

MOTHS OF THE *SEMIOTHISA SIGNARIA* COMPLEX (LEPIDOPTERA: GEOMETRIDAE)

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Abstract

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The *signaria* group of the genus *Semiothisa* is a complex of 10 extremely similar species, most of which are host-specific on certain genera of coniferous trees. An eleventh species, *S. sexmaculata*, is also treated in this revision because of its close resemblance to members of the *signaria* complex, although its true affinity appears to be with the *liturata-bisignata* group. The species are described and illustrated, and their synonymy, distribution, variation and biology are discussed in detail, including an account of industrial melanism in a population of *S. pinistrobata*. Two new species names are proposed, and eight lectotypes designated. The main center of distribution is northeastern North America, and all of the known species except *S. fuscaria* occur on this continent. The one Holarctic species, *S. signaria*, which is generally the commonest in collections, also has the widest range of host plants, feeding on at least six genera of coniferous trees.

INTRODUCTION

The genus *Semiothisa* is an enormous worldwide group, of which the sibling species complex treated here is but a small segment. The total number occurring in North America has yet to be determined, but it appears that there are at least 100 species in the region north of Mexico. The *signaria* group as discussed here includes 11 known species of which nine are exclusively North American, one is Holarctic, and one Japanese. The adults of these species are of extremely similar appearance, and the American ones have been hopelessly confused in collections and in the literature. No less than six have been lumped together by some authors under the name *Semiothisa granitata* (Guenée). In the McDunnough check list (1938: 158) at least four species were confused under the name *granitata*, and two were each listed twice under different names. However, McDunnough was well aware of the nature of the problem and encouraged me to work on them. Forbes (1948: 45) combined under *granitata* all of the species treated here except *sexmaculata*, but commented: "This supposed species breaks up into many strains, part of which may perhaps turn out really to be distinct species".

These are among the most characteristic moths of the Canadian and Hudsonian Zone coniferous forest. Adults of one or more species are nearly always in evidence through June and July in woods of spruce, fir, hemlock, larch, pine, or Douglas fir across southern Canada and the northern United States, and far to the south in both the eastern and western mountain systems. They rest on the trunks of the trees in the daytime and take flight readily when disturbed. They come to light at night, sometimes in abundance, but the adults are not wide ranging; few are found beyond the immediate vicinity of the trees upon which the larvae feed. The larvae of most are monophagous feeders on one genus or even one species of coniferous tree; only *signaria* is more general, feeding on at least six genera of conifers. Although these moths may be abundant and remain so year after year, they have never been held responsible for serious damage. I have seen adults of *granitata* so abundant at light in the woods of the National Agricultural Research Center at Beltsville, Md., that it seemed as though the pines in the vicinity should show obvious signs of defoliation; but they did not. Other species may be similarly abundant elsewhere. It is apparent that the natural control mechanisms which regulate their numbers are highly effective. However, with nine species widespread in the Nearctic Region, affecting nearly all northern conifers except the cedars and junipers, the group should be viewed as potentially important.

MATERIALS AND METHODS

The collecting of adults at light in Nova Scotia and New Brunswick over a period of years provided my first evidence that the various "strains" were indeed good species with highly specific host relationships. For example, it became obvious from repeated sampling of adults in different localities that *S. fissinotata* (Walker) was to be expected only in the presence of hemlock, and similarly with the other species and their respective hosts. I subsequently reared all of the northeastern species from eggs, compared the larvae, and divided some broods into several lots which were offered different foods. Study of 2555 additional reared specimens from the Canadian Forest Insect Survey reinforced and greatly extended my earlier ideas of the group, especially with regard to the western forms. I give a host plant analysis of this material in tabular form (Table I), indicating the number of specimens of each species examined from each kind of tree. All records from different species of *Picea* and *Abies* have been grouped together as no further breakdown of host preferences could be detected within these genera. The Forest Insect Survey material consisted of good quality spread specimens that had been reared from larvae collected directly from identified trees. A small incidence of error either in my species identifications or their host identifications may be represented in this data, as for example the records of *S. signaria dispuncta* (Walker) from *Thuja*, *S. banksianae* new name from *Pseudotsuga*, and of *S. oweni* (Swett) and *sexmaculata* (Packard) from spruce, but it is probably less than 1%. Single records of *dispuncta* from willow and birch, considered obviously incorrect, were not included in the table. I examined a total of 5486 adult specimens and reared 18 broods of larvae from eggs in connection with this research.

Originally I prepared a key to the larvae of this group but after rearing more broods and better understanding the variation within each species, I discarded it. Although each species has its own range of variation which differs from those of other species, the characters are subtle and overlap in such a way that I have been unable to construct keys that will work either for larvae or adults. Study of preserved larvae revealed no chaetotaxal characters that I could see, although it is

Table I. Host plant analysis of *Semiothisa* species based on material reared by the Canadian Forest Insect Survey. Figures refer to number of specimens reared from each kind of tree

	<i>signaria dispuncta</i>	<i>unipunctaria perplexa</i>	<i>pini- strobata</i>	<i>fissin- otata</i>	<i>banks- ianae</i>	<i>submar- morata</i>	<i>oweni</i>	<i>sexmac- ulata</i>
<i>Pinus strobus</i>	2		13					
<i>Pinus monticola</i>	10				1?			
<i>Pinus ponderosa</i>	2							
<i>Pinus resinosa</i>	1		1					
<i>Pinus contorta</i>								
<i>latifolia</i>	10	5			174			2
<i>Pinus banksiana</i>	2				21			
<i>Pinus sylvestris</i>					1			
<i>Larix</i> species	16		1		3	27	21	469
<i>Picea</i> species	439	3			2	1	1	3
<i>Tsuga canadensis</i>	14			18				
<i>Tsuga heterophylla</i>	187	2			1?			
<i>Pseudotsuga menziesi</i>	612	330			6?	1		
<i>Abies</i> species	137	4						10
<i>Thuja</i> species	1							

possible that with more experience one could find such differences. Even the genitalia are of little or no value for separating the species; only *sexmaculata* and possibly *fuscaria* (Leech) may be distinguished in this way. I have therefore resorted to the massive illustration of adults, hoping that this will serve to show how each species and subspecies appears. For adults, the color, pattern and size often provide the only characters that one can use, although knowledge of distribution and food plant association usually offers supporting evidence. With practice it becomes possible to identify nearly all good quality specimens on the basis of general appearance. The flight periods, being mostly synchronous or broadly overlapping, are of little value for distinguishing species. Only *fissinotata* differs significantly in this respect as it is the earliest to emerge in the spring.

DISTRIBUTION AND HOST RELATIONSHIPS

The members of this complex are mainly concentrated in eastern North America, where nine of the 10 Nearctic species are present. It is likely that all eastern species will be found to occur in Maine, New Hampshire, Vermont, northern New York, and Michigan, with the exception of *S. fraserata* n. sp., an endemic of the southern Appalachians. All except *fraserata* and the somewhat southern *S. granitata* occur in Nova Scotia, Ontario, and probably Quebec and New Brunswick. Only four occur as far west as the Rocky Mountains and three of those are the same as eastern species. The distribution of *granitata* has a southward displacement, extending north only to the latitude of southern Maine, but southward at sea level at least to Virginia. All others appear to be confined to regions north of the 40th parallel except in mountains. Although *granitata* will readily feed on jack pine and eastern white pine in the laboratory, it does not follow the ranges of these trees northward and is perhaps nowhere associated with them in nature. Despite the generally northern distribution of the group, most species do not range as far northward as their hosts. In the east, only *S. signaria dispuncta* and *S. sexmaculata* are known to reach Labrador. In the west, *dispuncta* occurs in southern portions of the Northwest Territories, the Yukon and the southern coast of Alaska (Ketchikan), and *submarmorata* occurs in the Yukon. None is known from the mainland of Alaska.

Three of the American species have become adapted exclusively to eastern larch, one to white pine, one to the two eastern species of hemlock, one to jack pine and lodgepole pine, one to pitch pine, scrub pine (*Pinus virginiana*) and possibly certain of the other hard pines, and one to Douglas fir. Even Fraser fir, found only on the highest mountains of the southern Appalachians, has associated with it a distinctive population which I describe as a new species. Differentiation of this isolated endemic is presumed to have paralleled that of its host. As might be expected of the species best adapted to a variety of hosts, *signaria* has the greatest distribution, occurring across both North America and Eurasia. Also, *signaria* is the only species regularly associated with species of spruce and fir, which happen to be the host trees with the most nearly continuous Holarctic distribution. Inasmuch as western North America has a greater variety of conifers that might serve as suitable hosts, it seems curious that the moths of this group should have attained (or maintained) their greatest diversity in the East.

VARIATION

Geographic variation among the nine eastern species is very slight. There is more variation in the West where *signaria* has a large Pacific Coast form that looks much like *fraserata*, the new species from North Carolina, and where *unipunctaria* varies greatly throughout its wide range from southern California and Arizona to Canada. Except for this variation of *signaria* and *unipunctaria* in the West, which needs more study, there are no confusing blend zones or areas of suspected hybridization. Despite their extreme similarity of appearance and structure, all eight species of the Northeast remain distinct everywhere. In Nova Scotia, where seven of them occur in close sympatry, with their various hosts often growing in mixed stands, examples of uncertain identity do not account for more than 1 or 2%. Those of intermediate appearance could either be hybrids or simply variants of one species or the other.

I have been able to examine numerous specimens of several species reared on inappropriate hosts, both deliberately and accidentally, and there is no evidence that this factor influences the color or pattern of the adult in any significant way, although it may affect size. Laboratory reared specimens, regardless of host, do sometimes differ slightly from caught ones in their greater intensity of coloring, as reared specimens of Lepidoptera in general so often do. But the modified coloring is rarely so extreme that one cannot at once identify reared specimens by comparison with their wild counterparts, or conversely.

CLASSIFICATION AND SYNONYMY

Genus *Semiothisa* Hübner

Semiothisa Hübner, 1818, Zutr. exot. Schmett. 1: 27, 30.

Type-species: *Semiothisa gambaria* Hübner, 1818. Designated by Moore, 1886, Lepidoptera of Ceylon 3: 465.

Macaria Curtis, 1826, British Entomology 6: 132.

Type-species: *Phalaena Geometra liturata* Clerck, 1759. Original designation.

Philobia Duponchel, 1829, in Godart and Duponchel, Hist. Nat. Lépidoptères ou Papillons de France 7(2): 105, 195.

Type-species: *Phalaena Geometra notata* Linnaeus, 1758. Original designation (p. 105).

Sciagraphia Hulst, 1896, Trans. Am. ent. Soc. 23: 329.

Type-species: *Macaria granitata* Guenée, 1857. Original designation.

NOTE. *Phalaena eleonora* Cramer (= *Macaria fasciata* Fabricius), a south Asian species, has also been given as the type-species of *Semiothisa* (see Wehrli 1940: 381), but this designation is invalid because it is not one of the originally included species. In the "Erstes Hundert" of the Zuträge zur Sammlung Exotischer Schmettlinge (sic), published in 1818, Hübner described and figured two new species under the generic name *Semiothisa*, which he was then using for the first time. These were *gambaria* (p. 27, figs. 159, 160) and *limbularia* (p. 30, figs. 179, 180), both from Surinam. In his discussion he compared each of these with a European species which he considered to be congeneric, these being *liturata* (Clerck) (but which he attributed to Schiffermüller) and *signaria* (Hübner). Thus only these four species were originally included in *Semiothisa*.

All of the species names listed by McDunnough (1938: 158) from 4680 to 4687 are treated in the present paper with the exception of *retractaria* (Walker), which belongs in the subfamily Sterrhinae, and *abruptata* (Walker), which was shown by Rindge (1961: 1) and by McGuffin (1972: 51) to be a species of the genus *Itame* Hübner. I had independently reached the same conclusion concerning *abruptata* on comparison of a specimen in the Franclemont collection at Cornell University with a photograph of the type, which I here reproduce (Fig. 235). I make a special point of mentioning *Itame abruptata* because of its close resemblance to, and past confusion with, the moths of the *Semiothisa signaria* complex. It is a rare species known only from a limited area of Ontario north of Lake Huron, and from northern Michigan and western Pennsylvania.

Semiothisa sexmaculata is hardly a member of the *signaria* complex in the strict sense but appears more closely related to the pine-feeding group that includes the Palearctic *liturata* (Clerck), and such Nearctic species as *minorata* Packard, *bisignata* (Walker), *distribuaria* (Hübner), and *adonis* (Barnes and McDunnough). Like these, it lacks the fovea (Fig. 8), a small depression devoid of scales near the base on the underside of the forewing. Its larva is also different. However, the two species groups are evidently connected through *sexmaculata* and *fuscaria*, and I therefore thought it well to include these in the present study.

Tephрина haliata Guenée (1857: 97), based on two males sent from California by Lorquin, cannot be identified and must remain a nomen dubium. Contrary to his custom, Guenée failed to indicate in which collection the types were deposited, and they have never been found. Their loss was mentioned by Oberthür in his discussion of *haliata* (1923: 247). I have not found them among the Guenée types in the U.S. National Museum. Although the brief description of *haliata* could be interpreted as applying to a species of this complex, it could also refer to other species, and one cannot be certain without seeing the types. If it could be shown that the name *haliata* does refer to a species of this group, it would either be an older name for *unipunctaria* (Wright) or would represent the northern Pacific Coast form of *signaria*. It would be the earliest name for any member of the complex except *signaria* (Hübner), although it has only page priority over *granitata* (Guenée).

Macaria contemptata Guenée (1857: 86) was supposed to have come from North America, but the male type in the U.S. National Museum, which I hereby designate the lectotype, is almost certainly a specimen of the Palearctic *S. aestimaria* (Hübner), and the name should be listed as a synonym of that species. It was eliminated from North American lists by earlier authors who realized that it was exotic, but no one identified it. The type of *contemptata* was figured by Oberthür (1920, pl. DVI, fig. 4228). The specimen is labelled as follows: "Ex Musaeo Ach. Guenée", "Ex Typicalibus Speciminibus", "Oberthür Collection", "Contemptata Gn. Am. bor.", "Barnes Collection", "Macaria contemptata Guenée—Sp. G X. No. 1054. Boite No. 240", "A servi de modèle à J. Culot, pour le No. 4228 de la Pl. DVI Vol. XVII, Études de Lépidoptérologie Comparée". A lectotype label has been added.

SUMMARY

The following is a taxonomic summary of the *Semiothisa signaria* complex in check list form, with the approximate geographical distribution given for each species and subspecies. Names in italics are junior synonyms or homonyms.

SEMIOTHISA Hübner

- | | |
|---|------------------------------------|
| 1a. <i>signaria signaria</i> (Hübner) | N. Palaearctic Region |
| b. <i>signaria disuncta</i> (Walker) | N. Nearctic Region |
| <i>inordinaria</i> (Walker) | |
| <i>subapicaria</i> (Walker) | |
| <i>haliata</i> (Walker) | |
| <i>irregularata</i> (Walker), revised synonymy | |
| <i>exnotata</i> (Walker), revised synonymy | |
| <i>quadrisignata</i> (Walker), revised synonymy | |
| 2. <i>fraserata</i> new species | Great Smoky Mts., N.C. |
| 3a. <i>unipunctaria unipunctaria</i> (Wright) | Mts. of western U.S. |
| b. <i>unipunctaria perplexa</i> (McDunnough) | B.C., Alta., Mont. |
| 4. <i>pinistrobata</i> Ferguson | NE. U.S., SE. Canada |
| 5. <i>fissinotata</i> (Walker) | NE. U.S., SE. Canada |
| <i>retinotata</i> (Walker) | |
| 6. <i>banksianae</i> Ferguson, new name | N.S. and S. Que. to B.C. and Wash. |
| <i>marmorata</i> Ferguson, homonym | |
| 7. <i>submarmorata</i> (Walker) | Nfld. to B.C., Yukon, NE. U.S. |
| 8. <i>oweni</i> (Swett) | Nfld. to Alta., NE. U.S. |
| 9. <i>granitata</i> (Guenée) | NE. U.S. |
| <i>succosata</i> (Zeller), new synonym | |
| 10. <i>fuscaria</i> (Leech) | Japan |
| 11a. <i>sexmaculata sexmaculata</i> (Packard) | Northern N. America |
| <i>unimodaria</i> (Morrison), new synonym | |
| <i>labradoriata</i> Moeschler | |
| b. <i>sexmaculata incolorata</i> (Dyar) | B.C., Wash., Ore., Idaho |
| <i>purcellata</i> (Taylor) | |

Nomen dubium: *Tephрина haliata* Guenée, 1857

New synonym: *Macaria contemptata* Guenée, 1857, described in error from "Amérique septentrionale", is a synonym of *Semiothisa aestimaria* (Hübner)

SYSTEMATIC AND BIOLOGICAL ACCOUNT OF THE
SEMIOTHISA SIGNARIA COMPLEX

Semiothisa signaria signaria (Hübner)

Figs. 26-29

Geometra signaria Hübner, [1800]-[1809] (Sammlung europäischer Schmetterlinge, 5, Geometrae), pl. 61, fig. 313.

Semiothisa signaria Hübner, 1818, p. 30; "1816" [1823], p. 298. Staudinger and Rebel, 1901, p. 332. Spuler, 1910, p. 97, pl. 6, fig. 18. Culot, 1919, p. 77, pl. 51, fig. 1038. Wehrli, 1940, p. 387. Nordström *et al.*, 1941, p. 300, pl. 42, fig. 13.

Ennomos signaria, Treitschke, 1827, p. 15; 1835, p. 168.

Philobia signaria, Duponchel, 1829, p. 207, pl. 149, fig. 6.

Macaria signaria, Guenée, 1857, p. 77. Walker, 1861b, p. 880. Frey, 1880, p. 205. Prout, 1915, p. 346, pl. 18g (figure mislabelled as *signata*). Matsumura, 1925, p. 177.

DIAGNOSIS. The nominate subspecies of *signaria* is the only member of this complex known to occur outside of the Nearctic Region, with the exception of *fuscaria* (Leech), which seems to be rather closely related to the North American *S. sexmaculata* (Packard). *Semiothisa signaria* is found in the coniferous forests of northern Europe, the mountains of central Europe and in the Soviet Union, reportedly as far east as the Amur River and the island of Sakhalin off the east coast

of Siberia. In Europe, as in North America, this species is apparently associated with woods of spruce and fir, but the nominate subspecies has had a reputation for rarity in Europe, in contrast to the abundance of subspecies *dispuncta* in the coniferous forests of this continent.

Nominate *signaria* is hardly distinguishable from subspecies *dispuncta* and has identical genitalia. It is a little browner, tending less toward the ash-gray tint of *dispuncta*, has yellower fringes and more yellow scaling along the costa above and beneath, tends to have a more prominent, whitish subterminal line, and more contrastingly banded hindwings in the female. These differences are slight, and if one mixed a number of European specimens with American ones, it is doubtful if most could be segregated again without reference to the locality labels. The differences are not nearly as great as between the two or more American subspecies. Especially good colored figures are given by Nordström *et al.* (1941, pl. 42, fig. 13), and Culot (1919, pl. 51, fig. 1038).

TYPES. Identification of *signaria* is based on Hübner's figure, which is easily recognized as representing the present species. No locality was given, but it seems probable that the specimen that Hübner illustrated came from the Alps of Bavaria, Austria, or Switzerland. I have not determined whether *signaria* is among the few Hübner types said still to exist in the Naturhistorisches Museum, Vienna. I have no information on the type of *agraptus* Schultz (see below).

SYNONYMY. The only other name appears to be *agraptus* V. Schultz, treated as an aberration of *signaria* by Wehrli (1940: 387), with reference given to the original description as "Wiss. Beilage z. Jahresbericht der Freiligrat-Schule in Lage 16.V.1930, p. 30" (1940: 686). I have not seen this description and do not know how the name *agraptus* should be applied.

FURTHER DESCRIPTION. The various published figures obviate the need for detailed description of the wing pattern. The color of *signaria* gives the general effect of a slightly warmer brown shade as compared with the grayer brown of *dispuncta*. There are more yellow scales in *signaria*, especially on the costa, irregularly along the transverse lines of the forewing, and in the fringes of both wings. All females examined show a relatively well-developed, almost straight white subterminal line on the forewing, bounded inwardly and outwardly by darker shading. The lines, as well as the subapical costal and median subterminal spots of the forewing, are as in *dispuncta*, but the underside tends to be more heavily marked with antemedial and postmedial bands on both wings.

Length of forewing: male, 13–14 mm; female, 13–15 mm. Mean length of forewing: males (of 6), 13.33 mm; females (of 6), 13.58 mm.

GENITALIA. Indistinguishable in both sexes from those of *dispuncta* and all of the most closely allied species.

MATERIAL EXAMINED. 14 adult specimens; 3 male, 3 female genitalia slides.

DISTRIBUTION. Material examined included six specimens from southern Bavaria (Baierbrunn, Haag b. Freising) and upper Bavaria (Bruckberg), received from Dr. Walter Forster, and six specimens in the U.S. National Museum without locality data. In the literature, *signaria* has been reported from Sweden, Poland, from the mountains of southern Germany, Switzerland, France (Alsace) and Hungary, the Ural, Altai and Caucasus mountains, the region of the Amur River, Siberia, and from the island of Sakhalin, north of Japan (Matsumura 1925: 177).

GEOGRAPHICAL VARIATION. Not studied.

FLIGHT PERIOD. Reported to fly from May to August (Wehrli 1940: 387), an extended period probably resulting from differences in both latitude and altitude. Related New World forms, sampled over a wide area, show similar dates, even when univoltine. On Sakhalin, many specimens were collected in July and August (Matsumura).

EARLY STAGES. It is now believed that the usual host plant of *signaria* in Europe is *Picea* (W. Forster, in litt.), although an early record of a single larva on *Pinus sylvestris* L., reported by Treitschke (1827: 16), has been quoted repeatedly in the literature (e.g., Duponchel 1829: 208; Culot 1919: 77; Prout 1915: 346). It has been reported on *Pinus sylvestris* L. and *Picea excelsa* Lam. in Hungary (Kovács 1958: 230). It may prove to feed on a variety of conifers, as does *dispuncta*. I have not seen larvae of *S. signaria signaria*.

REMARKS. Since nominate *signaria* is uncommon and has a limited range in Europe, it has remained unfamiliar to most authors working on the American fauna. However, its close affinity to Nearctic forms was noted long ago by Packard (1876: 287), and also by Prout (1915: 346). Prout's comment that there is "a very difficult group of closely similar forms in North America" first prompted my investigation of this relationship. As *signaria* supposedly occurs across the entire breadth of northern Eurasia, it is not surprising that it should prove to be Holarctic. I have not seen Siberian material, however, and there is no real certainty that those records refer to the same species.

Semiothisa signaria dispuncta (Walker)

Figs. 10-12, larvae; 30-61, 223-229, adults

Tephrosia dispuncta Walker, 1860, p. 405.

Macaria dispuncta, Hulst, 1896, p. 331.

Macaria granitata dispuncta, Barnes and McDunnough, 1917, p. 112.

Sciagraphia granitata, Dyar, "1902" [1903], p. 307, in part; 1904b, p. 105.

Sciagraphia dispuncta, Barnes and McDunnough, 1914, p. 208.

Semiothisa granitata, Packard, 1876, p. 285, in part. Forbes, 1948, p. 45, in part. McGuffin, 1955, p. 42. Ross and Evans, 1958, p. 40, in part.

Semiothisa granitata dispuncta, McDunnough, 1938, p. 158.

Semiothisa dispuncta, Ferguson, 1954, p. 309.

Semiothisa spp. (*granitata* group), in part, Prentice, 1963, p. 408.

Boarmia inordinaria Walker, 1860, p. 488; 1861a p. 39.

Macaria ? subapicaria Walker, 1861a, p. 40; 1862b, p. 1641.

Macaria haliata Walker, 1861b, p. 885.

Macaria irregularata Walker, 1861b, p. 890. **Revised synonymy.**

Semiothisa granitata irregularata, McDunnough, 1938, p. 158. Forbes, 1948, p. 45.

Larentia ? exnotata Walker, 1962a, p. 1186. **Revised synonymy.**

Semiothisa granitata exnotata, McDunnough, 1938, p. 158. Forbes, 1948, p. 45.

Macaria quadrisignata Walker, 1866, p. 1655. **Revised synonymy.**

Semiothisa granitata quadrisignata, McDunnough, 1938, p. 158.

Semiothisa signaria dispuncta, McGuffin, 1972, p. 28.

DIAGNOSIS. *Dispuncta* is here defined as a subspecies of *signaria* associated with coniferous forests of the Hudsonian, Canadian, and Transition zones across most of the northern portion of North America. It is known to occur from Newfoundland to British Columbia, southward in the Appalachian region to North Carolina, and in the mountains of the West at least to northern California and to the Black Hills of South Dakota. Exactly how far southward it does extend in the Rocky Mountain region is uncertain because of confusion with *unipunctaria*. Northward, *dispuncta* does not seem to range as far as its host plants, but it is present in southern portions of the Yukon and Northwest Territories. It also occurs well up the north shore of the Gulf of St. Lawrence, on the island of Newfoundland, and is present at least in southern Labrador.

Distinguishing characters are subtle, variable and hard to describe, but in general appearance *dispuncta* tends to be the most lightly marked, uniformly brownish species of the complex, without strong contrasts in shade between the fore- and

hindwing, as in the bluish-gray forewing and brown hindwing of *submarmorata* and *banksianae*; also generally without the bold contrasts and conspicuous white ground of *oweni*, *pinistrobata*, *granitata*, or the very pale, straight-lined pattern of *fissinotata*.

S. signaria dispuncta is the only member of the complex whose host preferences are relatively unspecialized, as it is now known to feed naturally on many species of the following genera: *Pinus*, *Larix*, *Tsuga*, *Pseudotsuga*, *Picea*, and *Abies*.

TYPES. Of *dispuncta*, 1 female (Fig. 225) in the British Museum (Nat. Hist.) from St. Martin's Falls, Albany River, Hudson Bay [northern Ontario]; of *inordinaria*, 1 female (Fig. 224) in the Canadian National Collection from the "Township of Montcalm, June" (Province of Quebec); of *haliata* (Walker, not Guenée), 1 male and 1 female in the British Museum (Nat. Hist.) from New York and Nova Scotia respectively, the latter (Fig. 228) hereby designated the lectotype; of *irregulata*, 1 male (Fig. 229) in the British Museum (Nat. Hist.) from New York, presumably from Trenton Falls (collected by Doubleday); of *exnotata*, 1 female (Fig. 226) in the British Museum (Nat. Hist.) from Nova Scotia; of *subapicaria*, 1 male (Fig. 223) in the Canadian National Collection from "Canada", ex D'Urban collection (probably from southern Quebec); of *quadrisignata*, 1 male (Fig. 227) in the British Museum (Nat. Hist.) from North America, presented by A. S. Packard.

SYNONYMY. I have assigned all of the names above to the synonymy of *dispuncta* after careful study of photographs of the types, and of the actual specimens in the cases of *subapicaria* and *inordinaria*. This was done with little hesitation except in the case of *quadrisignata*, which I thought at first might be the same as *pinistrobata*, the recently described species that feeds on white pine, especially since *quadrisignata* is probably from the New England States. Even for a badly worn male, however, the type hardly shows enough contrast for that species, and appears to agree better with *dispuncta* from the same region.

FURTHER DESCRIPTION. **Male:** almost exactly like nominate *signaria* from Europe, but shade of brown markings a little more grayish, less yellowish; ground color whitish, commonly obscured almost entirely by rather uniform suffusion of gray-brown scales; suffusion of ground variable: some specimens (including most females) with ground less heavily dusted with darker scales; markings as in nominate *signaria*, and as shown in illustrations. **Female:** like male but commonly paler as a result of the pale ground being less obscured, and tending to have more complete markings.

Length of forewing: eastern males, 12.5–15 mm; eastern females, 11.5–14.5 mm. Mean wing length of eastern specimens: males (of 84), 13.42 mm; females (of 73), 12.91 mm. Forewing length of Pacific Coast males, 14–17 mm; Pacific Coast females, 13.5–16 mm. Mean wing length of Pacific Coast specimens: males (of 16), 15.38 mm; females (of 23), 14.91 mm. Specimens from the Rocky Mountain region in Alberta and British Columbia seem to be intermediate.

GENITALIA. Exactly as in nominate *signaria* in both sexes.

MATERIAL EXAMINED. Adults: 2142, of which 1444 were reared; larvae: several broods reared from eggs; genitalia slides: 5 male, 4 female.

DISTRIBUTION. **Newfoundland:** Salmonier and Topsail, Avalon Peninsula; Stephenville, Bay St. George; Doyle's, Codroy Valley; near tree line, Table Mt. trail, Long Range, SW. Newfoundland; Goose Bay, Labrador. **Nova Scotia:** North Mountain, 1460', French Mountain, 1390', and Cape Smoky, Cape Breton Highlands Nat. Pk.; Baddeck, Victoria Co.; Kelly Mt., near Englishtown, Victoria Co.; Pictou, Pictou Co.; Parrsboro, Glenville, Fox Point and near Refugee Cove, Cumberland Co.; Debert, Colchester Co.; Mount Uniacke, Hants Co.; Smiley Brook, near Brooklyn, Hants Co.; Halifax watershed area, Rockingham, Hammond's Plains, Waverley, Armdale, Purcell's Cove, MacNab's Island, West Dover, and Halifax, Halifax Co.; Isle Haute, Bay of Fundy; Centreville, Auburn, and top of North Mountain near Garland, Kings Co.; Petite Riviere and Green Bay, Lunenburg Co.; White Point Beach, Caledonia, and Lake Kejimikujik, Queens Co.; Annapolis Royal and South Milford, Annapolis Co.; Argyle, Yarmouth Co. **New Brunswick:** Dorchester, Westmorland Co.; Kent Co.; Bathurst, Poke-

mouche, Caraquet, and Inkerman, Gloucester Co.; York Co.; St. Leonard, Madawaska Co. **Quebec:** Alwin; Baie Comeau; Berthierville; Chelsea; Chote; Chutes aux Outardes; Dozois; Forestville; Lake Barrière, Gatineau Co.; Lac Cayamont; Lac Culotte; Laniel; La Tuque; Maniwaki; Montcalm; near Mt. Albert, Cascapedia Rd., Gaspé Peninsula; Mt. Laurier; Natashquan, Saguenay Co.; Newago; Nicholas L.; Notre Dame de Bois, Frontenac Co.; Otter L.; Pt. Alfred; Rimouski; Roberval, Roberval Co.; Rouyn, Rouyn-Noranda Co.; Sanmauer; Shipshaw, Chicoutimi Co.; St. Ambroise; St. Michel des Saints; Val d'Or; Villeneuve Township, Papineau Co. **Ontario:** Achroy; Algonquin Park; Angus; Ardenvale; Ascalon; Ballantrae; Bannockburn; Bancroft; Barrow Bay; Batchawana Bay, Lake Superior; Bell's Corner; Bisco-tasing; Brightside; Brule L.; Chief's Pt.; Cochrane; Colpoy's; Douglas; Dunsford; Durham; Eganville; Franktown; Glasgow; Golden L.; Godderham; Green's Cr.; Havelock; Hayward; Hazeldean; Hearst; Hillsdale; Kapuskasing; Kearney; Killaloe; Kiosk; Latchford; London; Low Bush; Mallorytown; Manetville; Maynooth; McDiarmid; Merrickville; Minaki; Moose Factory; Nipigon; New Glasgow; Nicholson; Norland; North Bay; Old Chelsea; Orr L.; Ottawa; Paris; Pass L.; Pontypool; Priceville; Purdy; Sand L.; Sauble Falls; Sault Ste. Marie; Searchmont; Servoss; Smoky Falls; South March; Stittsville; St. Williams; Sudbury; Temagami; Utopia; Vandonf; Wilson's Corners. **Manitoba:** Aweme; Berens R.; Flin Flon; Kississing; Norway House; Riding Mountain National Park; "S.F.R."; Thicket Por.; Victoria Beach; Whitemouth. **Saskatchewan:** Cookson; Harlan; Melfort; Nipawin; Pleasantdale. **Alberta:** 29 mi W. Airdrie; Athabaska R.; Banff; Blairmore; Blue Ridge; Boyle; Calgary; Carstairs; Colinton; Cypress Hills; Elkwater; Entrance; Faust; Fiddle Cr.; Jasper Nat. Pk.; Grouard; Hinton; Hotchkiss; Jasper; Kananaskis; Marlboro; Nordegg; North Bridge; Notikewan; Perryvale; Rock L. Rd.; Saunders; Seebe; Sexsmith; Smith; Slave L.; 19 mi S. Slave L.; Venice; Wandering R.; Waterton Lakes; Whitecourt. **British Columbia:** Material examined from 330 different localities in B.C., representing most areas of the province, but the majority of records from the southern interior. **Northwest Territories:** Hay River. **Yukon:** Mi. 611, Aishihik Rd.; Mi. 978, Alaska Hwy; Mi. 46, Atlin Rd.; Klondike; Mi. 217, Mayo Rd. **Maine:** Ashland; Biddeford; Cumberland Co.; Lincoln; Mt. Katahdin, 1800'; Passadumkeag Bog, Penobscot Co.; Sebec L.; Waldeboro; Wales. **New Hampshire:** Bretton Woods, 1600'; Center Harbor; Franconia; Halfway House, Mt. Washington toll road; Jefferson Notch Rd., 3000', Coos Co. **Vermont:** Mt. Mansfield, 4000'. **Massachusetts:** Barnstable; Jamaica Pond; Nantucket. **Connecticut:** Beckley Bog, near Norfolk, Litchfield Co.; Litchfield. **New York:** Bear Mt.; Big Indian Valley, Catskill Mts.; Evans Center; Greene Co., 2500'; Whiteface Mt. trail; Ilion; Ithaca; Keene Valley, Essex Co.; McLean Bogs Reserve, Tompkins Co.; Meacham L., Adirondack St. Pk.; Raybrook, Essex Co.; Richmond Gulf, Sardinia; West Farms, New York City. **Pennsylvania:** New Brighton; Scranton. **Michigan:** Port Huron. **Wisconsin:** Bailey's Harbor, Door Co. **West Virginia:** Spruce Knob, ca. 4600', Pendleton Co. **North Carolina:** Highlands, 3865'; Macon Co. **South Dakota:** Spearfish Cr., Black Hills; Upper Spring Cr., near Hill City, Black Hills. **Wyoming:** Crook Co. **Montana:** Glacier Nat. Pk. **Washington:** Baker L., Whatcom Co.; Bellingham; Easton; Elwha R. S., Olympia Mts.; Friday Harbor; Marten L., Whatcom Co.; Mt. Rainier; Olympia; Shelton, Mason Co.; Skyline Ridge, Whatcom Co.; Smith L., Whatcom Co. **Oregon:** Alsea Mt.; Baker; Crater L.; Detroit; Tillamook. **California:** Anderson Springs, Lake Co.; Deer Park, Placer Co.; Guerneville, Sonoma Co.; Hat Cr. Ranger Station, Shasta Co.; Keddie, Plumas Co.; Mt. St. Helena, Napa Co.; Wagon Camp, Mt. Shasta. **Alaska:** Ketchikan.

GEOGRAPHICAL VARIATION. *Semiothisa signaria* appears to be represented in North America by at least two visibly different geographic populations. Subspecies *disrupta* in the strict sense, which closely resembles the Palearctic form, varies little throughout most of its vast range in North America, but in the Pacific Coast region from southern Alaska to northern California there occurs a large, pale form, which seems to reach its best development on Vancouver Island and Puget Sound (Figs. 50–53, 56–61). For the present I leave this western form within the concept of *disrupta* as I do not understand its relationships. It resembles *Semiothisa fraserata*, which I describe as a new species from North Carolina.

S. signaria disrupta shows no major variation within any given region. Specimens collected by J. G. Franclemont at Highlands, N.C., and some that I collected in apparent association with red spruce near the top of Spruce Knob, W. Va., look exactly like *disrupta* from eastern Canada. In the Rocky Mountain

region of Alberta and British Columbia it becomes slightly larger and darker, the reared ones often closely approaching *perplexa* in appearance, although most remain readily distinguishable. Southward in the Rocky Mountain region, as in Washington, Oregon and the Black Hills of South Dakota, size changes little but the color again becomes paler, more so than that of eastern specimens.

Maximum size and paleness is attained by the north Pacific Coast population, previously mentioned. The occurrence of this form happens to coincide almost exactly with the distribution of Sitka spruce, but nothing is known of its host relationships. Although the material examined from Oregon and California has been inadequate, it would appear that the distinction between this north Pacific Coast form and *unipunctaria* becomes obscure southward, especially in northern California. There is thus a definite possibility that it is wrongly placed here, and belongs with *unipunctaria*. Knowledge of its host plants would help provide the necessary evidence, because *unipunctaria* is believed to feed only on *Pseudotsuga*, and *signaria* feeds on a wide variety of conifers. *Semiothisa unipunctaria* remains the only species from which *S. signaria* cannot always be satisfactorily distinguished, but at least where their respective subspecies, *perplexa* and *dispuncta*, occur sympatrically in the interior of British Columbia, there would seem to be no doubt that they are different species.

FLIGHT PERIOD. Newfoundland, 4 July–6 Aug.; Nova Scotia mainland, 29 May–23 July (mostly in June); Cape Breton Island, 15 June–5 Aug.; Ontario and Quebec, 19 May–17 Aug.; New England, New York, 3 June–2 Aug., with a few later records suggesting partial second generation emergence, as for example 9 Aug. on Nantucket, Mass. (2 specimens), 12 Aug. at Litchfield, Conn., 15 Aug. at Big Indian Valley, Catskill Mountains, New York, and 8 Sept. at McLean, Tompkins Co., New York; North Carolina (Highlands), 23 June–5 July; South Dakota, Wyoming, 27 June–6 July; Vancouver Island, B.C., 10 May–14 Aug.; California, 12 May–14 Sept. One generation is indicated for the eastern region except for occasional second brood emergences as noted for southern portions of the range. The data for Vancouver Island indicate at least a partial second brood, as some August specimens are very fresh. The data for California suggest two broods.

EARLY STAGES. The larva is curiously dimorphic, occurring as a dark, heavily pigmented, purplish form, and as a green form devoid of purple coloring. There is some variation between the two extremes, but in the broods reared I noted a strong tendency for the offspring of each female to be nearly all alike. The following larval descriptions are based on Nova Scotian material reared from eggs on spruce, fir, and larch.

Green form: Ground color bright green; subdorsal line pure white, bordered ventrally by a green stripe darker than the ground; position of middorsal line marked by a dark green line bordered outwardly by a pair of addorsals of a somewhat paler green than the ground color; lateral line (i.e., the spiracular or stigmatal line) white, tinged with greenish or yellowish, sometimes varying to pale lemon yellow; minute brown spiracular openings lie within lateral line, near its dorsal edge; venter marked by a pair of dark green adventrals, bordered with whitish varying to pale green or yellow; adventrals separated by a narrow, green, midventral space, slightly paler than ground color; thoracic legs light brown to black, prolegs concolorous with green ground color. Head pale green, the epicranium marked laterally, or dorsolaterally, by a conspicuous blackish-brown dash, so situated that it appears in life as an extension of the dark green ventral component of the subdorsal line extending about half the vertical length of the head; this dark dash variable in color and extent, but seemingly always present (as in most of the related species). Setae and ocelli shining black. The green larvae tend to turn pinkish before pupation.

Purple form: Usual green ground color in this form obscured to a varying extent by dark purplish-brown pigmentation; entire dorsal area may appear purplish, with weak, sinuous, greenish or yellowish addorsals; green dorsolateral line replaced by a wide, dark, purplish stripe, bordered above by a reduced white subdorsal which may be segmentally interrupted, or even vestigial; lateral line (spiracular) pure white to yellowish, commonly interrupted by a prominent dark purplish spot in the middle of each segment (Fig. 11); underside marked by a pair of dark purplish subventral stripes, almost as wide as dorsolaterals, sometimes with a thin, white lateral margin. Thoracic legs with chitinous parts reddish brown, dark purplish basally; prolegs green to purplish. Head mostly dark, with a pale area dorsally and frontally, this being an epicranial extension of the pale dorsal area of the body; head with a dark brown area dorsolaterally, appearing as a continuation of the dark dorsolateral stripe, and laterad of this again a diffuse paler shade, opposite the white lateral stripe of the body; pale frontal and lateral areas of head tending to be marked by irregular spots of dark brown. Maximum length: 21 mm.

Dyar (1904b) described the early stages of this species under the name *Sciagraphia granitata*, having reared it from eggs at Kaslo, B.C. The larvae fed on spruce, choosing the needles of the previous year. His description of stage V (last instar), which follows, apparently represents a form intermediate between those I describe above and, if so interpreted, agrees well.

Stage V. Head rounded, slightly bilobed, clypeus level, broad; shining bluish green with a very broad band of black on the sides of the lobes, a little checkered in brown on its edges; width 1.8 mm. Body cylindrical, moderate, normal, smooth; bluish green like the old spruce needles, shaded with white; a white addorsal border to the dorsal vessel; white subdorsal lines, faint at the ends, both greenish white, not contrasted; an irregularly mottled triplicate black lateral band, touching the lower edge of the subdorsal line, not reaching the faint white, diffuse stigmatal line. A similar, less distinct triplicate subventral band, touching a faint white, ventral line. Thoracic feet brown, those of joint 10 green, of joint 13 black shaded. Tubercles concolorous, obsolete, setae rather long, black. Later olivaceous blackish spots shown distinctly on joints 6 to 8 in the substigmatal band.

The larvae entered the earth to pupate early in July; no moths emerged.

Ross and Evans (1958) also described the larva from British Columbia, under the name *Semiothisa granitata*, and listed various host plants. Their description is brief, but would seem to represent an intermediate color form. The early stages have been discussed more recently by McGuffin (1972: 29).

Although *S. signaria dispuncta* is the least specialized in its feeding habits, accepting all species of conifers that are regularly fed upon by members of this complex, the data indicate the most favored hosts to be spruces, firs and hemlocks of all species, as well as larch and Douglas fir. Larvae have been collected from six species of *Pinus*, but the relative scarcity of such records suggests that the pines tend to be avoided by *dispuncta*.

Semiothisa fraserata new species

Figs. 62-70

DIAGNOSIS. This is an unusually large, contrastingly marked form known only from high elevations in the mountains of North Carolina. Most of the type material was taken 6000 ft in the Great Smoky Mountains in an almost pure stand of Fraser fir (*Abies fraseri* (Pursh) Poir.). As no specimens are known to have been taken in any locality where this tree is absent, there is strong circumstantial evidence that it is the host plant. I had earlier intended to treat this as only a subspecies of *signaria*, but the discovery that normal *S. signaria dispuncta* also occurs

in the mountains of North Carolina along with *granitata*, *fissinotata* and *pinistrobata* at lower elevations, makes it difficult to explain *fraserata* as anything other than a distinct species. *Fraserata* is very similar in size and appearance to the large Pacific Coast form discussed under *dispuncta* but is more heavily marked with blackish. The more brightly marked females resemble those of *oweni*, except for their larger size.

TYPES. Holotype male, Richland Balsam Mountain, 6000', Jackson-Haywood County line, North Carolina, 30 June 1967, D. C. Ferguson, U.S. National Museum Type No. 73021; allotype female, same locality and collector but taken 1 July 1967. Paratypes: 118 males, 52 females, same locality, 30 June – 3 July 1967, D. C. Ferguson and J. W. Porter; 1 male, Mt. Mitchell, North Carolina, 6500', 23 June 1937, Ernest Shoemaker coll.; 1 female, same locality, 6600', 20 June 1937, E. Shoemaker; 1 female, Mt. Mitchell, ca. 6000', Yancey Co., North Carolina, 28 June 1967, D. C. Ferguson. Paratypes are being distributed to the collections of the U.S. National Museum, American Museum of Natural History, Peabody Museum of Natural History of Yale University, British Museum (Nat. Hist.), and to the Canadian National Collection.

FURTHER DESCRIPTION. **Male:** basically like that of *dispuncta* and similarly variable, but with a tendency to show more white ground color as in *pinistrobata*, and with the usual lines and spots comprising the pattern of the forewing more complete and darker, being very nearly black; medial line of forewing more commonly present and complete; subapical costal and median subterminal spots of forewing subequal, generally better developed than in *dispuncta*, and virtually black. **Female:** generally paler, brighter, better marked than male, showing more of the white ground color, and differing correspondingly from female of *dispuncta*; contrast between light and dark areas of wing much greater than in *dispuncta*, and in extreme examples approaching that of *oweni*.

In both sexes the blackish markings, including the subapical spot, are devoid of any warm brown tints, except on the underside, and the general gray-brown coloring of the wings, above and beneath, is grayer, less brownish, than in eastern *dispuncta*. *Fraserata* most closely resembles *signaria* of the Pacific Coast region, as mentioned in the diagnosis.

Length of forewing: holotype male, 16 mm; other males, 14–16 mm; allotype female, 15 mm; other females, 13–15 mm. Mean length of forewing: males (of 24), 15.35 mm; females (of 14), 14.36 mm.

GENITALIA. Indistinguishable from those of *S. signaria* in both sexes, except for larger size proportional to the size of the moth.

MATERIAL EXAMINED. 176 adults; 2 male, 2 female genitalia slides.

DISTRIBUTION. **North Carolina:** Richland Balsam Mountain, 6000', Jackson-Haywood County line; Mt. Mitchell, Yancey Co., at 6000–6500'; Black Mountains (7 specimens in collection of American Museum of Natural History).

GEOGRAPHICAL VARIATION. None.

FLIGHT PERIOD. All known material taken 20 June – 3 July except one female from the Black Mountains bearing the date 29 August 1911, this indicating at least a partial second generation.

EARLY STAGES. Unknown.

REMARKS. The material from the type locality was taken at light in the Fraser fir forest on the south side of the Blue Ridge Parkway, 600–800 ft down the slope from the Richland Balsam overlook. This site is on the crest of a westward sloping ridge where Fraser fir is the dominant tree, although some red spruce is also present. The Mt. Mitchell records were of course taken in the spruce-fir zone near the summit.

Semiothisa unipunctaria unipunctaria (Wright)

Figs. 71-82

Melanolophia unipunctaria W. S. Wright, 1916, p. 458.*Macaria unipunctaria*, Barnes & McDunnough, 1918, p. 148, pl. 21, figs. 10, 11.*Semiothisa unipunctaria*, McDunnough, 1938, p. 158.

DIAGNOSIS. *S. unipunctaria* is a relatively large western species occurring in its nominate form in the mountains of California, Nevada, Arizona, Utah, Colorado and New Mexico, where it is apparently associated with *Pseudotsuga*. It is to be expected that its distribution will coincide locally with that of its host plant. Nominate *unipunctaria* is pale, lightly marked, rather evenly dusted with dark scales, and often distinctively marked with a light brown subapical costal patch. Beginning in Colorado and thence northward through the Rocky Mountains to Alberta and British Columbia, the color gradually darkens, culminating in subspecies *perplexa*, the very different looking form that McDunnough described as a distinct species from British Columbia. The relationship between *unipunctaria* and the similarly large, pale, north Pacific Coast form discussed under *signaria* is highly uncertain, and careful field investigation is needed to clarify the taxonomic status of that form.

TYPES. Described from a male type and one male paratype from Glen Alpine Creek, Tahoe, Calif., 25 June 1915, collected by E. P. Van Duzee. These were in Wright's collection which is now in the San Diego Natural History Museum. I have not seen the types but have been able to study a series of 112 specimens in the U.S. National Museum from the vicinity of Tahoe City. The photograph of the paratype mentioned by Barnes and McDunnough (1918: 148), which I have examined, clearly represents the species that I here associate with the name.

SYNONYMY. None. There is a possibility that the nomen dubium, *haliata* Guenée, refers to this species and would have priority.

FURTHER DESCRIPTION. Sexes essentially alike except that the female may be paler. General coloration similar to that of *disrupta*, light gray-brown resulting from a rather even distribution of dark brown scales on a light ground. The usual three lines crossing the forewing dark brown, erect on inner margin, waved, subparallel, commonly weak and indistinct except near costa (but see discussion under geographical variation). Subapical costal spot subquadrate, commonly pale, contrasting yellowish brown proximally, darkening distally, but varying from all dark to obsolescent. Median subterminal spot dark brown, variable from well developed to absent, normally present but rather weak, diffuse. Hindwing about same color as forewing, faintly marked with only traces of one to three lines at inner margin, and a small discal spot. Underside with lines indistinct, diffuse, but with distinct discal spots on both wings.

Length of forewing: male, 15-17.5 mm; female, 15-17.5 mm. Mean forewing length: male (of 18), 16.42 mm; female (of 18), 16.53 mm.

MALE GENITALIA. Like those of *signaria* and most other species of the group; distal margin of ventral lobe of valve perhaps slightly more produced.

FEMALE GENITALIA. Hardly differing from those of *signaria* but larger, with a longer, tapering neck region on the bursa copulatrix, and a sterigma that is slightly truncated.

MATERIAL EXAMINED. 170 adults; 3 male, 3 female genitalia slides.

DISTRIBUTION. **California:** Glen Alpine Cr., Tahoe (types); Ward Cr., 2 mi S. of Tahoe City; Deer Park Springs, Lake Tahoe; Mt. St. Helena, Napa Co.; Monache Meadows, 8000', Tulare Co.; Greenhorn Mts., Kern Co.; Silver L., Amador Co.; Spring Mt., Sonoma Co.; Mt. San Hedron, Lake Co.; Dunsmuir, Siskiyou Co. **Nevada:** Kyle Canyon, 7500', Mt. Charleston, Clark Co. **Arizona:** Redington; Tucson; Palmerlee, Cochise Co.; Williams; Huachuca Mts.; White Mts., Apache Co.; Hochdorffer Hill, 8500', 12½ mi NNW. of Flagstaff, Coconino Co.; West Fork, 6500', 6½ mi ESE. of Flagstaff. **New Mexico:** Little Tesuque Canyon, vicinity of Santa Fe, 9200'. **Utah:** Vineyard; Snake Creek, near Midway,

Wasatch Co.; Cedar Breaks, Iron Co. **Colorado:** Chimney Gulch, Golden; Silverton; Science Lodge, Boulder Co., 9500'.

GEOGRAPHICAL VARIATION. Specimens from California, Nevada and Arizona mostly look alike, although those from Clark Co., Nevada, have a grayer, more crisply dusted appearance. The trend toward general darkening, including intensification of the three lines of the forewing and darker suffusion of the brown subapical spot, begins in Utah, Colorado, and perhaps even Arizona. The Utah specimens from Vineyard and near Midway are very pale, whereas that from Cedar Breaks is dark, approaching *perplexa*. Colorado specimens are intermediate, having heavier lines and darker coloration, except for one female from Golden that resembles typical *perplexa*. Five specimens in the U.S. National Museum from the White Mountains, Arizona (one labelled Hannagan's), are unlike other Arizona specimens examined in being more coarsely dusted with blackish and lacking any indication of the light brown subapical spot. They most closely resemble material from Montana discussed under *perplexa*. There is also the possibility that they are not *unipunctaria* but represent an Arizona population of *signaria* or an unrecognized species. The genitalia show no distinguishing features.

FLIGHT PERIOD. 13 June – 17 August, except that the specimen from Dunsmuir, Calif., bears the date 25 May, and specimens from Napa, Lake and Sonoma counties, California, were taken in April and September. These dates indicate one generation throughout most of the range but at least two generations in the Pacific Coast region.

EARLY STAGES. *S. unipunctaria* was reared on *Pseudotsuga* by Dr. R. W. Poole from a female taken near Flagstaff, Ariz. (pers. comm.). Its distribution in the Rocky Mountains and the Sierra Nevada strongly suggests an association with Douglas fir, consistent with what is known of its northern subspecies, *perplexa*.

***Semiothisa unipunctaria perplexa* (McDunnough)**

Figs. 83–91, 222

Macaria perplexa McDunnough, 1927, p. 244.

Semiothisa perplexa, McDunnough, 1938, p. 158.

Semiothisa unipunctaria perplexa, McGuffin, 1972, p. 33, fig. 88 (holotype).

DIAGNOSIS. It seems almost certain that *perplexa*, known mostly from Alberta and British Columbia, is a dark northern form of *unipunctaria*. I include here also the material collected in Montana, and similar specimens are to be expected in Washington, Idaho and Wyoming, although none is available. The very large sample of reared material studied indicates an almost exclusive association with *Pseudotsuga*, the few exceptions being perhaps accidental. It takes an experienced eye to separate all specimens of *perplexa* from *signaria dispuncta* and *banksianae*, but *perplexa* retains the large size, reduced median subterminal spot, and even sometimes the light brown subapical costal spot of nominate *unipunctaria*. Thus their similarity of size, appearance and food preference, as well as probable continuity of distribution, would seem to link *unipunctaria* and *perplexa* as one species. The sympatry of subspecies *perplexa* with *signaria* northward, where there is actually an intensification rather than a loss of distinguishing characters, suggests that *unipunctaria* and *signaria* are biologically distinct.

TYPES. The holotype (Fig. 222) is a male from Nicola, B.C., 24 May, No. 2546 in the Canadian National Collection. The allotype female is from Seton Lake (Lillooet), B.C., 6 June, and 3 male and 3 female paratypes are from Seton

Lake, Keremeos and Field, B.C., and Banff, Alta. All are in the Canadian National Collection.

SYNONYMY. None.

FURTHER DESCRIPTION. Little need be said to supplement the illustrations. The apex of the forewing is less acute than that of nominate *unipunctaria*, being frequently quite rounded in both sexes, more so than in any other species of the group. The usual pale ground color tends to be obscured, almost completely in males, less so in females, by brownish suffusion of a bluish-gray tint. The females, as indicated, are often generally paler than the males, having more of the whitish ground color showing. Both the median subterminal and subapical costal spots tend to be reduced, as in nominate *unipunctaria*, and at least a trace of the yellow-brown coloring, characteristic of the subapical spot in *unipunctaria*, is preserved in about one-third of the British Columbian specimens of *perplexa*. Montana specimens do not show it. The underside of *perplexa* is more yellowish than the upperside and is marked with diffuse bands and patches of reddish brown.

Length of forewing: male, 14–16.5 mm; female, 14–17 mm. Mean forewing length: British Columbia males (of 13), 15.31 mm; British Columbia females (of 19), 15.63 mm; Montana males (of 10), 14.60 mm; Montana females (of 7), 15.13 mm.

GENITALIA. Similar to those of the nominate form in both sexes.

MATERIAL EXAMINED. 375 adults, including types; 4 male, 2 female genitalia slides.

DISTRIBUTION. **British Columbia:** Athlmer; Ashcroft; Adams L.; Agate Bay Rd.; Australia Ranch; Alexandria; Alexis Creek; Anahim Cr.; Alkali L.; Aberdeen L. Rd.; Armstrong; Ashton Cr.; Barrière; Brideville; Barnhartville; Beaverdell; Boston Bar; Brisco; Baynes L.; Christina L.; Cranbrook; Canal Flats; Clinton; Chilcotin Rd.; Copper Mt.; Cache Cr.; Commonage; Creighton Valley; Creston; Cherry Cr.; Cinnemaus; Cornwall Lodge; Carquille; Chase; Camp Lister; Cisco; Celasta; Cascade; Chu Chua; Caribou; Deadman's R.; Dunn L.; Dutch Cr.; Deep Cr.; Penticton; Enderby; Elko; Edgewater; Ewing's Landing; Eneas Cr.; Forest L.; Falkland; Field; Fairmont; Fife; Ft. Steele; Finley Cr.; Free Cr.; Flathead R.; Golden; Grand Forks; Galloway; Graham's Landing; Goat Cr.; Hanceville; Heffler Cr.; Hospital Cr. Rd.; Halston Jct.; Hedley; Invermere; Kalemalka L.; Kaslo; Kamloops; Kelowna; Keremeos; Kettle Valley; Knutsford; Kimberley; Kokanee; Lumby; Lillooet; Lyons L.; Lac le Jeune; Louis Cr.; Lower Nicola; Lytton; Luxon Cr.; Larkin; Loon Cr.; Monte L.; Missazullah; McCulloch; McKinnley Cr.; Martin Cr.; Marguerite; Moyie L.; Mabel L.; McKay Cr.; Moha; Nicola; Niskonlith; Newgate; Okanagan L.; 150 Mi. House; Okanagan Falls; Oliver; Paxton Valley; Princeton; Pinaus L.; Pinintan L.; Pavillion; Pillar L.; Parson; Port Coquitlam; Premier L.; Quesnel; Rampart; Rossland; Riske Cr.; Rock Cr.; Ravine Cr.; Radium; Rayleigh; Revelstoke; Seton L. (Lillooet); Shuswap Falls; Sinclair; Skookumchuk; Squilax; Spillimacheen; Snowball Cr.; Summerland; Salmon R.; Sooke; Soda Cr.; Seymour Arm; Sweats Bridge; Webb's Bridge; St. Mary's Road; Slocan; Venable's Valley; Vernon; Wardner; Westwold; Whatshan L.; Westbank; Williams L.; Wilson's Landing; Westbridge; Wells Rd.; Wilmer; Whiskey Cr.; Windermere; Upper Columbia R.; Whitman's Cr.; Wedgeon L.; Wasa; Wyndell; Whipsaw Cr.; Woods L. **Alberta:** Banff; Crowsnest Pass. **Montana:** Big Timber Canyon, ca. 6500' (Halfmoon Park), Crazy Mts., Sweetgrass Co.; Glacier Nat. Pk.

GEOGRAPHICAL VARIATION. Montana specimens of both sexes tend to be somewhat paler than those from British Columbia and show almost no indication of the light yellowish or reddish brown coloring in the subapical costal spot characteristic of nominate *unipunctaria*. A small proportion (less than one-third) of the reared material from British Columbia has at least a trace of such coloring. Although this species must be present in Washington, Idaho and Wyoming, no material from those areas is available for study. A few specimens from Colorado, treated under nominate *unipunctaria*, are distinctly darker than normal southwestern *unipunctaria* and would thus appear to represent one stage in a cline toward subspecies *perplexa*.

FLIGHT PERIOD. As most of the material studied was reared from larvae, little data exist on the normal time of flight. Records for British Columbia fall

within a period from 24 May (type) to 13 July; for Alberta, 14 June – 17 July; for Montana, 27 June, 6 July.

EARLY STAGES. According to Ross and Evans (1958: 40), the larva is quite similar to that of *S. signaria dispuncta* (which they described under the name *granitata*). It was also described by McGuffin (1972: 33). Of 344 reared specimens that I examined, 330 had been reared from *Pseudotsuga menziesii* (Mirb.) Franco, five from *Pinus contorta latifolia* Engelm., four from *Abies* species, two from *Tsuga heterophylla* (Raf.) Sarg., and three from *Picea* species. Assuming that the sampling was without bias, yielding as it did similarly large numbers of related species (*signaria*, etc.) from other conifers, it seems safe to conclude that *perplexa* has a very definite preference for *Pseudotsuga*.

***Semiothisa pinistrobata* Ferguson**

Figs. 16–18, larvae; 20–25, 92–111, adults

Semiothisa pinistrobata Ferguson, 1972, p. 563. McGuffin, 1972, p. 31.

DIAGNOSIS. This is a northeastern species with a distribution that coincides with that of its host plant, white pine (*Pinus strobus* L.). The adults are about the same size as those of eastern *S. signaria dispuncta*, but in appearance tend more toward the contrasting coloring of *granitata* and *oweni*, with the ground color more whitish and the markings darker than in *dispuncta*. The preapical costal spot is not normally lighter brown as in *granitata* but blackish, and the black and white effect of the pattern is rarely, if ever, as extreme as in *oweni*, for which this species has nevertheless often been mistaken. As in *dispuncta*, there is some tendency toward sexual dimorphism, the females being paler. This is the only species of those treated in this paper in which industrial melanism is known to have developed (see discussion under geographical variation).

TYPES. Holotype male (Fig. 92) from Lake Kejimikujik, Queens Co., Nova Scotia, 2 July 1968, D. C. Ferguson, Type No. 72054 in U.S. National Museum; allotype female (Fig. 100), same data, also in U.S. National Museum. There were 90 male and 87 female paratypes designated, all from various localities in Nova Scotia and from my collection, now in the U.S. National Museum, although a few have been distributed to other collections.

SYNONYMY. None, but in the collection of the U.S. National Museum there is a male of this species labelled "Me./Macaria correlata Type Hulst". This specimen, received from the Museum of the Brooklyn Institute, was entered as Type No. 34219 in the USNM type register, with the locality given as North Carolina, rather than M[ain]e as indicated by the label. I have found no evidence that the name *Macaria correlata* was ever published, although Hulst (1896: 355) did describe *Selidosema correllatum* (a synonym of *Itame colata* Grote). The types of *S. correllatum* were from Colorado, California, and Oregon. The specimen from Colorado is in the American Museum of Natural History (Rindge 1955: 140); the other two are in the U.S. National Museum.

FURTHER DESCRIPTION. **Male:** forewing above with ground color whitish, variably dusted or shaded with gray to blackish scales, space between medial and postmedial lines usually palest; three lines commonly present, irregularly waved, blackish, expanded at costa, tending to fade out toward inner margin; medial often weakest; dark preapical costal spot variable but normally strong, subquadrate, usually very dark, almost blackish, occasionally browner suggesting that of *granitata*; median subterminal spot blackish, highly variable, sometimes even obsolete, hence of little value as a character, averaging about the same size as preapical costal spot; hindwing brown, usually much less marbled with white than forewing, especially toward costa, markings obsolescent except toward inner margin, where the three

lines become visible. Underside whitish, extensively shaded with light yellowish brown, often forming two ill-defined bands across the hindwing but no discrete markings on the forewing; preapical costal spot replaced beneath by area of light brown; costa, immediately before and after postmedial, often marked by areas of light buff yellow. Underside more decidedly brownish than that of *S. signaria dispuncta*, not as contrasting as in *granitata* or *oweni*, but similar to that of *submarmorata*. **Female:** like male but generally much paler, with white ground more extensively apparent both above and beneath; upperside of hindwing variable, either like that of male or uniformly marbled with white from inner margin to costa.

The melanic specimens (both sexes) show all degrees of darkening, although most (about 95%) are extremely dark, not intermediate. Rare individuals are just slightly darker than normal. In the darkest melanics the usual markings are nearly obliterated, except for a contrasting whitish subterminal present on the forewing in females but not in males. The hindwing is paler than the forewing, and the underside, especially along the veins, postmedial lines and costa, is shaded with rusty red-brown.

Length of forewing: male, 12–15 mm; female, 12–14.5 mm. Mean forewing length: males (of 75), 13.45 mm; females (of 56), 13.15 mm.

GENITALIA. Doubtfully distinguishable from those of *signaria*, although, in the female, the ductus bursae seems slightly stouter.

MATERIAL EXAMINED. 589 adults; 6 male, 2 female genitalia slides; 4 broods of larvae reared from eggs.

DISTRIBUTION. **Nova Scotia:** Halifax; Armdale, Halifax Co.; Waverley, Halifax Co.; Kearney Lake Road, Halifax Co.; MacNab's Island, Halifax Harbour; Mount Uniacke, Halifax-Hants Co. line; Smiley Brook, near Brooklyn, Hants Co.; Debert, Colchester Co.; Centreville, Kings Co.; Bridgewater, Lunenburg Co.; Petite Riviere, Lunenburg Co.; White Point Beach, Queens Co.; Caledonia, Queens Co.; Lake Kejimikujik, Queens Co.; South Milford, Annapolis Co.; Annapolis Royal, Annapolis Co. **New Brunswick:** Bathurst; Caraquet; Chamcook. **Quebec:** Dunlop Rd., Gatineau Pk.; Norway Bay; Kazubazua; Gracefield; Wright, Meach Lake, Ottawa Co.; Chelsea, Ottawa Co.. **Ontario:** Ottawa; Mer Bleue, near Ottawa; Toronto; Severn; Port Colborne; Constance Bay; Orillia; Thousand Islands; Bancroft; Angus; Missinabie; Chantry; Maynooth; Millridge; Biscotasing. **Maine:** Lincoln; Passadumkeag Bog, Penobscot Co.; West Pt., Little Wood Is.; Rangely; Sebec Lake; Augusta; Rumford; Wales; Waldeboro; Biddeford. **New Hampshire:** Bretton Woods; Cherry Mt., Coos Co.; Franconia; Monacknock (sic); Wolfboro; Hampton; Center Harbor; Union; Concord. **Vermont:** "Vt.". **Massachusetts:** Barnstable; Newton Highlands. **Connecticut:** Hamden, New Haven Co.; Washington, Litchfield Co. **New York:** Picton Island, Clayton; Ithaca; Ringwood Reserve, near Dryden, Tompkins Co.; East Concord; Catskill Mts. **New Jersey:** Fort Lee. **Michigan:** Clinton Co.; Rochester. **North Carolina:** Bat Cave, Henderson Co.; Highlands, Macon Co.; Mitchell Co.

GEOGRAPHICAL VARIATION. Except for the well-established industrial melanism in the vicinity of Halifax, N.S., this species varies little throughout its range. I have been able to examine adequate samples from widely separated localities. Twenty-two males and eight females collected by Dr. J. G. Franclemont at Highlands, N.C., appear similar to the normal, pale Nova Scotian specimens in every way, as do those from New York and most of New England. Fourteen males that I collected in a white pine grove just west of Concord, N.H., are more uniformly grayish and less well marked than usual.

The population of *S. pinistrobata* near Halifax, N.S., provides the only known example of industrial melanism in American species of *Semiothisa*. In 1944 and 1945 I collected the first such specimens at my home at Armdale, Halifax Co. (now a part of metropolitan Halifax), and have continued accumulating material from the same locality until 1973. Between 27 and 29 July 1967, and 8 to 20 July 1972, I collected a total of about 175 specimens and noted on both occasions that the population appeared to be exactly half black and half normal. Several were intermediate (Fig. 25) but would still be classed as melanic. The melanism is localized in a few isolated remnants of the original pine forest on the outskirts of the city.

I have seen only one similarly black example of this species from another area, a male labelled Clinton Co., Michigan, 11 June 1971.

The question might arise as to why industrial melanism should develop in an area relatively removed from the major centers of population, and indeed whether this is a case of industrial melanism at all. During many years of residence in one of these areas of white pine, where dwindling stands of the original forest still survive, I became familiar with the circumstances. Although air pollution is minimal, the white pine itself being intolerant of a smoky atmosphere, the bark on these trees is nevertheless almost totally devoid of lichens and so dark in color that the cryptic advantage thus conferred upon the melanic moths is very obvious. The dark moths match the bark almost perfectly (Figs. 23–25); the normal gray ones are conspicuous (Fig. 22). The pine trunks are even darker when wet (and sometimes greenish with algae), and the combination of moist bark and no lichens provides the conditions most favorable for the melanic form. With a summer rainfall of 24 in. (April–September, inclusive) and about 70 foggy days per year, conditions in this locality could decisively favor the melanic moths during a large proportion of the time.

As a basis for comparison, I examined the trunks of white pines in the vicinity of Kejimikujik National Park, in the sparsely inhabited interior of south-central Nova Scotia. There the bark was heavily encrusted with gray lichens, providing a perfect substratum, presumably the natural one, for resting moths of the normal form. Despite the heavy growth of lichens, generally indicative of moisture, this inland locality has only 10 foggy days per year and slightly less rainfall than the coastal area, so that the lighter, dryer bark, even without lichens, would reinforce the advantage conferred upon the normal gray form in that area.

Unfortunately, the year to year sampling at Armdale was not adequate to indicate whether any change in the proportions of the two forms occurred between 1944 and 1972. Neither is there any evidence as to when the melanic form first appeared. The small stands of pine in this locality support several species of *Semiothisa* and other pine-feeding Lepidoptera in some abundance, but industrial melanism appears to have arisen only in the one species. I do not know why the melanic form of *S. pinistrobata* has not replaced the normal form near other, larger cities in eastern North America where the species occurs; of course it may occur and not have been collected.

FLIGHT PERIOD. In Nova Scotia, 29 May – 18 Aug., with the peak from late June to mid July; two or three August specimens fresh, suggesting a small, partial second generation. In Ontario, Quebec, New England, New York, 21 May – 3 Aug., and 14 Aug. – 14 Sept., also with only partial second brood emergence indicated. In North Carolina, 9 June – 16 July, with no late summer collection records available.

EARLY STAGES. *Semiothisa pinistrobata* is invariably associated with *Pinus strobus* L. wherever this tree grows, and apparently feeds on no other host with the possible exception of *Larix*.

The larva (Figs. 16–18), although basically not very different from those of the other species, shows an obvious cryptic adaptation to feeding on the slender, blue-green needles of white pine. It is the most slender larva of the group and shows a reduction of the pink or purplish coloring, with intensification of the green ground color and white stripes. The only dark shade remaining dorsally is a thin, sharply defined, deep purplish, almost black spiracular stripe. Adjoining this dorsally is a pure white subdorsal stripe of equal width. A green middorsal line of similar width is flanked by a pair of irregular, yellowish-white addorsals, ill-defined outwardly where they may almost blend with the subdorsals. Laterally,

there is a well-defined spiracular stripe, alternating segmentally between pure white and diffuse yellowish shades, this stripe being separated from the dark supraspiracular by an intervening green line. The underside is green with a rather sharply defined pair of blackish subventral stripes, thinly margined with white. The thoracic legs are black, the prolegs green. The head is also green, contrastingly marked laterally with black, this being a projection of the supraspiracular stripe of the body. Beneath this, also on the side of the head, there is at least a trace of cream-colored shading, representing an anterior projection of the spiracular stripe. The linear pattern of the body is apparently never interrupted by dark spiracular spots or blotches as in *dispuncta* and *submarmorata*. Thus the long, slender larva of *pinistrobata*, stretched out full length on a pine needle in characteristic resting posture, blends almost imperceptibly with the white-striped green foliage of white pine.

The foregoing larval description was based on broods reared from females taken in Nova Scotia.

Semiothisa fissinotata (Walker)

Figs. 13-14, larvae; 112-131, 230-231, adults

Acidalia ? *fissinotata* Walker, 1862*b*, p. 1595.

Macaria retinotata Walker, 1862*b*, p. 1642.

Semiothisa fissinotata, McGuffin, 1972, p. 29.

DIAGNOSIS. A pale, lightly marked eastern species with postmedial line relatively straight and medial line indistinct or wanting. Associated with eastern hemlock (*Tsuga canadensis* (L.) Carr.) and probably Carolina hemlock (*Tsuga caroliniana* Engelm.), and with a distribution coinciding with that of the host plants. Spring emergence is early, with the peak of the flight averaging about 2 weeks earlier than that of the most closely related species, and in most areas a partial second generation in mid-summer. Once identified, this species is easily recognized by its light color, simplified pattern and host plant association, although for 110 years following Walker's original description it remained unaccepted as a species distinct from *granitata*.

TYPES. Of *fissinotata*, 2 males in the British Museum (Nat. Hist.) from Trenton Falls, N.Y., of which I hereby designate as lectotype the specimen shown in Fig. 230. Of *retinotata*, 2 females in the British Museum from Nova Scotia, of which I hereby designate as lectotype the specimen shown in Fig. 231.

SYNONYMY. The lectotype of *retinotata*, being a distinctively marked female agreeing with many other specimens examined from Nova Scotia, is more readily identifiable than *fissinotata*, but the latter has page priority. I have carefully compared the photograph of the type of *fissinotata* with many New York specimens, and consider that there is little if any doubt that it represents the present species.

FURTHER DESCRIPTION. **Male:** whitish ground color rather evenly dusted with brown or fuscous scales, giving a relatively uniform gray-brown effect except in those very pale specimens which have a predominantly white ground. Usual markings reduced and simplified, dark brown to blackish. Antemedial and postmedial lines of forewing present, weak, often interrupted, occasionally obsolescent, the latter more nearly straight than in other species of the group. Medial line wanting or only faintly indicated, mostly near costa. Median subterminal spot and preapical costal spot variable but tending to be much reduced, sometimes almost wanting. Hindwing above rather uniformly mottled with gray-brown or fuscous, the dark scaling sometimes arranged as a weak postmedial or partial medial band, more rarely as an antemedial. Fringes of both wings, which are lightly checkered, more yellowish than in any other species. Underside as pale or paler, with the markings of the upperside repeated indistinctly. Costa shaded with yellowish brown, especially beyond postmedial in position of preapical costal spot. **Female:** like male but broader winged, with the usual dark lines and spots more heavily indicated, including a more complete or frequent medial shade. More contrast between whitish ground and fuscous shading, giving wing a more variegated appearance than in male.

Reared specimens from both spring and summer generations tend to be much darker and more heavily marked than caught ones, but otherwise the characters are retained consistently.

Length of forewing: male, 12–14 mm; female, 11.5–14 mm. Mean length: male (of 38), 13.09 mm; female (of 38), 12.72 mm.

MALE GENITALIA. Indistinguishable from those of *S. signaria*.

FEMALE GENITALIA. For the most part indistinguishable from those of *signaria*, but apparently tending to have a very slightly longer, more slender ductus bursae and shorter neck region in the bursa.

MATERIAL EXAMINED. 294 adults; 3 male, 3 female genitalia slides; 5 broods of larvae reared from eggs.

DISTRIBUTION. **Nova Scotia:** Lake Kejimikujik, Queens Co.; Caledonia, Queens Co.; Annapolis Royal, Annapolis Co.; Lequille, Annapolis Co.; Auburn, Kings Co.; Bridgewater, Lunenburg Co.; Boulderwood and Williams' Lake, near Halifax; Rockingham, near Halifax; Hammond's Plains, Halifax Co.; Kearney Lake Rd., Halifax Co.; North Mountain, 1460', Cape Breton Highlands Nat. Pk. **Quebec:** Aylmer, Ottawa Co.; Brome; Chelsea; Kazubazua; Knowlton; Meach Lake, near Ottawa; Norway Bay. **Ontario:** Fisher Glen; Kettleby; Orangeville; Severn; Tillsonburg. **Maine:** Passadumkeag, Penobscot Co. **New Hampshire:** Concord; Jefferson, Coos Co. **Massachusetts:** Barnstable; Leverett. **Connecticut:** Beckley Bog, near Norfolk, Litchfield Co.; Bethany, New Haven Co.; Hamden, New Haven Co.; West Rock Park, New Haven; Yale Preserve, New Haven. **New York:** Yonkers, Westchester Co.; Bronx Park, New York City; Bear Mt.; Big Indian Valley, Catskill Mts.; West Shokan; Ilion; Tuxedo; Trenton Falls; Ithaca; McLean Bogs Reserve, Tompkins Co.; Ringwood Reserve, near Dryden, Tompkins Co.; Richmond Gulf, Sardinia. **New Jersey:** Boonton; Forest Hill; Green Pond, near Montclair; Newfoundland; Oakland; Paterson. **Pennsylvania:** Delaware Water Gap; Germania, Potter Co.; Longwood Gardens, Chester Co.; New Brighton; Scranton. **Kentucky:** Koomer Ridge Camp, Wolfe Co.; Natural Bridge St. Pk., Powell Co.; Valley Sta.; Daniel Boone Pk. **North Carolina:** Balsam, 3200', Jackson Co.; Bat Cave, Henderson Co.; Highlands, Macon Co. **South Carolina:** Cherry Hill Recreation Area, Oconee Co. **Georgia:** Tate Br. Campg., Chatahoochee N.F., Rabun Co.

GEOGRAPHICAL VARIATION. Very slight. Spring brood specimens everywhere seem paler and less heavily marked than summer ones. Thirty-three specimens examined from the Carolinas nearly all represent the summer brood and are similar to northern second brood specimens, although perhaps slightly larger.

FLIGHT PERIOD. In Nova Scotia, 28 May–23 June (one worn specimen 3 July on Cape Breton Island), and 2–21 July. In Quebec and Ontario, 27 May–16 June, and 2–21 July. In New England, 4 May–2 July and 6 July–4 Sept. In New York, New Jersey, Pennsylvania, 19 April–28 June and 10 July–17 Sept., but probably with some of the late June records representing second generation emergences. In Kentucky, 18–24 May and 5–15 July. In the Carolinas, 22 May–11 June and 30 June–5 Sept. In Georgia, one spring record only, 16–17 May. For all of the more northern localities where intensive collecting has been done, the majority of the records are for May and June, indicating that later generations are partial. This is supported by several laboratory rearings in which a fraction of the offspring, varying up to about 50%, emerged the same season, the remaining pupae diapausing for emergence the following spring.

EARLY STAGES. *S. fassinotata* seems to be associated exclusively with *Tsuga canadensis* (L.) Carr. in the northern part of its range, and probably with *Tsuga caroliniana* Engelm. in the southern Appalachians. Distribution data suggest that it is always present where these hemlocks grow but never in their absence, although, in the laboratory, the larvae will readily feed on other conifers.

The larva (Figs. 13–14) is closely similar to that of *S. signaria dispuncta*, being almost as variable, but it does differ in several features. The marking tends to be rather dull, without strong white lines, and with or without a dark purplish supraspiracular stripe. When absent, this stripe is replaced by dark green. Whether dark purple or green, the supraspiracular tends

to be only very thinly bordered above with a white subdorsal line. There is a dark green middorsal, flanked by a very weak pair of addorsals, these separated from the subdorsals by green ground color. The yellow-green to whitish spiracular is weak, diffuse, ill-defined, often broken, unlike that of *dispuncta* and *pinistrobata*. The ventral markings consist of a weak pair of purplish subventral lines, faintly edged with white. The head is strongly shaded with dark chestnut-brown laterally, green to pale brown mesially and frontally, the paler area being a direct continuation of the pale dorsal part of the body pattern. The thoracic legs are pale to dark brown, the prolegs mostly green, as in *dispuncta*. Larvae of *fissinotata* entirely lack the conspicuous purplish spiracular spots or blotches characteristic of the more heavily marked examples of *dispuncta*, and commonly present in all larvae of *submarmorata*.

Although most of the larvae of my five reared broods of this species were fed hemlock, it was determined that they could be switched to white pine, larch, Douglas fir, balsam fir, white and red spruce in later instars with no apparent difficulty, at least some of these larvae producing normal adults. About 50% of one large brood emerged as a second generation in August, 12 out of 32 from another brood, and of a third brood of which I kept record, 20 pupae overwintered with no summer emergences (all reared material from Nova Scotia).

Semiothisa banksianae new name

Figs. 152-163

Semiothisa perplexa, Ferguson, 1954, p. 310, pl. 15, fig. 15, not McDunnough, 1927.

Semiothisa marmorata Ferguson, 1972, p. 564. **Homonym.**

Semiothisa marmorata, McGuffin, 1972, p. 32.

DIAGNOSIS. This species is extremely similar in appearance to *submarmorata* but much larger, being nearly equal in size to *unipunctaria* and its subspecies *perplexa*. Like *S. submarmorata*, which is, however, the smallest American species of the complex with the sole exception of *sexmaculata*, *Semiothisa banksianae* has a relatively bluish-gray tint to the forewing, rather dark in the male, lighter in the female, a full complement of three transverse lines on the forewing, and a decidedly brownish hindwing. The known distribution of *banksianae* occupies a narrow belt across Canada from Nova Scotia to British Columbia and the Yukon Territory, following the distribution of the host plants, *Pinus banksiana* Lamb. in the east and *Pinus contorta latifolia* Engelm. in the west. The only known records for the United States are from the states of Michigan and Washington.

TYPES. Holotype male (Fig. 152) from Dorchester, Westmorland Co., New Brunswick, 17 July 1950, D. C. Ferguson, Type No. 72055 in the collection of the U.S. National Museum; allotype female (Fig. 155), same data, also in the U.S. National Museum. There were 32 male and 7 female paratypes designated from various localities in Nova Scotia, New Brunswick, and Ontario. These are in the U.S. National Museum, American Museum of Natural History, and the Canadian National Collection. The types of *marmorata* and of the replacement name *banksianae* are of course the same specimens.

SYNONYMY. *Semiothisa marmorata*, the name under which I described this species in 1972, proved to be a junior homonym of *Semiothisa marmorata* (Warren) (= *Tephriopsis marmorata* Warren, 1897: 114), a species found in South Africa and Rhodesia. Warren's species was correctly transferred to *Semiothisa* by Janse (1932: 216). In my work on the Macrolepidoptera of Nova Scotia (1954: 310), I treated the as-yet-undescribed *banksianae* as *perplexa* (McDunnough), being misled by its similarly large size.

FURTHER DESCRIPTION. Little need be added to supplement the illustrations and remarks made in the diagnosis. The underside is like that of *submarmorata* but somewhat paler, at least in the type material.

Length of forewing (eastern specimens): males, 14–16 mm; females, 14–16 mm. Mean length of forewing (eastern specimens): male (of 27), 14.83 mm; female (of 8), 14.81 mm.

MALE GENITALIA. Differing only very slightly, if at all, from those of the related species. They are distinctly larger than all except those of *unipunctaria*, in proportion to the size of the moth, and the linear costal lobe of the valve is longer and straighter than in the other species.

FEMALE GENITALIA. Hardly distinguishable from those of *signaria* and most of the allied species but larger, in proportion to the size of the moth. The corpus bursae seems distinctly longer in form than that of *submarmorata*, which *banksianae* otherwise most closely resembles.

MATERIAL EXAMINED. 247 adults, of which 201 were reared by the Canadian Forest Insect Survey; 2 male, 2 female genitalia slides; 1 brood of larvae reared from eggs on *Pinus banksiana*.

DISTRIBUTION. **Nova Scotia:** Purcell's Cove, Halifax Co.; Boulderwood, near Halifax; Debert, Colchester Co.; Glenville, Cumberland Co.; Kelly Mountain, near Englishtown, Victoria Co. **New Brunswick:** Dorchester, Westmorland Co.; Bartibog, Northumberland Co.; Caraquet, Gloucester Co. **Quebec:** Kazubazua. **Ontario:** Arnprior; Biscotasing; Buckham's Bay; Crown Point; Chalk River; Constance Bay; Earlton; Lochalsh; Low Bush; Merivale; Matachewan; Minaki; Owen Sound; Pembroke; Renfrew. **Manitoba:** E. Braintree; Spruce Woods. **Saskatchewan:** Harlan; Ft. à la Corne. **Alberta:** Airdrie; Banff; Buck Lake; Belly Rv. Rs.; Bluffton; Coleman; Crowsnest Pass; Edson; Entrance; Eisenhower; Healy Cr.; Harburg; Jasper; Nordegg; Pyramid Lake; Rimbey; Rocky Mt. House; Rat Lake; Saunders; Sunshine Road; Turner Valley; W. bank Saskatchewan R. near Rocky Mt. House; Waterton Lake; Winfield; Willow Creek. **British Columbia:** Alexis Creek; Arrow Creek; Bede Creek Rd.; Bryan Creek; Christian Valley; Copper Mt.; Canal Flats; Cascade; Cascade Valley; Cranbrook; Cluculz Creek; Carnaby; Chilliwak L.; Chuchi L.; Copper Creek; Creston; D. Varden Creek; Edgegate; Elko; Edgewater; Ekolt; Flathead; Fernie; Ferguson; Fife; Field; Gaffrey Creek Bridge; Grey Cr.; Grand Forks; Greenwood; Gold R.; Golden; Harpor; Hall Creek; Hospital Creek Rd.; Hasmer; Hazelton; Mile 38 and 39, Hudson-Hope Rd.; Isle Pierre; Irishman Creek; Jesmond; Kingsgate; Kettle Valley; Kimberley; Kleena Kleen; Kootenay Creek; Kitchener; Kaslo; Kokanee; Lone Butte; Lumby; Lumberton; Miocene; McGillivray School; Mt. Cartier; Mahon; Moyie L.; Muir Mt.; Malaspina Inlet; Moyee; Narcosli Creek; New Denver; Natal; Pinchi L.; Premier L.; Redstone; Remac; Squilax; Salsqua; Slocan; St. Mary's Rd.; Tete Jaune; Teras L.; Yoho Pk.; Yahk. **Yukon:** Mi. 843, Alaska Hwy.; Mi. 6, Carcross Rd. **Michigan:** Schoolcraft Co. (T 42 N., R 16 W, Sec. 13). **Washington:** Bellingham; Friday Harbor (the latter doubtfully identified).

GEOGRAPHICAL VARIATION. The western specimens associated with lodgepole pine appear to average slightly darker, with more of a bluish or purplish tint to the gray coloring, but since the western examples were nearly all reared and the eastern ones collected at light, this may not be a valid comparison. Size remains constant throughout the range.

FLIGHT PERIOD. 29 June – 1 August in Nova Scotia and New Brunswick; 29 June at Kazubazua, Que.; 7 July at Minaki, Ont.; 11 June in Michigan; 16 June at Nordegg, Alta.; 27 July at Bellingham, Wash. Data on flight time are limited because most material is reared. Only one generation is indicated.

EARLY STAGES. Of two attempts to rear larvae of this species from eggs in the Atlantic Provinces, only one was successful. The following description is based on live, mature larvae reared from a female taken at the type locality on 17 July 1950. This brood was reared on *Pinus banksiana*, which grows abundantly in that area.

Larva characterized by its large size, purplish ground color, with green occurring as part of the lateral stripe only, by the dark ventral border of the subdorsal line consisting of two or three very fine lines rather than one wider, solid line, and by the head being almost wholly blackish or dark brown.

Ground color light pinkish purple; subdorsal line represented by 2–3 separate, thin, closely parallel lines of dark violet, shaded dorsally by pure white; this again followed dorsally

by a faint, irregular, violet edging; dorsal area occupied by four narrow, sinuous, irregular, longitudinal violet lines, the median pair, or addorsals, enclosing a middorsal violaceous shade only slightly darker than the ground; lateral, or spiracular, line pale greenish yellow, wide and distinct but diffusely defined, shaded with a similarly broad border of green, both dorsally and ventrally; pale brown spiracles lie within greenish-yellow line, near its upper margin; ventral area with a pair of irregularly defined, dull whitish adventral lines, enclosing a midventral line of a similar or very pale purplish shade; adventrals shaded outwardly with darker violet; beyond these, a pair of similarly irregular, violaceous, ventrolateral lines, slightly paler than the ground, margined on both sides with the same darker violet shade as the adventrals; thoracic legs dark purplish brown; prolegs pale violet shading into green. Head almost entirely blackish as in *S. oweni* but slightly darker; setae and ocelli shining black. Maximum length: 25 mm.

Host data from over 200 adults reared from larvae collected by the Canadian Forest Insect Survey reveal that the usual food plant of *S. banksianae* is lodgepole pine in the Rocky Mountain region, and jack pine in the east. The few listed in the table from other hosts may represent accidental occurrences or sampling errors.

REMARKS. In Nova Scotia, jack pine is restricted to a few suitable areas, mainly in the central part of the province and very locally along the coast in Halifax and Guysborough counties and Cape Breton Island. In many years of collecting moths in that region, I never found *Semiothisa banksianae* except in the vicinity of jack pine stands, and thus soon recognized the host association. The three New Brunswick localities are also in areas of jack pine. The type locality was in an extensive, rather flat expanse of boggy coniferous forest with much jack pine, black spruce and larch, just east of Dorchester on the south side of what was then the main highway to Sackville and the Nova Scotia border.

The scarcity of United States records for this species would seem to reflect inadequate collecting in the jack pine areas of border states such as Maine, Michigan, Wisconsin and Minnesota, where *banksianae* is almost certainly present, and also of course the long standing difficulties of distinguishing the various species of this group. Like most of the others, it has simply been misidentified as *S. granitata*. During more than 6 weeks of intensive field work in the Crazy Mountains of Montana in 1966, I looked for and expected to collect adults of this species in stands of lodgepole pine in Big Timber Canyon, but found none. Only *S. unipunctaria perplexa* seemed to be present, presumably associated with the Douglas fir which also grows there. The only U.S. records seen are two males collected by M. C. Nielsen in Schoolcraft Co., Michigan, and two males in the U.S. National Museum from Washington, one labelled Bellingham, 27 July 1930, R. W. Clarke (ex collection J. F. G. Clarke), the other, Friday Harbor, 7 July 1924. The identity of the latter specimen is uncertain, but it appears to be this species.

Semiothisa submarmorata (Walker)

Fig. 15, larvae; 164-179, 232, adults

Macaria ? *submarmorata* Walker, 1861b, p. 887.

Macaria granitata submarmorata, Barnes & McDunnough, 1917, p. 112.

Semiothisa submarmorata, Warren, 1895, p. 134. McGuffin, 1972, p. 30.

Semiothisa granitata submarmorata, McDunnough, 1938, p. 158. Forbes, 1948, p. 45.

DIAGNOSIS. This is a northern, larch-feeding species almost exactly resembling *banksianae* but much smaller, being the smallest species treated in this paper with the exception of *sexmaculata*. Because of its size, somewhat similar appearance and association with larch, *submarmorata* is most likely to be confused with *sexmaculata*, but males at least are readily distinguished from *sexmaculata* by the presence of a well-developed fovea. Also, males may be separated from those of

sexmaculata by differences in the antennae, of which the individual segments, viewed ventrally, have a less exaggerated triangular shape. Pale, contrastingly marked specimens may also be confused with *pinistrobata* or even *oweni*. *Submarmorata* is intermediate in size between *sexmaculata* and *pinistrobata* (or *oweni*). The forewing tends toward a blue-gray appearance with markings moderately (but variably) contrasting on an evenly dusted whitish ground. The hindwing is decidedly brown, variably mottled with whitish, but often almost unmarked. Sexual dimorphism is moderately developed, females being lighter and more brightly marked than males. The distribution follows that of the food plant from Newfoundland to British Columbia, southward locally in larch swamps and bogs such as Beckley Bog near Norfolk, Conn.

TYPES. Described from one male (Fig. 232) from St. Martin's Falls, Albany River, Hudson Bay [northern Ontario], now in the British Museum (Nat. Hist.). The type was loaned to me for study at the U.S. National Museum in 1969. Although a most critical examination was inconclusive, the type being not only in poor condition but also a rather indefinite specimen with respect to color and marking, it was clear that it represented one of two things — either an unusually dark form of *oweni*, or that species to which I herein apply the name *submarmorata*. Normally these two species are 100% distinguishable. However, with a forewing length of 13.5 mm, the type falls within the size range of both. The present species and *oweni* have slightly different male antennae, those of *oweni* having the segments less dilated and the setae shorter, but the type of *submarmorata* has lost all but a few basal segments which do not show the characters clearly. I imagined that the remaining segments looked less like those of *oweni* than the other species. The genitalia are so similar to those of related species that these provided no clues. The rather well-developed "black and white" mottled pattern, both above and beneath, plus the alternating dark and light segmental scale pattern of the antennae suggest *oweni*, but the type of *submarmorata* is still darker and more obscurely marked than any material of *oweni* seen. The usual lines of the forewing are thin and well defined, not expanded and diffuse as in *oweni*. All things considered, I lean toward the opinion that *submarmorata* represents that species to which I here apply the name. This also fulfills the purpose of conserving the name, as this species would otherwise be nameless. *Semiothisa oweni*, on the other hand, with a recognizable type, is unambiguous and has had consistent use for the larger, very contrasty, black and white larch-feeding species since it was first recognized.

SYNONYMY. None.

FURTHER DESCRIPTION. **Male:** like *S. signaria dispuncta* but smaller, darker, the forewing having a more bluish gray aspect contrasting with a brownish hindwing, and with the usual three lines and other markings of the forewing tending to be darker and more complete. The almost pure white ground color of the forewing largely obscured by a dense overlay of gray-brown scales, giving the gray effect. Median subterminal spot as in *signaria*; subapical costal spot blackish brown, but usually weak, not prominent. Hindwing commonly variegated with white along inner margin, otherwise rather plain. Underside much browner, with hindwing and costa of forewing yellowish, the markings weak and diffuse; postmedial band across hindwing light brown. Forewing beneath often with a small patch of pure white scales just before apex, these comprising a portion of the subterminal line or shade, and repeating a similar but less obvious marking on the upperside. Other species, including *signaria*, also have this white patch, but with less contrast. **Female:** like male but with lines heavier and darker, and usually with more of the white ground color showing through, resulting in a generally paler, more contrasty aspect. Hindwing of female also with more white scaling, and with the transverse lines more evident, at least near inner margin.

Length of forewing: male, 11–14 mm; female, 10.5–13 mm. Mean wing length: male (of 75), 12.37 mm; female (of 54), 11.98 mm.

GENITALIA. Like those of *signaria* in both sexes.

MATERIAL EXAMINED. 203 adults, including type; 4 male, 3 female genitalia slides; 1 brood of larvae reared from eggs.

DISTRIBUTION. **Newfoundland:** Bonavista S.; Bonavista N.; Topsail, Avalon Peninsula; Witless Bay Line, Avalon Peninsula near St. Johns; Salmonier, Avalon Peninsula; Grand Falls; Humber; Doyles, Codroy Valley; Millville, Codroy Valley. **Nova Scotia:** Baddeck, Victoria Co.; French Mountain, Cape Breton Highlands Nat. Pk., Inverness Co.; Debert, Colchester Co.; Glenville, Cumberland Co.; Pudsey Point, Cumberland Co.; Halifax watershed area, Halifax Co.; Bog E. of Big Indian L., Halifax watershed area, Halifax Co.; Armdale, Halifax Co.; Mount Uniacke, Halifax-Hants Co. line; Smiley Brook, near Brooklyn, Hants Co.; Green Bay, Lunenburg Co.; Petite Riviere, Lunenburg Co.; Lake Kejimikujik, Queens Co.; Annapolis Royal, Annapolis Co. **New Brunswick:** Dorchester, Westmorland Co.; Caraquet, Gloucester Co. **Quebec:** St. Norbert; St. Chas. de Mondville; Shawville. **Ontario:** St. Martin's Falls, Albany River (type); Kapuskasing; Marten R.; Rock Falls; Bell's Corners; Lowbush; Verner; Cartier; Swastica; Shining Tree; Mer Bleue, near Ottawa; Ramsayville; Hearst; Franktown. **Manitoba:** Winnipeg; Spruce Woods. **Saskatchewan:** Glen Elder; Harlan. **Alberta:** Edson. **British Columbia:** Whatshan Lakes; Blewitt Road; Edgewood. **Yukon:** Burwash Creek, Kluane District. **Maine:** Passadumkeag Bog, Penobscot Co. **Connecticut:** Beckley Bog, near Norfolk, Litchfield Co.

GEOGRAPHICAL VARIATION. Specimens from Newfoundland tend to be slightly larger and show more of the white ground color than those from elsewhere. Although most Newfoundland examples could not be distinguished from mainland specimens individually, a few, especially females, are so pale that they might be confused with *oweni* or *pinistrobata*. A single male from Harlan, Sask., is the opposite extreme, being a rather unicolorous gray with markings reduced. Seventeen specimens from Connecticut appear to resemble eastern Canadian material in every detail.

FLIGHT PERIOD. In Newfoundland, 30 June – 6 Aug.; Nova Scotia, New Brunswick, Maine, 17 June – 1 Aug. Collected in Connecticut 21 June, in Saskatchewan 11 June, and in the Yukon 8 Aug. Most records from other Canadian provinces were reared from larvae.

EARLY STAGES. I reared a large brood of *submarmorata* from a female collected at Debert, N.S., on 17 June 1960. These larvae (Fig. 15) were unusually well marked and brightly colored, with a purple dorsolateral line and in some individuals a row of purplish spiracular spots. The ground color varied from green to deep pink, some being pink throughout the last instar, rather than turning this shade only before pupation as is usual in *signaria dispuncta* and other species. The larvae were distinctly smaller than those of all other species except *sexmaculata*, and hardly larger than the latter.

The brood was reared on larch except for a group of 17 that were transferred experimentally to *Pinus banksiana* in the penultimate instar. These fed readily upon the pine, and the change did not alter their appearance or size in any way. All larvae matured quickly and pupated, but the pupae died during hibernation as is so often the case with reared material of this genus. There is little evidence that *submarmorata* feeds in nature on anything other than larch, except perhaps by accident. Of 29 reared specimens from the Canadian Forest Insect Survey, 27 were from larch, one from spruce, and one from Douglas fir. Two other specimens reared from Douglas fir in British Columbia may also represent this species, although their identity is not certain. They could be dwarfed specimens of *banksianae*. Knowledge of the habitats in Nova Scotia where I collected this species repeatedly also would seem to point conclusively to an association with larch.

REMARKS. Presence of this species on the Beckley Bog, one of the few true *Sphagnum* bogs in Connecticut, was also revealing with respect to its habitat. Larch occurs here along with other bog plants in a completely isolated, relict community; one of the moths that came to light most commonly when I collected there on 21 June 1965 was *Semiothisa submarmorata*. This is the southernmost locality from which it is known, although it may be expected throughout the distribution of the host plant.

Semiothisa oweni (Swett)

Figs. 1-3, genitalia; 132-151, adults

Sciagraphia granitata, var. *oweni* Swett, 1907, p. 128.

Macaria oweni, Barnes & McDunnough, 1917, p. 113.

Semiothisa oweni, McDunnough, 1938, p. 158. Ferguson, 1954, p. 310, pl. 15, fig. 14.

McGuffin, 1972, p. 31, figs. 81-82.

Semiothisa granitata oweni, Forbes, 1948, p. 45.

DIAGNOSIS. This species is easily recognized by its boldly marked, contrasting black and white appearance. In fresh specimens the ground color of the forewing is cream, fading to white; that of the hindwing is always whitish. The three lines of the forewing tend to be complete; those of the hindwing broken and incomplete but forming one or more irregular dark bands above and beneath. The range is northern, from Newfoundland to Alberta, following that of the host, eastern larch (tamarack), although its distribution does not extend either as far north or as far south as does that of the food plant.

TYPES. Described from three males from Grand Lake, Newfoundland, of which one is in the Museum of Comparative Zoology, Harvard University, and another, which I hereby designate the lectotype, is labelled Type No. 10,275 in the collection of the U.S. National Museum. The handwritten date on the lectotype appears to read 18 June 1906, not August as stated in the original description. This specimen is badly worn but recognizable, and it has been possible to substantiate its identification by comparison with 112 other specimens from Newfoundland in the U.S. National Museum.

SYNONYMY. There is a slight possibility that the type of *submarmorata* (Wlk.) (Fig. 232), being in poor condition and difficult to recognize, is a very dark example of *oweni*, in which case the Walker name would have priority. However, I have chosen to regard *submarmorata* as a different species, under which this problem is discussed in more detail.

FURTHER DESCRIPTION. Similar in size and basic pattern to *signaria* and *granitata*, but ground color paler and blackish markings heavier, giving a very boldly marked and contrasting appearance. Sexes almost alike, the female only slightly paler and more brightly marked. Wing shape slightly more acute than that of *signaria*; i.e., apices a little more produced and hindwings more angulate. Ground color of forewing cream colored in fresh specimens, fading almost to white; of hindwing, white; fringes cream colored to whitish, lightly marked with dark rays opposite vein endings. All markings of forewing, including preapical costal spot, blackish rather than brown; of the hindwing lighter but gray rather than brown; antemedial and postmedial lines of forewing usually complete; medial line, variable in strength and position, could be described as complete in 40% of the examples, mostly females; when incomplete, represented by spots at costa, inner margin, and at fork of Cu_1 and Cu_2 . Antemedial and medial lines often contiguous or even confluent in whole or in part. Median subterminal and preapical costal spots variable in size, about as in the other species but always blackish, occasionally so expanded as to be almost united. Postmedial third of forewing variably shaded with gray; when dark, leaving a vague, irregular, whitish subterminal line that curves outward toward apex and tornus. Hindwing variably mottled or striated with dark grayish, commonly forming a nearly complete postmedial band, and incomplete medial and antemedial

bands. Underside white, heavily and contrastingly marked with dark gray-brown, with at least a trace of the usual yellow-brown shading at costa.

Length of forewing: male, 12–14.5 mm; female, 11.5–15 mm. Mean wing length: male, 13.42 mm; female, 14.49 mm. Newfoundland specimens average about 1 mm larger in forewing length than Nova Scotian ones, in both sexes.

GENITALIA. Similar to those of *signaria* in both sexes, except that in the male the valves appear slightly longer.

MATERIAL EXAMINED. 366 adults, including types; 5 male, 2 female genitalia slides; 1 brood of larvae reared from eggs and others collected by beating from the host plant.

DISTRIBUTION. **Newfoundland:** Salmonier, Avalon Peninsula; Grand L. (types); Doyles, Codroy Valley. **Nova Scotia:** French Mountain, Inverness Co.; Baddeck, Victoria Co.; Middle River, Victoria Co.; Brierly Brook, Antigonish Co.; Debert, Colchester Co.; Parrsboro, Cumberland Co.; Pudsey Point, Cumberland Co.; Halifax watershed area; Bog E. of Indian Lake, Halifax watershed area; Goodwood, West Dover, Armdale and Waverley, all in Halifax Co.; Mount Uniacke, Halifax-Hants Co. line; Petite Riviere, Lunenburg Co.; Green Bay, Lunenburg Co.; Caledonia, Queens Co.; Lake Kejimikujik, Queens Co.; Round Hill, Annapolis Co.; Digby and Acacia Valley, Digby Co. **New Brunswick:** Dorchester, Westmorland Co. **Quebec:** Mt. Lyall (Gaspé Peninsula); Mistassini; Laniel; Gracefield. **Ontario:** Bell's Corners; Franz; Hymers; Lefroy Twp.; Mer Bleue, near Ottawa; Merrickville; Ottawa; Prospect; Sault Ste. Marie; South River; Stittsville; Trenton. **Manitoba:** Aweme; Onah. **Saskatchewan:** Harlan. **Alberta:** Embarrass. **Maine:** Passadumkeag, Penobscot Co. **New Hampshire:** Franconia. **New York:** Lewis Co.; "N.Y., Bruce". **Michigan:** Atlanta. **Wisconsin:** Lake Katherine, Oneida Co.

GEOGRAPHICAL VARIATION. As well as being larger than those from the adjacent mainland, Newfoundland specimens tend to be darker and more evenly and densely dusted with dark scales. A few are nearly melanic in appearance. Although samples from elsewhere are hardly large enough to allow generalizations, those seen from Maine, Ontario, Wisconsin, Manitoba, and westward appeared generally similar to the Newfoundland examples. Nova Scotian specimens are of unusual brightness and contrast.

FLIGHT PERIOD. In Newfoundland, 18 June – 10 Aug.; in Nova Scotia, 2 June – 30 July. Only scattered records from elsewhere; for example, 29 June – 4 July 1956, in Maine; 15 June 1883 in Lewis Co., N.Y.; 4 July 1948 in Wisconsin; 5 July in Ontario; 25 June 1942 at Harlan, Sask.

EARLY STAGES. This species normally feeds only on eastern larch or tamarack, *Larix laricina* (Du Roi) K. Koch. In the Canadian National Collection there are 21 adults reared from larvae on larch, and one (Mistassini, Que.) labelled red spruce, the latter possibly the result of a sampling error. I collected many larvae from larch in Nova Scotia and reared one brood from eggs on this host. In the Atlantic Provinces, where I saw and collected *Semiothisa oweni* almost annually for about 25 years, it became obvious that adults occurred only in the presence of larch.

The larva is green with a wide, conspicuous, purplish-brown supraspiracular stripe, bordered above with a pale subdorsal, usually narrow and greenish white, occasionally pure white. The dorsum is marked only by a middorsal line of a darker green than the ground. The spiracular stripe is white but not especially contrasting, being broken at intervals by encroachments of the green ground. The ventral area is marked by a pair of purplish-brown subventral stripes, each bordered on both sides with white, and separated midventrally by a narrow strip of ground color. The thoracic legs are dark purple, the prolegs pale violet. The conspicuous purplish supraspiracular extends onto the head as a dark brown bar running down the side of the head to the antennal socket. Markings of the same dark shade occur near the back of the head above, separated from the dark lateral areas by pale brown. Maximum length: 20 mm.

The larvae of this complex extend the head in an essentially prognathous position when at rest, and in some of the species, including *oweni*, *pinistrobata*, *fissinotata* and *granitata*, markings of the head then match up with the stripes of the body to form continuous lines. This disruptive color pattern, by helping to conceal the head, further enhances the overall resemblance of the larva to the conifer needles.

Semiothisa granitata (Guenée)

Fig. 9, venation; 19, larva; 180-191, 233, adults

Macaria granitata Guenée, 1857, p. 85. Barnes & McDunnough, 1917, p. 112, in part.
Sciagraphia granitata, Hulst, 1896, p. 329, in part. Dyar, "1902"[1903], p. 307, in part.
 Holland, 1903, p. 339, pl. 43, fig. 37. Barnes & McDunnough, 1914, p. 207.
Semiothisa granitata, Packard, 1876, p. 285, in part. Hulst, 1894, p. 304, in part. McDunnough, 1938, p. 158, in part. Forbes, 1948, p. 45, in part.
 ? *Macaria succosata* Zeller, 1872, p. 485. Barnes & McDunnough, 1917, p. 112. **New synonym.**

Sciagraphia succosata, Barnes & McDunnough, 1914, p. 208.

Semiothisa succosata, McDunnough, 1938, p. 158.

DIAGNOSIS. *Semiothisa granitata* is a relatively distinctive member of the complex, being contrastingly marked, similar in size to *S. signaria*, but occurring only in the eastern United States from southern Maine and Ohio to the Carolinas. There is little doubt that it is associated with certain of the hard pines such as *Pinus rigida* Mill. and *Pinus virginiana* Mill. It is the only eastern species of the group in which the dark, subapical costal spot tends to be bright reddish brown, rather than blackish or grayish. Unlike most of the other species of the group, there is virtually no sexual dimorphism. This species was figured in color by Holland (1903 and later editions, pl. 43, fig. 37).

TYPES. The description of *granitata* was based on one female from Pennsylvania in the Paris Museum, but the type now appears to be lost. Barnes and McDunnough (1914: 197), referring to McDunnough's trip to Europe in 1913, wrote: "In the National Museum at Paris Ragonot's types and the few remaining types of Guenée were examined". McDunnough apparently saw the type of *granitata* at Paris, because in discussing this species on page 207 of the same paper, he stated: "The type specimen is at Paris and agrees well with Guenée's description; the lines are brownish on a white ground and the most marked feature is a brown spot on costa near apex". However, I have been advised by Mr. Pierre Viette (in litt., 1960) that the type is not in the Museum National d'Histoire Naturelle. Neither does it appear to be in the U.S. National Museum nor the British Museum (Nat. Hist.), and so must be regarded as lost. Fortunately its description, type locality, and placement by those authors who examined it leave virtually no doubt as to its identity. For example, Barnes and McDunnough (1914: 208), in discussing the type of *succosata* Zeller, said: "This may approach the true *granitata* more closely than some of the following forms" (i.e., *dispuncta*, *fissinotata*, *submarmorata*, etc.).

The name *succosata* was based on one male and two female syntypes from Massachusetts received by Zeller from A. S. Packard. I hereby designate as lectotype the male specimen (Fig. 233), now in the British Museum (Nat. Hist.), and it is being so labelled.

SYNONYMY. The photograph of the lectotype of *succosata* herein reproduced agrees exactly with specimens examined from Massachusetts and elsewhere within the range of the species, and I consider that there is no doubt that this represents the same species herein identified as *granitata*.

FURTHER DESCRIPTION. As the distinguishing features are mainly in the wing pattern, illustrations should obviate the need for detailed description. The general impression is one of contrast between the sharply defined dark markings and whitish ground color, with the grayish basal and outer areas having a purplish tint in fresh specimens. The ground color of the median space may be cream colored rather than white. The brown subapical patch may be obscure, but commonly it appears browner than any other area of the wing. Beneath, the hindwing is characterized by a rather wide, dark postmedial band, and a narrower, often wavy, antemedial one.

Length of forewing: males, 12–14.5 mm; females, 13–15 mm. Average male (of 30), 13.75 mm; average female (of 19), 13.74 mm.

MALE GENITALIA. Differing from the genitalia of *signaria* only in the form of the inferior lobe of the valve, which is somewhat wider and more rounded in *granitata*.

FEMALE GENITALIA. Hardly distinguishable from those of allied species, although neck region of bursa copulatrix longer than in most, and posterior ostial sclerite, or sterigma, unusually broad, with an almost truncated posterior margin. Sterigma of *signaria*, as in most others, more produced and rounded posteriorly.

MATERIAL EXAMINED. 238 adults; 2 male, 2 female genitalia slides; 2 broods of larvae reared from eggs.

DISTRIBUTION. **Maine:** Norway. **New Hampshire:** Manchester; Monacknock (sic?); Union. **Massachusetts:** Tyngboro; Barnstable. **New York:** Amityville, Suffolk Co.; Patchogue, Suffolk Co.; Ulster Co.; Ithaca, Tomkins Co. **New Jersey:** Atsion, Burlington Co.; Freehold; Fort Lee District; Lakehurst, Ocean Co.; Manahawkin, Ocean Co. **Pennsylvania:** Scranton; Reading, Berks Co.; Sinking Spring, Berks Co.; Adamstown, Lancaster Co. **Ohio:** Hocking Co. **Maryland:** Plummers Is., Cabin John; Bathesda; Beltsville; Adelphi, Prince Georges Co. **District of Columbia:** Washington. **Virginia:** Arlington; Fairfax; Falls Church; Christchurch, Middlesex Co.; Brush Mountain, Montgomery Co. **West Virginia:** Blackwater Falls St. Pk. **Kentucky:** Natural Bridge St. Pk., Powell Co.; Mt. Washington, Bullitt Co.; O. J. Leslie Farm, Nelson Co.; Valley Sta.; Daniel Boone Pk. **North Carolina:** Tryon; Johnson City; Wilksboro; Bat Cave, Henderson Co.; Brevard; Highlands. **South Carolina:** Cherry Hill Recreation Area, Oconee Co.

GEOGRAPHICAL VARIATION. None.

FLIGHT PERIOD. North of Washington, D.C.: 9 May – 28 June and 16 July – 28 Sept. (appears to be present almost constantly throughout the season to late September at Beltsville, Md.). South of Washington: 30 April – 14 June and 7 August – 12 Sept., except at higher elevations in the Appalachians where the dates more nearly correspond to those for the northern region. Apparently two broods at least throughout the range. Reared offspring from a spring female emerged in August 1956; from a female taken 23 August 1955, the following May (Lakehurst, N.J.).

EARLY STAGES. *S. granitata* seems to be present only in stands of *Pinus rigida* Mill. and *P. virginiana* Mill., and its distribution corresponds so closely with the occurrence of these trees that they seem likely to be the natural hosts. The distribution of *granitata* actually coincides perfectly with that of *P. rigida* alone, but I have found the moths so abundant where *P. virginiana* is the commoner tree that I am certain both species are normal hosts. At Beltsville, Md., it appeared that larvae also could be collected in greater numbers by beating *P. virginiana*.

The description that follows is based on two broods of larvae reared from females collected at Lakehurst, N.J. These larvae fed well upon white pine (*Pinus strobus* L.) and jack pine (*Pinus banksiana* Lamb.), trees with which they are not associated in nature.

The last instar larvae were dimorphic with quite different looking purplish and green forms, the purplish form predominating. These were pinkish purple with the usual green ground color almost completely obscured. The position occupied by the deep purple supra-spiracular stripe in other species here differs little from the ground color, but the subdorsal stripes are present, pure white, and variable from thin to rather wide. The entire dorsum,

between the subdorsal stripes, appears unicolorous purple without magnification, but is actually marked faintly with alternating paler and darker lines, with a thin greenish middorsal. The greenish-white spiracular stripes are wider than the white subdorsals, but their margins are diffuse. The ventral area is marked by alternating lighter and darker pinkish lines, including a pair of very thin, whitish-tinged subventrals and a composite ventral stripe consisting of three closely parallel, diffuse, whitish lines. The thoracic legs are reddish brown, the prolegs green with some purplish pigmentation laterally. The head is light reddish brown laterally, paler mesially and frontally, and beneath the dark lateral area where there is an extension onto the head of the greenish-white spiracular. The white subdorsals are also projected forward to some extent, and the head is speckled with pinkish white on the face.

A green form constituted a small percentage of one of the reared broods. These had much of the usual purplish ground color replaced by green, much as in the greener forms of *S. signaria dispuncta*. About a dozen larvae collected by beating pine trees at Beltsville, Md., in September 1973, were all of the green form (Fig. 19), entirely without pink or purplish coloring and mostly lacking even the usual dark dorsolateral stripe (ventral component of the subdorsal stripe); this dark stripe was visible in a few as a faint vestige.

REMARKS. Although easily reared on *Pinus strobus* and *P. banksiana*, *Semiothisa granitata* seemingly never occurs northward beyond the distributional limits of *P. rigida*. It is the only American species of the complex that is not known to occur in Canada, with the exception of the southern Appalachian *S. fraserata*.

Semiothisa fuscaria (Leech)

Figs. 192-193

Halia fuscaria Leech, 1891, p. 50.

Macaria fuscaria, Prout, 1915, p. 346.

Semiothisa fuscaria, Wehrli, 1940, p. 387. Inoue, 1956, p. 310; 1957, p. 245, pl. 47, fig. 1289.

DIAGNOSIS. This oriental species has a combination of characters that suggests a relationship somewhere between *sexmaculata* and the other species of the complex. It shares two major characters with *sexmaculata*, namely, the absence of the fovea near the base of the forewing, and the more coarsely biserrate and fasciculate male antennae almost exactly like those of its American counterpart. It also somewhat resembles *sexmaculata* in the color and pattern of both sexes. However, the genitalia are more like those of *signaria*. In size, *fuscaria* is also intermediate between *sexmaculata* and *signaria*.

TYPES. Described from three males and three females from Oiwake and Yokohama, Japan. The types are in the British Museum (Nat. Hist.).

SYNONYMY. None.

FURTHER DESCRIPTION. Description of this species is hampered by insufficient material as I have only two specimens. These were kindly sent to me by Mr. Hiroshi Inoue in 1964. *S. fuscaria* appears to be sexually dimorphic in almost the same way as *sexmaculata*. **Male:** Forewing distinctly narrower than that of female, and narrower than in male of *signaria*. Both wings almost uniformly dusted with brown on a white ground; forewing darkest beyond postmedial in preapical area, but preapical costal spot weak and brownish, not developed as a prominent dark spot; preapical costal spot shaded with white outwardly; antemedial, medial and postmedial lines of forewing present but weak; postmedial of hindwing also present, mostly as a diffuse shade. Underside almost exactly like that of *signaria*. Forewing without fovea near base. Antennae more heavily biserrate and fasciculate than in *signaria*, about the same as in *sexmaculata*. The male figured by Inoue (1957, fig. 1289) is better marked and more nearly resembles *signaria* than does the single example available to me. **Female:** Forewing broader than that of male, about the same as in *signaria* and *sexmaculata*. As in male, both wings rather evenly dusted with brown on a whitish ground, but with more contrast; lines similar; dark shade beyond postmedial forms an almost continuous band from costa to inner margin, as is often the case in *sexmaculata* but rarely in *signaria*. Dark preapical costal and medial subterminal spots better developed than in male but still not as contrasting as in *signaria* or *sexmaculata*. Underside about the same as that of *signaria*. Antennae not differing from those of allied species.

Length of forewing: male, 12 mm; female, 13.5 mm.

MALE GENITALIA. Essentially like those of *signaria*, as far as can be determined from one specimen. Those differences such as the form of the uncus, gnathos and ventral lobe of the valve, which distinguish *sexmaculata* and which might be expected in *fuscaria*, are not apparent in this specimen.

FEMALE GENITALIA. The rounded, dome-shaped sterigma is clearly of the type found in *signaria* rather than *sexmaculata*. However, the bursa copulatrix has the more globular shape characteristic of the latter species.

MATERIAL EXAMINED. Two adults; 1 male, 1 female genitalia slide.

DISTRIBUTION. **Japan:** Hokkaido; Honshu (Inoue 1956: 310). Also reported from central China but this needs to be verified.

GEOGRAPHICAL VARIATION. Not studied.

FLIGHT PERIOD. June–July.

EARLY STAGES. Not studied. Inoue (1957: 245) made no mention of the early stages, indicating that they were unknown to him.

***Semiothisa sexmaculata sexmaculata* (Packard)**

Figs. 4–6, 8, structural characters; 194–213, 234, adults

Macaria sex-maculata Packard, 1867, p. 44.

Semiothisa sex-maculata, Packard, 1876, pp. 285–287, as synonym of *granitata*.

Macaria granitata sexmaculata, Barnes & McDunnough, 1917, p. 112.

Semiothisa sexmaculata, McDunnough, 1938, p. 158. McGuffin, 1947, p. 113; 1955, p. 42; 1972, p. 27, figs. 18, 90–92, 204a–h. Forbes, 1948, p. 46. Ferguson, 1954, p. 310.

Ross and Evans, 1958, p. 40, in part.

Macaria unimodaria Morrison, 1874, p. 196. Barnes & McDunnough, 1917, p. 112. **New synonym.**

Sciagraphia unimodaria, Barnes & McDunnough, 1914, p. 207.

Semiothisa unimodaria, McDunnough, 1938, p. 158.

Semiothisa labradoriata Moeschler, 1883, p. 118.

DIAGNOSIS. *Semiothisa sexmaculata* is a small, larch-feeding species with a northern, transcontinental distribution in North America only. It is superficially similar to species of the *signaria* complex, especially to *submarmorata*, with which it is sympatric on the same food plant, but *sexmaculata* is the only American species of the group treated here that is easily distinguished by structural characters. In the male, the fovea at the base of the forewing is wanting, and both sexes show minor but consistent differences in the genitalia. Also, the male antennae are different, being more slender, more heavily setose, and with the triangular, ventral aspect of the individual segments exaggerated by elongation of the lateral processes. The larva also is distinctive and dimorphic, with very different-looking green and brown forms. The adults of both subspecies have the most highly developed sexual dimorphism of the complex, the males tending to be weakly marked and evenly brownish, the females with the usual variegated pattern of dark brown on a pale ground much as in *signaria*. There are indications that sexual dimorphism does vary geographically; in some areas males tend to resemble females. The lack of a fovea and the other distinguishing features suggest that *sexmaculata* does not, in the strict sense, belong with the *signaria* complex, but that it may be more closely related to the species group that includes *minorata*, *bisignata*, *bicolorata* and *distriбуaria*, having developed a resemblance to *signaria* by convergence. The Japanese *S. fuscaria* Leech is extremely close to *sexmaculata* and can hardly be distinguished by superficial characters.

TYPES. *Sexmaculata* was described from an unstated number of specimens, including both sexes, from Square Island, Labrador, 14 July [1860 or 1864]. Square Island is about 35 miles north of Battle Harbour, Labrador. When Packard

synonymized this name under *granitata* (1876: 285), he gave the type locality as Caribou Island, Strait of Belle Isle, Labrador, probably in error. The types should be in the Museum of Comparative Zoology, Harvard University.

The type of *unimodaria* (Fig. 234) was collected in Massachusetts in July. In the description there is no indication of the sex or number of specimens, although it seems safe to assume that there was only one. This specimen, a male in good condition, is now in the British Museum (Nat. Hist.).

Labradoriata was described from one male and one female from southern Labrador, and if these still exist they should be in the Zoological Museum of Humboldt University, Berlin.

SYNONYMY. Judging from the descriptions, there would seem to be little doubt concerning the identity of *sexmaculata* or *labradoriata*, and in regarding these as synonyms, my conclusions agree with those of earlier authors. Moeschler measured specimens by length of forewing, as I do in the present paper, and the measurements he gave for the types of *labradoriata* (male 11.5 mm, female 12.75 mm) fall within the limits for the species as given here. *Unimodaria* has generally been retained as a separate entity in previous works, including McDunnough (1938) and Forbes (1948), but the type is clearly a normal male of *sexmaculata*.

FURTHER DESCRIPTION. **Male:** fovea at base of forewing (Fig. 8) wanting or at most vestigial, fully scaled; color variable but most commonly uniformly brownish, more so than any other species here treated, much less distinctly marked than female; occasional males contrastingly colored, resembling females. Normal males evenly dusted with brown, leaving little of the whitish ground to impart the usual gray aspect to the wings. Fore- and hindwings almost alike. All three lines of forewing may be present, but normally weak and in part obsolescent; postmedial commonly strongest, almost erect, regular, bending inward to meet costa at 90°. Lines of hindwing also variable; usually distinct only toward inner margin, sometimes rather well defined, sometimes almost wanting. Subapical costal and median subterminal spots much reduced in male, not normally conspicuous. Discal spots vague or wanting. Underside marked with brown much as in related species. **Female:** usually lighter colored than male, with more whitish ground color showing, giving a decidedly more grayish aspect to the wings, and thus a closer resemblance to some other species of the group, especially to *submarmorata*. Hindwings usually somewhat browner than forewings. Markings as in male but more complete, darker, more contrasting; subapical costal and median subterminal spots tending to be much better developed, the latter most often large, rounded, blackish, conspicuous. Underside as in male but with markings darker. Occasional females browner, more unicolorous, resembling males.

Length of forewing: male, 10.5–12 mm; female, 10–13 mm. Mean wing length (Nova Scotia and Newfoundland): males (of 60), 11.33 mm; females (of 24), 10.83 mm.

MALE GENITALIA. These differ from the genitalia of all the foregoing species in the stouter, longer tooth on the gnathos, the smaller size of the two subapical spines on the dorsum of the hood-like uncus, and in the narrower, less rounded ventral lobe of the valve. Also, the uncus is acuminate and rather pointed, not tapered evenly to a truncated or shallowly notched tip as in the other species (Fig. 4).

FEMALE GENITALIA. Differing only slightly from those of preceding species. Corpus bursae less elongate, more globular in shape, resembling that of *fuscaria* rather than *signaria*, and the detached, sclerotized element of the ostium (the sterigma) lacks the usual evenly contoured, rounded or squarish shape, having a somewhat aborted form, depressed on the distal side.

MATERIAL EXAMINED. 639 adults, of which 469 were reared; 2 male, 2 female genitalia slides; an unrecorded number of live larvae collected from *Larix laricina*.

DISTRIBUTION. **Newfoundland:** Bonavista N.; Bonavista S.; Doyles, Codroy Valley; Grand Falls; Seal Cove, Avalon Peninsula; White Bay. **Nova Scotia:** French Mt., 1390', Cape Breton Highlands Nat. Pk., Inverness Co.; Baddeck, Middle River and Baddeck Bridge, Victoria Co.; Debert, Colchester Co.; Parrsboro and Glenville, Cumberland Co.; Halifax, MacNab's Island, West Dover, Waverley, Sackville, Armdale, and Halifax watershed area, Halifax Co.; Mount Uniacke, Hants Co.; Green Bay and Petite Riviere, Lunenburg Co.; White Point Beach and Lake Kejimikujik, Queens Co.; Aylesford, Kings Co.; South Milford, Annapolis Co. **New Brunswick:** Dorchester and Shediac, Westmorland Co.; Bathurst, Gloucester Co.; St. Andrews, Charlotte Co. **Quebec:** Covey Hill; Hemmingford; Joliette; Knowlton; Kazubazua; Laniel; Lac à la Tortue; L'Annonciation; Notre Dame de la Merci; Parent; St. Elizabeth; St. Charles de Mondville; Waterloo. **Ontario:** specimens examined from 74 localities in Ontario, indicating general distribution at least across the southern half of that province. **Manitoba:** Aweme; Onah; Wasagaming. **Saskatchewan:** Meadow L.; Prairie R.; Ushta Sdg. **Alberta:** Athabasca; Bluffton; Baptiste R., Bearberry; Cold L.; Caroline; Edson; Entrance; Grimshaw; Galloway; Harburg; Hotchkiss; Mickle R.; Miette Hot Spgs.; Nordegg; Rocky Mt. H.; Ricinus; Robb; Rimbey; Strachan; Weald. **Maine:** Bar Harbor; Passadumkeag, Penobscot Co. **New Hampshire:** Franconia. **Massachusetts:** Barnstable; Lunenburg. **Connecticut:** Beckley Bog, near Norfolk, Litchfield Co. **New York:** Yonkers, Westchester Co.; Cornell Preserve, South Hill, Ithaca, Tompkins Co.; Horseheads, Chemung Co.; Sardinia, Erie Co. **Michigan:** Clinton Co.; Shiawassee Co. **North Dakota:** McHenry Co.

GEOGRAPHICAL VARIATION. Little if any variation is apparent in the nominate subspecies, but west of the continental divide *sexmaculata* occurs as a larger, more diffusely marked subspecies, *incolorata* (Dyar), which is treated separately.

FLIGHT PERIOD. In Newfoundland, 29 June – 6 Aug.; Nova Scotia and New Brunswick, 17 May – 27 July and 10 Aug. – 6 Sept., indicating two broods. Other available records: Maine, 26 June – 5 July, 10 Aug.; Barnstable, Mass., 20 Aug.; Litchfield Co., Connecticut, 21 June; Yonkers, N.Y., 13 June; Horseheads, N.Y., 31 May, 14 June; Sardinia, N.Y., 13 Aug.; Ithaca, N.Y., 22 May; Aweme, Man., 25 May, 2 June; Nordegg, Alta., 12–28 June.

EARLY STAGES. The larva of *sexmaculata* was described by McGuffin (1947: 113–115; 1972: 28). This species is peculiar in having two sharply differing color forms in the last instar, one green, the other brown. Up to the beginning of the last instar all larvae are green or gray-green. After the last molt there is a transition period of about 2 days during which some of the larvae acquire the dark coloring of the brown phase. No other species of this group is known to have a larval form comparable with the brown phase of *sexmaculata*, but the green one closely resembles green larvae of *dispuncta*. However, larvae of *sexmaculata* may be distinguished by the absence of dark subventral lines.

I collected larvae of *sexmaculata* in Nova Scotia on several occasions, and my observations agree essentially with those of McGuffin. I noted also that the green form could be distinguished from that of *dispuncta* by its much smaller size, only 15 mm as opposed to 21 mm, and by the head and thoracic legs being entirely green. In *dispuncta*, the head has contrasting lateral, or dorsolateral, blackish-brown markings superimposed upon the green ground color. *S. submarmorata*, also on *Larix*, is heavily colored with purplish, has dark head markings and, at least in the one brood reared, is marked by conspicuous purplish-brown spiracular spots. Although these lateral spots may also occur in *dispuncta*, they evidently never do in *sexmaculata*.

The only known host plant of nominate *sexmaculata* is *Larix laricina*; subspecies *incolorata* has been reared from both *Larix* and *Pseudotsuga*.

Semiothisa sexmaculata incolorata (Dyar)

Fig. 7, antenna; 214-221, adults

Macaria minorata Packard, var. *incolorata* Dyar, 1904a, p. 906.*Macaria minorata incolorata*, Barnes & McDunnough, 1917, p. 112.*Sciagraphia purcellata* Taylor, 1908, p. 98. Barnes & McDunnough, 1917, p. 113.*Semiothisa sexmaculata incolorata*, McDunnough, 1938, p. 158. Forbes, 1948, p. 46.*Semiothisa sexmaculata*, Ross and Evans, 1958, p. 40, in part.

DIAGNOSIS. *Incolorata* is here treated as a western subspecies occurring in the southern interior of British Columbia, and in Idaho, Oregon and probably Washington. One of its more obvious features is a structural one. The male antennae (Fig. 7) are more heavily serrate and fasciculate than those of eastern *sexmaculata*, the lateral processes of each segment and the antennal setae both being distinctly longer. *Incolorata* is larger than the eastern form, generally more brownish, and with markings more indistinct or diffuse. As relatively little material has been available for study, its taxonomic status remains somewhat uncertain. Some specimens are more distinctive than others, but the significance of this variation will be understood only with more detailed knowledge of distribution and host associations, especially in Washington and Oregon.

I suspect that *incolorata* is the population primarily associated with *Larix occidentalis* Nutt. However, the gap in distribution between *L. occidentalis* and *L. laricina* is occupied, at least in part and at higher elevations, by *Larix lyallii* Parl., and records of this tree as a host are entirely lacking. In British Columbia, adults of *sexmaculata* have been reared several times from larvae on *Pseudotsuga*, the specimens appearing almost exactly like eastern *sexmaculata*, but, as all are females, one cannot take into account the male antennal characters mentioned earlier.

TYPES. *Incolorata* was described from six specimens from Kaslo, B.C., of which five males are in the U.S. National Museum. I hereby designate one of these as the lectotype (Fig. 215), and it is so labelled. *Purcellata* was based on three syntypes, originally from the Cockle collection, of which two females were acquired by the U.S. National Museum by way of the Taylor collection. These were also from Kaslo, B.C., and I hereby designate as lectotype the female taken 7 July 1907.

SYNONYMY *Purcellata*, the only synonym, clearly represents the female sex of *incolorata*, of which Dyar had described only males.

FURTHER DESCRIPTION. In addition to their larger size and browner coloring, males of *incolorata* differ from those of nominate *sexmaculata* in a further reduction of the dark brown markings. The three transverse lines and subapical costal spot of the forewing, commonly distinct in *sexmaculata*, are obsolescent in *incolorata*. The small discal spot of the hindwing is nearly always wanting. Some males are very nearly immaculate and suggest worn specimens of *Semiothisa minorata*. Females also tend to be larger and browner than eastern examples and to show a reduction of the dark markings comparable with those of males. The pattern gives the effect of being somewhat simplified, although the transverse lines of the forewing may be distinct, especially the postmedial. The usual two dark spots beyond the postmedial are less well developed and tend to be more diffuse or even wanting. In darker, well-marked specimens, these spots may be present but subdued by incorporation into a dark brown band just beyond, and parallel to, the postmedial. Such a band is rarely developed in females of nominate *sexmaculata*, which in general have a grayer, more crisply marked appearance.

Length of forewing: lectotype male of *incolorata*, 12 mm; other males, 10.5-13.5 mm; lectotype female of *purcellata*, 12 mm; other females, 11-13.5 mm.

MALE GENITALIA. Seemingly indistinguishable from those of nominate *sexmaculata*.

FEMALE GENITALIA. Not examined.

MATERIAL EXAMINED. 32 adults; 4 male genitalia slides.

DISTRIBUTION. **British Columbia:** Arrowhead L.; Athlmer; Cranbrook; Destiny Bay; Grand Forks; Kaslo; Wilmer. **Idaho:** Moscow Mts. **Oregon:** Wallowa Lake; Baker.

GEOGRAPHICAL VARIATION. There is considerable variation in size which may, or may not, have a geographical basis. Three of five specimens from Wallowa Lake are very small; those from Baker, Oregon, and British Columbia are generally larger. Much more material is needed as well as a better knowledge of local host associations.

FLIGHT PERIOD. 29 May – 15 August, probably with a partial second brood.

EARLY STAGES. Larvae from British Columbia were briefly described by Ross and Evans (1958), who mentioned the two color forms, similar to those of nominate *sexmaculata*. The host in the southern interior of British Columbia was stated to be western larch, but in the central interior north to the Yukon, eastern larch. There remains the question as to whether those on eastern larch should be referred to the nominate subspecies, but it should be pointed out that specimens from Nordegg, Alta., probably associated with eastern larch, have the more heavily fasciculate antennae of *incolorata*. As these specimens are therefore not clearly referable to either subspecies, there is no definite break between eastern and western populations related to host differences. I have seen four females reared in British Columbia by the Canadian Forest Insect Survey from larvae on *Pseudotsuga menziesii*, and one from *Pinus contorta*, the last possibly a sampling error. It is interesting to note that this is not the first record of *Pseudotsuga* serving as an alternate host for a larch-feeding moth. Voûte (1952) reported an occurrence of the larch casebearer, *Coleophora laricella* Hübner (Coleophoridae), on this tree.

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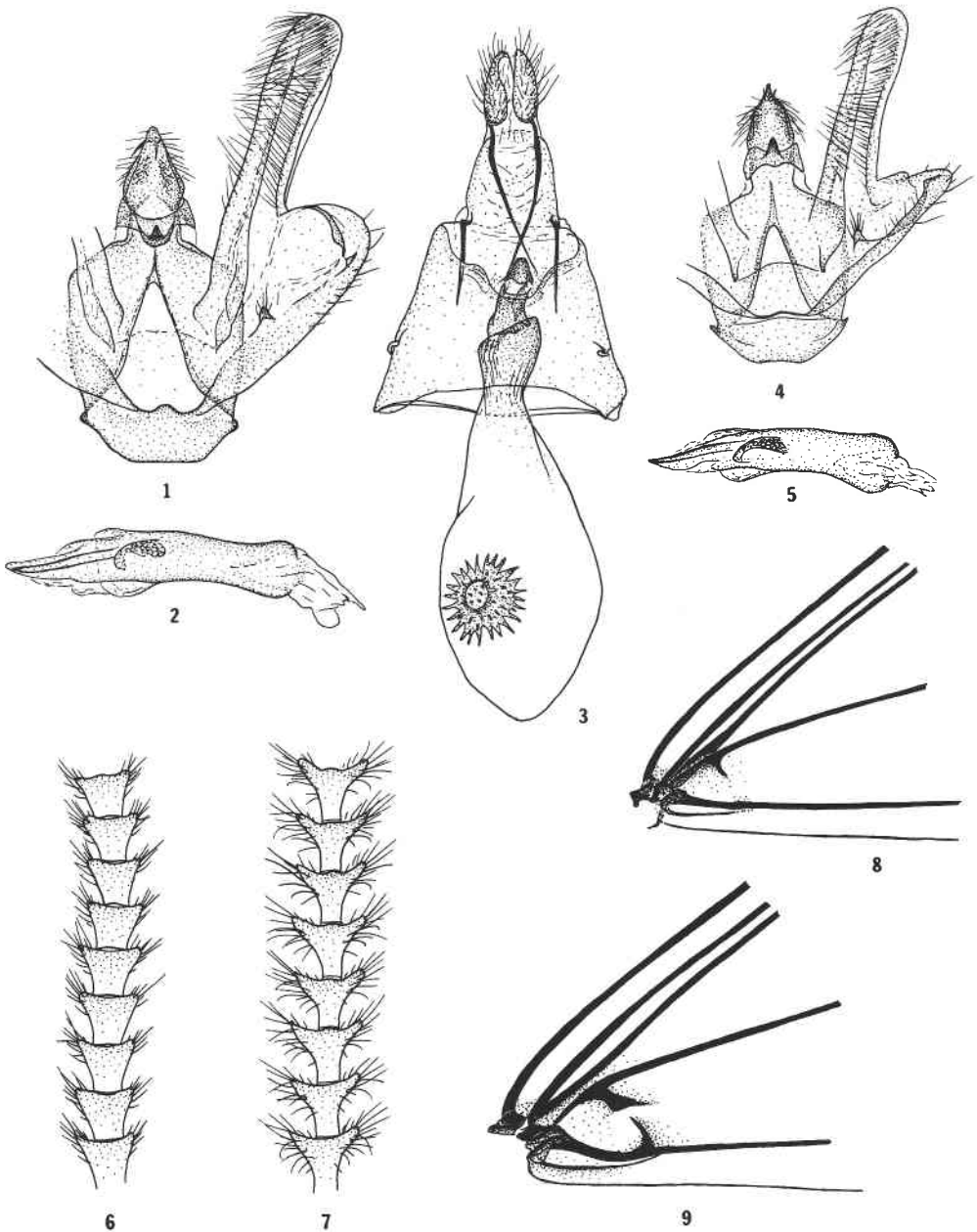
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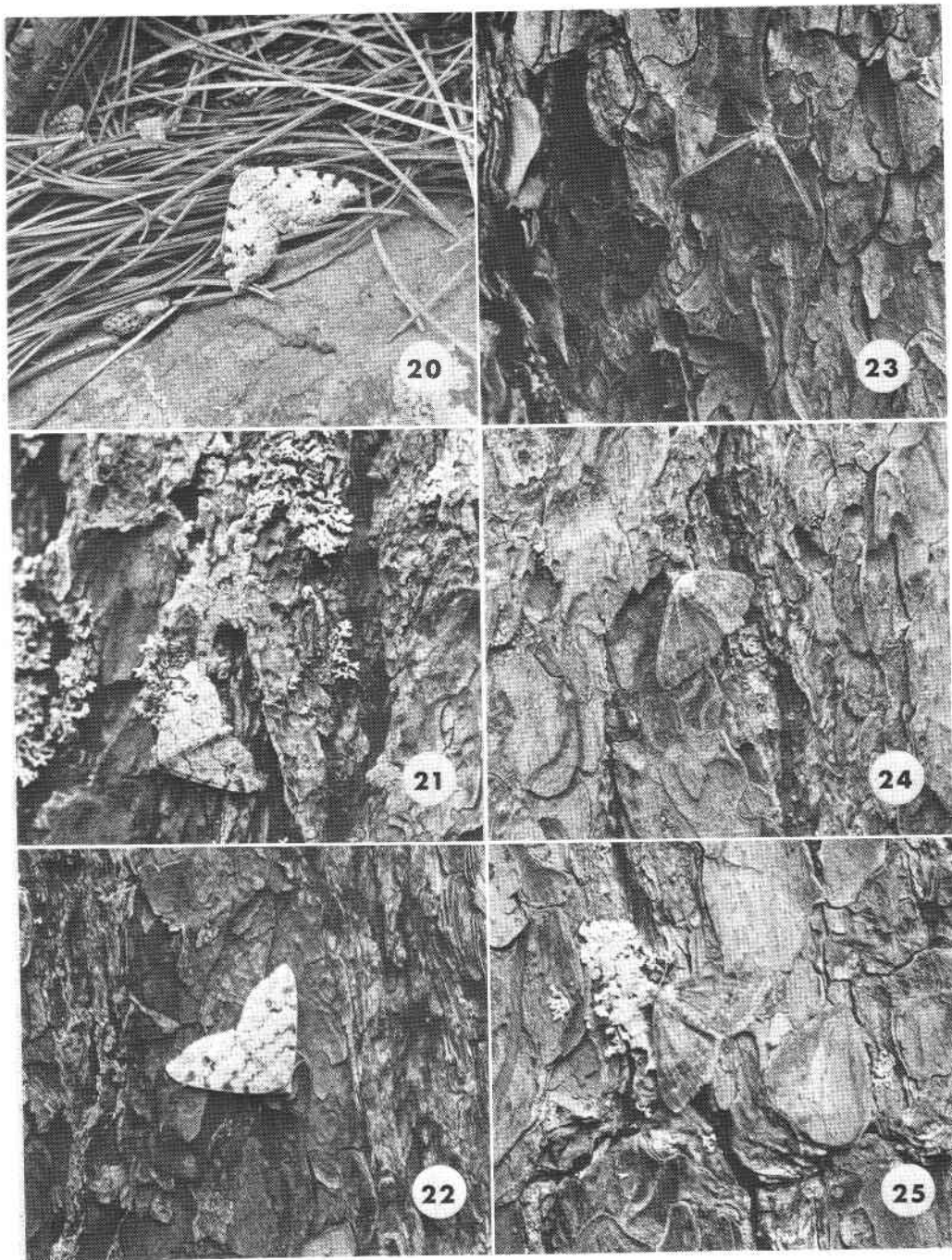
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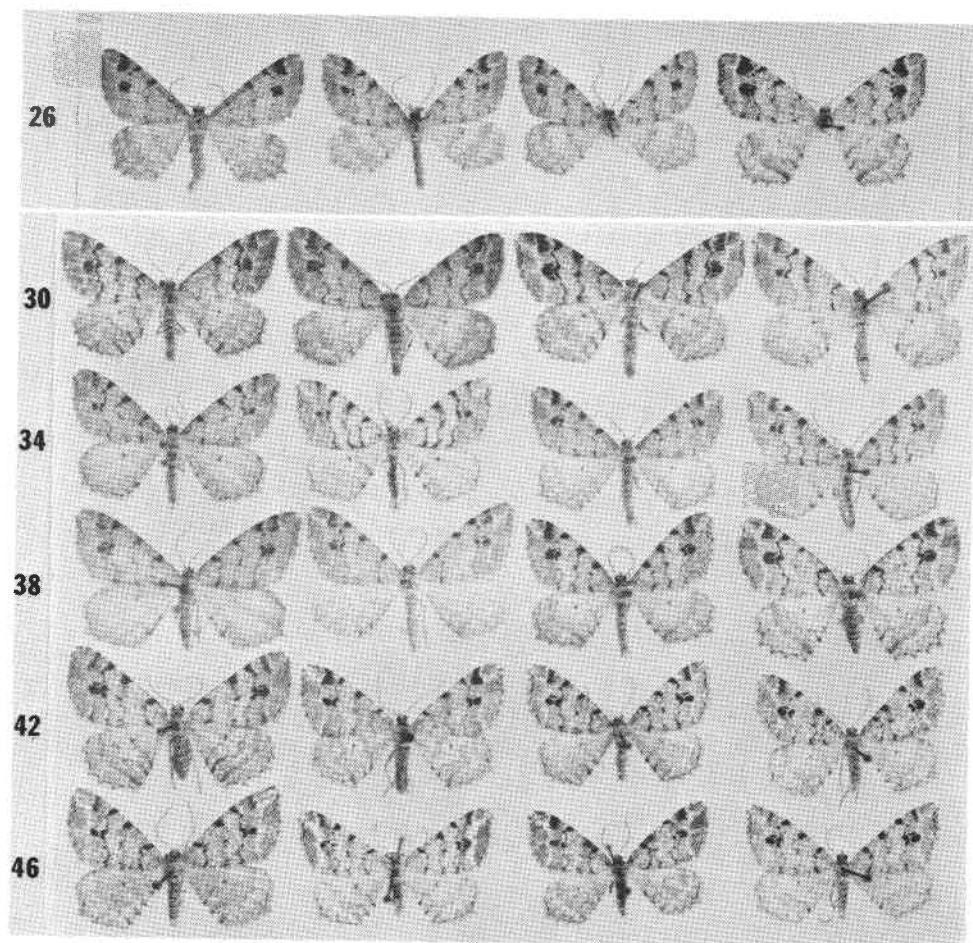
FIGS. 1-9. 1-2, *Semiothisa oweni* (Swett), male genitalia; 3, *S. oweni* (Swett), female genitalia; 4-5, *S. sexmaculata sexmaculata* (Pack.), male genitalia; 6, *S. sexmaculata sexmaculata* (Pack.), mid section of male antenna of specimen from Mer Bleue, near Ottawa, Ont.; 7, *S. sexmaculata incolorata* (Dyar), mid section of male antenna of specimen from Wallowa Lake, Ore.; 8, *S. sexmaculata sexmaculata* (Pack.), base of forewing showing characters of venation associated with vestigial fovea; 9, *S. granitata* (Gn.), same, showing vein structure of well-developed fovea. (Drawings by the author.)



FIGS. 10-19. Last instar larvae of *Semiothisa* species. 10-11, *S. signaria dispuncta* (Wlk.), Armdale, Halifax Co., N.S., reared from eggs on balsam fir; 12, *S. signaria dispuncta* (Wlk.), Lake Kejimikujik, Queens Co., N.S., reared from egg on balsam fir; 13-14, *S. fassinotata* (Wlk.), Lake Kejimikujik, Queens Co., N.S., reared from eggs on eastern hemlock; 15, *S. submarmorata* (Wlk.), Debert, Colchester Co., N.S., reared from eggs on eastern larch; 16-18, *S. pinistrobata* Fgn., Armdale, Halifax Co., N.S., reared from eggs (from melanic female) on white pine; 19, *S. granitata* (Gn.), Beltsville, Md., larva collected from scrub pine (*Pinus virginiana* Mill.). Magnification about 2 $\times$. (Photographs by the author.)

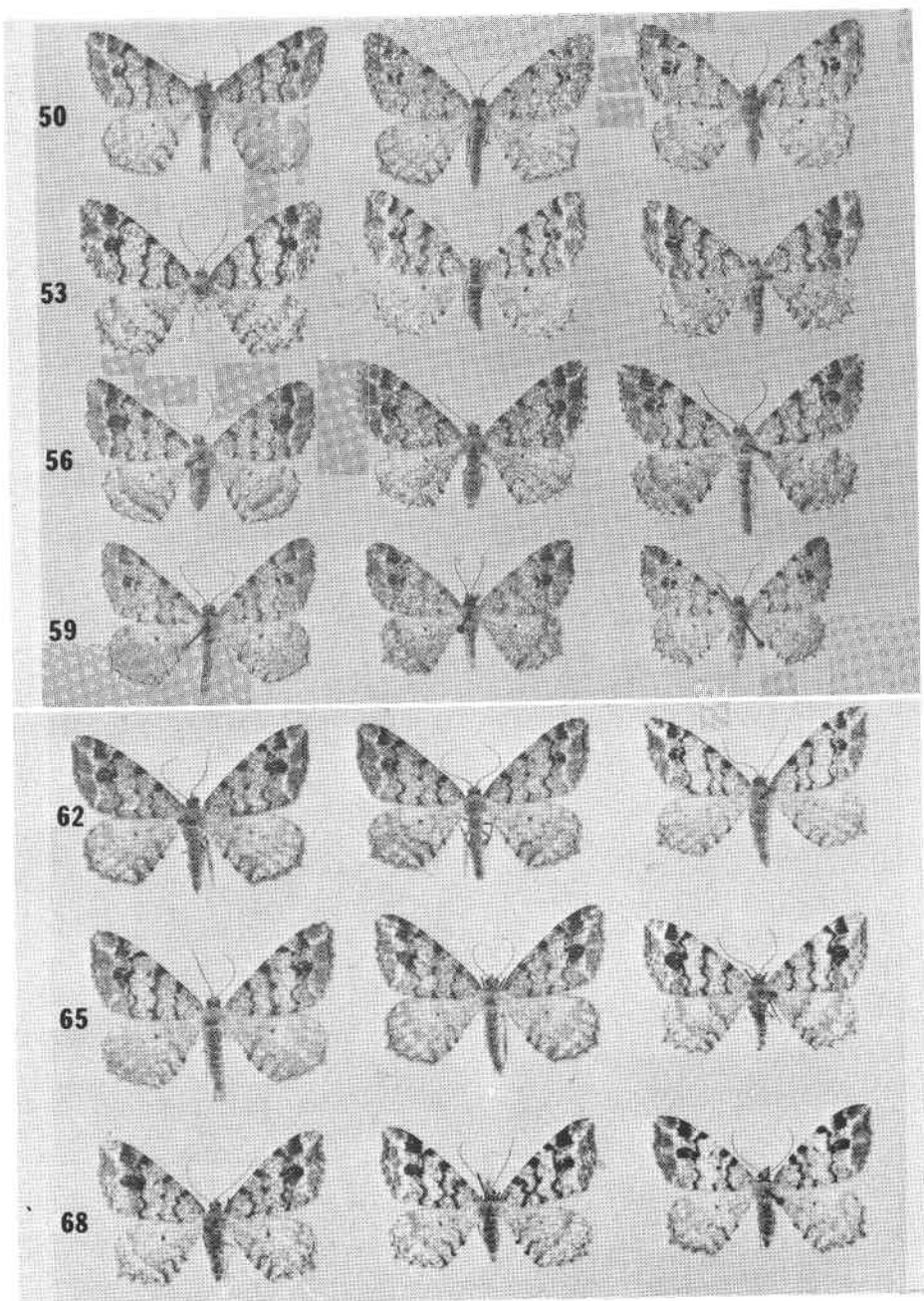


FIGS. 20-25. *Semiothisa pinistrobata* Fgn., adults photographed at Armdale, Halifax Co., N.S., July 1972; 20-22, normal form, 23-25, melanic form. 20, female at rest on ground; 21, male on partially lichen-covered bark of white pine; 22, male on pine bark without lichens; 23, melanic male on bark without lichens; 24, melanic female (worn); 25, intermediate (semi-melanic) female. About natural size. (Photographs by the author.)



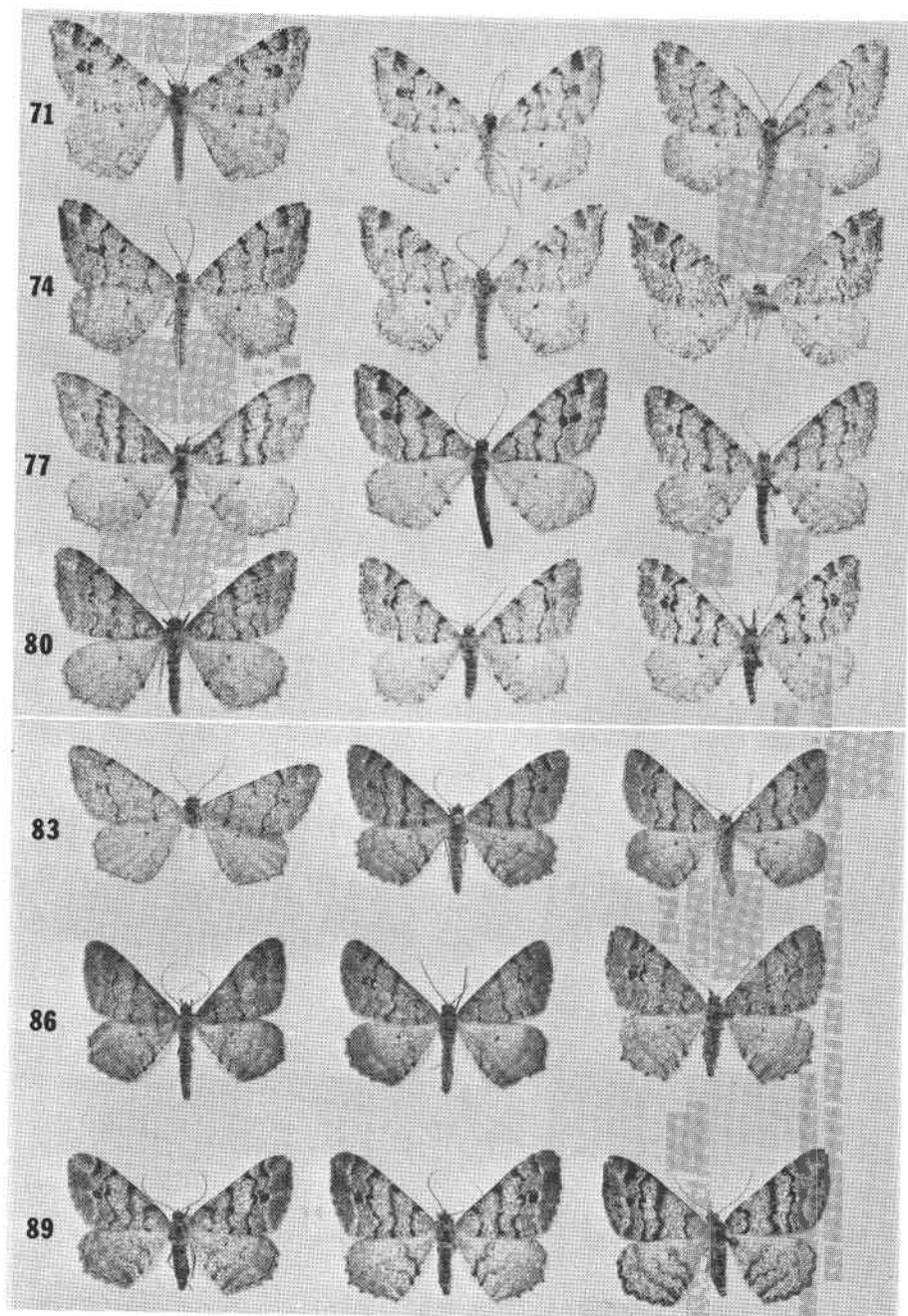
FIGS. 26-29. *Semiothisa signaria signaria* (Hbn.). 26, male, Haag b. Freising, Südbayern, Germany; 27, male, Baierbrunn, Südbayern, Germany; 28, male, same locality; 29, female, Bruckberg, Oberbayern, Germany.

FIGS. 30-49. *Semiothisa signaria dispuncta* (Wlk.); 30-40, males, 41-49, females. 30, Muchalat L., B.C., from larva on western hemlock; 31, Halston Jct., B.C., from larva on Douglas fir; 32, Slave L., Alta., from larva on white spruce; 33, Colpoys', Ont., from larva on balsam fir; 34, Halifax watershed area, N.S.; 35, French Mt., 1390', Cape Breton Highlands Natl. Park, N.S.; 36, Doyles, Codroy Valley, Nfld.; 37, same locality; 38, Jefferson Notch Rd., Coos Co., N.H.; 39, McLean Bogs Reserve, Tompkins Co., N.Y.; 40, Spruce Knob, ca. 4600', W. Va.; 41, St. Mary's Road, B.C., from larva on Douglas fir; 42, Fiddle Cr., Jasper Natl. Park, Alta., from larva on *Picea* sp.; 43, Bancroft, Ont., from larva on eastern hemlock; 44, Doyles, Nfld.; 45, same locality; 46, Armdale, N.S.; 47, Bathurst, N.B.; 48, Jefferson Notch, N.H.; 49, McLean Bogs Reserve, Tompkins Co., N.Y. All figures of adults approximately natural size.



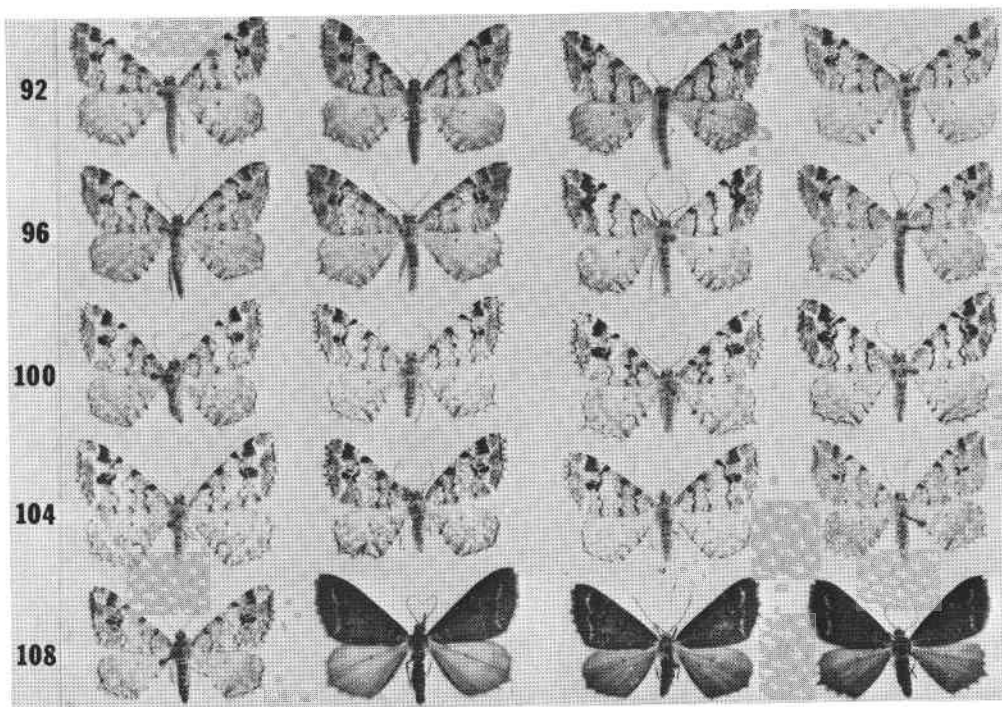
FIGS. 50-61. *Semiothisa signaria dispuncta* (Wlk.), western specimens. 50, male, Wellington, V.I., B.C.; 51, male, same locality; 52, female, same locality; 53, female, Nimpkish R., N. Vancouver Is., B.C.; 54, female, Upper Spring Cr., near Hill City, S.D.; 55, female, same locality; 56, female, Duck L., Powell R., B.C., from larva on western hemlock; 57, female, Trinity Valley, B.C., from larva on Engelmann spruce; 58, male, Anderson Springs, Lake Co., Calif.; 59, male, same locality; 60, female, same locality; 61, female, same locality.

FIGS. 62-70. *Semiothisa fraserata* Fgn.; 62-66, males, 67-70, females. 62, holotype, Richland Balsam Mt., 6000', Jackson-Haywood Co. line, N.C.; 63-66, same locality; 67, Mt. Mitchell, 6000', N.C.; 68-70, same locality as holotype.

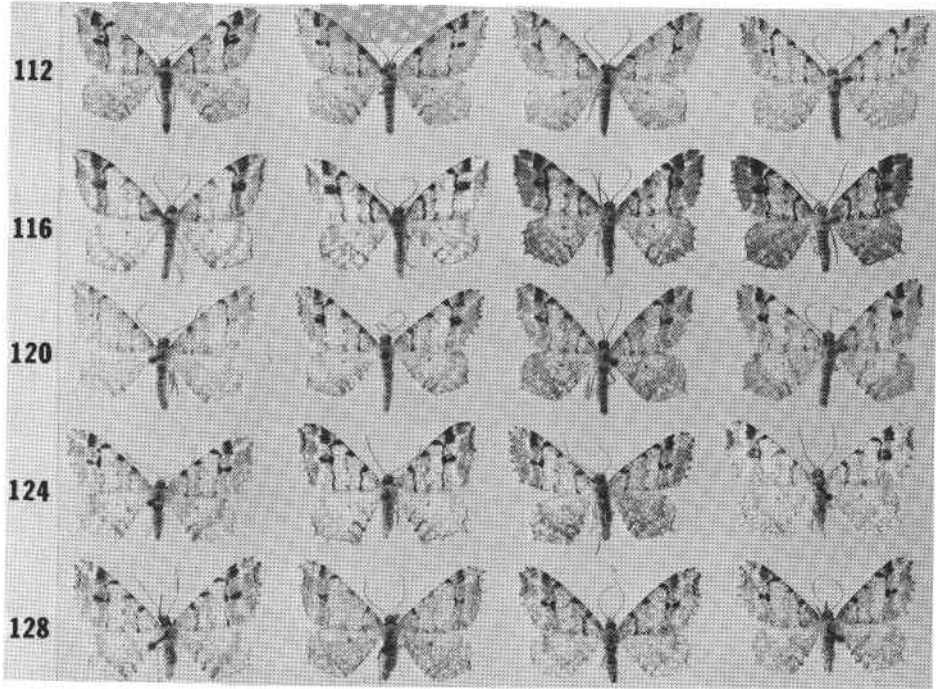


FIGS. 71-82. *Semiothisa unipunctaria unipunctaria* (Wright). 71, male, Greenhorn Mts., Kern Co., Calif.; 72, female, West Fork, 6500', 16 mi SW. of Flagstaff, Ariz.; 73-75, males, Kyle Canyon, 7500', Clark Co., Nev.; 76, female, same locality; 77-78, males, Science Lodge, 9500', Boulder Co., Colo.; 79-80, males, Big Timber Canyon, ca. 6500', Crazy Mts., Sweetgrass Co., Mont.; 81, female, Little Timber Cr., 5743', Crazy Mts., Mont.; 82, female, Big Timber Canyon, Crazy Mts., Mont.

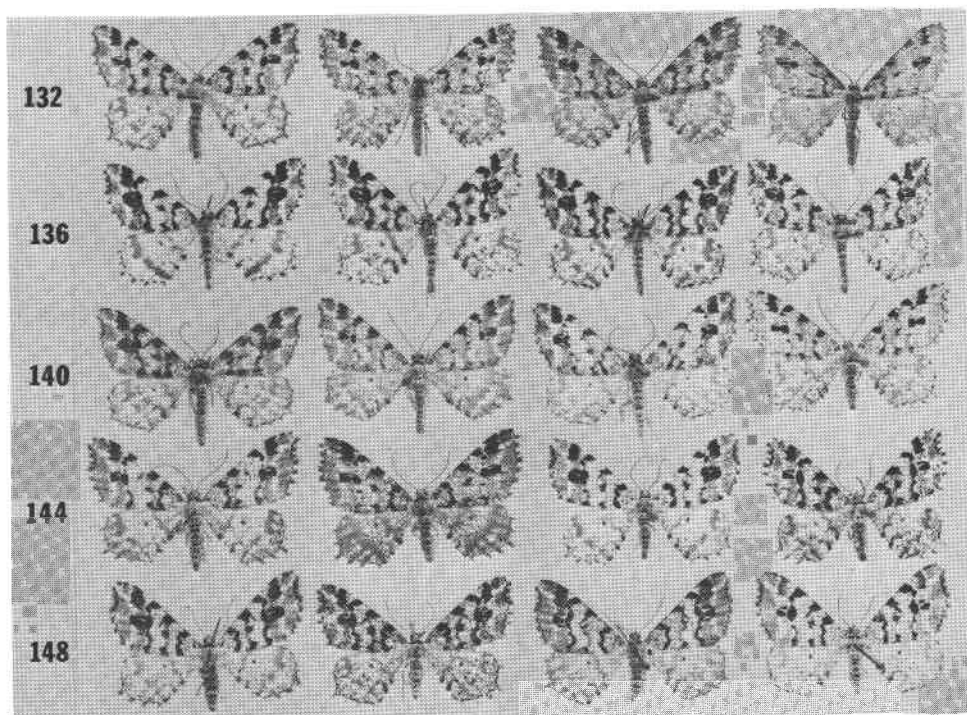
FIGS. 83-91. *Semiothisa unipunctaria perplexa* (McD.); 83-87, males, 88-91, females; all except 83 reared from larvae on Douglas fir. 83, paratype, Banff, Alta.; 84, Clinton, B.C.; 85, Sinclair, B.C.; 86, Premier L., B.C.; 87, Camp Lister, B.C.; 88, St. Mary L., B.C.; 89, Alexis Creek, B.C.; 90, Sinclair, B.C.; 91, Slocan, B.C.



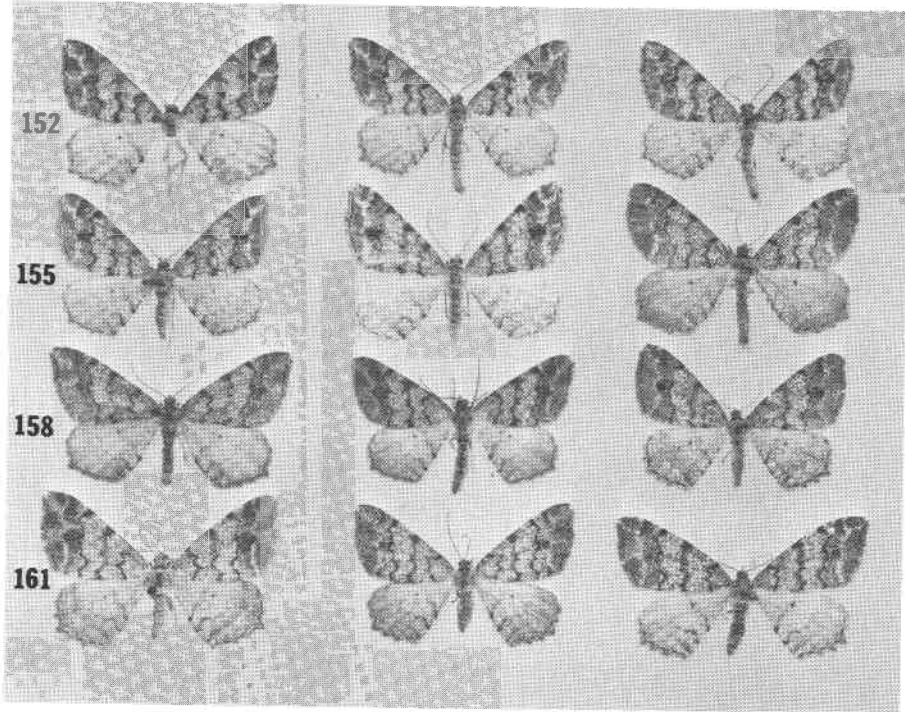
FIGS. 92-111. *Semiothisa pinistrobata* Fgn.; 92-99, 109, males, 100-108, 110-111, females (all from type series). 92, holotype, Lake Kejimikujik, Queens Co., N.S.; 93-96, same locality; 97, Boulderwood, Halifax, N.S.; 98, Waverley, Halifax Co., N.S.; 99, Concord, N.H. 100-106, Lake Kejimikujik, Queens Co., N.S.; 107, Hamden, New Haven Co., Conn.; 108, Ringwood Reserve, near Dryden, Tompkins Co., N.Y.; 109-111, melanic form, Armdale, Halifax Co., N.S., the last reared from egg on white pine.



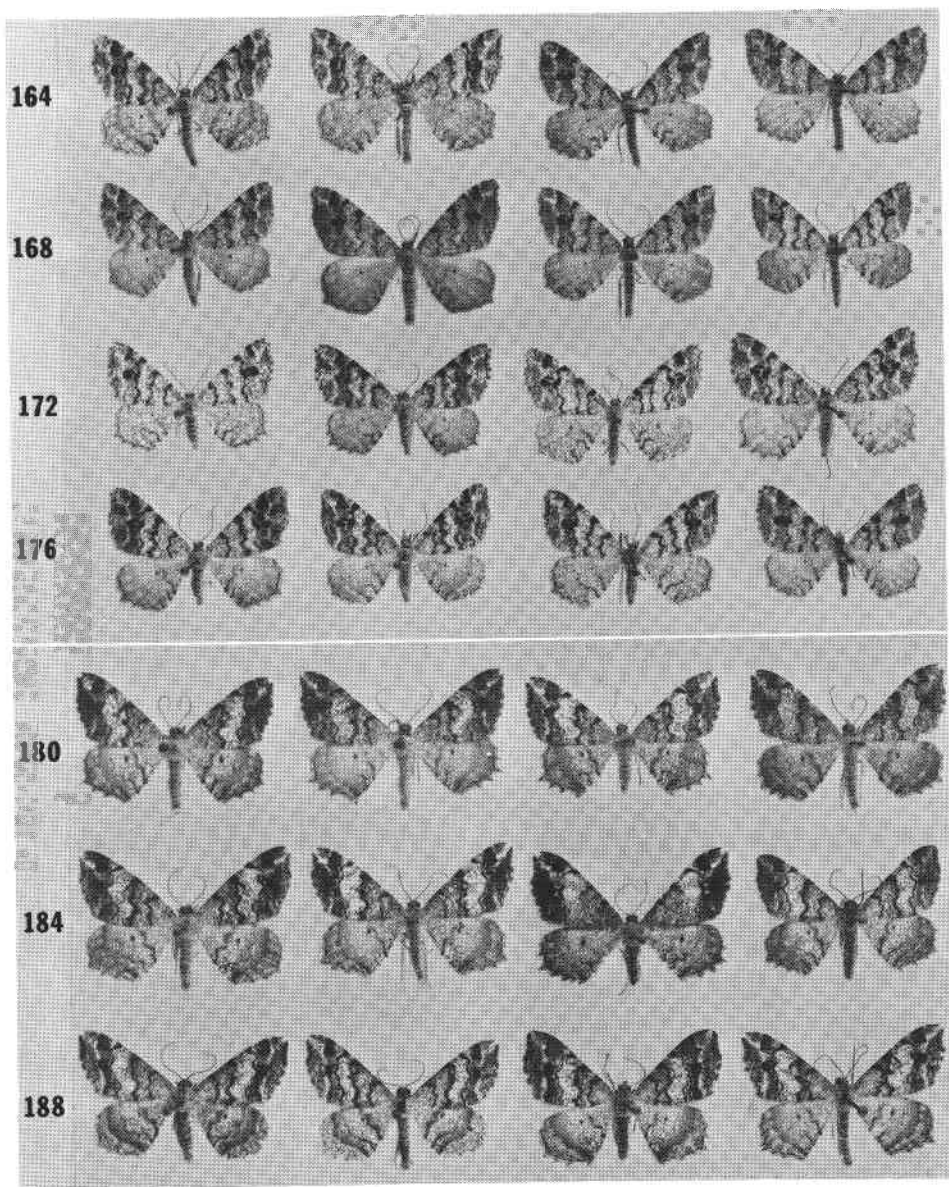
FIGS. 112-131. *Semiothisa fissinotata* (Wlk.). 112, male, Lake Kejimkujik, Queens Co., N.S.; 113-116, males, Hammonds' Plains, Halifax Co., N.S.; 117, male, Kearney Lake Rd., Halifax Co., N.S., reared from egg on hemlock; 118-119, Lake Kejimkujik, Queens Co., N.S., male and female reared from eggs on hemlock; 120, male, Hamden, New Haven Co., Conn.; 121, male, Ithaca, N.Y.; 122, male, Ringwood Reserve, near Dryden, Tompkins Co., N.Y.; 123, male, Boonton, N.J.; 124, female, New Brighton, Pa.; 125, female, Lake Kejimkujik, Queens Co., N.S.; 126, female, Trenton Falls, N.Y.; 127-128, females, Yale Preserve, New Haven, Conn.; 129, female, West Rock Pk., New Haven, Conn.; 130, female, Yale Preserve, New Haven, Conn.; 131, female, Hamden, New Haven Co., Conn.



FIGS. 132-151. *Semiothisa oweni* (Swett); 132-142, males, 143-151, females. 132-135, Doyles, Codroy Valley, Nfld.; 136, Green Bay, Lunenburg Co., N.S.; 137, Bog E. of Big Indian L., Halifax watershed area, N.S.; 138-140, near Big Indian L., Halifax watershed area, N.S.; 141-142, Passadumkeag, Penobscot Co., Me.; 143-145, Doyles, Codroy Valley, Nfld.; 146, Baddeck, N.S.; 147, same locality Fig. 137; 148, Debert, Colchester Co., N.S.; 149, same locality Fig. 137; 150-151, Passadumkeag, Penobscot Co., Me.

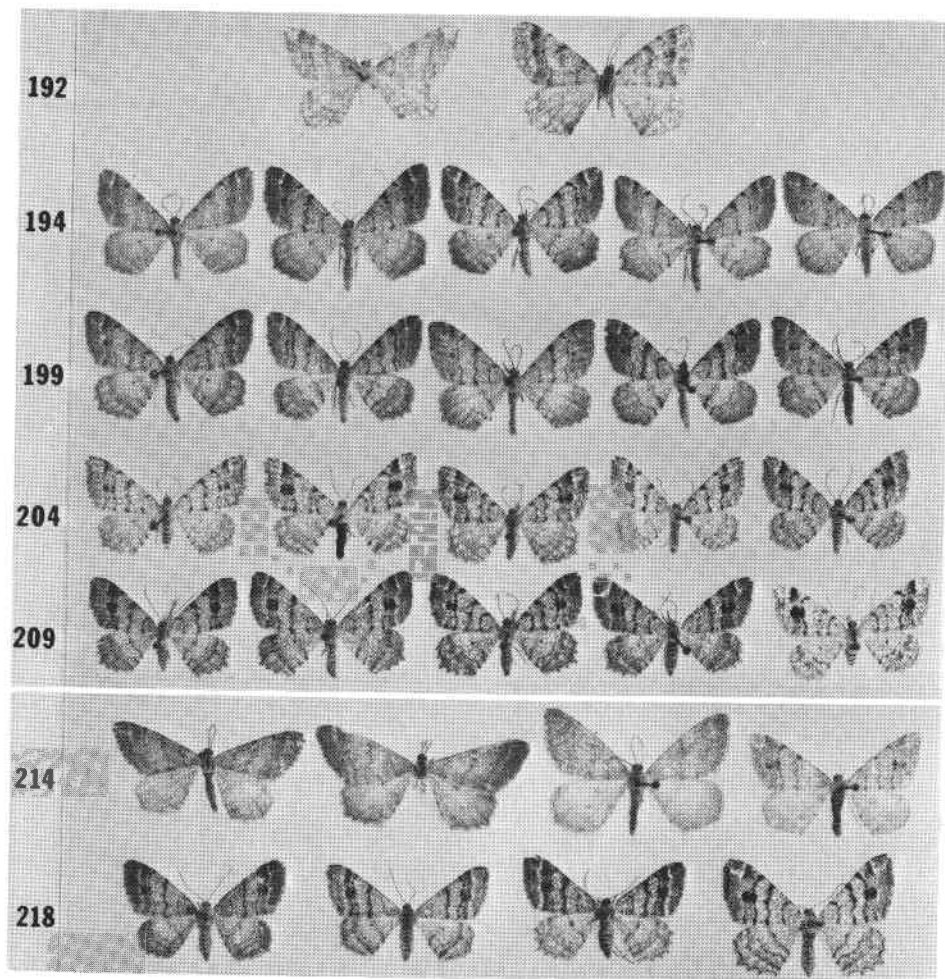


FIGS. 152-163. *Semiothisa banksianae* Fgn. 152, holotype male, Dorchester, N.B.; 153, male, Purcell's Cove, Halifax Co., N.S.; 154, male, Debert, Colchester Co., N.S.; 155, allotype female, Dorchester, N.B.; 156, female, same locality; 157, male, Squilax, B.C., from larva on lodgepole pine; 158, male, Nordegg, Alta.; 159, male, Lochalsh, Ont., from larva on jack pine; 160, female, Cranbrook, B.C., from larva on lodgepole pine; 161, female, Gold River, B.C., from larva on lodgepole pine; 162, female, Hasmer, B.C., from larva on lodgepole pine; 163, female, Coleman, Alta., from larva on lodgepole pine.



FIGS. 164-179. *Semiothisa submarmorata* (Wlk.); 164-171, males, 172-179, females. 164-166, Doyles, Codroy Valley, Nfld.; 167, Bog E. of Big Indian L., Halifax watershed area, N.S.; 168, Debert, Colchester Co., N.S.; 169, same locality Fig. 167; 170-171, Beckley Bog, near Norfolk, Litchfield Co., Conn.; 172-173, Doyles, Codroy Valley, Nfld.; 174, Armdale, Halifax Co., N.S.; 175-177, Bog E. of Big Indian L., Halifax watershed area, N.S.; 178-179, Beckley Bog, near Norfolk, Litchfield Co., Conn.

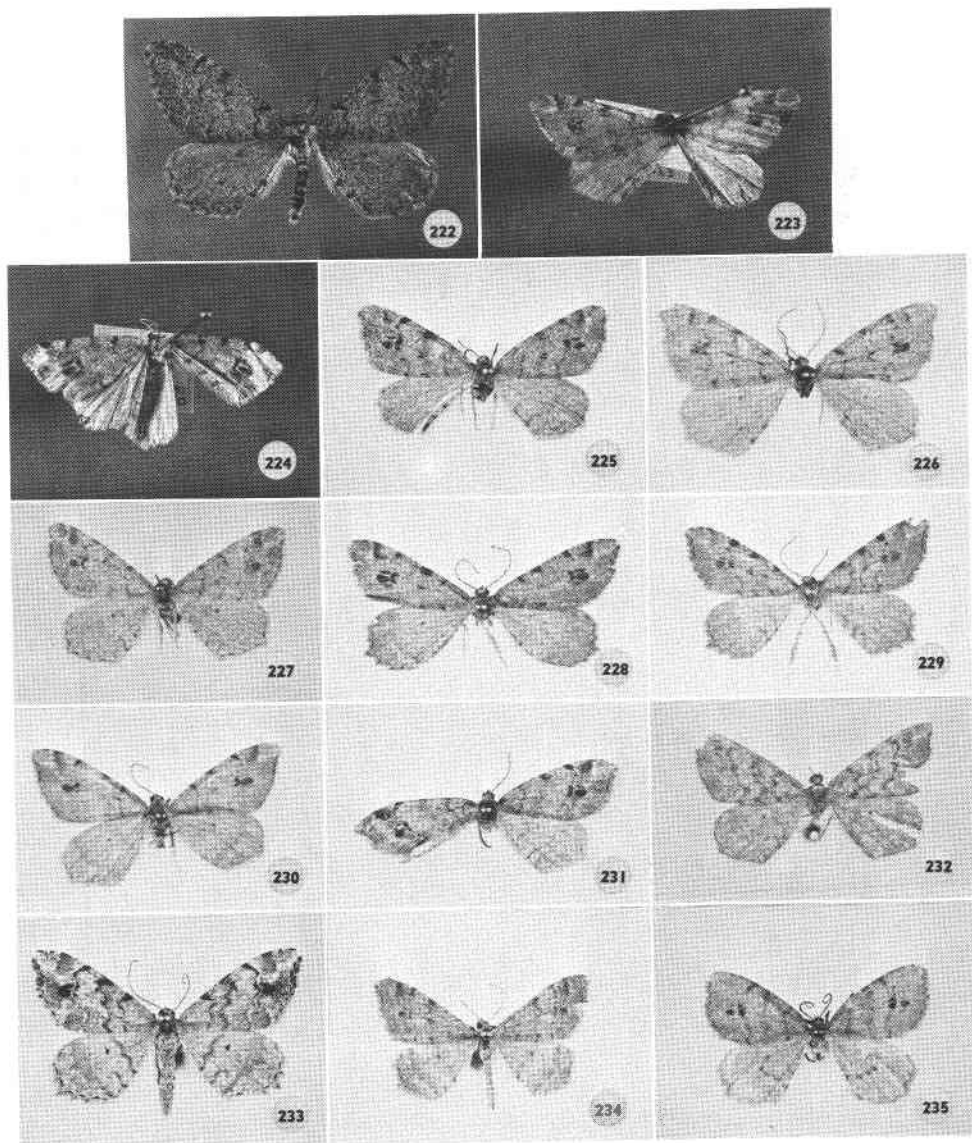
FIGS. 180-191. *Semiothisa granitata* (Gn.). 180-181, males, Arlington, Va.; 182, female, same locality; 183-185, males, Beltsville, Md.; 186, female, Adelphi, Prince Georges Co., Md.; 187-189, males, Lakehurst, N.J., reared from eggs on scrub pine and jack pine; 190, female, same data; 191, male, Barnstable, Mass.



FIGS. 192–193. *Semiothisa fuscaria* (Leech). 192, male, Mt. Kumotori, 1800 m, Okutama, Japan; 193, female, Mt. Azusa, Naguno Pref., Japan.

FIGS. 194–213. *Semiothisa sexmaculata sexmaculata* (Pack.); 194–203, males, 204–213, females. 194–196, Doyles, Codroy Valley, Nfld.; 197, Debert, Colchester Co., N.S.; 198–199, Bog E. of Big Indian L., Halifax watershed area, N.S.; 200, Dorchester, N.B.; 201, Horseheads, N.Y.; 202–203, Beckley Bog, near Norfolk, Litchfield Co., Conn.; 204–205, Doyles, Codroy Valley, Nfld.; 206, Armdale, Halifax Co., N.S.; 207, Mt. Uniacke, Hants Co., N.S.; 208, same locality Figs. 198–199; 209, Parent, Que., from larva on white spruce [host error?]; 210, Berthierville, Ont., from larva on eastern larch; 211, Beckley Bog, near Norfolk, Litchfield Co., Conn.; 212, Sardinia, N.Y.; 213, Yonkers, Westchester Co., N.Y.

FIGS. 214–221. *Semiothisa sexmaculata incolorata* (Dyar); 214–216, males, 217–221, females. 214, paralectotype, Kaslo, B.C.; 215, lectotype, Kaslo Cr., B.C.; 216, Spring Cr., Baker, Ore.; 217, paralectotype of *Sciagraphia purcellata* Taylor, Kaslo, B.C.; 218, Cranbrook, B.C., from larva on lodgepole pine; 219, Grand Forks, B.C., from larva on Douglas fir; 220, Athlmer, B.C., from larva on Douglas fir; 221, Bluffton, Alta., from larva on eastern larch (possibly the nominate subspecies).



FIGS. 222-235. Types. 222, holotype male of *Macaria perplexa* McD.; 223, holotype male of *Macaria* ? *subapicaria* Wlk.; 224, holotype female of *Boarmia inordinaria* Wlk.; 225, holotype female of *Tephrosia dispuncta* Wlk.; 226, holotype female of *Larentia* ? *exnotata* Wlk.; 227, holotype male of *Macaria quadrisignata* Wlk.; 228, lectotype female of *Macaria haliata* Wlk.; 229, holotype male of *Macaria irregularata* Wlk.; 230, lectotype male of *Acidalia* ? *fissinotata* Wlk.; 231, lectotype female of *Macaria retinotata* Wlk.; 232, holotype male of *Macaria* ? *submarmorata* Wlk.; 233, lectotype male of ? *Macaria succosata* Zell.; 234, holotype male of *Macaria unimodaria* Morr.; 235, holotype male of *Camptogramma* ? *abruptata* Wlk. (Figs. 222-224 from Graphics Unit, Canada Department of Agriculture; 225-235 from British Museum (Nat. Hist.).) Approximately natural size.

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