

American Museum Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N. Y. 10024

NUMBER 2482

FEBRUARY 16, 1972

A Review of the North American Moths of the Genus *Cleora* (Lepidoptera, Geometridae)

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ABSTRACT

The genus *Cleora* is a large group of moths primarily Old World in distribution. It is represented in the New World by two species only, *sublunaria* (Guenée) and *projecta* (Walker), both of which occur in eastern North America. These two moths and their genitalia are redescribed and figured, and keys are provided to separate them.

INTRODUCTION

Fletcher (1967) recently revised the African species of *Cleora* Curtis, and included in his paper a check list of the species of the world; they number more than 150 with quite a few subspecies. Of this total, only two species are known from the New World, both occurring in eastern North America. Several revisionary papers have been published covering the Old World species (Fletcher, 1967, p. 7). The North American species were briefly redescribed and illustrated by McDunnough (1920) and Forbes (1948), but both works are brief and incomplete. As a result I decided to revise this small group, giving keys and full descriptions of the moths and their genitalia.

Both of the North American species are closely allied to the type species of the genus, *cinctaria* (Denis and Schiffermüller), in that the male antennae have two pairs of pectinations on each segment. This character will

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distinguish our species of *Cleora* from all the other North American geometrids. *Cleora cinctaria* is Palearctic, occurring from western Europe to Japan. Presumably our species were derived from the Old World, possibly either from *cinctaria* itself or a closely allied species. For a discussion of the affinities of this genus, see Fletcher (1967, pp. 7, 8).

During the course of this study, I have examined 207 specimens and 32 genitalic dissections; approximately two-thirds of the moths are in the collection of the American Museum of Natural History. Males of both species rather than females are more commonly represented in collections. For *sublunaria* the ratio is 2.4 males for one female; for *projecta*, 3.7 males for one female. Apparently the females do not react positively to light in the same manner as the males do.

All specimens and genitalia illustrated in the present paper are from the collection of the American Museum of Natural History.

My generic description is based on our two species only, and does not necessarily apply to specimens from the Old World.

ACKNOWLEDGMENTS

The author wishes to acknowledge with thanks the cooperation and aid of the following colleagues who have sent him information about types, and have allowed him to study specimens in their charge: Dr. J. M. Burns of the Museum of Comparative Zoology, Harvard University; Dr. J. P. Donahue of the Los Angeles County Museum of Natural History; Dr. D. C. Ferguson of the Systematic Entomology Laboratory, United States Department of Agriculture, for the United States National Museum, Smithsonian Institution; Mr. D. S. Fletcher of the British Museum (Natural History); Dr. W. C. McGuffin of the Entomology Research Institute, for the Canadian National Collection; Mr. A. Blanchard, of Houston, Texas; Mr. R. Leuschner, of Gardena, California; Mr. D. Schweitzer, of Stafford, Pennsylvania.

The present paper has been supported in part by National Science Foundation Grant GB-6478X1. This assistance is gratefully acknowledged.

GENUS *CLEORA* CURTIS

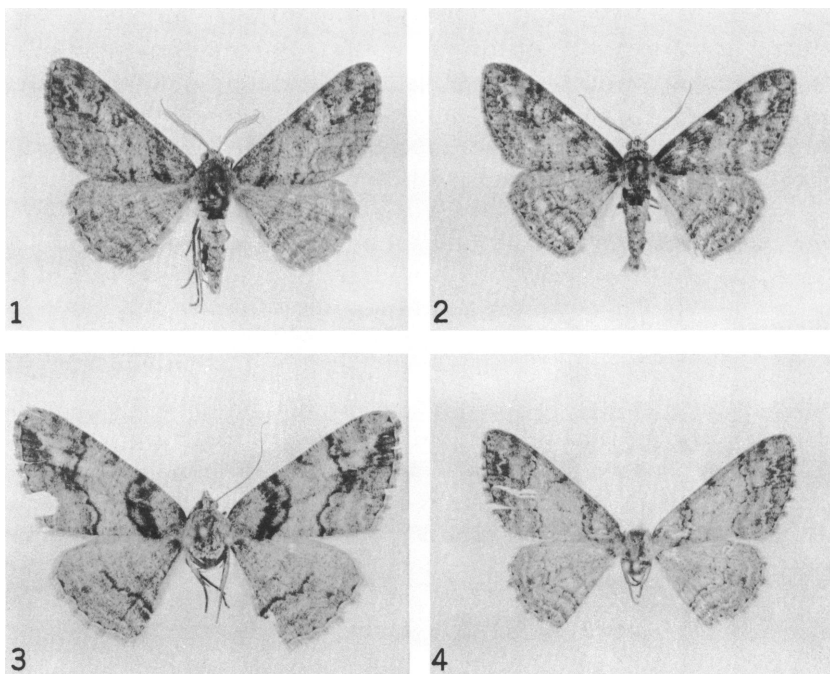
Cleora CURTIS, 1825, pl. 88. McDUNNOUGH, 1920, p. 19. FORBES, 1948, p. 52. FLETCHER, 1967, p. 4.

DIAGNOSIS: The males of the North American species are easily distinguished from all our other Cleorini by the antennae being doubly bipectinate. Additional diagnostic characters include the forewings having 12 veins, with R_1 and R_2 normally separate, with a small fovea in the male, and the hind wings with eight veins. The proboscis is well developed.

ADULTS: Head, eyes large, equal to, or broader than, front; front flat, with raised row of scales between bases of antennae and more prominent band ventrally; tongue well developed; palpi rising to middle of eye, first segment long scaled below, and with third segment small, horizontal or weakly decumbent; antennae with about 52 to 55 segments, male doubly bipectinate for two-thirds length, with longer pectinations arising distally on segments, up to 0.85 mm. in length, scaled above and ciliate beneath, with shorter pectinations arising basally on segments, up to 0.30 mm. in length, slightly fewer in number than longer pectinations, flattened, unscaled but with fine ciliae from ventral edge, and with terminal one-third of simple segments having paired terminal setae; female antennae simple, scaled above, shortly ciliate and with paired terminal setae below. Thorax with large patagia of mixed spatulate and hairlike scales, and with small posterior tufts; fore tibia unarmed, with process in male arising medially, in female distad of middle, in both sexes extending to, or just beyond, end of tibia; hind tibia with two pairs of spurs, male without groove or hair pencil. Abdomen with low flat crest of scales across first tergite; male without row of setae on ventral surface of third segment and with last segment unmodified. Forewings broad, elongate, alike in both sexes; 12 veins present; areole absent; R_1 and R_2 separate, R_5 from stalk about midway to branching of R_3 and R_4 ; M_1 from upper angle, with dc weakly curved; Cu_1 from lower angle; small fovea present in male. Hind wings broad, weakly concave between veins; frenulum strong in both sexes; Sc approximate to R for one-half length of cell; R and M_1 from before upper angle; M_3 from lower angle; Cu_1 from just before lower angle.

Upper surface of wings varying in color from grayish brown to purplish brown, with median area usually paler; forewings having both t. a. and t. p. lines prominent and complete. Under surface gray or brownish gray, with reduced maculation.

MALE GENITALIA: Uncus elongate, tapering to long, slender apex; socius absent; gnathos elliptical, large, with slender sides and moderate median enlargement; valves symmetrical, extending more or less to end of uncus, with smoothly sclerotized costa, apical area covered with numerous fine setae, with sacculus sclerotized, in form of strongly raised ridge, with medial process another raised ridge, and having prominent, spinelike digitate process anterior of medial process; transtilla moderate; anellus with broad base, tapering and elongate posteriorly, with inverted Y-shaped ridge; cristae very long and curved; tegumen and saccus elongate, rather slender; aedeagus shorter than, or equal to, combined lengths of tegumen and saccus, straight, with bluntly pointed, sclerotized posterior end; vesica, when exerted, somewhat tubular, more or less swollen anteroventrally,



FIGS. 1-4. Adults. 1. *Cleora projecta* (Walker), male, Lakehurst, New Jersey, May 1-10 (F. Lemmer). 2-4. *C. sublunaria* (Guenée). 2. Male, Ocean County, New Jersey, April 18, 1952 (O. Buchholz). 3. *Boarmia atrolinearia* Hulst, lectotype female, Kentucky. 4. *Cleora areataria* Broadwell, holotype female, Hemlock Falls, New Jersey, April 22. All figures $\times 1.5$.

with saclike arm extending to left before apex and bearing two small sclerotized processes.

FEMALE GENITALIA: Papillae anales simple, membranous, scarcely distinguishable from adjacent membranous area, lengthily exsertile, with apophyses posteriores two to three times longer than apophyses anteriores, being from about 4.3 to 5.0 mm. in length; sterigma with ventral surface of eighth segment broadly sclerotized, and with small ridges outlining roughly circular platelike areas laterad of ostium bursae; intersegmental membrane between A_7 and A_8 with more or less circular, sclerotized areas ventrolaterally; ductus bursae sclerotized, with parallel sides, approximately twice as long as wide; ductus seminalis arising ventrally from near junction of ductus bursae and corpus bursae; latter elongate, slender and with longitudinal striations posteriorly, and becoming swollen anteriorly; signum small to medium in size, situated ventrally.

EARLY STAGES: Unknown or undescribed.

FOOD PLANTS: One of our species (*projecta*) has been reared on *Myrica Gale* Linnaeus. The caterpillar of the Palearctic *cinctaria* is said to be a general feeder (Forbes, 1948, p. 52).

TYPE SPECIES: *Geometra cinctaria* Denis and Schiffermüller; by original designation.

DISTRIBUTION: Eastern North America.

KEY TO SPECIES

BASED ON COLOR

Front white, with black transverse median band *sublunaria*

Front brown or grayish brown, with or without brownish black transverse median band *projecta*

BASED ON MALE GENITALIA

Valve with medial process extending posteriorly beyond end of sacculus ridge, narrow and evenly curved, and with inner margin having numerous, small dentations of equal size *sublunaria*

Valve with median process about equal in length to sacculus ridge, broad, with inner margin having at least one very large projection *projecta*

BASED ON FEMALE GENITALIA

Sterigma with posterior margin of eighth segment broadly and evenly rounded *sublunaria*

Sterigma with posterior margin of eighth segment having small median projection *projecta*

Cleora sublunaria (Guenée)

Figures 2-5, 7, 9, 11

Boarmia sublunaria GUENÉE, 1857, p. 248. GROTE, 1873, p. 159. ANON., 1882, p. 24. OBERTHÜR, 1913, p. 272, pl. CLXVIII, fig. 1644 (type female).

Cleora sublunaria: PACKARD, 1876, p. 442. DYAR, "1902" [1903], p. 326. SMITH, 1903, p. 77. BARNES AND McDUNNOUGH, 1917, p. 117. McDUNNOUGH, 1920, p. 20, pl. 2, fig. 12 (male genitalia), pl. 9, fig. 8 (male antenna), pl. 10, fig. 6 (venation); 1938, p. 163. FORBES, 1948, p. 52, fig. 73 (sacculus ridges of male genitalia). KIMBALL, 1965, p. 180, pl. 22, fig. 20 (male). FLETCHER, 1967, p. 112. MCFARLAND, "1966" [1968], p. 16.

Selidosema sublunaria: BARNES AND McDUNNOUGH, 1914, p. 211.

Boarmia transfixaria WALKER, 1860, p. 347. PACKARD, 1876, p. 435 [placed as synonym of *Cymatophora humaria* (Guenée), although given as *C. humaria* Packard, in error].

Selidosema transfixarium: DYAR, "1902" [1903], p. 325.

[*Selidosema*] *transfixaria*: BARNES AND McDUNNOUGH, 1914, p. 221 (placed as synonym of *sublunaria*).

Boarmia atrolinaria HULST, 1888, p. 214. SMITH, 1891, p. 72. RINDGE, 1955, p. 137.

Alcis atrolinaria: DYAR, "1902" [1903], p. 321. SMITH, 1903, p. 76.

Cleora atrolinaria: BARNES AND McDUNNOUGH, 1917, p. 117 (placed as synonym of *sublunaria*).

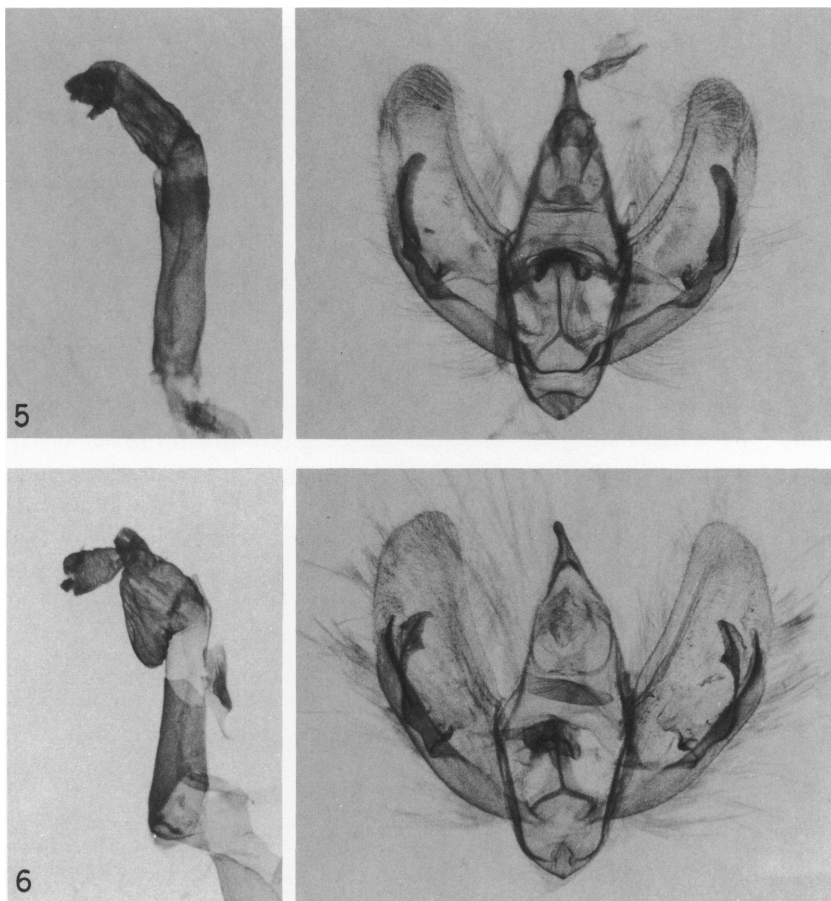
Cleora areataria BROADWELL, 1907, p. 180. BARNES AND McDUNNOUGH, 1917, p. 117 (placed as synonym of *sublunaria*).

Selidosema areaxaria (*sic*): BARNES AND McDUNNOUGH, 1914, p. 211.

DIAGNOSIS: This species can be recognized by the front being white with a black, transverse median band; the white is usually more intense on the raised ventral band of scales. The underside of the prothorax also tends to be covered with white scales. In *projecta* both the front and the under surface of the thorax are brown or grayish brown. There are good characters in the male genitalia to separate the two species; see the key for this.

MALE: Head with eyes large, broader than front; front white, with black band between bases of antennae and across middle of front; palpi with first segment mostly white, terminal portion and with other segments having mixed white, grayish black, and black scales; antennae with longer pectinations 0.7 mm. in length, shorter pectinations 0.2 mm. Thorax above with mixed gray, grayish brown, and blackish brown scales; patagia with narrow black transverse band; below white or pale brownish white, long scaled; legs white or brownish white, with variable number of dark grayish brown and brownish black scales. Abdomen above with raised scales on first segment light gray or white, with second segment brownish black medially, and with remainder of segments covered with mixture of gray, grayish brown and brownish black scales; below similar to upper surface but with more light gray scales.

Upper Surface of Wings: Forewings with mixture of light gray, dark gray, brownish gray, and brownish black scales, producing a more or less grayish brown coloration, with the median area tending to be paler gray than remainder of wing; cross lines black; t. a. line arising on costa one-third of distance from base as more or less wide spot, curving evenly across wing, meeting inner margin just basad of one-third of distance from base, and having much broader basal band; discal spot round, black or brownish black, with white or grayish white, slightly raised scales in center; median line obsolescent or nebulous; t. p. line arising on costa two-thirds distance from base, angled inward to cell R_5 , then roughly S-shaped into cell Cu_2 , tending to be thickened on veins, thence outwardly curved to inner margin, with entire line more or less shaded distally by nebulous dark shade band; s. t. line varying from obsolescent to having anterior and posterior pale gray spots; terminal line represented by brownish black intravenular spots; fringe concolorous with wing. Hind wings concolorous with fore-



FIGS. 5, 6. Male Genitalia. 5. *Cleora sublunaria* (Guenée), Batsto, New Jersey, April 25, 1970 (D. Schweitzer). 6. *C. projecta* (Walker), Chester's Island, Charlton County, Georgia, March 31, 1940 (J. W. Cadbury).

wings; median cross line weakly represented, rather nebulous; discal spot small, round or elongate; extradiscal line complete, outwardly dentate on veins, paralleling outer margin but with basal bend near anal angle; s. t. line usually represented as nebulous, rather broad, incomplete gray band; outer portion of wing similar to that of forewing.

Under Surface of Wings: All wings gray, more or less evenly suffused with brown and brownish gray scales; discal spots present on all wings, large, dark grayish brown; outer cross lines present on all wings, similar

in course to those of upper surface; terminal line of intravenular spots; fringe concolorous with wing.

Length of Forewing: 13 to 17 mm.

FEMALE: Similar to male; in general tending to have upper surface of wings less contrastingly colored and more evenly grayish, but some specimens contrastingly marked, with broad pale median area tending to be set off by dark cross lines.

Length of Forewing: 14 to 17 mm.

MALE GENITALIA: Uncus tending to be strongly curved ventrally; valve with sacculus ridge extending about seven-tenths of length of valve, of even height but tapering somewhat apically; medial process 0.60 to 0.65 mm. in length, extending beyond posterior end of sacculus ridge by about 0.1 mm., evenly curved and of even width, having outer edge with numerous, small dentations of equal size; digitate process an elongate, curved spine arising from anterodistal corner of lightly sclerotized area; cristae varying from about 25 to 40 on each side, closely arranged in ovate area; aedeagus 1.0 to 1.5 mm. in length; vesica with small sclerotized processes variably dentate, one usually with numerous fine teeth, the other tending to be thicker and having single tooth.

FEMALE GENITALIA: Sterigma broadly sclerotized, with posterior end evenly rounded; ductus bursae 0.4 mm. in length; corpus bursae tapered at posterior end and being lightly sclerotized and with a few longitudinal striations, and with anterior end gently swollen; signum small, indented, circular, about 0.2 mm. in diameter; apophyses posteriores 4.6 to 5.0 mm. in length.

EARLY STAGES: Unknown.

FOOD PLANT: Unknown.

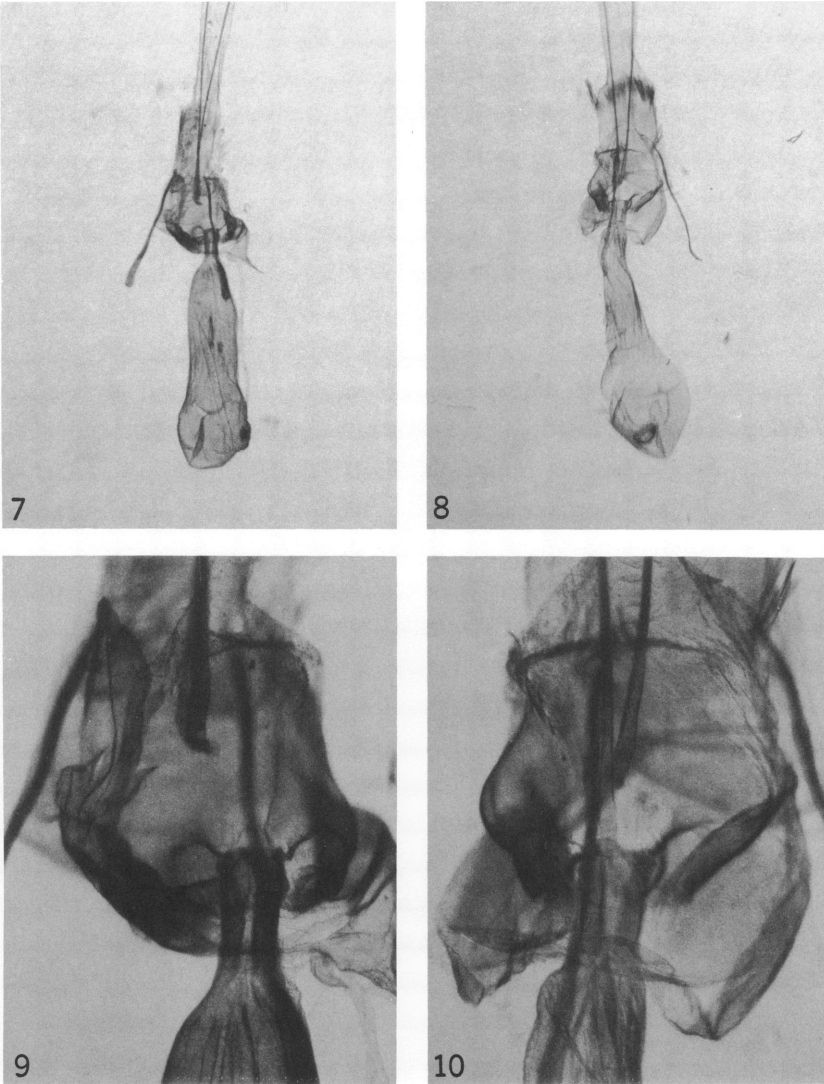
TYPES: Guenée described *sublunaria* from a single female. This specimen is in the collection of the United States National Museum.

Walker's type of *transfixaria* was a single female; this specimen is in the British Museum (Natural History).

Hulst described *atrolineararia* from one male and one female. The latter specimen is in the collection of the American Museum of Natural History (Rindge, 1955, p. 137), and is hereby designated as the lectotype. It is illustrated in figure 3. The male is in the collection of the United States National Museum, and lacks the abdomen (as does the lectotype) and one hind wing.

Broadwell's holotype female of *areataria* is in the collection of the American Museum of Natural History; it is illustrated in figure 4. The genitalia are mounted on slide FHR 3227.

TYPE LOCALITIES: "Amérique septentrionale" (*sublunaria*); St. John's



FIGS. 7-10. Female Genitalia, showing entire structure, and more magnified view of sterigmal area. 7, 9. *Cleora sublunaria* (Guenée), Jackson, Mississippi, March 8, 1964 (B. Mather). 8, 10. *C. projecta* (Walker), Chester's Island, Charlton County, Georgia, March 31, 1940 (J. W. Cadbury).

Bluff, east Florida (*transfixaria*); Kentucky (*atrolinearia*); Hemlock Falls, South Orange, Essex County, New Jersey (*areataria*).

DISTRIBUTION: Eastern and southeastern United States (see fig. 11). The northern limit appears to be about at latitude 41° N., as specimens are known from northern New Jersey and the area around New York City, and again in central Illinois. In the west the species extends as far as longitude 98° W., with moths being known from Texas and Kansas. Records from the southeast are scarce, but the species is known from South Carolina, Georgia, and western Florida; the species is apparently uncommon along the coastal plains. The type of *transfixaria* from St. John's Bluff, east Florida, was collected by E. Doubleday before 1840 (D. S. Fletcher, in letter). This locality is between Jacksonville and the sea, in Duval County. No recent specimens have been taken in this area.

TIME OF FLIGHT: February and March in the southern portion of the range; northern captures are usually March and April, with a few May records.

REMARKS: One hundred and twenty-three specimens (87 males, 36 females) and 13 genitalic dissections (10 males, three females) have been studied.

This species presumably was poorly represented in the collections of the earlier workers on our North American moths, and consequently these men were usually unacquainted with it. The males of *sublunaria* are usually about twice as numerous in collections as are females; they are also easier to recognize and hence to name, due primarily to their specialized antennae and a rather limited amount of variability in coloration and maculation. However, a series of 16 males from the Wedge Plantation, Charleston County, South Carolina, caught in 1968 and 1969, show considerably more variation in color than do other series of this sex from other localities. The upper surface of the wings ranges in color from being mostly pale gray with either a faintly reddish brown to a dark grayish black band on the outside of each cross line, to specimens that are successively more and more evenly and heavily suffused with dark grayish black, resulting in some moths that are almost uniformly of this last color. The series of 12 females from the same locality is less variable than the males, but show the same increase in over-all dark shading.

It is interesting to note that three of the four names applicable to this species were based on single females; the lectotype of the fourth name is now also a female. Some members of this sex tend to be rather more variable with regard to coloration and maculation than do the males, and this has apparently caused the proliferation of names. Both the type of *sublunaria* (Oberthür, 1913, pl. CLXVIII, fig. 1644) and the lectotype of

atrolinearia are heavily marked specimens, with a broad, brownish black shade band basad of the t. a. line. On the other hand, the holotype of *areataria* is a much more lightly marked, "normal" example. I have not seen the type of *transfixaria*, but from reading the description it may be a somewhat heavily marked specimen.

Cleora projecta (Walker)

Figures 1, 6, 8, 10, 11

Boarmia projecta WALKER, 1860, p. 396.

Cleora projecta: FLETCHER, 1967, p. 112.

Selidosema manitoba GROSSBECK, 1911, p. 225. BARNES AND McDUNNOUGH, 1912, p. 35, pl. 16, fig. 1 (cotype male).

Cleora manitoba: BARNES AND McDUNNOUGH, 1917, p. 117. McDUNNOUGH, 1920, p. 20, pl. 2, fig. 10 (male genitalia); 1938, p. 163. FORBES, 1948, p. 52, fig. 74 (sacculus ridges of male genitalia). MUNROE, "1949" [1950], p. 99. KIMBALL, 1965, p. 180. TAYLOR AND TAYLOR, 1965, p. 190. FLETCHER, 1967, p. 112 (placed as synonym of *projecta*). COVELL, 1970, p. 177.

DIAGNOSIS: See that of *sublunaria*.

MALE: Head with eyes narrower than those of *sublunaria*, narrower than front; front grayish brown or brownish gray, some specimens with dark grayish brown across middle of front; palpi more or less unicolorous grayish brown; antennae with longer pectinations 0.80 mm. in length, shorter pectinations 0.23 mm. Thorax above grayish brown to dark brownish gray; collar with or without narrow dark band apically; below with prothorax tending to be concolorous with front and palpi, becoming pale gray or pale grayish brown posteriorly; legs brownish gray, with variable number of dark brown scales. Abdomen above with raised scales on first segment gray, with second segment brownish black medially, and with remainder of segments covered with mixture of gray, grayish brown and grayish black scales; below similar to upper surface but paler.

Upper Surface of Wings: Forewings with mixture of pale gray, grayish brown, and brownish black scales, producing a more or less dark grayish brown or faintly purplish brown coloration; median area varying from slightly paler than adjacent areas to contrastingly grayish white; cross lines black, similar in course to those of *sublunaria*, but with t. p. line arising about three-fourths of distance from base; discal spot variable, ranging from obsolescent to elongate dash; outer portion of wing similar to that of *sublunaria* but with s. t. line tending to be more completely represented. Hind wings concolorous with forewings; median cross line varying from obsolescent to fairly strongly represented; discal spot small, usually weakly represented; outer portion of wing similar to that of *sublunaria*, but with



FIG. 11. Distribution of *Cleora sublunaria* (Guenée) and *C. projecta* (Walker).

s. t. line tending to be more sharply defined.

Under Surface of Wings: All wings brownish gray, evenly covered with grayish brown and dark brownish gray scales; discal spots and outer cross line faintly represented; terminal line varying from absent to having grayish black intravenular dots; fringe concolorous with wing.

Length of Forewing: 15 to 18 mm.

FEMALE: Similar to male; some specimens tending to have upper surface of wings less contrastingly colored and slightly grayer.

Length of Forewing: 14 to 17 mm.

MALE GENITALIA: Similar to those of *sublunaria* but differing mainly as follows: uncus tending to be less strongly curved; valve with sacculus ridge slightly higher; medial process 0.5 to 0.6 mm. in length, posterior

end terminating within 0.02 mm. of posterior end of sacculus ridge, broadest posteriorly and medially, anterior end tapering to point, with one (rarely two) large, prominent enlargement in central region; cristae fewer in number, ranging from about 16 to 25 and tending to be more slender and slightly shorter; aedeagus slightly longer and wider, being 1.6 to 1.7 mm. in length, and tending to have blunter and more heavily sclerotized posterior end.

FEMALE GENITALIA: Similar to those of *sublunaria* but differing mainly as follows: sterigma with posterior margin having small, median terminally raised protuberance; signum larger, 0.3 to 0.4 mm. in diameter and with smoother outer margin; apophyses posteriores slightly shorter, ranging from 4.2 to 4.8 mm.

EARLY STAGES: Undescribed. This species has been reared by Dr. W. C. McGuffin and Mr. K. Bolte; they found some larvae in a boggy area near Chaffey's Locks, Ontario (in letter).

FOOD PLANT: *Myrica Gale* Linnaeus.

TYPES: Walker described *projecta* from a single male; this specimen is in the collection of the British Museum (Natural History). Its genitalia are mounted on Geometridae slide 5163.

Grossbeck described *manitoba* from a series of 12 males; the type is No. 1048 in the Canadian National Collection, Ottawa.

TYPE LOCALITIES: "———?" (*projecta*); Winnipeg, Manitoba (*manitoba*).

DISTRIBUTION: Eastern North America (see fig. 11). The northern limit appears to be at about latitude 50° N. (southern Manitoba). Other northern localities are to be found in northern Wisconsin, and the southern portions of Ontario, Quebec, and Maine. The species extends down the Atlantic Coast, being found in western Pennsylvania, New Jersey, the coastal plains of South Carolina, Georgia, and Florida, southern Mississippi, and into eastern Texas. The western limit of distribution seems to be about the same as that for *sublunaria*, namely longitude 98° W. Our present records indicate that *projecta* does not occur in midwestern United States.

TIME OF FLIGHT: March and April in the southern portion of the range; northern captures are in April, May, and June.

REMARKS: Eighty-four specimens (66 males, 18 females) and 19 genitalic dissections (12 males, seven females) have been studied.

There are a number of characters that can be used, in addition to those noted in the diagnosis, to separate *projecta* and *sublunaria*. The two species have eyes of different sizes, with those of the present species being narrower than those of *sublunaria*. The male antennae of *projecta* have longer pectinations than do those of the preceding species. *Cleora projecta* tends to be

larger and to have both the upper and undersides of the wings darker than in *sublunaria*. On the under surface of the wings *projecta* tends to have both the discal dots and cross lines noticeable less strongly represented than in *sublunaria*.

The females of *projecta* are even less well represented in the material studied than those of *sublunaria*. As far as can be told, the members of this sex appear to be less variable than those of the preceding species. The males of *projecta* are quite variable in the coloration of the median area of the upper surface of the forewings; this varies from white or grayish white to being concolorous with the remainder of the wing.

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