

# Nepticulidae of North America

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## NEPTICULIDAE OF NORTH AMERICA

BY ANNETTE F. BRAUN

*Description of the Family*

The genera composing the family Nepticulidae form a well-defined and easily recognized group which possesses structural characters sharply distinguishing it from all other Lepidoptera. *Scoliaula* and *Trifurcula* of the European fauna, *Obrussa*, *Glaucolepis* and *Ectoedemia* of the North American fauna, are monobasic or at most represented by but a few species each; *Nepticula*, which is almost cosmopolitan in its range, appears to be unlimited in number of species. The family includes the smallest of the Lepidoptera; some species of *Nepticula* expand scarcely three millimeters.

The moths, because of their minute size and retired habits, and very rapid and irregular flight, are not frequently met. Early in the spring, some species may be collected resting in the crevices of bark. Later, moths may sometimes be found on leaves, usually those of their food plants. Occasionally because of the peculiarity of all the individuals of a single generation maturing and emerging at the same time, great numbers of moths may be seen on leaves of the food plant and neighboring plants. To secure an adequate representation of the group, however, rearing of the moths from larvae is necessary.

The family characteristics of the Nepticulidae may be given as follows:

Head and face tufted. Antennae not exceeding three-fourths of wing length, rather thick, with basal segment enlarged and concave beneath to form an eye-cap. Labial palpi short, porrected or drooping. Maxillary palpi long, filiform, folded. Tongue rudimentary. Posterior tibiae with bristles above.

*Fore wings* (Figs. 1 to 6).—Media coalescing with radius from base to beyond middle of wing, so that all the branches of radius and media appear to arise from one stem; or coalescing with cubitus for a short distance from base, then, either passing obliquely



outward to radius just beyond  $R_{2+3}$ , and anastomosing with radius to beyond middle of wing, as before, or remaining separate from radius, in which case (*Trifurcula*)  $R_{4+5}$  is absent.  $R_{2+3}$  coincident.  $R_{4+5}$  separating beyond M, or coalescing to apex. Cubitus unbranched, sometimes coincident with M or becoming obsolete beyond its point of separation from M. Second anal vein very prominent. Cross veins absent. A jugum is present in females of the more primitive genera.

*Hind wings* (Figs. 1 to 6).—Subcosta and  $R_1$  coincident;  $R_s$  and M coalescing to about the middle of the wing. Media one or two branched. Cubitus unbranched. No cross veins. Frenulum of male consisting of a single strong spine; of female rudimentary, of several minute spines. The function of the frenulum is performed in the female by a series of curved spines along base of costa. One-half to almost as broad as the fore wings.<sup>1</sup>

*Fore wings*.—1b very prominent, simple at base; 2 often becoming obsolete; 3 absent, veins present between 4 and 8 seeming to arise from one stalk; stalk apparently arising from lower median or from upper median beyond 10, sometimes connected with lower median just beyond 10. 9 absent.

*Hind wings*.—3 and 4 absent; cell open between 2 and 5+6.

A striking and unique characteristic of the family is the entire absence of true cross veins. That the apparent cross vein present in some genera, passing obliquely from cubitus to radius just beyond  $R_{2+3}$  is in fact a portion of media, is shown by studies on the tracheae of pupal wings published elsewhere, and by the occasional persistence in the imago of the tracheae which precede the wing veins.

Discussion of the origin and phylogenetic relationships of the family is reserved until a more complete account of the structure of the various parts is given.

The *head* is rough tufted, both on the face and crown. This tuft is composed of irregular hair-like scales, usually of a color contrasting with the eye-caps and with the rest of the body. Behind the tuft and eyes, the scales form a pair of flap-like structures, usually lying flat, but sometimes erected in dead

<sup>1</sup>Owing to the fact that in the greater part of the published work on Microlepidoptera the Comstock-Needham system of vein nomenclature has not been used, the following characterization of the venation is given for purposes of convenience.

specimens, the so-called "collar." This collar may be concolorous with the eye-caps, thus contrasting with the thorax, or it may be concolorous with the thorax or tuft, in which case it is inconspicuous. The antennae are comparatively short, usually not exceeding two-thirds of the wing length, rather thick with the basal segment dilated and concave beneath to form an eye-cap, which is usually clothed with white or whitish scales. The tongue is very short, curled, the two halves rather easily separated, and less than half the length of the six-jointed and folded maxillary palpus. The labial palpi are well-developed, protracted in life, usually drooping in the dead insect.

The two pair of *wings* are in general similar in shape, elongate ovate, pointed. In the male the humeral area of the hind wing is usually considerably expanded (Fig. 2), resulting in a broadening of the basal half of the wing; often the costa is excised beyond the middle.

The most striking peculiarity of the venation of the fore wings is the tendency for the base of media to coalesce with radius or with the base of cubitus, in contrast to the course taken in the majority of the Lepidoptera, where its disappearance takes place through atrophy. The supposed "cross vein" which, when present, closes cell R, is a portion of media, and its presence indicates the coalescence of the basal part of media with cubitus. This difference in the course taken by the medial trachea is not of taxonomic significance, since in *Nepticula* we find the respective conditions present in two otherwise closely related species, and sometimes in individuals of the same species, e.g. in *N. nyssaefoliella* (Figs. 1 and 2). As an extreme case of coalescence, exhibited in *Scoliaula*, we find but a single main vein traversing the middle of the wing, from which all veins, except the anal veins, seem to arise. The extraordinary development of the second anal vein, which forms a projecting ridge on the underside of the fore wing, more striking in the female, is apparently correlated with its function of serving as a fastening for the row of spines along the costal margin on the upper side of the hind wing of the female, which here preserve their primitive function of locking the two wings together (Figs. 1, 3 and 5). The true frenulum in the female consists merely of a group of minute func-

tionless spines. In the male, however, the frenulum is represented by a single strong spine (Figs, 2, 4 and 6) which hooks into a well-developed frenulum-hook. Near the base of the dorsal margin, best observed in the female of species of *Ectoedemia* (Fig. 3), is a structure which may be interpreted as a jugum, vestigial in the males even of the more primitive genera, probably functional in females of *Ectoedemia*.

Projecting from the wing membrane are numerous minute curved pointed hairs, the "fixed hairs" or aculeae. These are most numerous on the underside of the fore wing, near the dorsum.

The scale-covering of the wings consists in general of the usual flat, striated, toothed scales, amongst which are scattered hair scales. In the more primitive species the scales are uniform in structure over the wing membrane, and are almost or quite lusterless. The tendency in such species is toward a general dull ochreous or drab color, without definitely defined markings. Later we find the fore wings with definite markings in the shape of fasciae and spots, which, in more specialized species, become sharply defined through the structural differentiation of the scales forming them, so that the wings are ornamented with metallic silvery, golden or bluish spots and fasciae; finally, the entire fore wing is clothed with these metallic scales. The cilia are composed of hair-like scales or of very attenuated scales of the striate toothed type—the latter occur most commonly in the costal and apical areas.

In the males of some species, androconia are present, forming an oval opaque area on the upper side of the hind wing from the base to near the middle of the wing (shown in dotted outline on Figs. 2 and 6). Various other secondary sexual characters, in the nature of tufts of scales and hairs are present. The series of spines along the costal margin of the hind wing, which serve in the female to hold the two wings together, have in the male, with few exceptions, entirely lost their original function. In rare instances (*e.g.* *N. rhamnicola*) these spines have preserved in the male a structure and function identical with those in the female. In the earlier genera, and in the more primitive species of later

genera, these structures though modified have not entirely lost their spine-like character (Fig. 4). Even where modified, they may be distinguished from the rest of the scale covering of the hind wing by the fact that they are thicker, yellowish, more heavily chitinized structures. Instead of projecting forward, they extend obliquely backward, lying flat on the surface of the wing. In some species of *Nepticula*, these spines become greatly elongated, forming a flattened bunch of hairs lying on the wing within the costa (Fig. 2).

A feature common to all the genera is the presence of bristles on the upper side of the posterior tibiae. The position of the middle spurs of the posterior tibiae—whether situated in the middle, or above or below the middle—is a generic character.

With the exception of several gall-making species of *Ectoedemia*, the larvae of all species of which the life history is known, are miners within the tissues of leaves (rarely in fruits) or in bark. They show a preference for trees and shrubs, but not a few mine leaves of herbaceous plants. When full grown, the larva, with few exceptions, leaves the mine and dropping to the ground, spins a dense flattened cocoon amongst the rubbish or in the loose surface soil.

The *egg* is a minute oval body attached to the surface of the leaf or bark by a minute glistening speck of cement, which renders its location visible even to the naked eye.

The *larva* of *Nepticula* upon hatching eats directly into the leaf, and makes a very narrow linear mine, which is at first often difficult to discern, since in its early stages, the larva consumes but a small part of the leaf tissue. This mine may continue as a linear mine, gradually broadening throughout its course, or it may at some period abruptly enlarge into a blotch. In the latter portions the mine is semitransparent and easily visible. The mine of any one species is very constant and characteristic in appearance, and in most instances serves for immediate identification of the species. The species of *Ectoedemia* are gall-producers or bark-miners in forest trees.

The *larva* is slightly flattened, with head deeply retracted into the prothorax, due to the lengthening of the dorsal side of the head. For the details of head structure, the reader is referred to

the work of other writers, particularly Traegaardh<sup>2</sup>. Locomotor organs are represented by mere roughened protuberances; such rudimentary feet are present on segments three and four, on segments six to eleven and sometimes on the last segment in *Nepticula*; in *Ectoedemia* there are sometimes one or two additional pairs of rudimentary processes.

The *cocoon* is spun of dense brown or yellowish silk, flattened oval in general outline, but usually broader at its anterior end, around which a fissure extends, guarded by the smooth projecting edges of the two halves of the cocoon. Through this fissure the pupa is thrust at emergence. In some species, the flat projecting edges form a rim extending entirely around the cocoon.

The *pupa* is flattened ovate; all the appendages are free and segmented; segments one to seven of the abdomen are free. The resemblance to the pupa of the primitive Eriocraninae has been pointed out by Miss Mosher in her paper on "A Classification of the Lepidoptera based on Characters of the Pupa."<sup>3</sup>

The *moth* is active almost immediately after emergence, running rapidly up and down the sides of the breeding jar, and in an incredibly short time has the full use of its wings. When at rest the wings lie almost horizontal, meeting in a line down the middle of the back.

From the phylogenetic point of view, the Nepticulidae is probably one of the most interesting and instructive groups of Microlepidoptera, combining as it does, characters of acknowledged specialization with primitive, almost Trichopteran characters.

A number of characters obviously ally this family to the Eriocranid group of the Micropterygidae. Such characters are the primitive structure of the pupa in comparison to that of other Lepidoptera, and its many points of resemblance to the Eriocranid pupa, and the presence of the vestigial jugum, which can be discerned readily in females of *Ectoedemia* and *Obrussa*.

The row of slightly curved spines near the costal margin of the hind wing of the female, which presses against or hooks onto a

<sup>2</sup>"Contributions toward the Comparative Morphology of the Trophi of the Lepidopterous Leaf-Miners" by Ivar Traegaardh; Arkiv for Zoologi, viii, no. 9, (1913), Stockholm.

<sup>3</sup>Bull. Ill. State Lab. Nat. Hist., xii, art. 2, (1916).

chitinized ridge extending along the underside of the second anal vein of the fore wing (or rarely along the base of the anal furrow), or catches into a series of similiar spines on the underside of the fore wing and functions to hold the wings together in flight, in place of either frenulum or functional jugum, is preserved in better condition than elsewhere in the Lepidoptera. Its homology with similar functional structures in Trichoptera can scarcely be questioned. That the presence in males of a single-spined frenulum is not inconsistent with otherwise primitive structure is shown by the fact that in some Trichoptera, both true frenulum spines and the series of hooked spines are present.<sup>4</sup>

As noted before, a similar condition is occasionally found in *Nepticula*, where both functional curved spines and single-spined frenulum occur together.

Such considerations suggest the possibility that the Nepticulidae may have been derived from ancestry of coördinate rank with the Micropterygidae, rather than that they are descended from that group itself.

The venation affords but little clue to the origin of the group. The tendency toward crowding together and anastomosis of the main tracheal branches is unique in the Lepidoptera, but it is perhaps significant that a similar tendency is seen in some of the small Trichoptera. The absence of true cross veins (the humeral cross vein alone is occasionally present) might be regarded as a primitive character; on the other hand it may be directly due to the anastomosis of the main veins.

#### *Key to the Genera*

(European genera are included in brackets for convenience)

A.  $R_5$  (vein seven) of fore wing present.

B. Media of fore wing with three branches (veins four, five and six present).

[**Scoliaula**]

BB. Media of fore wing with one or two branches.

C. Media of fore wing with two branches (vein four absent).

D. Media of hind wing two-branched (veins five and six present).

4. **Glaucolepis**

DD. Media of hind wing single-branched. . . . . 3. **Obrussa**

<sup>4</sup>Cf. Kellogg, V. L., "The Affinities of the Lepidopterous Wing," Amer. Nat., xxix, pp. 709 to 719, (1895).



CC. Media of fore wing single-branched (veins four and five absent).

D. Middle spurs of posterior tibiae in or above the middle. 1. **Nepticula**

DD. Middle spurs of posterior tibiae below the middle.

2. **Ectoedemia**

AA. R<sub>5</sub> (vein seven) of fore wing absent.....[**Trifurcula**]

### 1. **NEPTICULA** von Heyden<sup>5</sup>

*Nepticula* von Heyden, Berich. Vers. Naturf. Mainz, 201, (1842); Zeller, Linn. Ent., iii, 249, 301 to 303 (1848). Type: *Tinea aurella* F.

*Generic characters*.—Basal segment of antennae dilated and concave beneath to form a large eye-cap. Middle spurs of posterior tibiae in or above the middle. Fore wings elongate ovate, pointed; hind wings  $\frac{1}{2}$  to  $\frac{2}{3}$ .

*Venation*. (Figs. 1, 2 and 5). Fore wings; media coalescing with radius from base to beyond middle of wing, or coalescing with cubitus at base and passing obliquely to radius beyond R<sub>2+3</sub>, and anastomosing with radius to beyond middle of wing as before. R<sub>4</sub> sometimes coincident with R<sub>5</sub>. Media single-branched. Cubitus usually reaching nearly to margin. Hind wings; media single-branched.

As far as known the larvae of all of the North American species are miners within the tissues of leaves. The egg is placed on either the upper or under surface of the leaf, often along the side of a vein, and the larva passes directly into the interior of the leaf. The larva usually mines just beneath the upper epidermis, consuming the palisade layer of cells, and in later stages, some of the spongy parenchyma cells (Fig. 7). In thin leaves the mine seems more transparent, because of the originally smaller number of these cells and the looseness of their arrangement. Where the upper or lower surface is mined indiscriminately, as is the case with leaves of poplar by *N. populetorum*, the cross-section of the leaf shows palisade cells on either side. Some species mine different sides of the leaf at different periods of larval life. The mine may be a linear tract, gradually increasing in breadth to its end, or it may at some point suddenly enlarge into a blotch. A change in the character of the mine usually indicates the beginning of a new instar. There are four larval instars. The mine formed during the first instar is very short, rarely exceeding a few millimeters in length. The large conspicuous portion is made during the last larval instar in the few days preceding the escape

of the larva from the mine. The larva leaves the mine by a semi-circular slit in the upper or the lower epidermis and spins the characteristic cocoon, usually brownish, but occasionally yellowish or whitish, in the surface soil or amongst rubbish, often near the base of the tree; occasionally it spins on the twigs or branches. Pupation does not take place immediately; in the summer generations it occurs a few days before emergence, in the overwintering generation it may be delayed until spring.

A few species have but one generation a year; most species (in the latitude of Cincinnati) have two or three; a few of the oak-feeding species may have as many as four generations. The length of the life cycle is approximately six weeks, except in the case of the single-generation species, where several months may elapse between oviposition and the attainment of full growth by the larva. The moths from the overwintering generation of larvae emerge in May and June, a few species in April.

A comparison of blotch-making species with linear-mine species would seem to indicate that in some respects the former are more primitive, since these species are practically identical with the earlier *Ectoedemia* in wing structure. This is not universally true, however, and the fact that some of the smaller linear mine-making species (in which veins  $R_4$  and  $R_5$  are coincident and  $M$  coalescent with  $R$ ) are very closely related in general habitus to these blotch-makers, may indicate that the differences in venation are directly due to size and breadth of wing.

Where species described in the genus *Nepticula* have not been available to the author for examination, they have been tentatively retained in this genus. Localities cited under geographical distribution without authority stated are from the author's personal observations.

Only the references to original descriptions and notes published subsequent to Dyar's List (1902) are cited under each species; for other references the reader is referred to Dyar's List. The scientific names of plants of the eastern United States are those used in Gray's New Manual of Botany (Seventh Edition).

<sup>5</sup>The name *Stigmella* Schranck (Fauna Boica, ii, (2), p. 169, (1802) is a *nomen nudum*, no species having been mentioned.

The few listed species named from larvae and not yet reared, are grouped at the end of the known species, with such additional information as has been secured about them.

*Key to the Species of Nepticula*

- a. Fore wings with pale spots or fasciae.
  - b. A silvery or pale golden metallic spot at or very near the base of the wing.
    - c. A median fascia.
      - d. A costal and a dorsal spot at three-fourths....3. **pteliaeella**
      - dd. No such spots at three-fourths.
        - e. Thorax and extreme base of wing purple...1. **argentifasciella**
        - ee. Thorax and extreme base of wing golden.....2. **scintillans**
      - cc. No. median fascia ..... 4. **quadrinotata**
    - bb. Without such a spot.
      - c. Basal third of wing buff.....11. **cerea**
      - cc. Basal third of wing not buff.
        - d. A pale costal spot at one-third.....5. **trinotata**
        - dd. Without a pale costal spot at one-third.
          - e. Two pale fasciae.
            - f. Thorax creamy buff.....10. **rhamnicola**
            - ff. Thorax dark.
              - g. Head black.....8. **intermedia**
              - gg. Head ochraceous.
                - h. First fascia dull yellow.....9. **diffasciae**
                - hh. First fascia shining.
                  - i. Thorax and base of fore wing bronzy; expanse 5.5 mm.
                    - 6. **ceanothi**
                  - ii. Thorax and base of fore wing purple; expanse 4 to 4.5 mm.
                    - 7. **bifasciella**
    - ee. One pale fascia.
      - f. Fascia more or less interrupted.
        - g. Male with a chitinous plate from base to near middle of costa of hind wing.
          - h. Fascia silvery ..... 38. **platanella**
          - hh. Fascia not silvery; male with long hair-pencil from base of costa of hind wing.....40. **similella**
        - gg. No such chitinous plate in male.....39. **clemensella**
      - ff. Fascia complete.
        - g. Fascia before the middle; wing lusterless.
          - h. Whitish costal and dorsal spots at three-fourths.
            - 41. **thoracealbella**
          - hh. No such spots at three-fourths.....49. **latifasciella**
        - gg. Fascia in or beyond middle of wing.
          - h. Apex white .....28. **apicialbella**
          - hh. Apex not white (sometimes with white apical cilia).
            - i. Fore wing almost lusterless; fascia not more shining than remainder of wing.

- j. Fascia at two-thirds.....37. **variella**
- jj. Fascia at or near middle of wing.
  - k. Head, except eye-caps, black.....35. **canadensis**
  - kk. Head not black.
    - l. Cilia, creamy white.....36. **ulmella**
    - ll. Cilia gray ..... 34. **fuscotibiella**
- ii. Fore wing almost lusterless; fascia shining white, silvery or golden.
  - j. Collar white.....29. **tiliella**
  - jj. Collar not conspicuously paler than the head.
    - k. Apical cilia white; marginal line defined.
      - l. Expanse 4 mm.....30. **rubifoliella**
      - ll. Expanse 5 to 6 mm.....31. **nyssaefoliella**
    - kk. Apical cilia not white; marginal line not defined.
      - l. Head paler behind.....32. **slingerlandella**
      - ll. Head not paler behind.....33. **rosaefoliella**
- iii. Fore wing with a metallic luster; fascia silvery or golden.
  - j. Fascia preceded by a purple or deep golden brown band.
    - 17. **purpuratella**
  - jj. No such band.
    - k. Fascia the only pale marking.
      - l. Basal half of wing metallic golden or bronzy; fascia ill-defined internally.
      - m. Entire apical area deep purple.
        - 16. **unifasciella**
    - mm. Costal half of apical area purple.
      - 15. **resplendensella**
    - ll. Fascia well-defined internally, contrasting with ground color.
      - m. Wing purple before the fascia, brown beyond.
        - 22. **altella**
    - mm. Wing not as above.
      - n. Fascia noticeably beyond the middle.
        - o. Fascia indistinct ..... 18. **obscuraella**
        - oo. Fascia distinct.
          - p. Wing brown with bronzy and purple reflections.
          - q. Entire tuft ochraceous.
            - 19. **ostryaefoliella**
          - qq. Tuft ochraceous behind only.
            - 20. **paludicola**
          - pp. Wing bluish black. .21. **myricafoliella**
    - nn. Fascia at or near the middle.
      - o. Tuft black.....25. **quercipulchella**
      - oo. Tuft reddish or ochraceous.

- p. Ground color bronzy.
- q. Collar pale yellowish (usually)
  - 24. **opulifoliella**
- qq. Collar not pale. . . . 23. **corylifoliella**
- pp. Ground color purplish black.
  - q. Legs reddish yellow.
    - 26. **condaliafoliella**
  - qq. Legs silvery and fuscous.
    - 27. **juglandifoliella**
- kk. With additional silvery or golden markings.
  - l. A semi-elliptical golden metallic spot on dorsum proximal to fascia. . . . . 12. **rhoifoliella**
  - ll. Metallic markings along termen or at apex.
    - m. Termen margined with silvery scales from dorsum to apex . . . . . 13. **terminella**
    - mm. Apex golden metallic, concolorous with fascia . . . . . 14. **villosella**
- aa. Fore wings without pale spots or fasciae.
- b. Ground color pale ochreous or yellowish.
  - c. A purplish fuscous band across apex of fore wing.
    - d. Fore wing dusted with fuscous scales.
      - e. A dark brown spot at base of dorsal margin. 51. **nigriverticella**
      - ee. No such spot. . . . . 52. **populetorum**
    - dd. Fore wing not dusted . . . . . 50. **crataegifoliella**
  - cc. No such band; wing dusted.
    - d. Tuft fuscous or blackish. . . . . 53. **saginella**
    - dd. Tuft ochreous. . . . . 54. **pallida**
- bb. Ground color gray, brown or bronzy.
  - c. Ground color pale gray.
    - d. Wings evenly dusted with fuscous. . . . . 46. **punctulata**
    - dd. Wings not dusted; a fuscous spot in apex. . . . 48. **belfrageella**
  - cc. Wings brown, usually with purple or bronzy luster.
    - d. Size large (9 mm.) . . . . . 47. **grandisella**
    - dd. Not exceeding 6 mm. expanse.
      - e. Fore wing with metallic bronzy or golden reflections.
        - f. Wing deep reddish or purplish bronzy. . . . . 42. **pomivorella**
        - ff. Wing paler, with greenish golden reflections. . . 43. **chalybeia**
      - ee. Fore wing dark brown, with faint purple reflections.
        - f. Tarsi of middle and hind legs pale ochreous. . 44. **flavipedella**
        - ff. Tarsi of middle and hind legs whitish. . 45. **castaneaefoliella**

### 1. **Nepticula argentifasciella** Braun

*Nepticula argentifasciella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 100, (1912).

Palpi black. Tuft black behind, ochraceous in front. Antennae black, eye-caps silvery white. Thorax and base of fore wings dark purple. Fore wings dark brown, with metallic reflections when viewed obliquely. At the basal fifth of the wing there is a brilliant silvery fascia, becoming decidedly

broader as it nears the dorsum; sometimes it broadens so considerably as almost to reach the base of the wing. At the middle of the wing is a second fascia, in some specimens almost wedge-shaped, with its base resting on the dorsum. At the extreme apex of the wing is a silvery patch of scales of variable extent; in some cases it extends from the costa around the apex broadening toward the tornus, and occasionally it is connected along the dorsum by a few silvery scales with the second fascia; sometimes it is reduced to a rather large spot at the tornus. The color of these fasciae varies considerably, depending on the direction of the light, either silver, or when viewed very obliquely, a metallic pale blue. Cilia dark brown. Hind wings and cilia dark brown. Legs black, fore and middle tarsi and last segment of the hind tarsi buff. Abdomen black above, sometimes silvery beneath.

Expanse—4 to 4.5 mm.

*Localities*.—Cincinnati, Ohio; Powell County, Kentucky.

The larva is a miner in leaves of basswood (*Tilia americana*). The egg is deposited on the upper surface of the leaf, but the larva upon hatching mines much closer to the lower than to the upper epidermis, forming at first a very narrow serpentine mine (Fig. 32) about 3.5 to 4 cm. in length, with a width nowhere greater than .5 mm. This portion of the mine is scarcely visible from the upper side, except for the tiny specks of leaf substance consumed here and there. Within the last twenty-four or thirty-six hours of larval life the linear mine suddenly expands into a blotch, 3.5 to 4 mm. in breadth. In this area, which often obliterates part of the early serpentine mine, the mine is semi-transparent and pale green. The larva spins a somewhat flattened reddish cocoon, broader at its anterior end.

There are two or three generations a year; larvae become full grown toward the end of June, in August and the latter part of September.

## 2. *Nepticula scintillans* new species

Palpi whitish. Tuft and collar black; eye-caps silvery white. Thorax and base of fore wing golden. Fore wing, except at the base, very dark purple with a silvery fascia across the middle, broadest on the dorsal margin. A second silvery fascia crosses the apex of the wing. At the extreme apex the cilia are dark brown, elsewhere silvery gray. Hind wings and cilia gray. Legs gray, with paler tarsi. Abdomen black, silvery beneath.

Expanse—3 mm.

*Locality*.—Cincinnati, Ohio.

*Type material*.—Holotype (writer's collection); paratype (Acad. Nat. Sci. Phila.); three paratypes (writer's collection).

Five specimens, bred from narrow linear mines on hawapple (*Crataegus mollis*). The mine (Fig. 11) is a tortuous serpentine tract, soon becoming brownish, and rarely exceeding 1 mm. in breadth at its end. The cocoon is dark brown.

Larvae may be found in June, and in July and early August. The second generation of larvae usually overwinters, but occasionally larvae of a third generation are found in late August.

### 3. *Nepticula pteliaeella* Chambers

*Nepticula pteliaeella* Chambers, Psyche, iii, 137, 1880; 276, 1881; Dyar's No. 6214.

Tuft on head dark brown; eye-caps white. Thorax and base of fore wing at the dorsum silvery; a silvery fascia before the middle, a costal and opposite dorsal spot at three-fourths, on a dark brown ground color. Cilia silvery around the apex, becoming brown toward the dorsum. Hind wings and cilia dark brown. Legs brown outwardly, inner surfaces and apical segments of tarsi silvery. Abdomen dark brown above, paler beneath.

*Expanse*—4 to 4.5 mm.

*Localities*.—Kentucky (Chambers); Ohio.

The larvae is a miner in leaves of hop tree (*Ptelea trifoliata*). The egg is deposited on the upper side of the leaf; the mine (Fig. 12) which is everywhere much contorted, is at first very indistinct, and sometimes blotch-like; later it becomes more distinct, but is more or less obscured by the scattered frass. Deserted mines become whitish or yellowish. The larva is a very bright green in color. Cocoon dark brown.

Two generations a year; larvae may be collected in July and in August and September.

### 4. *Nepticula quadrinotata* new species

Head dark brown; eye-caps silvery white. Thorax and fore wings dark brown; markings silvery white, consisting of an elongate spot at base of dorsum, a small spot on the costa before the middle, a larger triangular spot at the tornus, and a similar spot on the costa nearer the apex. Cilia brown, with silvery tips around the apex. Hind wings and cilia brown. Legs grayish iridescent. Abdomen brown above, silvery beneath.

*Expanse*—4 to 5 mm.

*Localities*.—Cincinnati, Ohio; Fairfield County, Ohio; Powell County, Kentucky.

*Type material*.—Holotype (writer's collection); paratype (Acad. Nat. Sci. Phila.); six paratypes (writer's collection).

The larva, which is very pale green with a brighter green line of ingested food, mines leaves of hornbeam (*Carpinus caroliniana*)

and hazel (*Corylus americana*). The mine (Fig. 13) for the first 3 or 4 cm. of its length is a very fine linear one, usually closely following the midrib or one of the lateral veins; later doubling on itself for a short distance before it expands into an irregular pale brownish blotch, which may occupy the entire space between two lateral veins. The blotch often obliterates the earlier linear mine. Cocoon brownish, usually with an olive green tinge.

Two generations a year; mines in July and from late August to the middle of October, but never common.

A very distinct species. The mine should not be confused with that of *N. ostryaefoliella* Clemens on hop hornbeam and birch, which is linear, gradually increasing in breadth throughout.

##### 5. *Nepticula trinotata* Braun

*Nepticula trinotata* Braun, Can. Ent., xlvi, 18, 1914.

Palpi very pale ocherous. Tuft ocherous. Antennæ fuscous, eye-caps whitish. Thorax with deep blue reflections. Fore wings with deep blue reflections in the basal third, velvety black beyond and somewhat irrorated in the apical third, the scales here having pale bluish iridescent bases. At the basal third on the costa is a white spot of variable size, faintly tinted with lilac in some lights. At the apical third there is a costal and an opposite dorsal spot, each shining white and larger than the spot at the basal third. The costal spot is usually more oblique, its tip extending outwardly beyond the opposite dorsal spot. Cilia almost entirely pure white. Hind wings and cilia pale silvery gray. Legs pale grayish ocherous, tarsal joints dark tipped. Abdomen purplish fuscous above, paler and iridescent beneath in the female.

*Expanse*.—4.5 to 5 mm.

*Localities*.—Cincinnati, Ohio, and vicinity.

The larvae form blotch mines on *Carya cordiformis* (*Hickoria minima*) and occasionally on *C. ovata*. The mine (Fig. 33) is at first an extremely narrow linear tract, later suddenly expanding into a broader tract, 1 mm. or more in width, which in turn becomes a blotch, varying in width from 3 to 6 mm. The mine is almost transparent even in the early linear portion, which thus distinguishes it from that of *N. juglandifoliella* Clemens on hickory. This is the large blotch mine to which Chambers refers<sup>6</sup>.

<sup>6</sup> Psyche, iii, 66, 1880.

The larva is of a dull grayish color. Cocoon reddish brown.

There are two generations a year, the mines of the first appearing during the early part of July and those of the second generation at the beginning of September.



### 6. *Nepticula ceanothi* Braun

*Nepticula ceanothi* Braun, Ent. News, xxi, 172, 1910.

Tuft ochraceous; eye-caps shining creamy buff. Thorax and basal third of fore wing bronzy with purple and blue reflections. A shining golden fascia at one-third and a second similar fascia at two-thirds; beyond the first fascia the ground color of the wing is dark brown. Cilia brown, pale iridescent gray toward their tips. Hind wings and cilia brownish gray. Upper surface of abdomen dark brown; lower surface of body and legs metallic gray with bronze reflections.

*Expanse*.—4.5 to 5 mm.

*Localities*.—Dutch Flat, Placer County, California (G. R. Pilate); Eureka, California (Barber); Mt. Lowe, California.

The larva mines leaves of *Ceanothus divaricatus*, forming a narrow brownish contorted tract (Fig. 14), about 3 cm. in length, with a breadth of 1 mm. at the end and almost filled with frass.

Cocoon red dishbrown. The type specimens were bred from mines received from Dutch Flat, California, in February; imagoes in March and April.

The mines occur in great numbers on the same plant in southern California.

### 7. *Nepticula bifasciella* Clemens

*Nepticula bifasciella* Clemens, Proc. Ent. Soc. Phila., i, 133, 1862; Tin. No. Am., 183, 1872; Busck, Proc. Ent. Soc. Wash., v, 209, 1903; Dyar's No., 6188.

Syn. *serotinaeella* Chambers, Can. Ent., v, 126, 1873; Dyar's No. 6221.

Tuft ochraceous; eye-caps shining cream color. Thorax and base of fore wings to the first fascia dark purple; beyond the first fascia the wings are dark brown with bronzy reflections; the fasciae are silvery or golden according to the light, the first fascia at one-third, the second at two-thirds of the wing length. Cilia concolorous, becoming silvery at their tips. Hind wings and cilia gray.

*Expanse*.—4 to 4.5 mm.

*Localities*.—Pennsylvania (Clemens); Kentucky (Chambers); Ohio.

The larva is a miner in leaves of wild cherry (*Prunus serotina*), and occasionally on wild plum (*Prunus americana*). The mine (Fig. 15) is much contorted, especially at first, often by confluence forming a blotch, later distinct, with the frass scattered to near the the end, where it is collected into a broad line. The leaf of wild cherry is discolored and reddish around the mine. Cocoon ochereous, sometimes reddish.

This species is one of the earliest to appear in the spring; larvae become full grown by the middle of May; later generations occur in June and July and in September. The mines are especially common on the leaves of young saplings a few inches above the ground.

The name *prunifoliella* used by Clemens in referring to the empty mines of this species is a *nomen nudum*.

#### 8. *Nepticula intermedia* new species

Head black; eye-caps silvery white. Thorax bronzy, base of fore wings plum-purple, followed by a shining silvery or golden fascia. Beyond this fascia the wing is dark brown, with but faint bronze reflections. A second silvery or golden fascia crosses the wing at two-thirds. Cilia silvery around the apex. Hind wings and cilia gray, with faint purple metallic reflections. Legs black.

*Expanse*.—3 to 3.5 mm.

*Localities*.—Cincinnati, Ohio; Kentucky.

*Type material*.—Holotype (writer's collection); paratype (writer's collection).

Two specimens bred from serpentine mines (Fig. 16) on leaves of sumac (*Rhus* spp.). The loosened epidermis is bright green at first, later yellowish, and is marked by a broad blackish frass line nearly as broad as the mine. Larva very bright green. Usually there are but two generations a year, larvae maturing in July overwintering, but occasionally a third generation appears. Chambers makes brief mention of these mines on sumac.<sup>7</sup>

#### 9. *Nepticula diffasciae* Braun

*Nepticula diffasciae* Braun, Ent. News, xxi, 172, 1910.

Tuft ochraceous; eye-caps and collar creamy white. Thorax and fore wings brownish black, the latter irrorated in the apical third. There are two pale fasciae; the first at one-third is creamy buff, the second at two-thirds is white, more shining and usually narrower than the first. Cilia whitish around the apex, gray at the tornus. Hind wings and cilia brownish. Abdomen brown at the base, dark gray behind. Legs brownish.

*Expanse*.—5.5 to 5.8 mm.

*Locality*.—Dutch Flat, Placer County, California (Pilate).

The mine (Fig. 17) on the upper side of leaves of an unidentified shrub, is a long tortuous tract, almost indistinguishable at first, later semitransparent, with scattered frass. The end of the mine is whitish and almost transparent. The cocoon is of a sordid

<sup>7</sup> Psyche, iii, 66, 1880.

yellowish color. The mines from which the type series was reared were collected in March and produced imagoes in May.

10. **Nepticula rhamnicola** Braun

*Nepticula rhamnicola* Braun, Ent. News, xxvii, 56, 1916.

Syn. *rhamnella* || Braun (not Herr.-Sch.), Journ. Cin. Soc. Nat. Hist., xxi, 96, 1912.

Tuft ochereous in the summer generation, black in the overwintering generation. Antennae black narrowly ringed with pale gray, eye-caps creamy buff. Thorax creamy buff, patagia dark brown. Fore wings brown, the tips of the scales blackish. At the basal third of the wing is a cream colored fascia with its edges often indented by dark scales. At two-thirds of the wing length is a more shining silvery fascia. Cilia pale gray, whitish around the apex. Hind wings and cilia gray. Fore and middle pair of legs ochereous, somewhat shaded with gray, hind pair predominantly gray. Abdomen brown above, paler beneath.

*Expanse*.—4.5 to 5.5 mm.

*Locality*.—Ohio, along little Miami River.

The mines (Fig. 35) are very common in leaves of *Rhamnus lanceolata* growing along the banks of the little Miami River in Hamilton and Clermont Counties, Ohio. The egg is deposited on the underside of the leaf, and the larva upon hatching makes a short contorted mine within a small area, so that its presence is indicated from above by a blackish discolored spot on the leaf; the mine then extends as a fine line nearly straight for a distance of about 1.5 cm.; during this time it is not visible on the upper surface of the leaf. The larva then crosses to the upper surface, continuing the linear mine for a distance of about 1.5 cm. further. The mine now suddenly expands into a broader tract or blotch, and from thence to its end has a width of from 2 to 3 mm. The length of the broad tract is about 2 cm. and in it nearly the entire leaf substance is consumed. The formation of the blotch occupies approximately the last two days of the larval period within the mine. Larva bright green; cocoon tawny.

There are three generations a year; mines are most abundant in October.

This species may be distinguished from its nearest ally, *N. diffasciae*, by its whitish thorax.

11. **Nepticula cerea** new species

Head buff; eye-caps a little paler. Thorax and base of fore wings to just beyond one-third, creamy buff. From the base a few fuscous scales extend along the costa to the middle of the pale area, where they join a small triangular

fuscous spot which is sometimes faintly connected with the dorsum by a few scattered fuscous scales. Following the pale basal area, a broad dark brown band crosses the wing, succeeded by a narrower silvery white fascia. The apical third of the wing is dark brown, except the cilia at the apex which are pure white. Hind wings and cilia gray. Legs buff, except posterior tibiae and basal segments of tarsi which are fuscous. Abdomen fuscous above, buff beneath.

*Expanse*.—3.5 mm.

*Localities*.—Cincinnati, Ohio, June 15 and August 28; Oak Station, Allegheny County, Pennsylvania (Marloff), May 25.

*Type material*.—Holotype (writer's collection); paratype (writer's collection); paratype (Marloff collection).

## 12. *Nepticula rhoifoliella* Braun

*Nepticula rhoifoliella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 93, 1912.

Head black; eye-caps silvery white. Thorax blackish purple. Fore wings very lustrous, base of the costa plum-purple. A large semi-elliptical patch of scales just beyond the base of the wing and resting on the dorsum, but not reaching to the extreme costa, is deep brilliant golden, shading along its edges into reddish bronze. This golden patch, while it does not constitute a definitely limited marking, is nevertheless distinctly differentiated from the rest of the wing. Beyond this the wing is deep purple with bronze reflections, crossed at three-fifths by a straight shining silvery or pale golden fascia. Cilia of the general hue, the tips but little paler around the apex. Hind wings and cilia gray. Legs black, except the tibiae and tarsi of the middle pair, which are silvery. Abdomen blackish above, somewhat paler beneath.

*Expanse*.—3.5 mm.

*Localities*.—Ohio; Kentucky; St. Louis, Missouri (Miss Murtfeldt).

The larvae make contorted serpentine mines (Fig. 34) on the upper side of leaves of poison ivy (*Rhus toxicodendron*). The loosened epidermis is pale brownish yellow and the frass is dispersed, in most places, throughout the entire breadth of the mine. Cocoon brown.

There are three generations; mature larvae may be found in June, toward the end of July and in September.

This species is very distinct from any other species. The golden patch of scales, standing out even to the naked eye as paler and more lustrous than the remainder of the wing, immediately identifies it.

**13. *Nepticula terminella* Braun**

*Nepticula terminella* Braun, Can. Ent., xlv, 23, 1914.

Tuft on the face dull brownish, on the vertex and head black; color and eye-caps shining white, with a very faint yellow tinge. Thorax bronzy. Costal half of the fore wing to the fascia, blue-purple, the blue predominating at the extreme edge; below the costa the wing shades into a deep brilliant golden color, becoming more bronzy as it nears the fascia. The fascia is situated just beyond the middle of the wing, is almost straight and has a brilliant silvery luster. Apical third of the wing blue-purple, blue predominating. Just below the apex a double row of silvery scales margins the termen, becoming a single row toward the dorsum and sometimes connected with the fascia. Cilia gray. Hind wings and cilia gray, with a purple tinge. Legs dark gray, tibiae and tarsi of the fore pair and tarsi of the others, ochereous. Abdomen dark purplish gray above, yellowish beneath toward the tip, anal tuft yellow.

*Expanse*.—5 to 5.5 mm.

*Localities*.—Ohio; Kentucky; Oak Station, Pennsylvania (Marloff).

The mine (Fig. 36) occurs on various species of oak, most commonly on red oak (*Quercus rubra*) and pin oak (*Q. palustris*). It is a pale greenish, gradually broadening linear tract, 3.5 mm. wide at the end (being thus broader than any except the true blotch mines on oak), with a blackish line of frass through the center. Larva yellow even when very young; thus this mine can early be distinguished from the other linear mines on oak. Cocoon ochereous to brown.

There are three generations a year, and in favorable seasons, a fourth. Mines containing full-grown larvae may be collected in the middle of June, the latter part of July, the end of August and beginning of September, and during October and early November.

**14. *Nepticula villosella* Clemens**

*Nepticula villosella* Clemens, Proc. Ent. Soc. Phila., i, 84, 1861; Tin. No. Am., 174, 1872; Braun, Journ. Cin. Soc. Nat. Hist., xxi, 94, 1912; Dyar's No. 6224.

Syn. *dallasiana* Frey and Boll, Stett. Ent. Zeit., xxxvii, 228, 1876; Dyar's No. 6195.

Tuft orange-ochraceous; eye-caps pale golden. Thorax and fore wings to the fascia brilliant metallic bronzy, somewhat purple at the base of costa; fascia at two-thirds golden. Wing beyond the fascia blue-purple, with a large spot at the apex and the apical cilia golden, concolorous with the fascia. Hind wings and cilia gray. Legs black, posterior tarsi silvery. Abdomen black.

*Expanse*.—4.5 mm.

*Localities*.—Pennsylvania (Clemens); Texas (Boll); Ohio; Kentucky.

The larva is a miner in leaves of blackberry (*Rubus* spp.) and occasionally wild raspberry (*Rubus occidentalis*). The mine (Fig. 18) is a tortuous brown linear tract, scarcely broader than the pale brownish larva within. Cocoon brownish.

Three generations; mature larvae are found in the latitude of Cincinnati in the middle of June, latter part of July and in October.

Distinguished from all other species by the metallic golden apex.

15. **Nepticula resplendensella** Chambers

*Nepticula resplendensella* Chambers, Cin. Quart. Journ. Sci., ii, 118, 1875; Dyar's No. 6217.

Palpi whitish, tuft pale reddish saffron. Fore wings, including cilia with a brilliant metallic luster, golden or silvery, except the basal half of the costal margin, and a large spot extending along the base of the costal cilia nearly to the tip and more than half way across the wing, which are deep purple. Tips of tarsi pale yellowish.

*Expanse*.—6 mm.

*Locality*.—Kentucky (Chambers).

The above description is compiled from Chambers' diffuse description of this species. I have not taken the species nor examined the type, but it is very close to the following species, if not identical with it.

16. **Nepticula unifasciella** Chambers

*Nepticula unifasciella* Chambers, Cin. Quart. Journ. Sci., ii, 119, 1875; Journ. Cin. Soc. Nat. Hist., ii, 193, 1880; Dyar's No. 6223.

Head orange-ochraceous; eye-caps silvery white. Upper surface of thorax and basal two-thirds of fore wing brilliant metallic bronzy or golden, except toward the costal margin where the color shades into purple, so that a silvery or golden fascia at the apical third is scarcely defined internally. Behind the fascia, the wings are deep purple. Cilia purple, golden at their tips. Abdomen, legs and under side of wings shining brownish black.

*Expanse*.—4.5 mm. (Chambers)

*Localities*.—Kentucky (Chambers); Texas (Chambers); Cincinnati, Ohio.

Specimens in my collection answer Chambers' description in every respect, but vary in expanse from 5 mm. (male) to 7 mm. (female). The larva is probably an oak miner. Moths were collected in the middle of June resting on leaves of red oak.

**17. *Nepticula purpuratella* new species**

Tuft ochraceous or orange; eye-caps silvery white. Thorax deep bronzy or golden. Extreme base of the fore wing concolorous with the thorax, shading outwardly to a paler lustrous golden color, which at the outer limits of the basal third is followed by a deep bronzy band with purple and reddish reflections varying in intensity, and occupying approximately the middle of the wing. This is followed by a brilliant silvery fascia. Apical area beyond the fascia deep bronzy, usually suffused with brilliant purple. In one specimen the purple reflections are almost entirely absent, so that the dark band preceding the fascia and the apical area are deep bronzy-golden. Cilia gray with bronzy reflections, those around the apex silvery tipped. Hind wings and cilia brownish gray. Legs brownish, with tibiae and tarsi whitish, except those of the hind pair, which are bronzy brown. Abdomen bronzy brown.

*Expanse*.—4.5 to 4.8 mm.

*Localities*.—Pittsburgh, Pennsylvania (Engel); Oak Station, Allegheny County, Pennsylvania (Marloff).

*Type material*.—Holotype (U. S. N. M.); paratype (writer's collection); paratype (Marloff collection).

Three specimens, collected in May and early June. The only American species, thus far known, in which the fascia is preceded by a dark band separating it from the paler basal area.

**18. *Nepticula obscurella* Braun**

*Nepticula obscurella* Braun, Journ. Cin. Soc. Nat. Hist., xxi. 95, 1912.

Tuft ochereous. Antennae brownish, eye-caps whitish. Thorax brown. Fore wings shining golden brown, tinged with bronze along the extreme costa and in the apex. Just beyond two-thirds of the wing-length there is an indistinct narrow whitish fascia, broadest in the middle of the wing and fading out toward the ends. When viewed at some angles this fascia is scarcely visible. Cilia of the general hue, their tips around the apex paler and concolorous with the fascia. Hind wings grayish brown. Legs gray, tibiae and tarsi pale. Abdomen brown.

*Expanse*.—3.5 mm.

*Localities*.—Montclair, New Jersey; Long Island, New York.

The mine (Fig. 19) is a narrow serpentine track on the upper side of bayberry (*Myrica carolinensis*), with frass dispersed across the mine. Cocoon ochraceous. There are two generations a year.

**19. *Nepticula ostryaefoliella* Clemens**

*Nepticula ostryaefoliella* Clemens, Proc. Ent. Soc. Phila., i, 83, 1861; Tin. No. Am., 172, 1872; Dyar's No. 6208.

Tuft ochraceous; eye-caps and collar shining cream-colored. Thorax and fore wings shining brown with faint bronzy and purple reflections, which

become deeper toward the apex which is predominantly purple. At two-thirds of the wing length is a shining silvery fascia. Cilia tipped with white around the apex. Hind wings gray, with faint purple reflections. Legs and abdomen shining brown.

*Expanse.*—4 mm.

*Localities.*—Pennsylvania (Clemens); Fairfield County, Ohio; Powell County, Kentucky; Jackson County, North Carolina; Field, British Columbia.

The description is based on a specimen bred from mines collected on *Betula glandulosa* and *B. fontinalis* at Field, British Columbia, August 22, 1915. The mine (Fig. 20a) is a rather broad serpentine track, gradually increasing in breadth to the end, where it measures about 2 mm. across, with a line of frass through the middle. The length of the mine varies with the species of birch; on the thin-leaved *Betula lenta* (Fig. 20b) it is sometimes twice as long as it is on thick-leaved species, and attains the maximum breadth of 2 mm. several centimeters before the end; often the frass is scattered across the mine for part of its length. Similar mines occur also on *Betula lutea*, but I have never seen this mine on *Ostrya*, where Clemens found it, whence the name *ostryaefoliella* given to the larva. The cocoon is reddish brown. There are two generations in the south, one in the north.

The moth is very similar to the preceding species, but has a more distinct fascia and pale collar.

#### 20. *Nepticula paludicola* new species

Tuft clay-colored or fuscous on the face, shading to buff or ochraceous on the head; eye-caps and collar shining cream-colored. Thorax and base of fore wings shining deep golden with purple reflections; the purple reflections become more pronounced outwardly, so that the apical area of the wing beyond the fascia is deep purple, with the golden color showing only at the bases of the scales. A silvery or golden fascia at nearly two-thirds the wing length. Cilia concolorous with the wing; their tips silvery around the apex. Hind wings gray. Legs shining brown outwardly, silvery beneath, with the posterior tarsal segments paler, sometimes the last two or three ochraceous.

*Expanse.*—3.5 to 4.5 mm.

*Localities.*—New Jersey, at Retreat, Pemberton, New Lisbon and White's Bog (H. B. Scammell).

*Type material.*—Holotype (U. S. N. M.); three paratypes (U. S. N. M.)



Four specimens, in the National Museum collection, bred from mines on leaves of cranberry (*Oxycoccus macrocarpus*). The mine (Fig. 21) is a serpentine track, closely following the margin of the leaf for the greater part of its length; it is sometimes bent back on itself, but then the two parts are contiguous. Cocoon ocherous. The imagoes appeared in May and July.

This species is closely allied to *N. ostryaefoliella* in which, however, the entire tuft is ochraceous and the fascia is a little more posterior.

**21. *Nepticula myricafoliella* Busck**

*Nepticula myricafoliella* Busck, Proc. U. S. Nat. Mus., xxiii, 238, 1900; Dyar's No. 6204.

"Antennae silvery fuscous, extreme tip white. Face and head tufted, light golden yellow. Eye-caps silvery white. Thorax and fore wing deep bluish black with strong metallic reflections. At two-thirds from base is a transverse, silvery white fascia, a little broader on the dorsal than on the costal edge. Dorsal cilia at the fascia white; rest of cilia dark purplish gray. Hind wing light gray. Abdomen shining black above, silvery below. Legs purplish. All tarsi white.

"Alar expanse, 2.8 mm."

*Locality*.—Florida (Dyar).

The specimens, from which the above description by Mr. Busck was made, were bred from upper serpentine mines on *Myrica cerifera*. The mine (Fig. 22) is extremely narrow, measuring scarcely 1 mm. across at the extreme end where the larva makes its exit.

**22. *Nepticula altella* Braun**

*Nepticula altella* Braun, Can. Ent., xlvi, 21, 1914.

Tuft orange-ochraceous in front, becoming pale behind. Antennae fuscous, eye-caps creamy white. Thorax dark purplish brown. Fore wings before the fascia purple brown, beyond it brown with purple reflections; the general color to the naked eye is deep purple before the fascia and brown beyond it. A silvery fascia crosses the wing at three-fifths, and is usually a little broader on the margins of the wings. Cilia gray, hind wings deep purple, becoming brown toward the tip. Legs fuscous, tarsi of the middle and hind pair silvery. Abdomen purplish brown.

*Expanse*.—6.5 to 7 mm.

*Locality*.—Southwestern Ohio, locally in pin oak forests.

The species has but one generation a year; moths appear in May. The mines occur on the first leaves of the pin oak (*Quercus palustris*) that appear in the spring, never on the leaves that come

later. The mine (Fig. 37), which may best be regarded as a lower side mine, is at first much contorted, winding and twisting within a small area, causing a brownish discoloration of the surrounding leaf. This portion of the mine seems to be formed early in the season, and the leaf around it is always dead when further feeding is resumed in October, and the larva starts out to mine into the fresh green portion of the leaf where the mine is more distinct, due to partial eating of the leaf substance. The larva then becomes full fed in a week or ten days and leaves the mine to spin a dark brown cocoon. The mine is extremely long but measures only 1 to 1.5 mm. in width at its end. Larva yellow, with a row of dark brown dashes along the mid-ventral line.

This species may be separated from all other species by the fact that the wing is purple before the fascia and brown beyond, the reverse being true in all other cases where there is a difference in color before and behind the fascia.

### 23. *Nepticula corylifoliella* Clemens

*Nepticula corylifoliella* Clemens, Proc. Ent. Soc. Phila., i, 83, 1861; Tin. No. Am., 172, 1872; Braun, Journ. Cin. Soc. Nat. Hist., xxi, 91, 1912; Dyar's No. 6193.

Syn. *virginiella* Clemens, Proc. Ent. Soc. Phila., i, 83, 1861; Tin. No. Am., 172, 1872; Braun, Journ. Cin. Soc. Nat. Hist., xxi, 90, 1912; Dyar's No. 6225; *minimella* Chambers, Can. Ent., v, 127, 1873; Dyar's No. 6203.

Tuft ochreous to orange-ochraceous. Eye-caps silvery white, sometimes shading to fuscous outwardly. Thorax and fore wings bronzy brown, with blue-purple reflections toward the costa and in the entire apical part of the wing beyond the fascia, where the color is then predominantly purple. Sometimes the purple reflections are entirely lacking proximal to the fascia. The fascia is situated just beyond the middle of the wing, rather broad, narrowing toward the costa. Cilia silvery-tipped at the apex. Hind wings and cilia gray, with purple reflections. Legs purplish black, except middle pair and tarsi which are silvery. Abdomen above purple, silvery iridescent beneath.

*Expanse*.—3.5 mm.

*Localities*.—Pennsylvania (Clemens); Kentucky (Chambers); Ohio; Plummer's Island, Maryland (Busck).

*Food plants*: hazel (*Corylus americana*), hop hornbeam (*Ostrya virginiana*), hornbeam (*Carpinus caroliniana*) and black birch (*Betula lenta*). The mine (Fig. 40) is a long, very narrow winding tract scarcely broader than the larva, with frass collected into a central line or dispersed across the mine. Larva

pale green. Cocoon brown. Larvae may be found in June and early July, and from late August until October.

Although specimens bred on hazel are usually darker than those from other food plants, there is sufficient range of variation in color among specimens bred from any one of the other food plants, to justify the conclusion that all are conspecific.

24. **Nepticula opulifoliella** Braun

*Nepticula opulifoliella* Braun, Can. Ent., xlvii, 22, 1914.

Tuft ochraceous; color usually pale yellowish; eye-caps pale shining buff, sometimes fuscous outwardly. Thorax dark fuscous, with purple and blue reflections. Fore wings with pronounced purple and blue reflections toward the costa and beyond the fascia, shading to bronzy green below the fold. At three-fifths is a broad very shining silvery fascia with faint golden luster. Cilia gray, extreme tips pearly white. Hind wings and cilia gray. Legs dark fuscous, except the middle pair, which are silvery. Abdomen purplish fuscous above, paler beneath in the female.

*Expanse*.—3.5 to 4 mm.

*Localities*.—Cincinnati, Ohio; Balsam, North Carolina.

The larvae form brownish, much contorted serpentine mines (Fig. 38) in leaves of Opulaster (*Physocarpus opulifolius*). Larva yellowish; cocoon reddish brown. Two generations; larvae in July and September.

This species is very close to *N. corylifoliella*, from which it is difficult to distinguish it. The pale collar when present is a reliable character. The more yellowish eye-caps, less lustrous wing with absence of reddish tints, will aid in separating this species from *N. corylifoliella*.

25. **Nepticula quercipulchella** Chambers

*Nepticula quercipulchella* Chambers, Bull. Geol. Surv. Terr., iv, 105, 1878; Dyar's No. 6216.

Head black; color and eye-caps yellowish white, silvery; thorax and fore wings deep blue black, bronzed and with purple and violet reflections; the fascia is behind the middle, silvery white and a little widest on the dorsal margin, and the wing behind the fascia is darker than before it, whilst the cilia are paler and less lustrous than the wing. Under surface of wing, abdomen and legs cupreous black.

*Expanse*.—4 mm.

*Locality*.—Kentucky (Chambers).

The above description is essentially that given by Chambers. According to him "the larva is bright green, with a deeper green line of contents; it makes a long narrow, winding, and gradually

widening track, similar to that of *N. quercicastanella* Chambers in leaves of *Quercus alba*." Chambers asserts that the larva from which he bred the type specimen formed a new mine when nearly grown, a fact if true at variance with all observations on this group.

Except for the absence of silvery scales along the termen, the moth is very close to *N. terminella*. The green color of the larva, however, precludes the possibility of their identity.

**26. *Nepticula condaliafoliella* Busck**

*Nepticula condaliafoliella* Busck, Proc. U. S. Nat. Mus., xxiii, 238, 1900; Dyar's No. 6192.

"Face and head tufted, reddish yellow, eye-caps shining white. Antennae dark fuscous. Thorax and fore wing deep black with purplish metallic reflections; just beyond the middle of wing is a transverse silvery white fascia, a little broader on the dorsal margin than on the costal. Cilia at apex white; dorsal cilia light purplish-gray, concolorous with hind wing. Abdomen black above, silvery below; anal tuft silvery white. Legs reddish yellow.

"Alar expanse, 3.1 mm."

*Locality*.—Palm Beach, Florida (Dyar).

The moths were bred in February from upper side mines on leaves of *Condalia ferrea*. "Egg is deposited on underside of leaf near edge, and the mine is a contorted serpentine with black frass in a continuous central line. Cocoon is chestnut brown, 1.6 by 1 mm."

**27. *Nepticula juglandifoliella* Clemens**

*Nepticula juglandifoliella* Clemens, Proc. Ent. Soc. Phila., i, 84, 1861; Tin. No. Am., 173, 1872; Chambers, Bull. Geol. Surv. Terr., iv, 105, 1878; Braun, Journ. Cin. Soc. Nat. Hist., xxi, 91, 1912; Dyar's No. 6199.

Syn. *caryaefoliella* Clemens, Proc. Ent. Soc. Phila., i, 84, 1861; Tin. No. Am., 174, 1872; Dyar's No. 6190.

Tuft ochraceous, eye-caps and collar shining creamy white. Thorax and fore wings deep purplish black, uniformly purple beyond the fascia which is situated just beyond the middle, silvery white and broadest on the dorsum. Cilia silvery around the apex, elsewhere concolorous with the wings. Hind wings and cilia gray. Legs silvery white, except the upper surface of the posterior femora and tibiae, which are purplish black. Abdomen purplish above, silvery beneath.

*Expanse*.—3.5 to 3.8 mm.

*Localities*.—Pennsylvania (Clemens); Kentucky (Chambers); Ohio.

The mine (Fig. 39) is a serpentine track usually whitish, with black line of frass through the center, found on various species

of hickory and on walnut and butternut. The larva is pale green (almost white when feeding on walnut). Cocoon brownish red.

There are three generations; full grown larvae may be found in the middle of June, latter part of July, and in late August and early September.

The purple fore wings and white collar separate this species from its nearest allies.

**28. *Nepticula apicialbella* Chambers**

*Nepticula apicialbella* Chambers, Can. Ent., v, 127, 1873; Braun, Can. Ent., xlv, 21, 1914; Dyar's No. 6185.

Syn. *leucostigma* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 88, 1912.

Tuft ochraceous, collar creamy white. Antennae dark brown, faintly annulate with a paler shade; eye-caps white. Thorax dark purplish brown. Fore wings dark brown, with a faint purple luster. Beyond the middle of the wing there is a narrow, oblique white fascia, convex outwardly and reaching the margin farther from the base on the dorsum. The scales at the extreme tip of the wing are white, forming with the whitish apical cilia, a very distinct pale patch. The cilia except at the apex as just described, are gray. Hind wings and cilia dark gray. Legs shining grayish ochreous, hind femur creamy white, hind tarsi dark gray. Abdomen dark purplish above, pale beneath.

*Expanse*.—4 mm.

*Localities*.—Kentucky (Chambers); Ohio.

The larvae make upper side serpentine mines on red elm, white elm and cork elm (*Ulmus fulva*, *U. americana* and *U. racemosa*). The mine (Fig. 43) is brownish in color with a conspicuous line of frass through the middle. Cocoon reddish brown.

Three generations; full grown larvae in mid-June, late July and in August and September.

The oblique fascia and white apex distinguish this species from all others.

**29. *Nepticula tiliella* Braun**

*Nepticula tiliella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 90, 1912.

Tuft ochraceous, collar white. Antennae black, eye-caps shining white. Thorax black. Fore wings almost black, with a very faint purple luster. There is a shining pure white fascia, slightly oblique and a little convex outwardly, at the middle of the wing. Cilia gray on the dorsum, shining white from the tornus to the costa. Hind wings and cilia gray. Legs silvery gray, tinged with ocher, hind tibiae and tarsi blackish above. Abdomen blackish above, silvery gray beneath.

*Expanse*.—3.5 mm.

*Localities*.—Ohio; Kentucky.

Larvae in serpentine mines on the upper side of leaves of basswood (*Tilia americana*); the mine (Fig. 41) is characterized by the tendency toward a spiral form, with either the early or later portion inside; and the frequency of angular turns. Cocoon brownish red.

Two generations; full grown larvae in early July and late August.

The pure white fascia and the white cilia against which the outermost row of black scales is sharply defined, distinguish this species.

### 30. *Nepticula rubifoliella* Clemens

*Nepticula rubifoliella* Clemens, Proc. Acad. Nat. Sci. Phila., 1860, 214; Tin. No. Am., 152, 1872; Busck, Proc. Ent. Soc. Wash., v, 208, 1903; Dyar's No. 6219.

Head ochereous; eye-caps silvery white. Thorax and fore wings almost black, with a shining silvery or faintly golden fascia at the middle of the wing; the fascia is convex outwardly and somewhat narrowed in its middle, sometimes almost interrupted. Cilia whitish, so that the marginal line of scales is defined. Hind wings and cilia gray. Legs silvery as is also the underside of the abdomen.

*Expanse*.—4 mm.

*Localities*.—Pennsylvania (Clemens); Ohio; Kentucky.

The larvae mine leaves of blackberry, forming at first very narrow linear mines, which closely follow a vein or the margin of the leaf before enlarging into an irregular blotch (Fig. 23).

Mines containing larvae may be collected in July and September. Larva pale green; cocoon dark brown.

### 31. *Nepticula nyssaefoliella* Chambers

*Nepticula nyssaefoliella* Chambers, Psyche, iii, 66, 1880; Braun, Ent. News, xx, 429, 1909; Dyar's No. 6206.

Tuft ochraceous; eye-caps shining white. Thorax and fore wings black with very faint purple reflections. In the middle of the wing is a shining silvery or pale golden fascia, slightly convex outwardly. Cilia around the apex white, with marginal line of scales defined. Hind wings pale gray, with an oval patch of androconia in the male. Legs silvery gray. Abdomen purplish, silvery beneath in the male.

*Expanse*.—4.5 to 6 mm.

*Localities*.—Kentucky (Chambers); Ohio; North Carolina.

The larvae mine leaves of sour gum (*Nyssa sylvatica*), forming narrow linear mines which abruptly enlarge into blotches (Fig. 24), measuring 2 cm. or more in length, with an average width of

5 or 6 mm. Cocoon pale greenish brown. There are two or three generations a year; the larvae of the first generation become full grown in June.

This is one of the most abundant species; moths may often be collected in great numbers in the vicinity of the food plant.

From *N. rubifoliella*, its nearest ally, it is distinguished by the larger size, and equal breadth of fascia throughout.

### 32. *Nepticula slingerlandella* Kearfott

*Nepticula slingerlandella* Kearfott, Journ. N. Y. Ent. Soc., xvi, 187, 1908; Slingerland, Proc. N. Y. State Fruit Growers' Assoc., 122, 1909; Crosby, Bull. 308, Cornell Univ. Agric. Exp. Sta., 1911; Can. Ent., xlv, 25, 1912.

Tuft ochraceous, becoming paler behind, where it merges into the pale ochraceous or whitish collar. Eye-caps white. Thorax and fore wings black with a faint bronzy luster, somewhat irrorated beyond the shining white fascia, which is situated just beyond the middle of the wing. Cilia pale gray. Legs yellowish, shaded with fuscous, especially the posterior tibiae and tarsi.

*Expanse*.—3.5 to 5 mm.

*Localities*.—New York State (Slingerland and Crosby); Ohio.

The larvae mine leaves of cultivated plums and prunes, wild plum (*Prunus americana*) and occasionally sweet cherry, forming narrow linear mines which abruptly enlarge into irregular blotches. This species attains economic importance in the plum orchards of northern New York, where its ravages have been the subject of a bulletin by Mr. C. R. Crosby, in which further details of its life history, with numerous figures, are given. There is a single generation of moths in New York, and the larvae which are full grown in July do not produce moths until the following year; in the latitude of Cincinnati a second brood of larvae may usually be collected in September.

### 33. *Nepticula rosaefoliella* Clemens

*Nepticula rosaefoliella* Clemens, Proc. Ent. Soc. Phila., i, 85, 1861; Tin. No. Am., 176, 1872; Braun, Journ. Cin. Soc. Nat. Hist., xxi, 89, 1912; Dyar's No. 621S.

Tuft ochraceous; eye-caps shining creamy white. Fore wings almost black, with a very faint dark blue and bronzy luster. Just beyond the middle of the wing is a rather broad straight silvery or very pale golden fascia. Cilia of the general hue, scarcely paler tipped opposite the apex. Hind wings dark gray. Fore pair of legs gray, middle and hind pair silvery, hind tibiae and tarsi black above. Abdomen black, silvery gray beneath.

*Expanse*.—4.5 mm.

*Localities*.—Pennsylvania (Clemens); Ohio.

Originally named from mine and larvae in leaves of *Rosa lucida*, it mines leaves of various species of rose, but is particularly partial to the climbing wild rose, *Rosa setigera*. The mine (Fig. 42) is serpentine usually much contorted, frequently closely following the edge of the leaf in its early course, with a broad line of frass, and measuring at its end 1.5 to 2 mm. across. Larva green. Cocoon yellowish brown, much flattened. Three generations; full grown larvae in June and early July, in August and in October; mines containing larvae may, however, be found at almost any time during the summer and fall up to November.

This species may be distinguished from *N. slingerlandella* by the darker head, dark cilia, and somewhat broader wings.

#### 34. *Nepticula fuscotibiella* Clemens

*Nepticula fuscotibiella* Clemens, Proc. Ent. Soc. Phila., i, 133, 1861; Tin. No. Am., 182, 1872; Dyar's No. 6197.

Syn. *ciliaefuscella* Chambers, Can. Ent., v, 128, 1873; *discolorella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 86, 1912.

Tuft ochraceous; eye-caps whitish. Thorax and fore wings fuscous, faintly purple, with the scales before the fascia paler at their bases, so that this portion of the wing is somewhat irrorated and paler than that beyond the fascia where the wing is dark fuscous purple. The fascia is just beyond the middle, dull white, sometimes a little convex and broadening on the dorsum. Cilia gray, pale gray around the apex. Hind wings gray. Legs shining gray, shaded with ochereous. Abdomen blackish above, yellowish beneath.

*Expanse*.—4 to 4.5 mm.

*Localities*.—Pennsylvania (Clemens); Kentucky (Chambers); Ohio.

The larvae mine leaves of various species of willow. The mine (Fig. 25) is a gradually broadening linear tract, sometimes straight, but often bent back on itself toward the end; occasionally (on *Salix discolor*) its latter portion is a more or less spiral blotch (Fig. 44). Cocoon ochereous or brownish. There are at least three generations a year; larvae may be collected from June until the end of October.

In spite of the difference in appearance of the mine, I am forced to conclude that *N. discolorella* is identical with *N. fuscotibiella*, since it is impossible to separate the moths.

#### 35. *Nepticula canadensis* new species

Head black, except eye-caps and palpi which are dull white. Thorax and fore wings dull black, with a faint brownish purple tinge; an irregular dull



white fascia crosses the middle of the wing. Cilia gray. Hind wings gray. Body and legs of the same dull blackish color.

*Expanse*.—5.5 mm.

*Locality*.—Bear Creek, near Roger's Pass, British Columbia (altitude about 6000 ft.).

Holotype in writer's collection.

One specimen, bred from mines collected on leaves of alder (*Alnus tenuifolia*), August 19, 1915. A short serpentine mine abruptly enlarges into a blotch (Fig. 26), which often extends across the space between two lateral veins. Cocoon dark brown. The mines were observed only in a single locality, although common there, some leaves containing as many as a dozen mines.

### 36. *Nepticula ulmella* Braun

*Nepticula ulmella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 87, 1912.

Palpi creamy white. Tuft ochreous on the face, tinged with red above, and sometimes with a few dark brown scales behind. Antennae creamy white, broadly banded above with dark brown, so that only a narrow line of the pale color appears between the annulations. Eye-caps creamy white. Thorax brownish, somewhat peppered. Scales of the fore wing creamy white, shading to dark brown at their tips, except where they form a creamy white oblique fascia at the middle of the wing. The general color of the fore wing is thus a somewhat mottled dark brown. The fascia, beginning at the middle of the wing on the costa, reaches the dorsum somewhat behind the middle, and is sometimes broken with a few dark-tipped scales. Cilia creamy white. Hind wings pale gray, with a pale bluish luster. Legs creamy white. Abdomen above gray, beneath pale straw-colored.

*Expanse*.—4 to 5 mm.

*Localities*.—Ohio; Kentucky; Pittsburgh, Pennsylvania (Engel).

The larvae are miners in leaves of red elm and cork elm (*Ulmus fulva* and *U. racemosa*). The mine (Fig. 45) starts as a very fine brown, or rarely whitish line, not very winding in its early course, and at about half its length abruptly enlarging to a breadth of 1 mm. From thence it continues to increase gradually in width, until it attains a breadth slightly in excess of two mm. The broad portion of the mine is usually so much contorted that it is not possible to trace the course of the mine, the whole having the appearance of an irregular blotch. The cocoon is reddish brown. Contrary to the usual habit among the American species that I have observed, a large proportion of the larvae spin cocoons within the mines, generally in the center of the blotch. This is

especially true of the generation which passes the winter in the cocoon.

There are two generations; mature larvae are found in July and in September.

The creamy white fascia and cilia, together with the pale bases of the scales, distinguish this species.

### 37. *Nepticula variella* Braun

*Nepticula variella* Braun, Ent. News, xxi, 173, 1910.

Tuft pale ochreous to ochraceous, with an occasional admixture of fuscous scales; collar and eye-caps creamy. Thorax dark fuscous. Ground color of fore wings sordid cream color, which in most specimens is almost overlain with fuscous, leaving only the apex of the wing and a more or less distinct fascia at the apical third of the ground color. Sometimes the dusting of the basal two-thirds of the wing is less dense, occasionally lacking toward the costal or dorsal margins, rarely reduced to a few scattered scales. Cilia fuscous, sometimes creamy around the apex. Hind wings gray, the basal half in the male overlain with purplish black scales. Abdomen and legs above fuscous, silvery beneath.

*Expanse*.—5.5 to 7.5 mm.

*Locality*.—Alameda County, California (Pilate).

The larvae form serpentine mines on leaves of California live oak (*Quercus agrifolia*), and on deciduous oaks. The length of the mine varies, being longer on the thinner-leaved deciduous oaks. Cocoon yellowish brown. Larvae mining leaves in January produce imagoes in late February and in March.

### 38. *Nepticula platanella* Clemens

*Nepticula platanella* Clemens, Proc. Ent. Soc. Phila., i, 83, 1861; ii, 133, 1862; Tin. No. Am., 173, 183, 192, 1872; Busck, Proc. Ent. Soc. Wash., v, 209, 1903; Dyar's No. 6209.

Syn. *maximella* Chambers, Can. Ent., v, 126, 1873; Dyar's No. 6202.

Tuft pale ochreous to ochraceous; eye-caps silvery white. Thorax and fore wings dark brown with a bluish luster. At the middle of the costal margin is a small oblique silvery streak, and opposite it on the dorsal margin is a similar streak, usually larger than the costal streak and broader on the margin. Rarely both spots are very minute. Occasionally these two streaks meet, forming a more or less interrupted concave fascia. Last row of scales around the apex pale yellowish at their bases, thus forming a dark line in the whitish cilia. Hind wings yellowish fuscous, in the male with a sword-shaped yellowish chitinous plate on the upper side from base to near middle of costa, margined along the costa with bristly black scales. Beyond this the costa is excised. Legs fuscous above. Abdomen fuscous above, with ochreous anal tuft.

*Expanse*.—5.5 to 7 mm.

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*Localities.*—Pennsylvania (Clemens); Kentucky (Chambers); Washington, District of Columbia (Busck); Ohio.

The mines (Fig. 28) are abundant on leaves of sycamore (*Platanus occidentalis*) and begin as slender linear tracks usually filled with frass. Several days before pupation the mine is abruptly enlarged into a large usually almost circular blotch, which often covers the linear portion of the mine. Larva pale green; cocoon ochraceous.

There are three generations of larvae, the earliest to be found during June.

There is considerable variation in size of the white spots and it is but rarely that they form a fascia. Females may be distinguished from specimens of *N. clemensella* by the larger size, males from that and all other species except *N. similella*, by the peculiar chitinous plate along the costa of the hind wings.

### 39. *Nepticula clemensella* Chambers

*Nepticula clemensella* Chambers, Can. Ent., v, 125, 1873; Dyar's No. 6191.

Tuft ochraceous; eye-caps silvery white. Fore wings bluish black. A narrow oblique silvery streak on the middle of the costa (rarely inconspicuous) and an opposite dorsal streak, usually meeting in the male to form a narrow oblique fascia. Cilia silvery with a brown line formed by the dark tips of the terminal row of scales around the apex. Hind wings yellowish fuscous, similar in the sexes. Legs and abdomen fuscous above; anal tuft yellow in the male.

*Expanse.*—4.5 to 5.2 mm.

*Localities.*—Pennsylvania (Clemens); Kentucky (Chambers); Plummer's Island, Maryland (Busck); Ohio.

The larva mines leaves of sycamore (*Platanus occidentalis*), forming a linear mine gradually increasing in breadth, with its terminal portion expanded into a small blotch three or four times the diameter of the end of the linear mine (Fig. 29). Larva pale green; cocoon ochraceous. There are three generations a year.

This species is much less common than *N. platanella* and uniformly smaller, the largest specimens scarcely attaining the expanse of the smallest *N. platanella*.

### 40. *Nepticula similella* new species

Tuft ochraceous to ochraceous; eye-caps silvery white, (occasionally tinged with ocher. Thorax and fore wings deep bluish black, the extreme bases of the scales more or less iridescent blue, especially in the apical half of the wing. At the middle of the wing an oblique narrow costal streak, shining white but

not silvery, usually meets the apex of a shorter, broader dorsal streak. The tips only of the last row of scales around the apex are dark, thus forming a dark line in the white cilia. Hind wings gray; in the male with a narrow chitinous plate from base to one-third of costa, with a long yellowish costal hair-pencil lying along it. Legs and abdomen fuscous above, silvery beneath, with yellow anal tuft in the male.

*Expanse*.—5 to 6 mm.

*Localities*.—Cincinnati, Ohio; Powell County, Kentucky.

*Type material*.—Holotype (writer's collection); paratype (Acad. Nat. Sci. Phila.); eight paratypes (writer's collection).

Ten specimens, bred from larvae mining leaves of pin oak (*Quercus palustris*) in a single isolated locality east of Cincinnati; I have also observed a few mines on chestnut in Kentucky. The egg is placed on the upper side of the leaf. The early portion of the characteristic mine (Fig. 27) is very narrow, completely filled with frass, and bent several times in close S-shaped curves; the larva next mines just above the lower epidermis, forming a blotch scarcely visible above except for occasional spots here and there toward the edges of the blotch, where the leaf substance is more fully consumed; then a conspicuous large blotch is formed where the mine is transparent and whitish, with frass accumulated toward the beginning of the blotch. Larva pale green; cocoon ochraceous.

Females of this species can only be distinguished from those of *N. platanella* by the less shining costal and dorsal spots; males differ in the yellowish costal hair-pencil of the hind wings.

#### 41. *Nepticula thoracealbella* Chambers

*Nepticula thoracealbella* Chambers, Can. Ent., v, 127, 1873; Dyar's No. 6222.

Syn. *badiocapitella* Chambers, Can. Ent., viii, 160, 1876; Dyar's No. 6186.

Tuft ochraceous on the face, becoming reddish brown on the vertex; eye-caps white. Thorax white, occasionally with a few scattered dark brown scales. Fore wings dark brown, slightly irrorated; a creamy white irregular fascia just before the middle concave toward the base and usually wider on the dorsal margin; at the apical fourth a distinct creamy white costal spot and an opposite dorsal spot, whose apices occasionally touch; cilia creamy white, sometimes grayish on the dorsum. Hind wings pale gray, cilia whitish. Legs creamy white, with outer surfaces of hind legs fuscous. Abdomen gray above, silvery beneath, with yellow anal tuft.

*Expanse*.—4 to 5 mm.

*Localities*.—Kentucky (Chambers); Ohio; Allegheny County, Pennsylvania (Marloff).

The published description of *N. badiocapitella* is practically identical with that of *N. thoracealbella*; this fact combined with the variability of specimens, leads to the conclusion that they apply to the same species. The life history is not known, but the species is evidently two brooded, as I have taken moths in May and July.

42. **Nepticula pomivorella** Packard

*Micropteryx pomivorella* Packard, Amer. Nat., vi, 685, 1872; *Nepticula pomivorella* (Packard), Busck, Can. Ent., xxxiii, 52, 1901; Dyar's No. 6211.

Tuft orange-ochraceous; eye-caps and collar shining pale buff. Thorax and fore wings shining bronzy, with strong purple and blue reflections increasing toward the apex. Cilia gray. Hind wings and cilia gray. Legs shining bronzy; hind tarsi yellowish. Abdomen dark brown, with purple reflections.

*Expanse*.—5 mm.

*Localities*.—Massachusetts (Packard, Fernald); Washington, District of Columbia (Busck); Ohio.

The larvae mine long narrow serpentine tracks (Fig. 10) on leaves of apple, gradually widening to 2 or 2.5 mm. at the end. Cocoon reddish brown.

This species is extremely common in some localities, but rare and seldom met with in others.

43. **Nepticula chalybeia** Braun

*Nepticula chalybeia* Braun, Can. Ent., xlvi, 20, 1914.

Palpi grayish ochereous. Tuft ochereous, sometimes shading to reddish brown above, collar yellowish white; antennae fuscous, eye-caps yellowish white. Thorax steel-gray. Fore wings very narrow, steel-gray, with faint greenish golden reflections. Cilia gray, faintly purple tinged around the apex. Hind wings gray. Legs gray, tarsi ochereous. Abdomen dark gray, with a purplish luster.

*Expanse*.—3.5 to 4 mm.

*Locality*.—Cincinnati, Ohio.

The larvae mine leaves of wild pear (*Pyrus communis*) and cultivated pear, making rather short serpentine tracks (Fig. 46), often not exceeding 2 cm. but sometimes reaching 3 cm. in length, and broadening to 1.5 to 2 mm. across at the end. The mined portion of the leaf very shortly turns dark brown. Larva bright green; cocoon dark brown. There are three generations a year; mined leaves may be collected in early June, in July and during the last part of August.

Its paler color, with absence of purple, narrow wings and smaller size separate this species from *Nepticula pomivorella*. It is apparently confined to pear as a food plant, as apple trees adjacent to pear trees covered with the mines, are entirely free from them.

44. ***Nepticula flavipedella*** Braun

*Nepticula flavipedella* Braun, Can. Ent., xlvii, 19, 1914.

Palpi whitish. Tuft usually dark brown, collar creamy white; rarely the tuft is reddish ochreous on the face, brown on the vertex. Antennae fuscous, eye-caps creamy white. Thorax dark purplish brown. Fore wings dark brown, with dark blue and purple reflections; cilia with silvery tips. Hind wings and cilia gray. Fore legs, except the femora, dark brown; middle legs pale silvery, tarsi pale ochreous; hind legs silvery, tibiae dark brown, tarsi pale ochreous. Abdomen dark purplish above, paler beneath in the female.

*Expanse*.—3.5 to 4.5 mm.

*Localities*.—Ohio; Kentucky.

The mine (Fig. 48) is a very characteristic linear tract, occurring most commonly on pin and swamp white oak, but occasionally on other species of oak. The egg is placed on the upper side of the leaf and the larva for the first few millimeters mines near the upper surface, making a very narrow indistinct mine. Then the mine abruptly enlarges slightly and for a length of 8 or 9 mm., the leaf substance is entirely consumed and the mine rendered transparent. Then follows another enlargement, and the mine, often much contorted, increases very gradually in breadth to the end where it measures 2 mm. across. This latter portion of the mine is not transparent, but the mine is distinctly visible. The frass is sprinkled in separate grains across the breadth of the mine. The figure shows the appearance of the mine when held toward the light.

There are three generations a year; mines can be collected during early June, the latter half of July, and the early part of September. The larva is usually green, occasionally purplish, and escapes from the mine through the lower surface of the leaf. The cocoon is almost white.

Though very distinct in larval work, this species in the imaginal state is almost indistinguishable from *N. castaneaefoliella*. The yellowish middle and hind tarsi and the deeper purple suffusion of the fore wings are, however, constant differences.

**45. *Nepticula castaneaefoliella* Chambers**

*Nepticula castaneaefoliella* Chambers, Cin. Quart. Journ. Sci., ii, 117, 1875; Dyar's No. 6189.

Tuft black, collar, eye-caps and palpi creamy white. Thorax and fore wing dark brown, with slight bronzy and purple reflections; the tips of the scales are somewhat darker, so that under a lens, the wing is slightly irrorated especially toward the apex. Cilia silvery at the tips. Hind wings gray. Posterior tibiae and fore legs, except the femora, dark brown; legs otherwise whitish. Abdomen dark above, whitish beneath.

*Expanse*.—4 to 4.5 mm.

*Localities*.—Kentucky (Chambers); Ohio; Falls Church, Virginia (Heinrich).

The larvae form very long, much contorted, linear mines (Fig. 30) on leaves of chestnut (*Castanea dentata*), measuring but little over 1 mm. in width at the end, with a fine central line of frass. Larva bright green; cocoon ocherous. Chambers reports it also on white oak.

**46. *Nepticula punctulata* Braun**

*Nepticula punctulata* Braun, Ent. News, xxi, 174, 1910.

Tuft buff, usually becoming brownish on the vertex; collar buff; eye-caps pale buff. Fore wings pale grayish buff, each scale tipped with fuscous, giving the wing a finely peppered appearance. Cilia pale gray. Hind wings pale gray, tinged with buff. Legs and abdomen gray.

*Expanse*.—4.5 to 5.5 mm.

*Localities*.—California: Dutch Flat, Placer County; Loma Linda, San Bernardino County (Pilate); Yosemite Valley.

The larvae mine leaves of *Ceanothus cuneatus* and *Rhamnus californica*. The mine (Fig. 31) is a serpentine track, often bent back on itself and indistinct in its early stages on the thick-leaved *Ceanothus*, pale green with broad black line of frass on the *Rhamnus* leaves. Cocoon reddish brown or grayish.

The mines on *Ceanothus* from Dutch Flat were collected in January, those on *Rhamnus* from Yosemite in July.

The species is distinct in the evenly distributed dark dusting.

**47. *Nepticula grandisella* Chambers**

*Nepticula grandisella* Chambers, Journ. Cin. Soc. Nat. Hist., ii, 193, 1879; Dyar's No. 6198.

"Chiefly remarkable for its large size for this genus, having an *al. ex.* of over  $\frac{3}{8}$  inch. Face, sordid, straw or sandy yellow, with palpi a little paler; eye-caps, white; antennae, reddish brown. Body, wings and legs brown. Texas."

I know this species only from the above description, and it may not be correctly placed in this genus.

48. **Nepticula belfrageella** Chambers

*Nepticula belfrageella* Chambers, Can. Ent., vii, 75, 1875; Dyar's No. 6187.

"Face pale yellowish; eye-caps white; antennae brown; thorax and primaries pale gray, darker toward the apex of the primaries, and with a fuscous spot at the apex. *Al. ex.* from 2½ to over three lines. Season, April."

*Locality*.—Bosque County, Texas (Chambers).

49. **Nepticula latifasciella** Chambers

*Nepticula latifasciella* Chambers, Bull. Geol. Surv. Terr., iv, 106, 1878; Braun, Can. Ent., xlvi, 18, 1914; Dyar's No. 6200.

Tuft on the face ochereous, dark brown on the vertex; collar and eye-caps creamy. Thorax and extreme base of fore wings creamy-buff. Remainder of fore wing deep purple brown, with a very broad creamy-buff fascia just before the middle; two or three creamy-buff scales at the extreme apex forming with the creamy-white cilia around the apex a conspicuous pale spot. Cilia elsewhere gray. Hind wings and cilia gray. Legs creamy-buff, outer surfaces fuscous. Abdomen dark brown.

*Expanse*.—4 to 4.5 mm.

*Localities*.—Kentucky (Chambers); Falls Church, Virginia (Busck); Ohio; Allegheny County, Pennsylvania (Marloff).

The larvae mine leaves of red and scarlet oaks, and probably chestnut (Chambers). Although the mine varies in length from 3 to 5 cm. on different species of oak, with a breadth of about 1.5 mm. at its end, it has in general the same appearance (Fig. 47). The frass is at first deposited in a broad blackish line through the center, later dispersed across the entire breadth, and toward the end collected into a broad band. The larva is bright green and escapes from the mine through the lower epidermis of the leaf. Cocoon whitish or occasionally ochraceous.

This is one of the earliest species to appear in the spring; moths may be found resting on tree trunks during the latter part of April. Mines may be found in June, the latter part of July, in September, and often during late October.

50. **Nepticula crataegifoliella** Clemens

*Nepticula crataegifoliella* Clemens, Proc. Ent. Soc. Phila., i, 83, 1861; Tin. No. Am., 173, 1872; Braun, Can. Ent., xlvi, 17, 1914; Dyar's No. 6194.

Palpi pale ochereous. Tuft ochereous, faintly tinged with red above. Antennae ochereous, partly suffused with fuscous, eye-caps ochereous. Thorax and fore wings ochereous, the extreme edge of the costa near the base purplish



fuscous, and a broad purplish fuscous band at the apex of the wing. Beyond this band the cilia are pale ocherous, giving the appearance of an ocherous apex preceded by a dark band. Cilia opposite the ends of the band concolorous with it. Hind wings and cilia pale gray. Legs ocherous. Abdomen purplish fuscous above, ocherous beneath.

*Expanse*.—3.5 to 4.5 mm.

*Localities*.—Pennsylvania (Clemens, Marloff); Ohio; Kentucky.

Mines occur on several species of hawapple, most commonly on *Crataegus crus-galli* and *C. punctata*; Clemens notes it on *C. parvifolia* Ait. The mine (Fig. 49) is comparatively short, rapidly increasing in diameter and measuring about 2 mm. in width in the later portion of its course, with an irregular line of frass running through it. Larva bright green; cocoon reddish brown.

There are two generations a year; larvae may be collected in early July and at the beginning of September.

This species is distinguished from all others with yellowish ground color by the entire absence of dusting. The much broader mine and bright green larva separate it in early stages from *N. scintillans*.

#### 51. *Nepticula nigriverticella* Chambers

*Nepticula nigriverticella* Chambers, Cin. Quart. Journ. Sci., ii, 118, 1875; Dyar's No. 6205.

Syn. *maculosella* Chambers, Journ. Cin. Soc. Nat. Hist., ii, 193, 1879; Dyar's No. 6201.

Face ochraceous, tuft above dark brown; collar and eye-caps pale ocherous, antennal stalk fuscous. Thorax and fore wings pale ocherous dusted with purplish black scales. At the base of the dorsal margin is a purplish black spot extending half way across the wing, and occasionally narrowly reaching the costa, which is often dark brown near the base. At the beginning of the cilia is a broad purplish black fascia; beyond it the cilia are pale ocherous. Hind wings and cilia pale grayish buff, sometimes darker. Legs pale ocherous.

*Expanse*.—5 mm.

*Localities*.—Kentucky (Chambers); Ohio; Texas (Chambers).

The range of variation of captured specimens taken in May at Cincinnati is sufficient to include *N. maculosella* described from Texas specimens.

#### 52. *Nepticula populetorum* Frey and Boll

*Nepticula populetorum* Frey, and Boll, Stett. ent. Zeit., xxxix, 276, 1878; Dyar's No. 6212.

Tuft ocherous, becoming dark brown behind. Collar and eye-caps pale creamy, antennal stalk dark fuscous. Thorax and fore wings buff or pale

ocherous, more or less densely dusted with purplish fuscous scales. These scales form a purplish fuscous fascia at the beginning of the cilia. Cilia pale gray, whitish around the apex. Hind wings pale gray. Legs and underside of abdomen pale ocherous; abdomen above gray.

*Expanse*.—5 mm.

*Localities*.—Texas (Boll); Ohio; Kentucky; San Bernardino County, California (Pilate).

The larvae mine leaves of several species of poplar—in Ohio leaves of cottonwood (*Populus deltoides*). The mine (Fig. 8) is indiscriminately placed on the upper or the lower side of the leaf. It is a whitish, gradually broadening linear track, 2 or 2.5 mm. broad at its extremity, with a black line of frass. Cocoon ochraceous. In the latitude of Cincinnati there are several generations a year; mines containing larvae may be found in June, in the latter part of July, and in September.

This species differs from the preceding in the absence of the dark spot at the base of the dorsum.

53. ***Nepticula saginella*** Clemens

*Nepticula saginella* Clemens, Proc. Ent. Soc. Phila., i, 85, 1861; v, 146, 1865; Tin. No. Am., 175, 271, 1872; Busck, Proc. Ent. Soc. Wash., v, 220, 1903; Dyar's No. 6220.

Syn. *quercicastanella* Chambers, Can. Ent., v, 127, 1873; Dyar's No. 6215; *fuscocapitella* Chambers, Can. Ent., v, 128, 1873; Dyar's No. 6196.

Face ocherous or pale buff, head above dark brown; collar and eye-caps pale ocherous. Thorax and fore wings pale ocherous, buffish, or even whitish, and dusted with fuscous scales, often more densely toward the outer half of the wing, where the dark scales are either evenly distributed or collected into spots, but never form a band. Cilia pale ocherous. Hind wings pale gray. Legs and abdomen beneath pale ocherous; abdomen sometimes fuscous above.

*Expanse*.—4 to 5.5 mm.

*Localities*.—Pennsylvania (Clemens); Falls Church, Virginia (Heinrich); Kentucky (Chambers); Ohio; Texas (Chambers).

The mines occur on various species of oaks and on chestnut. The mine (Fig. 9) is a whitish linear tract varying in length and width, but usually about 1.5 to 2 mm. wide at its extremity, with a black line of frass running through it; the frass is occasionally more or less dispersed in parts of the mine. Tenanted mines may be found almost any time from June to October. Larva bright green; cocoon usually whitish, occasionally ochraceous.

54. *Nepticula pallida* Braun

*Nepticula pallida* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 85, 1912.

Palpi pale ochereous. Tuft ochereous, the scales on the vertex tipped with orange; antennae pale ochereous, eye-caps whitish. Thorax very pale buff. Fore wings very pale buff, evenly dusted with purplish gray, a little more densely toward the apex of the wing. Cilia very pale buff. Hind wings pale gray, tinged with ochereous. Legs and abdomen very pale buff.

*Expanse*.—4 mm.

*Locality*.—Cedar Point, Ohio.

The type specimen was bred from a mine on a narrow-leaved willow, *Salix* sp. The mine (Fig. 50) occurs on the lower side of of the leaf and is extremely narrow at first, extending along the midrib, later doubling on itself once or twice, and gradually and evenly increasing in breadth to its end, where it measures a scant 1.5 mm. across. The entire length of the mine is approximately 4.5 cm. The color is brownish throughout, and the mine is not at all transparent. The frass is distributed in a broad tract throughout the entire length of the mine. Cocoon reddish brown.

The pale head distinguishes this species from *N. saginella*.

*Species known only in the Larval State*

Several species named by Clemens from mine and larva still remain unbred and their identity cannot be determined. These are *Nepticula amelanchierella*, *N. anguinella*, and *N. platea*. These are later referred to under "Food Plants, Mines and Larvae." The empty mines to which Clemens applied the name *N.?* *prunifoliella* are doubtless the work of the species later described by Chambers as *N. serotinaeella*, which is regarded as a synonym of *N. bifasciella* Clemens.

In addition to these, many other species have been observed in the larval state, but not reared.

2. **ECTOEDEMI**A Busck

*Ectoedemia* Busck, Proc. Ent. Soc. Wash., viii, 97, 1907. Type: *E. populella* Busck.

*Generic characters*.—Basal segment of antennae enlarged and concave beneath to form an eye-cap. Labial palpi somewhat longer than in *Nepticula*. Middle spurs of posterior tibiae below the middle. Fore wings elongate ovate, pointed, jugum present in the female; hind wings  $\frac{2}{3}$  to  $\frac{3}{4}$ , nearly as long as the fore wings.

*Venation* (Fig. 3).—Fore wings; media coalescing with cubitus at base, then passing obliquely to radius beyond  $R_{2+3}$ , and anastomosing with radius to beyond middle of wing.  $R_4$  separate. Media single-branched. Cubitus reaching margin. Hind wings: media single-branched.

The position of the middle spurs on the posterior tibiae, the relatively smaller eye-caps, and broader wings will distinguish this genus from those species of *Nepticula* which have identical venation.

The larvae of the species whose life history is known form galls on twigs or petioles, or are miners in the bark of twigs. The egg is somewhat more circular in outline than that of *Nepticula*. There is but a single generation of the moths a year, as would be expected from the peculiarities of the life history.

In all but the unicolorous *E. populella*, the fore wings are mottled with fuscous scales, or with dark-tipped scales. Ill-defined markings are formed by the grouping of these dark scales in patches. The markings differ from those species of *Nepticula* which resemble *Ectoedemia* most in structural characters.

#### *Key to the Species of Ectoedemia*

- a. Fore wings unicolorous. . . . . 1. **populella**
- aa. Fore wings mottled.
  - b. Dark-tipped scales evenly distributed. . . . . 2. **castaneae**
  - bb. Dark-tipped scales more or less collected into patches.
    - c. Base of fore wing with scattered dusting except near costa. . . . . 5. **obrutella**
    - cc. Dusting dense near base of wing.
      - d. A poorly defined pale fascia at basal third. . . . . 4. **heinrichi**
      - dd. No fascia at basal third. . . . . 3. **phleophaga**

#### 1. *Ectoedemia populella* Busck

*Ectoedemia populella* Busck, Proc. Ent. Soc. Wash., viii, 98, 1907.

“Antennae dark cupreous brown, basal joint forming a small eye-cap enlarged by heavy light yellow scaling. Face and head reddish ochereous. Thorax dark brown. Fore wings unicolorous shining dark cupreous brown, with strong green and violet iridescence according to the light. Hind wings lighter cupreous brown, with ochereous cilia. Abdomen shining dark fuscous. Legs ochereous-fuscous with a bluish metallic sheen.

“Alar expanse: 7–8.5 mm.”

*Localities*.—Massachusetts (Miss Clarke); New Hampshire (Koebele); Ohio.

The larvae form galls on petioles of leaves of poplar. "The gall is almost globular, of about the size of a pea, and is a swelling of the petiole close to the leaf; it is somewhat rugose longitudinally and of a grayish color. The course of the petiole is generally very distinct along its upper side, being smooth and of a reddish brown or yellowish color. The cavity is more or less irregular on account of the woody fibers, which run through the walls of the gall and which are not eaten by the larva." I have noted the galls on petioles of leaves of *Populus grandidentata* at Sugar Grove, Fairfield Co., Ohio. The larvae mature in October, the moths issuing in May of the following year.

### 2. *Ectoedemia castaneae* Busck

*Ectoedemia castaneae* Busck, Proc. Ent. Soc. Wash., xv, 103, 1913.

Palpi and lower part of face ocherous; tuft black above. Antennae fuscous with narrow pale annulations and creamy-white eye-caps. Thorax blackish brown, sprinkled with ocherous scales posteriorly, the tip ocherous. Scales of the fore wing bluish white, mostly deeply tipped with blackish brown, so that the wing appears almost uniformly densely dusted. Cilia fuscous. Hind wing dark fuscous, blackish along the costa, with lighter ocherous-fuscous cilia; male with a yellowish costal hair-tuft. Legs ocherous, shaded with fuscous outwardly. Abdomen dark fuscous with ocherous anal tuft and ocherous underside.

*Expanse*.—7.5 to 8 mm.

*Localities*.—Vietch, Virginia (Hopkins and Snyder); Powell County, Kentucky; Allegheny County, Pennsylvania (Marloff).

The larvae form galls encircling young twigs of chestnut, resembling in shape and size, as Mr. Busck notes, egg-masses of the forest tent caterpillar. Galls were observed on chestnut in Kentucky, but no moths were reared.

### 3. *Ectoedemia phleophaga* Busck

*Ectoedemia phleophaga* Busck, Ins. Insc. Men., ii, 3, 1914.

Palpi pale ocherous; tuft ocherous, sometimes dark tipped above. Antennae dark fuscous with narrow pale annulations and creamy-white eye-caps. Thorax and basal half of fore wings dark bluish fuscous; on the outer half of the wing the scales are paler, bluish toward their bases and tipped with black. A poorly defined light ocherous costal patch at the apical third and a similar patch opposite it on the dorsal margin. Hind wings and cilia pale ocherous fuscous; in the male with the costa excised from the middle and with a long pale ocherous hair-pencil at the base of costa. Legs ocherous on the inner side, fuscous outwardly. Abdomen yellowish fuscous.

*Expanse*.—9 to 10 mm.

*Locality*.—Falls Church, Virginia (Snyder, Heinrich, Busck).

“The larva \* \* \* lives in the lower layer of the bark of chestnut just above and encroaching upon the cambium; the mine is a slender serpentine, a few millimeters broad and several inches long, often doubling upon itself and broadening out to twice or more in width in early spring, when the larva reaches maturity; in April and early May the full-grown larva leaves the bark and falls to the ground where it makes a closely woven, reddish brown cocoon amongst the rubbish, often boring down a few inches in the loose surface soil to find a suitable moist place on the underside of an old leaf or twig. The cocoon is oval, flattened, about 2 by 3 millimeters in diameter and 1.5 millimeters thick.” The imagoes emerge during September of the same year.

This insect has been regarded as an important factor in the spread of the chestnut bark disease.

The species is distinguished from its allies by the almost uniform dark bluish fuscous color of the basal half of the fore wings, and the pale head.

#### 4. *Ectoedemia heinrichi* Busck

*Ectoedemia heinrichi* Busck, Proc. Ent. Soc. Wash., xvi, 149, 1914.

Palpi pale ochereous, face and head black; antennae dark fuscous with narrow pale annulations; eye-caps creamy-white. Thorax pale ochereous, more or less dusted with blackish scales. Fore wings pale ochereous, densely dusted with blackish fuscous scales which tend to form patches, leaving usually the extreme base of the wing, except along the costa, and two poorly defined transverse fascia, one at the basal third, the other at the apical third, on which the dark dusting is absent or scattered. The second fascia is the less distinct and is sometimes almost obliterated by scattered dusting. Cilia pale ochereous, with a row of dark-tipped scales around the base. Hind wings and cilia fuscous; male with the costa excised from the middle and with a yellowish hair-pencil at base of costa. Legs ochereous. Abdomen yellowish fuscous above, pale ochereous beneath.

*Expanse*.—9 to 10 mm.

*Localities*.—Virginia (Heinrich); Ohio; Kentucky.

The larva forms a characteristic oval spiral mine in the bark of young branches of pin oak (*Quercus palustris*), well illustrated by Mr. Busck in a photograph accompanying the original description. The mine is a narrow linear track, closely coiled in a flattened oval spiral, resembling a watch spring; the empty egg shell often remains attached to the bark in the center of the

mine after the larva has deserted the mine. The bark of old mines cracks and often breaks away entirely, leaving the inner bark exposed, producing scars which persist for a number of years. The larvae are found chiefly on young saplings, but are also found on outer branches of trees, wherever the growth is unusually long and vigorous.

The larvae are full grown in October and early November, producing moths in May and June of the following year.

#### 5. **Ectoedemia obrutella** Zeller

*Trifurcula obrutella* Zeller, Verh. zool.-bot. Ges. Wien, xxiii, 316, 1873.

*Ectoedemia obrutella* (Zeller), Busck, Proc. Ent. Soc. Wash., xv, 103, 1913; xvi, 149, 1914; Dyar's No. 6226.

Syn. *bosqueella* Chambers, Bull. Geol. Surv. Terr., iv, 106, 1878; Busck, Proc. Ent. Soc. Wash., v, 208, 1903; Dyar's No. 6229.

Head pale ochereous, sometimes black (Chambers); antennae fuscous, eye-caps white. Fore wings pale ochereous, slightly iridescent, and dusted, more densely in the male than in the female, with coarse brown scales, which are most numerous toward the apex. For a short distance from the base, the costa is black, more conspicuously so in the male. Toward the base of the inner margin the dusting is least dense. Cilia pale yellowish gray, with marginal row of dark scales. Underside of fore wings darker than the hind wings which are pale grayish, with paler more yellowish cilia. Legs pale ochereous. Abdomen gray, with yellowish anal tuft.

*Locality*.—Texas (Boll, Chambers).

#### 3. **OBRUSSA** Braun

*Obrussa* Braun, Can. Ent., xlvii, 196, 1915. Type: *O. ochrefasciella* Chambers.

*Generic characters*.—Eye-cap large. Labial palpi well developed. Middle spurs of the posterior tibiae above the middle. Fore wings elongate ovate, with jugum in the female; hind wings a little over one-half.

*Venation* (Fig. 4).—Fore wings; media coalescing with cubitus at base, then passing obliquely to radius beyond  $R_{2+3}$ , and anastomosing with radius to beyond middle of wing.  $R_4$  separate.  $M_1$  and  $M_2$  coalescing for a short distance beyond separation of M and R.  $M_3$  absent. Cubitus becoming obsolete beyond its separation from M. Hind wings; media single-branched.

Represented by a single species whose early stages are entirely unknown. In the male the row of spines along the costal edge of the hind wing is preserved unmodified, except that the individual spines are weaker and not curved.

1. **Obrussa ochrefasciella** Chambers

*Nepticula ochrefasciella* Chambers, Can. Ent., v, 128, 1873.

*Obrussa ochrefasciella* (Chambers), Braun, Can. Ent., xlvii, 196, 1915; Dyar's No. 6207.

Palpi pale ochereous; tuft ochraceous; antennae fuscous, with narrow pale annulations; eye-caps pale buff. Thorax and fore wings blackish brown, almost black in the basal third. A broad pale ochereous fascia at the basal third; at two-thirds are some scattered paler scales, sometimes (in female) forming an indistinct line across the wing. Cilia around the apex and last row of scales at the extreme apex pale ochereous. The underside of the wing in the male from base to outer edge of fascia on the costa, and nearly to tornus on dorsum, is clothed with close set ochereous androconia; this area in the female though paler is not definitely outlined. Hind wings gray, ochereous toward the base in the male; cilia gray. Legs dull ochereous, shaded with fuscous outwardly. Abdomen fuscous, with yellow anal tuft in the male.

*Expanse*.—6.5 to 8 mm.

*Localities*.—Kentucky (Chambers); Ohio; Allegheny County, Pennsylvania (Marloff); New Hampshire (Busek).

4. **GLAUCOLEPIS** new genus

*Generic characters*.—Eye-cap large. Middle spurs of posterior tibiae in the middle. Fore wings elongate ovate; hind wings nearly equaling the fore wings in breadth in the male, three-fourths in the female.

*Venation* (Fig. 6).—Fore wings: cubitus coincident with media, which anastomoses with radius from  $R_{2+3}$  to beyond middle of wing.  $M_3$  absent;  $M_2$  arising before separation of M and R. Hind wings: media two-branched.

Type: *Glaucolepis saccharella* Braun (*Nepticula saccharella* Braun).

Apart from the general structural characters, which easily distinguish this genus from its allies, the great breadth of the hind wing of the male, nearly equaling that of the fore wing, is a striking character.

The larva of the only known species is a miner in leaves, forming extremely long linear mines. The cocoon is similar to that of the other genera, considerably flattened, with projecting rim extending entirely around it.

1. **Glaucolepis saccharella** Braun

*Nepticula saccharella* Braun, Journ. Cin. Soc. Nat. Hist., xxi, 97, 1912.

Tuft brownish ochereous, more or less intermixed with dark brown, sometimes entirely dark brown. Antennae brownish ochereous, broadly ringed with



black; eye-caps silvery white, with a bluish luster, sometimes becoming blackish outwardly. Thorax and basal fourth of the fore wing shining with a bright blue or purple metallic luster. Ground color of the remainder of the wing black. There is a rather broad shining silvery fascia just beyond the middle of the wing, broadening and curving toward the base as it approaches the dorsum. When viewed at some angles, this fascia shows pale blue reflections. Cilia shining pale bluish, with a line of dark scales through their middle. Hind wings and cilia gray, with a bluish luster in the female; in the male with the costal margin beset with black scales, and a bunch of black hair-scales near the middle of the dorsal margin; an oval pale yellowish patch of androconia. Legs metallic iridescent. Abdomen dark brown above with a faint bluish luster, much paler beneath and bluish.

*Expanse*.—4 mm.

*Locality*.—Ohio.

The larvae form long serpentine mines (Fig. 51), 13 or 14 cm. in length, in leaves of sugar maple (*Acer saccharum*) and occasionally red maple (*Acer rubrum*), in which the loosened epidermis is pale green and a black line of frass extends through the middle of the mine. The numerals in the figure mark the length of the mine on the respective dates indicated. Larva pale green; cocoon ochereous, regularly oval, much flattened and smooth, with projecting rim extending entirely around it.

Mined leaves may be collected in early July and late August; sometimes the larvae of a third generation are found in October. Moths from the overwintering pupae emerge in May and June.

#### FOOD PLANTS, MINES AND LARVAE

The characteristic and constant form of the mine, and the fact that each species of *Nepticula* and its allies is confined to one plant or at most to a few closely related plants, permits of ready identification in the early stages. Because of this fact, the list of food plants and descriptions of mines occurring on them has been compiled in the hope that it will be an aid to the collector in identifying his specimens.

*Salix* spp., Willow:

(1) *N. pallida*; mine linear, narrow at the end (Fig. 50).

(2) *N. fuscotibiella*; mine linear, gradually broadening, club shaped at the end, sometimes blotch-like toward the end (Figs. 25, 44).

*Populus grandidentata*, Poplar:

(1) *E. populella*; globular swelling of petiole close to leaf.

*Populus deltoides*, Cottonwood:

(1) *N. populetorum*; whitish mine gradually increasing to a breadth of 2 to 2.5 mm. at end (Fig. 8).

*Myrica cerifera*, Wax Myrtle:

- (1) *N. myricafoliella*; mine serpentine, very narrow (Fig. 22).

*Myrica carolinensis*, Bayberry:

- (1) *N. obscurella*; mine serpentine, very narrow (Fig. 19).

*Juglans cinerea*, Butternut:*Juglans nigra*, Walnut:

- (1) *N. juglandifoliella*; serpentine mine very gradually increasing in breadth (Fig. 39).

*Carya* spp., Hickory:

- (1) *N. juglandifoliella*; serpentine mine very gradually increasing in breadth.
- (2) *N. trinotata*; linear track expanding into a blotch (Fig. 33).

*Corylus americana*, Hazel:

- (1) *N. corylifoliella*; very narrow serpentine mine scarcely broader than the larva.
- (2) *N. quadrinotata*; narrow linear mine, expanding into an irregular blotch.

*Ostrya virginiana*, Hop Hornbeam:

- (1) *N. corylifoliella*; very narrow serpentine mine scarcely broader than the larva (Fig. 40).
- (2) *N. ostryaefoliella*; linear track gradually reaching a breadth of 2 mm., at the end.

*Carpinus caroliniana*, Hornbeam:

- (1) *N. corylifoliella*; very narrow serpentine mine scarcely broader than the larva.
- (2) *N. quadrinotata*; narrow linear mine, expanding into an irregular blotch (Fig. 13).

*Betula* spp., Birch:

- (1) *N. corylifoliella*; very narrow serpentine mine scarcely broader than the larva.
- (2) *N. ostryaefoliella*; linear track gradually reaching a breadth of 2 mm., at the end (Fig. 20a, b).

*Alnus tenuifolia*, Narrow-leaved Alder:

- (1) *N. canadensis*; short serpentine mine abruptly enlarging into a blotch (Fig. 26).

*Castanea dentata*, Chestnut:

- (1) *N. castaneaefoliella*; long contorted mine with central line of frass (Fig. 30); larva green.
- (2) *N. saginella*; shorter whitish mine with frass in a central line or dispersed; larva green.
- (3) *N. latifasciella*; serpentine mine; frass at first in a broad line later dispersed and toward end gathered into a band; larva green.
- (4) *N. similella*; see under *Quercus* (8).
- (5) *E. castaneae*; larva makes a gall encircling twig.
- (6) *E. phleophaga*; larva makes a serpentine track in the bark.

*Quercus* spp., oaks:

- (1) *N. terminella*; mine a broadening linear tract, 3.5 mm. wide at the end; larva yellow (Fig. 36).
- (2) *N. saginella*; whitish linear mine with frass in a central line or dispersed (Fig. 9); larva green.
- (3) *N. latifasciella*; serpentine mine; frass at first in a broad line, later dispersed and toward the end gathered into a band (Fig. 47); larva green.
- (4) *N. flavipedella*; linear mine; a short indistinct portion followed by a transparent area, then a gradually broadening serpentine track, not transparent, but easily visible above (Fig. 48); larva green.
- (5) *N. anguinella* Clemens, Proc. Ent. Soc. Phila., i, 85, 1861; Tin. No. Am., 175, 1872. "May be found in the leaves of oaks early in October and in the latter part of June. The mine is a very narrow serpentine tract, which is filled or discolored throughout its length by blackish excrement. The larva fits the mine closely, in color lemon-yellow, with ten square dark brown or blackish spots on the ventral surface."

It should be possible to recognize this species, when found, from Clemens' description of the larva.

- (6) *N. platea* Clemens, Proc. Ent. Soc. Phila., i, 85, 1861; Tin. No. Am., 175, 1872. "Mines oaks early in October. The mine is a moderately broad, winding tract, with a broad line of dispersed grains of excrement. The larva is purplish, with a pale green vascular line and a row of reddish-brown dorsal dashes. The mine is much broader than that of the preceding miner."

The statement that the larva is purple can not be regarded as conclusive, since such color is often produced in larvae feeding on leaves with autumnal coloration.

*Quercus alba*, White Oak:

- (7) *N. quercipulchella*; long, narrow, winding and gradually widening track; larva bright green.

*Quercus palustris*, Pin Oak:

- (8) *N. similella*; linear mine expanding into an underside blotch, followed by a large conspicuous nearly transparent blotch (Fig. 27); larva pale green.
- (9) *N. altella*; lower side, very long serpentine mine, not distinctly visible (Fig. 37); larva yellow with row of dark brown dashes.
- (10) *E. heinrichi*; flattened oval spiral mine in bark of young branches.

*Quercus agrifolia*, California Live Oak:

- (11) *N. variella*; serpentine mine.

*Ulmus* spp., elms:

- (1) *N. apicialbella*; narrow serpentine mine (Fig. 43).
- (2) *N. ulmella*; narrow linear track enlarging into an irregular blotch (Fig. 45).

*Platanus occidentalis*, Sycamore:

- (1) *N. platanella*; narrow linear mine, abruptly enlarging into a large blotch (Fig. 28).
- (2) *N. clemensella*; linear mine, gradually broadening with terminal portion expanded into a small blotch (Fig. 29).

*Physocarpus opulifolius*, Opulaster:

- (1) *N. opulifoliella*; brownish contorted serpentine mine (Fig. 38).

*Pyrus communis*, Pear:

- (1) *N. chalybeia*; serpentine mine (Fig. 46).

*Pyrus malus*, Apple:

- (1) *N. pomivorella*; serpentine mine, usually broadening to 2 or 2.5 mm. (Fig. 10).

*Amelanchier canadensis*, Service Berry:

- (1) *N. amelanchierella* Clemens, Proc. Ent. Soc. Phila., i, 84, 1861; Tin. No. Am., 174, 1872. "In the leaves of service-berry or June-berry, *Amelanchier canadensis*, in June and July. The mine rather a broad tract, sometimes much contorted, with rather irregular edges, placed most often toward the base of the leaf and having a rather broad 'frass' line of a dark brown color."

This species seems to be distributed wherever its food plant occurs, as I have observed untenanted mines on the leaves in central Ohio, in Kentucky, and in North Carolina.

*Crataegus* spp., Hawapple:

- (1) *N. crataegifoliella*; serpentine mine with a breadth of about 2 mm., at the end (Fig. 49).
- (2) *N. scintillans*; contorted serpentine mine, scarcely exceeding 1 mm. in breadth (Fig. 11).

*Rubus* spp., Blackberry, Raspberry:

- (1) *N. villosella*; narrow serpentine mine (Fig. 18).
- (2) *N. rubifoliella*; short narrow linear mine, expanding into a blotch (Fig. 23).

*Rosa* spp., Rose:

- (1) *N. rosaefoliella*; serpentine mine (Fig. 42).

*Prunus serotina*, Wild Black Cherry:

- (1) *N. bifasciella*; narrow serpentine mine (Fig. 15).

*Prunus americana*, Wild Plum:

- (1) *N. bifasciella*; narrow serpentine mine.
- (2) *N. slingerlandella*; narrow linear mine, abruptly enlarging into an irregular blotch (also on cultivated plums and prunes, and sweet cherry).

*Ptelea trifoliata*, Hop Tree:

- (1) *N. pteleaeella*; very long, much contorted, narrow serpentine mine (Fig. 12).

*Rhus toxicodendron*, Poison Ivy:

- (1) *N. rhoifoliella*; narrow contorted serpentine mine (Fig. 34).

*Rhus* spp., Sumac:

- (1) *N. intermedia*; narrow contorted serpentine mine (Fig. 16).

*Acer saccharum*, Sugar Maple:

*Acer rubrum*, Red Maple:

- (1) *Glaucolepis saccharella*; very long linear mine (Fig. 51).

*Condalia ferrea*, Black Ironwood:

- (1) *N. condaliafoliella*; contorted serpentine mine.

*Rhamnus lanceolata*, Buckthorn:

- (1) *N. rhamnicola*; linear mine expanding into an irregular blotch (Fig. 35).

*Rhamnus californica*:

- (1) *N. punctulata*; serpentine mine.

*Ceanothus divaricatus*:

- (1) *N. ceanothi*; contorted mine, scarcely exceeding 1 mm. in breadth (Fig. 14).

*Ceanothus cuneatus*:

- (1) *N. punctulata*; short, narrow indistinct mine (Fig. 31).

*Tilia americana*, Basswood:

- (1) *N. tiliella*; serpentine mine (Fig. 41).

- (2) *N. argentifasciella*; indistinct linear mine, expanding into a blotch (Fig. 32).

*Nyssa sylvatica*, Sour Gum or Pepperidge:

- (1) *N. nyssaefoliella*; linear mine abruptly expanding into a blotch (Fig. 24).

*Oxycoccus macrocarpus*, Cranberry:

- (1) *N. paludicola*; serpentine track, in part following the margin of the leaf (Fig. 21).

### List of Genera and Species

- |                                     |                                     |
|-------------------------------------|-------------------------------------|
| 1. <b>Nepticula</b> von Heyden      | 16. <i>unifasciella</i> Chambers    |
| 1. <i>argentifasciella</i> Braun    | 17. <i>purpuratella</i> Braun       |
| 2. <i>scintillans</i> Braun         | 18. <i>obscura</i> Braun            |
| 3. <i>pteliaeella</i> Chambers      | 19. <i>ostryaefoliella</i> Clemens  |
| 4. <i>quadrinotata</i> Braun        | 20. <i>paludicola</i> Braun         |
| 5. <i>trinotata</i> Braun           | 21. <i>myricaefoliella</i> Busck    |
| 6. <i>ceanothi</i> Braun            | 22. <i>altella</i> Braun            |
| 7. <i>bifasciella</i> Clemens       | 23. <i>corylifoliella</i> Clemens   |
| <i>serotinaeella</i> Chambers       | <i>virginiella</i> Clemens          |
| 8. <i>intermedia</i> Braun          | <i>minimella</i> Chambers           |
| 9. <i>diffasciae</i> Braun          | 24. <i>opulifoliella</i> Braun      |
| 10. <i>rhamnicola</i> Braun         | 25. <i>quercipulchella</i> Chambers |
| <i>rhamnella</i> Braun              | 26. <i>condaliafoliella</i> Busck   |
| 11. <i>cerea</i> Braun              | 27. <i>juglandifoliella</i> Clemens |
| 12. <i>rhoifoliella</i> Braun       | <i>caryaefoliella</i> Clemens       |
| 13. <i>terminella</i> Braun         | 28. <i>apicalbella</i> Chambers     |
| 14. <i>villosella</i> Clemens       | <i>leucostigma</i> Braun            |
| <i>dallasiana</i> Frey and Boll     | 29. <i>tiliella</i> Braun           |
| 15. <i>resplendensella</i> Chambers | 30. <i>rubifoliella</i> Clemens     |

- |  |   |
|--|---|
| 31. nyssaefoliella Chambers  | 50. crataegifoliella Clemens  |
| 32. slingerlandella Kearfott   | 51. nigriverticella Chambers<br><i>maculosella</i> Chambers                                 |
| 33. rosaefoliella Clemens  | 52. populetorum Frey and Boll   |
| 34. fuscotibiella Clemens<br><i>ciliaefuscella</i> Chambers<br><i>discolorella</i> Braun | 53. saginella Clemens<br><i>quercicastanella</i> Chambers<br><i>fuscocapitella</i> Chambers |
| 35. canadensis Braun   | 54. pallida Braun   |
| 36. ulmella Braun  | 55. amelanchierella Clemens<br>(Larva)  |
| 37. variella Braun   | 56. anguinella Clemens (Larva)  |
| 38. platanella Clemens<br><i>maximella</i> Chambers                                      | 57. platea Clemens (Larva)  |
| 39. clemensella Chambers   | 2. <b>Ectoedemia</b> Busck  |
| 40. similella Braun  | 1. populella Busck  |
| 41. thoracealbella Chambers<br><i>badiocapitella</i> Chambers                            | 2. castaneae Busck  |
| 42. pomivorella Packard  | 3. phleophaga Busck   |
| 43. chalybeia Braun  | 4. heinrichi Busck  |
| 44. flavipedella Braun   | 5. obrutella Zeller<br><i>bosqueella</i> Chambers   |
| 45. castaneaefoliella Chambers   | 3. <b>Obrussa</b> Braun   |
| 46. punctulata Braun   | 1. ochrefasciella Chambers  |
| 47. grandisella Chambers   | 4. <b>Glaucolepis</b> Braun   |
| 48. belfrageella Chambers  | 1. saccharella Braun  |
| 49. latifasciella Chambers   |   |

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Through the courtesy of the United States National Museum, material in this family was sent to me for study. I have also examined a number of species from Mr. Fred Marloff's collection.

## EXPLANATION OF PLATES

## Plate V

- Fig. 1.—Wings of *Nepticula nyssaefoliella*, female.  
 Fig. 2.—Wings of *Nepticula nyssaefoliella*, male.  
 Fig. 3.—Wings of *Ectoedemia heinrichi*, female.  
 Fig. 4.—Wings of *Obrussa ochrefasciella*, male.  
 Fig. 5.—Wings of *Nepticula terminella*, female.  
 Fig. 6.—Wings of *Glaucolepis saccharella*, male.  
 Fig. 7.—Cross-section of mine of *Nepticula saginella*.  
 Fig. 8.—Mine of *Nepticula populetorum* (No. 52).  
 Fig. 9.—Mine of *Nepticula saginella* (No. 53).  
 Fig. 10.—Mine of *Nepticula pomivorella* (No. 42).

## Plate VI

- Fig. 11.—Mine of *Nepticula scintillans* (No. 2).  
 Fig. 12.—Mine of *Nepticula pteliaeella* (No. 3).  
 Fig. 13.—Mine of *Nepticula quadrinotata* (No. 4).  
 Fig. 14.—Mine of *Nepticula ceanothi* (No. 6).  
 Fig. 15.—Mine of *Nepticula bifasciella* (No. 7).  
 Fig. 16.—Mine of *Nepticula intermedia* (No. 8).  
 Fig. 17.—Mine of *Nepticula diffasciae* (No. 9).  
 Fig. 18.—Mine of *Nepticula villosella* (No. 14).  
 Fig. 19.—Mine of *Nepticula obscurella* (No. 18).  
 Figs. 20a, 20b.—Mines of *Nepticula ostryaefoliella* (No. 19).  
 Fig. 21.—Mine of *Nepticula paludicola* (No. 20).  
 Fig. 22.—Mine of *Nepticula myricaefoliella* (No. 21).  
 Fig. 23.—Mine of *Nepticula rubifoliella* (No. 30).  
 Fig. 24.—Mine of *Nepticula nyssaefoliella* (No. 31).  
 Fig. 25.—Mine of *Nepticula fuscotibiella* (No. 34).  
 Fig. 26.—Mine of *Nepticula canadensis* (No. 35).  
 Fig. 27.—Mine of *Nepticula similella* (No. 40).  
 Fig. 28.—Mine of *Nepticula platanella* (No. 38).  
 Fig. 29.—Mine of *Nepticula clemensella* (No. 39).  
 Fig. 30.—Mine of *Nepticula castaneaefoliella* (No. 45).  
 Fig. 31.—Mine of *Nepticula punctulata* (No. 46).

## Plate VII

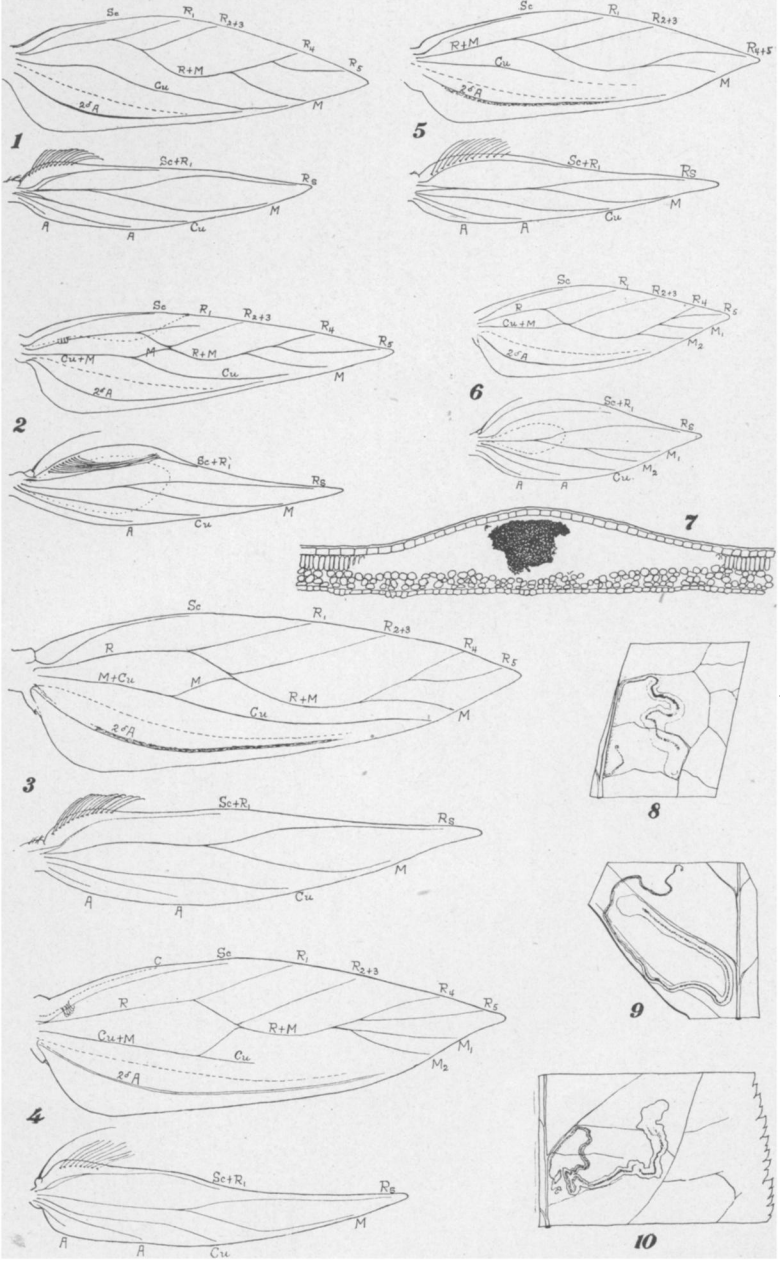
- Fig. 32.—Mine of *Nepticula argentifasciella* (No. 1).  
 Fig. 33.—Mine of *Nepticula trinotata* (No. 5).  
 Fig. 34.—Mine of *Nepticula rhoifoliella* (No. 12).  
 Fig. 35.—Mine of *Nepticula rhamnicola* (No. 10).  
 Fig. 36.—Mine of *Nepticula terminella* (No. 13).  
 Fig. 37.—Mine of *Nepticula altella* (No. 22).  
 Fig. 38.—Mine of *Nepticula opulifoliella* (No. 24).  
 Fig. 39.—Mine of *Nepticula juglandifoliella* (No. 27).  
 Fig. 40.—Mine of *Nepticula corylifoliella* (No. 23).

- Fig. 41.—Mine of *Nepticula tiliella* (No. 29).  
Fig. 42.—Mine of *Nepticula rosaefoliella* (No. 33).  
Fig. 43.—Mine of *Nepticula apicialbella* (No. 28).

## Plate VIII

- Fig. 44.—Mine of *Nepticula fuscotibiella* (No. 34).  
Fig. 45.—Mine of *Nepticula ulmella* (No. 36).  
Fig. 46.—Mine of *Nepticula chalybeia* (No. 43).  
Fig. 47.—Mine of *Nepticula latifasciella* (No. 49).  
Fig. 48.—Mine of *Nepticula flavipedella* (No. 44).  
Fig. 49.—Mine of *Nepticula crataegifoliella* (No. 50).  
Fig. 50.—Mine of *Nepticula pallida* (No. 54).  
Fig. 51.—Mine of *Glaucolepis saccharella*.





BRAUN — NEPTICULIDAE OF NORTH AMERICA

