to transverse posterior line.





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FIG. 10. Distribution of *Drepanulatrix secundaria* Barnes and McDunnough and *baueraria* Sperry.

in form of black, outwardly pointing projections, often shaded with light gray or white at tips of scallops; outer margin straight between apex and vein  $M_3$ ; terminal intervenular black dots present; fringe concolorous. Hind wings lighter than forewings, white lightly dusted with brown black scales except basally; discal dot smaller than on forewings, dark, rounded; cross lines usually absent, sometimes traces of two lines at inner margin only; terminal intervenular black dots present; fringe concolorous.

**UNDER SURFACE OF WINGS:** Ground color cream white without cross lines. Forewings lightly sprinkled with brown black scales along costa and terminally, sometimes apically faintly shaded with orange or pinkish; discal dot and terminal intervenular dots present; fringe concolorous or with terminal half shaded with pinkish. Hind wings sometimes whiter than primaries, somewhat speckled with darker scales, especially outwardly; no markings except dark discal dot and terminal intervenular dots; fringe as on primaries. Expanse: 24 to 27 mm.

**FEMALE:** Like male; forewings often more suffused with orange or orange brown. Expanse: 20 to 23 mm.

**MALE GENITALIA:** Uncus tapering to blunt apex, hairs about twice width of uncus at base of hairs; socius with five to eight long hairs; gnathos complete, reduced anteriorly; valves long, thin, evenly tapering to narrow apex, costal arm present with height subequal to width; cristae three to five in number; anellus subrectangular, length subequal to, or slightly longer than, width, with small median anterior cleft either present or absent; saccus elongate, constricted in posterior half, broadly rounded at apex; aedeagus straight, slightly swollen distally, ratio of length to width approximately 10:1, vesica armed with three or four capitate spines located in one group in basal half of aedeagus, all shorter than uncus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum a transverse oval plate; ductus bursae very long, sclerotized at posterior end in form of short subrectangular plate one-fourth total length of ductus, remainder narrow membranous, with some sclerotized longitudinal ridges in anterior portion, curving to juncture with

bursa on anterior portion thereof, the ductus being four times length of ovipositor rods; bursa copulatrix membranous, extending anterior of junction with ductus bursae in form of broad conical projection, this continuing as ductus seminalis, posterior of junction as large rounded sac with many minute, sclerotized, zigzag lines as ornamentation, the bursa being about half as long as ductus bursae.

**EARLY STAGES:** Unknown.

**TYPES:** United States National Museum, dated July 1-7, and with "male genitalia on slide July 24, 1938 J.F.G.C. No. 1910." No allotype was designated from the type series; the female labeled "Photograph Pl. 2 No. 12" is hereby designated as lectoallotype. Four paratypes are in the United States National Museum collection; the remaining two are in the Museum of Comparative Zoölogy, Harvard University, paratypes nos. 16826 and 2-16826. The dates of the type series range from June 16-23 to July 1-7.

**TYPE LOCALITY:** Mineral King, Tulare County, California.

**RANGE:** Mountains of California, north to British Columbia and Idaho; Utah. (See fig. 10.) On the wing in June and July.

**FOOD PLANT:** Unknown.

**REMARKS:** Fifty-eight specimens examined. Relatively few specimens of this montane species are in collections. In general appearance somewhat similar to *baueraria*, but distinguished from that species by the more lightly marked forewings and the whiter and more immaculate secondaries; also the genitalia of these two species are very distinct. The two specimens from Provo, Utah, have the forewings darker than do typical specimens from California; more material is needed from the Rocky Mountain area to determine the extent of variation.

*Drepanulatrix secundaria* can be distinguished immediately from all other species in the genus by the capitate spines in the basal half of the aedeagus. The long tapering nature of the valves, uncus, and saccus is characteristic also.

The female genitalia are easily recognized by the very long narrow ductus bursae that joins the bursa copulatrix in the anterior portion thereof, and by the ductus seminalis, arising at anterior end of the bursa.

*Drepanulatrix baueraria* Sperry

## Figure 14B

*Drepanulatrix baueraria* SPERRY, 1948, Bull. Brooklyn Ent. Soc., vol. 43, p. 55.

MALE: Head, vertex, front, and thorax above concolorous with forewings, ranging in color from pinkish cinnamon to light orange brown; palpi concolorous or shaded with gray black; antennal pectinations one and one-half times length of eye, terminal 12 per cent simple. Thorax ventrally dirty white to light brown; legs concolorous, more silky in appearance, prothoracic and mesothoracic legs tinged with smoky. Abdomen silken white with few gray or brown scales, concolorous with hind wings.

UPPER SURFACE OF WINGS: Forewings pinkish cinnamon to orange brown, more or less heavily irrorate with tiny, short, black lines; median area usually concolorous with remainder of wing, rarely partially shaded with black or dark brown below discal dot between transverse anterior and transverse posterior lines; all cross lines usually present, distinct, dark brown or black, sometimes variously reduced or absent but subterminal line always showing; transverse anterior line arising at about one-fourth distance from base at right angle going to cell, turning posteriorly rather sharply going to inner margin at one-fourth to one-third distance from base with slight basal bend between cubital and vanal veins; median cross line arising at one-half distance from base, less distinct than transverse anterior line, curved or angled in cell basad of discal dot, then straight to inner margin paralleling transverse anterior line; discal dot black, prominent, rounded, sometimes shaded outwardly or completely encircled with light gray or white; transverse posterior line arising at about two-thirds distance from base going across cell, curved broadly towards base below cell, then subparalleling median line to inner margin; area between transverse posterior and subterminal lines concolorous with remainder of wing, sometimes shaded with orange, pink, or brown next to subterminal line; subterminal line usually complete, prominent, rarely only line showing on wing, arising on costa somewhat nearer apex than to transverse posterior line, indented below cell, then roughly paral-

lel to transverse posterior line, in form of outwardly pointing projections darkened outwardly, often shaded with light gray or white at tips of scallops; terminal area usually concolorous with rest of wing, rarely with black or dark brown shading between apex and subterminal line in anterior portion of wing; outer margin straight from apex to vein  $M_3$ ; terminal intervenular dots present; fringe concolorous. Hind wings basally lighter than forewings, usually concolorous or slightly lighter terminally; discal dot present, dark, rounded, rarely absent; cross lines usually represented, often weakly, three in number, sometimes only two, arising on inner margin going as far as discal dot, then disappearing; terminal intervenular black dots present; fringe concolorous.

UNDER SURFACE OF WINGS: Ground color cream white, without any cross lines. Primaries lightly irrorate with dark scales along costa and terminally, apically shaded with cinnamon; discal dot and terminal intervenular dots present; rarely with black cloud near apex; fringe concolorous or with terminal half shaded with pinkish. Secondaries sometimes whiter than primaries, somewhat speckled or irrorate with darker scales outwardly; no markings except dark discal dot and terminal intervenular dots; fringe as on primaries. Expanse: 20 to 28 mm.

FEMALE: Like male; coloration of forewings as in male or tending to be shaded with orange or red brown; wings of even color, sometimes with terminal area darkened; transverse anterior, median and transverse posterior lines reduced or absent, subterminal line usually prominent; discal dot and terminal intervenular black spots present. Hind wings as above, terminal intervenular dots weak. Expanse: 20 to 28 mm.

MALE GENITALIA: Uncus slightly tapering terminally, apex pointed, fairly heavily haired with maximum length of hairs being subequal to width of uncus at base of hairs; socius with five to eight long hairs; gnathos complete, reduced anteriorly; valves tapering, straight, apex rounded, costal arm present, wider than high; transtilla of equal width, not narrowed medially; cristae apparently absent; anellus almost square, corners rounded, without anterior median cleft; saccus constricted about one-half length

towards base with apex broadly rounded; aedeagus straight, anteriorly with one side broadly pointed approximately one-tenth length of aedeagus, ratio of length to width approximately 5:1, vesica without spines. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum small, transversely oval; ductus bursae long, small sclerotized plate posteriorly wider than long, remainder membranous, narrowed medially, enlarged anteriorly to form very wide juncture with bursa, there being no line of demarcation between the two; ductus seminalis arising opposite posterior end of bursa; bursa copulatrix membranous, elongate, somewhat oval in outline, side opposite bursa set off by longitudinal constriction marked medially with transverse sclerotized lines, with this area having many minute, sclerotized, zigzag lines as ornamentation, these weak at posterior end, bursa and ductus together almost three times as long as length of ovipositor rods.

**EARLY STAGES:** Eggs: Slightly wedge shaped; longitudinal ridges slightly raised, transverse ridges fairly prominent, the intervening cells being rather well defined. Color pale shining greenish white, somewhat opalescent, not becoming mottled with red. Size: 0.63–0.66 mm. long, 0.40–0.43 mm. wide, 0.33–0.36 mm. high.

**LARVAE, FIRST INSTAR:** Head yellowish buff; mouth parts and lower margin of labrum light brown; ocelli black. Body translucent light green with prominent darker green dorsal and spiracular stripes; all setae light, arising from concolorous tubercles. Head width: 0.30 mm.

**SECOND INSTAR:** Head light yellow brown with lateral regions near ocelli shaded with dark brown purple; antennae dark, terminally black. Body concolorous green except for prothorax which is pale yellowish green dorsally; prominent dorsal and subspiracular bands of purple brown; all setae dark, arising from black tubercles; legs translucent, almost concolorous with head. Head width: 0.48 mm.

**THIRD INSTAR:** Similar to second instar, except head pale gray green shaded with orange brown dorsally and laterally. Head width: 0.70 mm.

**FOURTH INSTAR:** As before. Head width: 1.04 mm.

**FIFTH INSTAR:** Head pale green, shaded with orange brown dorsally and laterally, dotted with brown and black dots on each side of epicranial suture; ocelli black, all six well developed; antennae orange brown shaded with purple on basal segment, terminal segment deep purple black; labrum concolorous with head, shaded with yellow brown distally; spinneret and palpi concolorous with head, the latter with terminal segment black; setae light colored, arising from light brown tubercles. Metathorax with setae 2a, 2b located anterior to 1a, 1b; abdominal segment I with setae 1 and 3 located above anterior margin of spiracle; abdominal segment II with setae 4 and 5 on same level, below lower rim of spiracle; seta 6 on abdominal segments I and II arising from black tubercle sometimes in prominent blackish spot, posteriorly this spot decreasing in intensity and located just anterior to seta 6. Body yellow green with indistinct longitudinal stripes; posterior margins of segments pale; dorsal stripe dark, bounded laterally by indistinct whitish lines; subdorsal stripe dark, just below setae 1 and 2, the area between these stripes lightly shaded with white; spiracular stripe white, wide; ventral stripe white, the area between these stripes faintly shaded with white; all legs concolorous, sometimes with dark spot at base of mesothoracic and metathoracic legs and in similar location but fainter on abdominal segments I and II. Head width: 1.44 mm. Occasionally larvae are brownish green in color, otherwise the same. All larvae when mature and in prepupal condition turn unicolorous red brown.

**PUPAE:** Mesothoracic spiracle with small ridge on posterior margin; mesothoracic wings extending to, or almost to, posterior margin of fourth abdominal segment; distance between ends of prothoracic legs and maxillae about 1.2 mm. in length; prothoracic femora exposed for approximately 0.5 mm.; tips of metathoracic legs usually not exposed.

**TYPE:** Collection of Grace H. and John L. Sperry, Riverside, California.

**TYPE LOCALITY:** Big Sur, (Monterey County), California.

**RANGE:** Coastal regions of central California to central Washington. (See fig. 10.) Recorded as being on the wing every month of the year.

**FOOD PLANTS:** *Ceanothus thyrsiflorus* Esch-

scholtz and *C. sorediatus* Hooker and Arnott.

PARASITES: *Chaetophlepsis* species, probably undescribed (*ex* larvae); and *Patelloa* species (*ex* pupae); both Larvaevoridae. *Apanteles* species, also apparently undescribed (Braconidae). These parasites emerged from a mixed lot of *monicaria* and *baueraria*.

REMARKS: One hundred and seventy-six specimens examined. Closest to *secundaria* in general appearance, but distinguished from that species by the fact that the forewings are somewhat darker, with heavier maculation, and the hind wings are largely concolorous with the primaries. The male genitalia, however, show a close relationship to those of *monicaria*. Some examples are very similar to the latter in maculation, but usually they are quite distinct.

The male genitalia of this species are distinguished by the spineless vesica and the aedeagus without the elongate blade-like process found in *monicaria*. They may be distinguished further from those of the latter species by the complete gnathos, short costal arms, and the equal width of the transtilla medially.

This species is recognized by the very broad and undelimited junction of the ductus bursae and bursa copulatrix in the female genitalia and by the nature of the bursa ornamentation.

#### *Drepanulatrix monicaria* (Guenée)

Figure 14C

*Tephrosia monicaria* GUENÉE, 1857, Histoire naturelle des insectes, vol. 10, p. 100. OBERTHÜR, 1923, Études de lépidoptérologie comparée, vol. 20, p. 249.

*Deilinia monicaria*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix monicaria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Tephrosia californiaria* PACKARD, 1870, Proc. Boston Soc. Nat. Hist., vol. 13, p. 388; 1876, A monograph of the geometrid moths . . . of the United States, p. 422, pl. 9, fig. 15. (New synonymy.)

*Alcis californiaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 345. DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 321.

*Drepanulatrix californiaria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 178.

*Tephrosia ferruginosaria* PACKARD, 1870, Proc. Boston Soc. Nat. Hist., vol. 13, p. 388; 1871,

*ibid.*, vol. 16, pl. 1, fig. 21; 1876, A monograph of the geometrid moths . . . of the United States, p. 426. GROSSBECK, 1912, Jour. New York Ent. Soc., vol. 20, pp. 288, 290. (New synonymy.)

*Catopyrrha ferruginosaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 340.

*Drepanulatrix ferruginosaria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 178.

*Tephrosia celataria* HULST, 1888, Ent. Amer., vol. 3, p. 216. BEUTENMÜLLER, 1892, Bull. Amer. Mus. Nat. Hist., vol. 4, p. 194.

*Deilinia celataria*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix celataria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Lozogramma mercedulata* STRECKER, 1899, Lepidoptera Rhopalocera Heterocera, suppl. 2, p. 9.

*Apacasia mercedulata*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 317; 1905, Proc. Ent. Soc. Washington, vol. 7, p. 93.

*Drepanulatrix mercedulata*, BARNES AND McDUNNOUGH, Check list, p. 112.

*Deilinia indurata* DYAR, 1908, Proc. Ent. Soc. Washington, vol. 10, p. 56.

*Drepanulatrix indurata*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179.

MALE: Head, vertex, front, and thorax above concolorous with forewings, ranging in color from light or dark gray to reddish brown; palpi concolorous, often shaded with darker gray; antennal pectinations varying in length from less than one and one-half to almost twice length of eyes, terminal 14 per cent to 18 per cent simple. Thorax ventrally dirty white to light brown; legs concolorous, fore legs tinged with brown or gray. Abdomen dull white with some gray or brown scales, concolorous with hind wings.

UPPER SURFACE OF WINGS: Forewings rather variable in color, ranging from light or dark gray to reddish brown, shaded with orange, pink, red brown, dark gray, or blackish scales, these often broadly suffusing wings in varying degrees; median area concolorous with remainder of wing, sometimes partially or completely shaded with black except on costal and inner margins; all cross lines usually indistinct or absent, sometimes distinct, black; transverse anterior line, when present, leaving costa basad of one-fourth distance from base, going towards cell, turning posteriorly rather sharply, then to inner margin at

one-fourth distance from base with rather prominent basal bend between cubital and vanal veins; median cross line nearly always indistinct; when present, often lost in black median area, arising on costa one-half distance from base, curved to cell going basad of discal dot, then straight to inner margin; discal dot black, prominent, rounded, usually shaded outwardly or completely encircled with light gray or white; transverse posterior line, when present, leaving costa at right angle at about two-thirds distance from base, then across cell, curved broadly towards base below cell, then with smaller outward bend to inner margin at two-thirds distance from base; area between transverse posterior and subterminal lines concolorous with basal portion, sometimes shaded with orange, pink, or brown next to subterminal line; subterminal line complete or rudimentary, most prominent of cross lines, sometimes only line showing, arising indistinctly on costa somewhat nearer apex than to transverse posterior line, roughly paralleling outer margin, indented below cell, in form of outwardly pointing projections darkening outwardly, often shaded with light gray at tips of scallops; terminal area usually concolorous with rest of wings, sometimes with black shading between apex and subterminal line, converging on latter towards inner margin; outer margin straight or very slightly concave between apex and vein  $M_3$ ; terminal intervenular black dots present; fringe concolorous. Hind wings dull white to pale gray, sprinkled with dark gray or brown black scales, sometimes with faint pink or brown cast, appearing either quite lighter than, or almost concolorous with, forewings; discal dot dark, round, usually prominent; cross lines usually absent, sometimes median and postmedian lines faintly showing along inner margin, going as far as discal spot, then disappearing; terminal intervenular black dots present; fringe concolorous or lightly shaded with pink.

**UNDER SURFACE OF WINGS:** Ground color dull white to light gray without any cross lines. Primaries lightly dusted with brown black scales, especially along costa and outer margin; basal portion of cell sometimes slightly smoky; discal dot and terminal intervenular dots present, somewhat weaker than above; rarely with black cloud near apex

where subterminal line starts on upper side, quickly disappearing; fringe concolorous or slightly tinged with pink. Secondaries whiter than primaries, evenly speckled with darker scales; no markings except dark discal dot and terminal intervenular dots; fringe as on primaries. Expanse: 20 to 28 mm.

**FEMALE:** Like male; coloration of forewings ranging from gray brown, pink, orange to red brown; wing of even color, sometimes with median area dark red brown, almost purplish, area between transverse posterior and subterminal line often shaded with orange, darker in terminal area; transverse anterior, median and transverse posterior lines absent, sometimes very faint; subterminal line usually somewhat more prominent than others, often marked by change in color of wing; discal dot and terminal intervenular dots somewhat weaker than in male. Hind wings as in male, terminal intervenular dots weaker. Expanse: 17 to 25 mm.

**MALE GENITALIA:** Uncus slightly tapering terminally, apex pointed, heavily haired with maximum length of hairs twice width of uncus at base of hairs; socius with five to eight long hairs; gnathos incomplete anteriorly; valves subequal in width, slightly tapered, straight, apex broadly rounded, costal arm erect, almost twice as high as wide; transtilla very narrow at center line; cristae numerous, from 15 to 25 or more in number; anellus subrectangular with anterior median cleft, almost twice as long as wide, widest near posterior end; saccus constricted about one-half length towards base with apex bluntly pointed or rounded; aedeagus anterior portion curved, posteriorly with one side extending as long, thin, blade-like process approximately one-third length of aedeagus, ratio of length to width approximately 5:1, vesica without spines. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Operculum small, round; ductus bursae with transverse oval to subrectangular sclerotized plate at posterior end, remainder all membranous, somewhat narrower, broadly joined to bursa dorsally on left side (in ventral view), the ductus subequal in length to length of ovipositor rods; ductus seminalis arising from dorsal surface of bursa near junction of ductus; bursa copulatrix small, rounded, membra-

nous, median area with sclerotized lines and rows of inwardly pointing teeth extending from broad junction with ductus to opposite end which is membranous, the bursa being subequal in length to length of ductus bursae.

**EARLY STAGES:** Eggs: Slightly wedge shaped; longitudinal and transverse ridges prominently raised, intervening cells well defined. Color shining greenish white, becoming mottled with reddish orange, in some cases becoming completely this color. Size: 0.63–0.71 mm. long, 0.43–0.46 mm. wide, 0.33–0.36 mm. high.

**LARVAE, FIRST INSTAR:** Head yellow; ocelli black; labrum brown; setae colorless. Body pale, translucent yellow green with dorsal reddish stripe on posterior part of body; often with wide subspiracular band; all legs concolorous with body; setae black, prominent, arising from grayish tubercles. Head width: 0.30 mm.

**SECOND INSTAR:** Head yellow brown, shaded with darker brown on lateral regions; setae light. Body pale green, with dorsal and subspiracular stripes usually prominent, sometimes partially reduced; several indistinct, incomplete, narrow longitudinal lines. Head width: 0.48 mm.

**THIRD INSTAR:** Similar to second instar, with more dark mottling on head capsule and body somewhat darker, often with blackish spots on anterior portions of abdominal segments and ventrally below spiracles. Some larvae are brown instead of green, but are otherwise similar. Head width: 0.74 mm.

**FOURTH INSTAR:** Similar to preceding instar. Head width: 1.12 mm.

**FIFTH INSTAR:** Larvae quite variable in color and pattern, ranging from bright apple green almost without markings to gray green, greenish brown, gray brown to dark brown with dark lateral and yellow and red dorsal maculation. Metathorax with setae 2a, 2b ventrally below 1a, 1b; abdominal segment I with setae 1 and 3 located above anterior margin of spiracle; abdominal segment II with seta 4 higher than seta 5, located on level with lower rim of spiracle. Head width: 1.53 mm.

**PUPAE:** Mesothoracic spiracle with fairly prominent, dark, raised ridge on posterior margin; mesothoracic wings extending to posterior region of fourth abdominal segment;

distance between ends of prothoracic legs and maxillae about 1.6 mm.; prothoracic femora exposed for approximately 0.8 mm.; tips of metathoracic legs exposed.

**TYPES:** *Monicaria*, location unknown, reported as lost (Dyar, 1902, p. 306; Oberthür); described from a single male. *Californiaria*, Museum of Comparative Zoölogy, Harvard University, type no. 11591 (?); described from three males according to the original description. A second male in this collection labeled as type is a faded specimen and may be an example of *baueraria*; a genitalic preparation should be made to determine this. The location of the third male type is unknown. *Ferruginosaria*, Museum of Comparative Zoölogy, Harvard University, type no. 14592; apparently described from a single female. *Celataria*, according to the original description, was described from two males from Havilah, California. One of these is in the United States National Museum, type no. 34203, and is somewhat worn. The second is in the American Museum of Natural History and is in fairly good condition, and this second specimen is hereby designated as lectotype. A third specimen in the collection at Rutgers University is simply labeled "California" and "type" by Hulst; this specimen is a spurious type and may fall under *baueraria*. *Mercedulata*, Chicago Natural History Museum (?); described from a single male. *Indurata*, United States National Museum, type no. 11700; described from eight males, six of which are in the United States National Museum collection.

**TYPE LOCALITIES:** "Californie" (*monicaria*); "Cal." (*californiaria*, *ferruginosaria*); Havilah, California (*celataria*); near San Francisco, California (*mercedulata*); Placer County, California (*indurata*).

**RANGE:** Pacific coast states from southern California to southern Alaska. (See fig. 7.) Recorded as being on the wing during every month of the year.

**FOOD PLANTS:** The author has reared this species from *Ceanothus thyrsiflorus* Eschscholtz and *C. sorediatus* Hooker and Arnott from larvae collected by beating in Marin and San Mateo counties, California. There are specimens labeled "Lands End, San Francisco, Cal. ex *Ceanothus* F. X. Williams" in the California Academy of Sciences. Claude



Smith has reared specimens in Los Angeles County, California, from *Ceanothus* species. A specimen in the Los Angeles County Museum is similarly labeled but is without locality data.

**PARASITES:** *Chaetophlepsis* species, probably undescribed (*ex* larvae) and *Patelloa* species (*ex* pupae); both Larvaevoridae. *Apanteles* species, also apparently undescribed (Braconidae). These parasites emerged from a mixed lot of *monicaria* and *baueraria*.

**REMARKS:** Six hundred and seventy-six specimens examined. A widespread and rather variable species. It is usually fairly easy to recognize, but some specimens, especially when old and worn, are difficult to place and may be confused with *baueraria*. Usually *monicaria* has the forewings much grayer and less definitely marked than in the latter species; the genitalia of the two are quite distinct, however, and can be used without hesitation to separate the two species.

The male genitalia of this species differ from all others except *baueraria* by having spineless vesica and may be distinguished from the latter by the elongate blade-like process on the aedeagus. These two closely related species may be separated further by the incomplete gnathos, the larger costal arm, and by the transtilla's being quite narrow medially in *monicaria*.

This species has the smallest female genitalia in the genus and is unique in having the rounded bursa copulatrix.

Rearing experiments have shown that typical *monicaria*, *californiaria*, and *ferruginosaria* are the same species. *Californiaria* was the name applied by Packard to those males with the median area of the forewings suffused with black scales, while *ferruginosaria* is the corresponding female with the median area shaded with darker scales. Adults of these forms were obtained from field-collected larvae; they were mated and the progeny reared. Specimens from this F<sub>1</sub> generation were then interbred, and the F<sub>2</sub> generation was brought to maturity without any trouble and with mortality figures that were even lower than those for the F<sub>1</sub> generation in some cases.

#### APODREPANULATRIX, NEW GENUS

**ADULT:** In addition to the characters noted for the group: Antennal pectinations of male arising on median portion of segments, about twice length of eye, terminal 6 per cent to 8 per cent of antennae simple. Forewings with apex prolonged, outer margin somewhat falcate to vein M<sub>3</sub>; both wings with outer margin more or less scalloped; veins M<sub>3</sub> and Cu<sub>1</sub> approximate or not at base. Forewings and hind wings concolorous; forewings with four cross lines, hind wings with three cross lines usually present; discal dots present or not on forewings above, absent from secondaries; terminal intervenular dots absent.

**MALE GENITALIA:** Uncus long, simple, strong, hook-like, lightly haired; socius weak; gnathos a large, well-developed ring narrowed anteriorly; valves simple, curved posteriorly, heavily haired, with costal region sclerotized in form of pointed arm; costa extending mediad of base of valves as subrectangular plate from whence well-developed transtilla arises; cristae present or apparently absent; annellus a simple shield-like structure; furca absent; saccus projecting well beyond base of valves, bluntly pointed, longer than uncus; aedeagus long, slender, cylindrical, posterior end with one side projecting as subtriangular process, vesica armed with four to seven heavy spines extending from center to apex of aedeagus. Ventral surface of eighth abdominal segment without plate.

**FEMALE GENITALIA:** Ostium surrounded with sclerotized band anteriorly, ranging in width from less than one-third to subequal to width of ductus bursae; operculum present as large, subtriangular, transversely ridged organ; ductus bursa membranous, subequal in width, shorter than ovipositor rods in length; ductus seminalis arising from ventral surface of ductus bursae; bursa copulatrix large, roughly ovoid in shape, anterior end membranous, with right (in ventral view) posterior section sclerotized, ornamentation of bursa in form of large, inwardly pointing teeth more or less aligned in rows.

**EARLY STAGES:** Partially described by McDunnough and Dyar for the two included species. The following larval and pupal descriptions were made from material collected for the author by Mr. L. R. Rupert.

EGGS: Undescribed.

LARVAE FIFTH INSTAR: Head, first adfrontal seta ( $Adf_1$ ) at or slightly below middle of clypeus, second adfrontal ( $Adf_2$ ) below branching of epicranial suture; first posterior seta ( $P_1$ ) below level of  $Adf_2$ , second posterior seta ( $P_2$ ) vertically above  $P_1$ , these three setae forming an acute angle; lateral seta ( $L_1$ ) below  $P_1$ , these forming an almost straight line with  $Adf_2$ ; first anterior seta ( $A_1$ ) on level with lower margin of ocellus two, second anterior seta ( $A_2$ ) well above ocellus one, third anterior seta ( $A_3$ ) below  $Adf_1$  in horizontal plane, the three anterior setae forming a slightly obtuse angle; all six ocelli well developed, located on lateral surface of head; second ocellar seta ( $O_2$ ) higher than ocellus one, third ocellar seta ( $O_3$ ) posterior to ocellus five, the three forming an acute angle; subocellar seta ( $SO_2$ ) posterior to lowest ocellus. Thorax, prothorax with setae 1a, 1b and 2a, 2b well separated; setae 3 double, above spiracle; seta 4 on level with lower rim of spiracle; seta 5 approximate; setae 6 and 7 approximate. Mesothorax, seta 2a slightly posterior to 1a; seta 2b below 1a, 1b; seta 3 posterior to 2a, on horizontal plane with 4; seta 5 ventral and approximate to 4; seta 6 ventral to 2a. Metathorax similar to mesothorax except seta 2a below 1a and 1b; seta 2b anterior to 2a. Abdomen, segment I, seta 1 just anterior to spiracle; seta 2 posterior; seta 3 above and anterior to spiracle; seta 4 on level with and posterior to spiracle; seta 5 anterior to 3, below spiracle; seta 6 below spiracle; seta 7 on level with 6, posterior to 2. Segments II to VI, seta 1 anterior to spiracle; seta 2 posterior; seta 3 slightly posterior to 1, higher than spiracle; seta 4 below lower rim of spiracle, ventrally below 2; seta 5 slightly posterior to 3, lower than 4; seta 6 ventrally below spiracle; seta 7 on level with or lower than 6, posterior to 4. Segment VII similar except seta 1 closer in vertical plane to spiracle; seta 6 ventrally posterior to 4. Segment VIII similar to segment VII except setae 6 and 7 forming a line towards spiracle.

PUPAE: Shiny brown, in a rather loose cocoon. Head, epicranial suture absent; antennae subequal in length to wing cases; labial palpi small, triangular; maxillae slight-

ly shorter than wing cases. Thorax, metathorax about one-fourth length of mesothorax on dorsal surface; mesothoracic spiracle with large, prominent, kidney-shaped ridge on posterior margin; mesothoracic wings extending to just before posterior margin of fourth abdominal segment; metathoracic wings narrowly exposed ventrally to anterior portion of fourth abdominal segment; prothoracic legs approximately four-fifths length of maxillae, femora shortly exposed; mesothoracic legs subequal in length to maxillae; metathoracic legs exposed for short distance caudad of maxillae, subequal in length to antennae. Abdomen, spiracles without furrows; no furrow between segments IX and X, but with deep furrow on lateral surface of segment X; cremaster of eight recurved spines, the terminal two much heavier than remainder.

GENOTYPE: *Aspilates liberaria* Walker.

This genus includes two rather closely related species, the genitalia of which have a rather different appearance from those of the other *Drepanulatrix*-complex species. The male genitalia, when seen in a lateral view, are much more S-shaped than in the others, as the uncus and tegumen are strongly concave while the saccus bends dorsally to complete the S. Besides the above, this genus may be further distinguished by the lack of the small spine at the tip of the uncus, the strongly developed gnathos, the valves with the pointed costal arm, the nature of the transtilla, and by the distribution of the spines of the aedeagus from the median region to the apex.

The female genitalia of this genus are easily recognized by the sclerotized band about the ostium, the large operculum, the membranous ductus bursae with the ductus seminalis arising therefrom, and by the structure and ornamentation of the bursa copulatrix.

The two included species are closely related, yet it is fairly easy to distinguish between them and to separate them from neighboring genera. Two of the characters that may be used for the latter are that the hind wings are concolorous with the forewings and the secondaries usually have three cross lines and a scalloped outer margin. Within the genus the species may be separated as follows:

## KEY TO ADULTS

1. Wings above in male orange brown; in female, orange brown to yellow brown; with fringes dark; eastern North America . . . *liberaria*  
Wings above gray brown to light brown in both sexes, with fringes concolorous; western North America . . . . . *litaria*

## KEY TO MALE GENITALIA

1. Costal arm of valves subequal in height to length of anellus . . . . . *liberaria*  
Height of costal arm half the length of anellus . . . . . *litaria*

## KEY TO FEMALE GENITALIA

1. Sclerotized band of ostium as wide as, or wider than, width of ductus bursae . . . *liberaria*  
Sclerotized band of ostium one-third of, or less than, the width of ductus bursae . . . *litaria*

*Apodrepanulatrix liberaria* (Walker)

## Figure 14D

*Apicia* ? *liberaria* WALKER, 1860, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 20, p. 239. HULST, 1895, Ent. News, vol. 6, p. 15.

*Aspilates liberaria*, HULST, 1887, Ent. Amer., vol. 3, p. 10. GOODELL, 1878, Canadian Ent., vol. 10, p. 40.

*Deilinia liberaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327.

*Drepanulatrix liberaria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112. McDUNNOUGH, 1933, Canadian Ent., vol. 65, p. 121 (life history).

*Cabera* (*Drepanulatrix*) *liberaria*, FORBES, 1948, Mem. Cornell Univ. Agr. Exper. Sta., no. 274, p. 71.

*Macaria integraria* WALKER, 1861, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 23, p. 889. HULST, 1887, Ent. Amer., vol. 3, p. 10. PACKARD, 1876, A monograph of the geometrid moths . . . of the United States, p. 297.

*Deilinia integraria*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix integraria*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

*Aspilates lintneraria* PACKARD, 1874, Sixth Ann. Rept. Peabody Acad. Sci., p. 44; 1876, A monograph of the geometrid moths . . . of the United States, p. 209, pl. 9, figs. 37, 38.

*Zonosoma lintneraria*, GUMPFENBERG, 1892, Nova Acta Deutschen Akad. Naturf., Halle, vol. 58, p. 293.

*Deilinia lintneraria*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix lintneraria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179.

*Diastictis helena* HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 332. (New synonymy.)

*Cymatophora helena*, DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 313.

*Drepanulatrix helena*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 179.

*Drepanulatrix liberaria helena*, BARNES AND McDUNNOUGH, 1917, Check list, p. 112.

MALE: Head, vertex orange brown with broad cream-colored band between posterior margins of antennal bases; front deep orange brown; palpi lighter, deep cream color. Thorax dorsally concolorous with forewings, ventrally somewhat lighter; legs concolorous, somewhat tinged with light orange brown. Abdomen pale orange brown, anterior segments above suffused with darker orange brown, with a few darker scales, concolorous with hind wings.

UPPER SURFACE OF WINGS: Forewings yellow brown to orange brown, lightly sprinkled with dark scales, sometimes suffused with orange red scales; median area sometimes broadly suffused with dull black between transverse posterior and median lines; cross lines usually present, distinct, dull black, sometimes reduced or lacking; transverse anterior line arising on costa basad of one-fourth distance from base of wing at obtuse angle going to radial vein, turning posteriorly to cubital vein going at right angle to costa, concave below cubital vein, then roughly parallel outer margin to vanal vein, bent sharply basally to inner margin; median line arising on costa two-fifths distance from base going to radial vein, broadly or sharply curved outwardly in cell, inwardly projecting on cubital and vanal veins, convex between these veins, often extending basally between vanal vein and inner margin; discal dot absent; transverse posterior line arising on costa or at radial veins, about three-fifths distance from base, broadly outcurved opposite cell to veins  $M_1$  or  $M_2$ , then going basally with second outward bend between veins  $Cu_2$  and vanal, going basally again to inner margin; median

area, when suffused with black scales, with ground color showing along costa and often between branches of cubital vein; subterminal line in form of black, intervenular, outwardly pointing triangles, sometimes narrowly outwardly edged with light gray and white, sometimes partially reduced posteriorly, going from about 2 mm. before apex roughly paralleling outer margin; terminal area usually with black shade line running from apex to subterminal line opposite cell; fringe pinkish or suffused with black. Hind wings concolorous with forewings; median and transverse posterior lines of primaries continued on and completely crossing secondaries, subparallel with outward bulges about veins  $M_1$  and  $Cu_2$ , meeting inner margin at about two-fifths and three-fifths distance from base; no discal dots; when area between median and transverse posterior lines of forewings is suffused with black, this area is also suffused on hind wings although with less intensity as more ground color shows through; subterminal line continued from forewings, sometimes being reduced or absent, as on forewings, subparalleling outer margin; fringe as on primaries.

**UNDER SURFACE OF WINGS:** Yellow brown or orange brown, somewhat lighter than upper surface, lightly dotted with black scales; no cross lines, although subterminal line sometimes showing as two or three black dots in costal portion of forewings; discal dots usually present on all wings, small, weak; fringes pinkish. Expanse: 27 to 30 mm.

**FEMALE:** Like male; forewings more variable in color, either being orange brown as in male, with similar maculation, or grayish cream heavily overlain with black, pink and red brown scales everywhere except area between transverse posterior and subterminal lines; area between median and transverse posterior lines of both wings and between subterminal line and outer margin on forewings often heavily suffused with pink or red brown. Expanse: 25 to 31 mm.

**MALE GENITALIA:** Uncus with terminal two-thirds of equal width, apex bluntly pointed; valves with apex bluntly pointed, costa strongly projecting posteriorly in form of acutely pointed arm subequal in height to length of anellus; costa projecting medially

as large broad plate produced anteriorly as narrow finger-like projection, plate from posterior point of attachment to valves to end of projecting being from two-thirds to subequal in height of costal arm, and with well-developed transtilla arising from anteromedial portion of plate, being subequal in width for entire length; cristae apparently absent; anellus semicircular, widest medially; saccus slightly longer than wide; aedeagus straight, ratio of length to width approximately 5:1, with five or six spines, rarely four, in vesica, one being heavier and longer than others, subequal in length to uncus, the remainder successively shorter towards apex. No plate on venter of eighth abdominal segment.

**FEMALE GENITALIA:** Ostium with thick sclerotized band posteriorly, being as wide or wider than width of ductus bursae, somewhat serrate medially opposite large, subtriangular, transversely ridged operculum; ductus bursae membranous, shorter than ovipositor rods, not constricted at junction with bursa, which is medial; bursa copulatrix large, posterior end sclerotized, right side (in ventral view) with sclerotization extending farther anteriorly, whole organ medially with large number of sclerotized, inwardly pointing teeth in well-defined longitudinal rows posteriorly, not noticeably so anteriorly.

**EARLY STAGES:** The larvae and pupae described by McDunnough; eggs undescribed.

**TYPES:** *Liberaria*, *integraria*; British Museum (Natural History); both described from single females. *Lintneraria*, according to the original description, was described from three males. Two males labeled as being the types are in the United States National Museum, one of these being type no. 338, the other unnumbered, while a third male type, in poor condition, is the suffused form mentioned in the original description and is in the Museum of Comparative Zoölogy, Harvard University. Of these, type no. 338 in the United States National Museum collection is hereby designated as the lectotype, with the other two specimens as lectoparatypes. *Helena*, Rutgers University collection; described from a single female, in rather poor condition.

**TYPE LOCALITIES:** "—" (*liberaria*); "United States" (*integraria*); no locality data (*lintneraria*); the United States National Museum

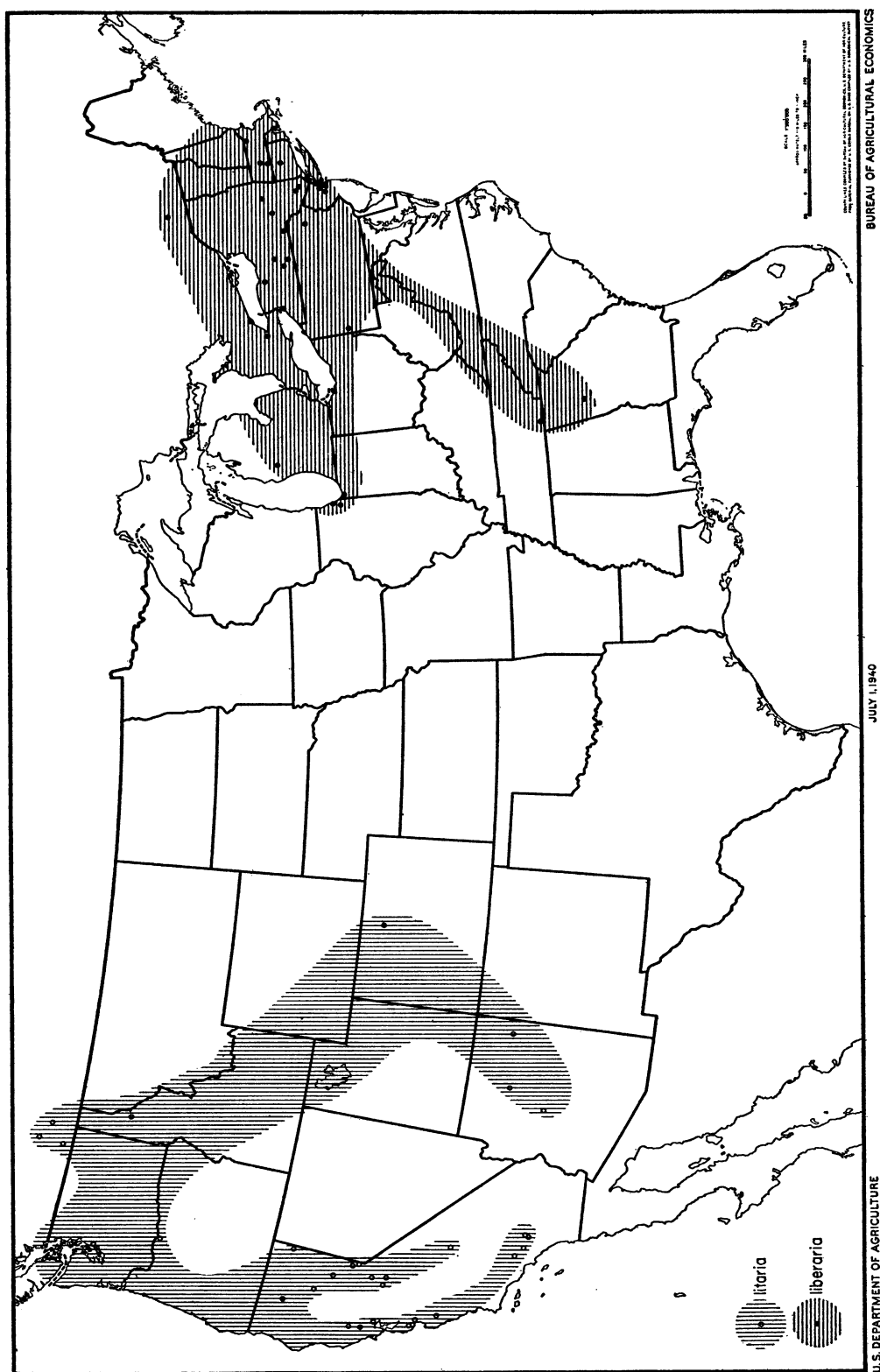


FIG. 11. Distribution of *Apodrepanulatrix liberaria* (Walker) and *litaria* (Hulst).

um lectoparatype is labeled "NY," while the one in the Museum of Comparative Zoölogy is also without locality data); the type of *helena* is labeled "Taken in Brklyn by Miss Jackson Sept. 1892." According to the original description, this is Brooklyn, New York.

**RANGE:** Eastern United States, from Georgia to Ontario and Quebec, and from the Atlantic Ocean to Wisconsin. (See fig. 11.) Reported by Forbes as extending as far as Arizona. On the wing from August through October, rarely as early as June.

**FOOD PLANT:** *Ceanothus americanus* Linnaeus.

**REMARKS:** One hundred and eighteen specimens examined. A rather variable species, especially in the female. This is another species that shows the median area of the forewings suffused with black in some examples. This was named *helena* by Hulst, but it is apparently only another color variety, similar to *californiaria*, and is probably not worthy of being retained.

#### *Apodrepanulatrix litaria* (Hulst)

##### FIGURE 14E

*Aspilates litaria* HULST, 1887, Ent. News, vol. 2, p. 211.

*Deilinia litaria*, HULST, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 327. DYAR, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 306.

*Drepanulatrix litaria*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 178, pl. 13, fig. 14.

*Deilinia fumosa* HULST, 1886, Trans. Amer. Ent. Soc., vol. 23, p. 328. DYAR, 1904, Proc. U. S. Natl. Mus., vol. 27, p. 904 (larval description). BARNES AND McDUNNOUGH, 1912, Contributions to the natural history of the Lepidoptera of North America, vol. 1, no. 4, p. 33, pl. 15, fig. 20.

*Drepanulatrix fumosa*, BARNES AND McDUNNOUGH, 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, 178.

**MALE:** Head, vertex concolorous with thorax above, brown scales with gray tips, gray sometimes forming indistinct band between antennal bases; front and palpi yellow brown to dark brown. Thorax dorsally concolorous with forewings, ventrally lighter; legs brown, irrorate with black brown scales. Abdomen light gray brown dotted with darker scales, concolorous with hind wings.

**UPPER SURFACE OF WINGS:** Forewings gray brown to light brown, more or less sprinkled with black, black brown, purple brown, and dark orange brown scales; cross lines usually present, dark, somewhat diffuse, sometimes indistinct; transverse anterior line often indistinct, arising on costa about one-fifth distance from base at obtuse angle going to radial vein, turning posteriorly to cubital vein going about at right angle to costa, concave below cubital vein to vanal vein, bent sharply basally to inner margin; median line usually distinct, diffuse, leaving costa about two-fifths distance from base at right angle, going to inner margin with outward bend in cell and above vanal vein; discal dot usually present near outer margin of median line, sometimes reduced or rudimentary, light gray or white; transverse posterior line usually distinct, arising on costa two-thirds distance from base at right angle, crossing cell with outward bulge, indented below cell, then paralleling median line to inner margin; area between transverse posterior and subterminal lines often lighter in color than remainder of wing, being less heavily suffused with dark scales; subterminal line usually prominent, complete, sometimes partially suppressed posteriorly, in form of outwardly pointing teeth most prominent opposite cell, inwardly prominently margined with red brown filling in concavities of teeth, outwardly narrowly edged with light gray, leaving costa about 2 mm. before apex going straight across wing; terminal area usually with black shade line running from apex to subterminal line opposite cell; fringe concolorous. Hind wings concolorous with forewings; median and transverse posterior lines of primaries continued on and completely crossing secondaries, although sometimes weakly represented, subparallel, meeting inner margin at one-half and three-fourths distance from base; area between these lines sometimes suffused with darker scales; no discal dots; subterminal line continued from forewings, sometimes reduced, subparalleling outer margin; fringe concolorous.

**UNDER SURFACE OF WINGS:** Light brown or yellow brown, somewhat lighter than upper surface, more or less dotted or irrorate with dark brown or black brown scales, sometimes with orange yellow cast to primaries; no cross

lines except subterminal line often showing at apex of primaries and at anal angle of secondaries, more or less complete; discal dots present on all wings, dark, usually prominent; fringes concolorous, sometimes faintly pink tipped. Expanse: 29 to 36 mm.

**FEMALE:** Like male; forewings tending to be as in male or dark gray to smoky; cross lines, except for subterminal line, less prominent, more diffuse, sometimes lacking. Expanse: 28 to 31 mm.

**MALE GENITALIA:** Uncus with terminal two-thirds slightly tapering, apex bluntly pointed; valves with apex bluntly rounded, costa strongly projecting posteriorly in form of sharply pointed arm, in height half length of anellus; costa projecting medially as large broad plate produced posteriorly as broad rounded projection, the plate from posterior point of attachment to valve to end of projection being subequal to, or longer than, height of costal arm, with well-developed transtilla arising from anteromedial portion of plate very broad basally, tapering medially; cristae present, 10 to 12 in number; anellus widest near anterior end; saccus length equal to width; aedeagus straight, ratio of length to width approximately 8:1, with from four to seven spines, usually five or six, in vesica, one being markedly longer than others, subequal in length to uncus, the remainder successively shorter towards apex. No plate on venter of eighth abdominal segment.

**FEMALE GENITALIA:** Ostium with sclerotized band posteriorly, being one-third or less width of ductus bursae in width, non-serrate medially opposite large, subtriangular, transversely ridged operculum; ductus bursae membranous, shorter than ovipositor rods, not constricted at junction with bursa which is just to left (in ventral view) of median line; bursa copulatrix large, with right posterior section sclerotized, whole organ medially with large number of sclerotized, inwardly pointed teeth usually in short longitudinal rows posteriorly, not noticeably so anteriorly.

**EARLY STAGES:** The (mature?) larvae de-

scribed by Dyar (1904); eggs, larval instars, and pupae undescribed.

**TYPES:** *Litaria*, United States National Museum, type no. 34209; designated and discussed by Barnes and McDunnough (1916). The second type specimen, in the Rutgers University collection, is probably not conspecific. *Fumosa*, United States National Museum, the type being restricted to the specimen figured by Barnes and McDunnough (1912) and being called by them "type female." At least three other "types" are in existence. Two are in the United States National Museum: a male labeled "Soda Spgs. Siskiyou. Sept. 18. Male Genitalia on slide April 23, 1940 J.F.G.C. No. 2928" bears type no. 3884, and a female with type no. 34208 is without locality data. Another female is in the Rutgers University collection and is labeled "Utah."

**TYPE LOCALITY:** "Colo. Bruce" (*litaria*, *fumosa*).

**RANGE:** Western United States, British Columbia to Oregon and California, and through the Rocky Mountain states to Arizona. (See fig. 11.) On the wing from May through November.

**FOOD PLANT:** *Ceanothus* (Dyar, 1904).

**REMARKS:** One hundred and seventy-six specimens examined. Another wide-ranging, rather variable species. Easily distinguished from the other species in the genus by the dark brown or black brown color of the wings as compared with the orange brown of *liberaria*.

The male genitalia are similar to those of *liberaria* but can be distinguished by the size and shape of the costal arm, being much smaller in this species and with the apex more rounded, by the nature of the transtilla and its base, and by the presence of cristae.

The female genitalia of *litaria* can be distinguished from those of *liberaria* by the much narrower sclerotized band of the ostium, the more lightly sclerotized nature of the bursa copulatrix with fewer and more poorly defined longitudinal sclerotized lines.



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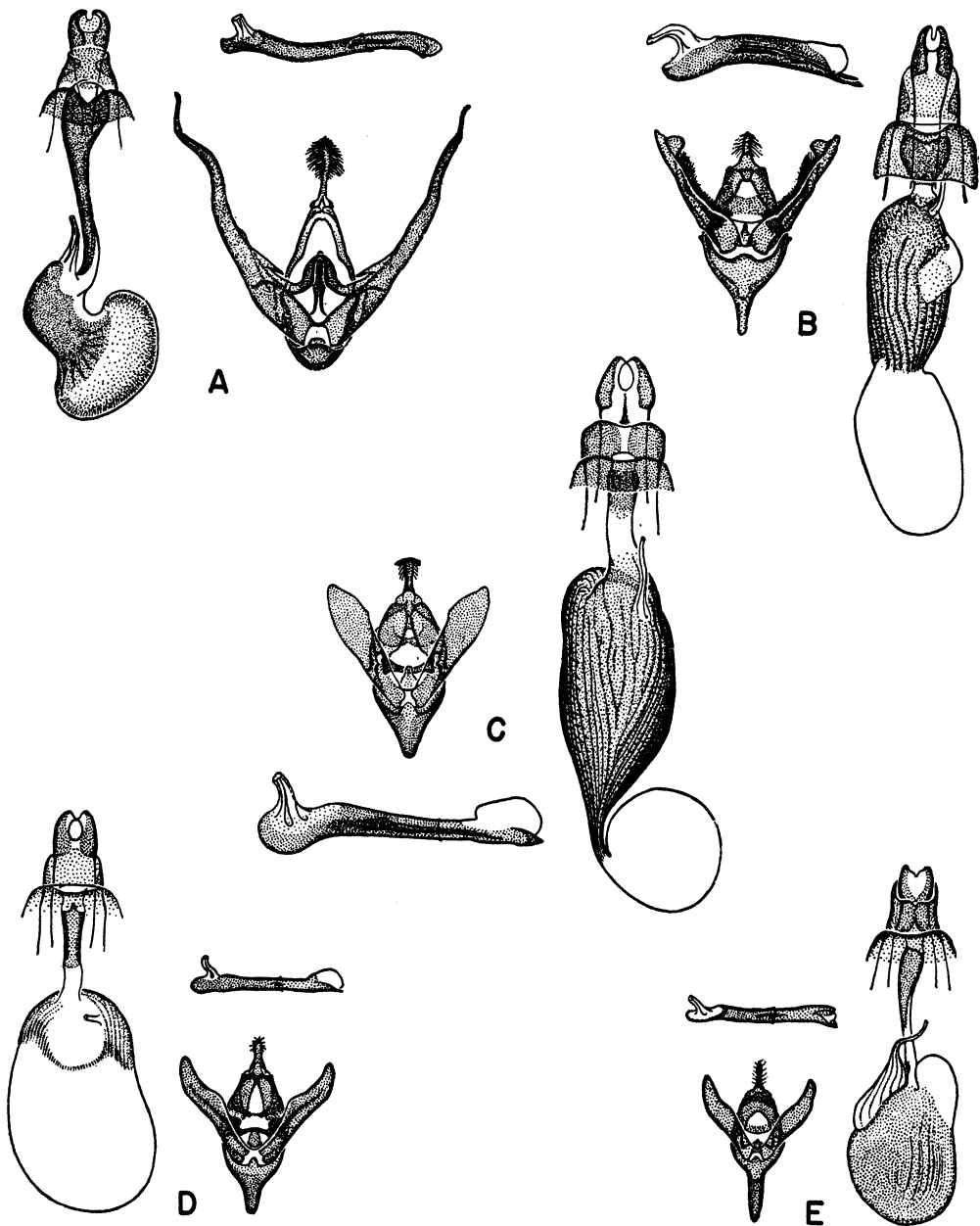


FIG. 12. A. *Eudrepanulatrix rectifascia rectifascia* (Hulst). Male: Keddie, Plumas County, California, July 19, 1941 (F. H. Rindge). Female: Cisco, Placer County, California. B. *Drepanulatrix unicalcararia* (Guenée). Male: Bass Lake, Madera County, California, May 3, 1947 (F. H. Rindge). Female: Cisco, Placer County, California. C. *D. hulstii hulstii* (Dyar). Male: San Antonio Ranger Station, Santa Clara County, California, July 21, 1948 (R. van den Bosch). Female: San Diego, California, April 20, 1911 (L. E. Ricksecker). D. *D. bifilata bifilata* (Hulst). Male: Los Gatos, Santa Clara County, California, August 9, 1942 (G. E. Pollard). Female: Warrens Creek, Mono County, California, July 20, 1941 (C. Henne). E. *D. quadraria usta* Rindge. Male: San Diego, California, March 14, 1910 (L. E. Ricksecker). Female: San Diego, California, April 25, 1911 (L. E. Ricksecker).

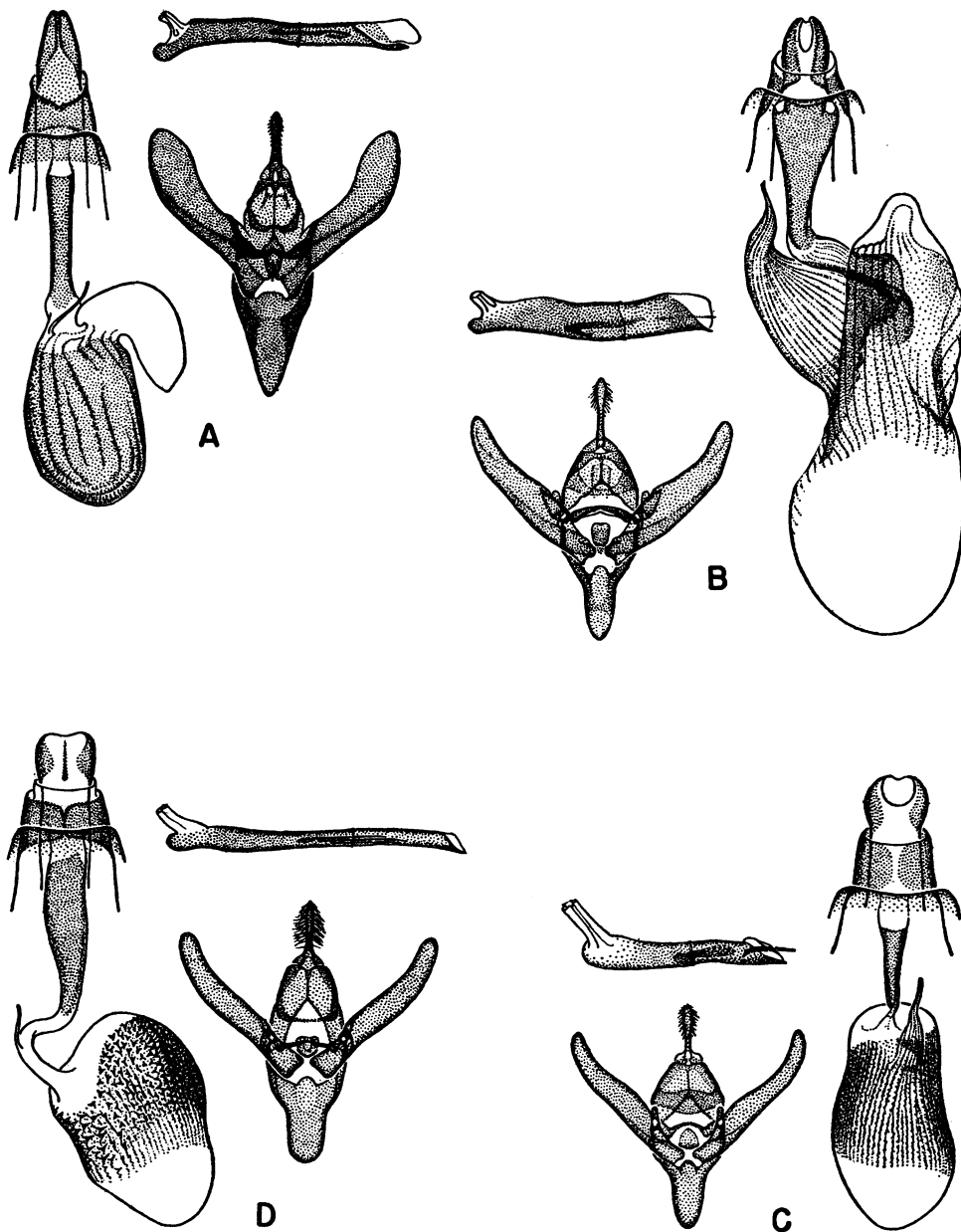


FIG. 13. A. *Drepanulatrix foeminaria* (Guenée). Male: Wallace, Idaho, April 25, 1934 (ex Guedet collection). Female: Cisco, Placer County, California. B. *D. nevadaria* (Hulst). Male: Miami Ranger Station, Mariposa County, California, July 3, 1946 (F. H. Rindge). Female: Miami Ranger Station, Mariposa County, California, July 3, 1946 (F. H. Rindge). C. *D. carnearia carnearia* (Hulst). Male: Cloudburst Canyon, Los Angeles County, California, May 21, 1942 (F. H. Rindge). Female: Cisco, Placer County, California. D. *D. falcataria* (Packard). Male: Alma, Santa Clara County, California, March 24, 1946 (G. E. Pollard). Female: Plumas County, California, June.

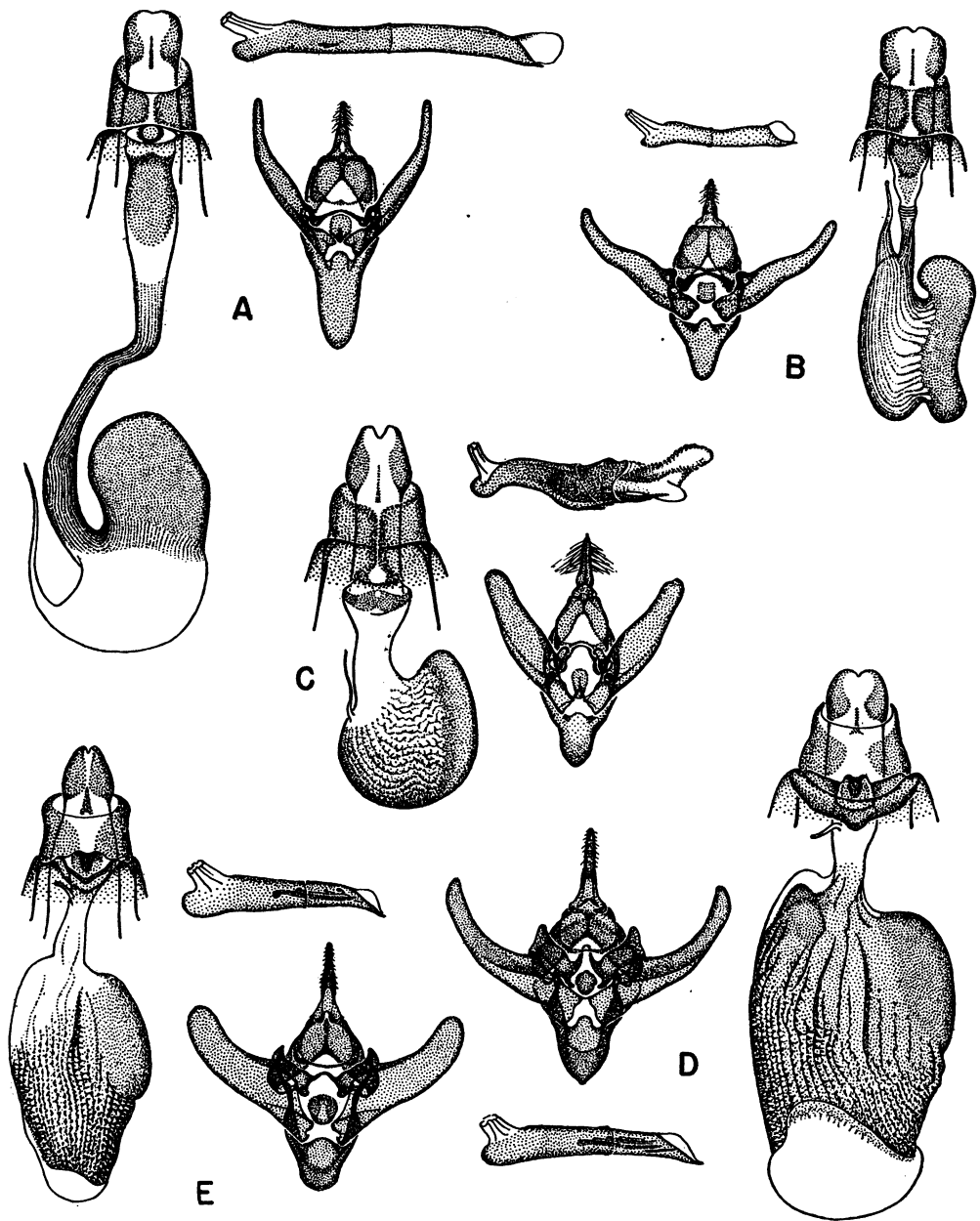


FIG. 14. A. *Drepanulatrix secundaria* Barnes and McDunnough. Male: Miami Ranger Station, Mariposa County, California, July 1, 1946 (F. H. Rindge). Female: Cisco, Placer County, California. B. *D. baueraria* Sperry. Male: Mt. Tamalpais, Marin County, California, March 15, 1948 (F. H. Rindge). Female: Kings Mountain, San Mateo County, California, January 14, 1949 (F. H. Rindge). C. *D. monicaria* (Guenée). Male: Berkeley, Alameda County, California, July 17, 1948 (F. H. Rindge). Female: San Diego, California, April 28, 1911 (L. E. Ricksecker). D. *Apodrepanulatrix liberaria* (Walker). Male: Horseheads, New York, September 20, 1940 (L. R. Rupert). Female: Staten Island, New York, September 21, 1899 (*ex* Grossbeck collection). E. *A. litaria* (Hulst). Male: Nelson Creek, Plumas County, California, August 29, 1940 (W. R. Bauer). Female: California (*ex* collection Hy. Edwards).







