Analysis of Morphology and Fauna of Geometrinae (Lepidoptera: Geometridae) of the Caribbean Region

David M Plotkin

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Analysis of morphology and fauna of Geometrinae (Lepidoptera: Geometridae) of the Caribbean region

By

David M. Plotkin

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Analysis of morphology and fauna of Geometrinae (Lepidoptera: Geometridae) of the Caribbean region

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The Geometrinae, commonly known as emerald moths, are a diverse group of Lepidoptera with over 450 Neotropical species. However, Caribbean Geometrinae have received relatively little attention compared to the Geometrinae of mainland Central and South America. Using the method of Lee and Brown (2006), whole body mounts of descaled specimens of both Caribbean and mainland Neotropical Geometrinae were prepared. Morphological variation of exo- and endoskeletal characters among species, genera, and tribes of Neotropical Geometrinae is described. A faunistic study of Caribbean Geometrinae was also conducted using material from museums and private collections. The study includes definitions of species of Caribbean Geometrinae, descriptions of new species, and illustrations of adult imagoes, genitalia, and other external characters. A key to the species of Caribbean Geometrinae is also provided.
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Species of Caribbean Geometrinae

Nemoriini

Dichorda rhodocephala Prout
- Adult

Lissocholra n.sp.
- Adult

Nemoria n.sp.1
- Adult

Nemoria n.sp. 2
- Adult

Nemoria n.sp. 3
- Adult

Nemoria punctilinea (Dognin)
- Adult

Nemoria rectilinea (Warren)
- Adult

Nemoria toxeres (Prout)
- Adult

Phrudocentra centrifugaria (Herrich-Schäffer)
- Adult

Synchlorini

Synchloara n.sp.1
- Adult

Synchloara n.sp.2
- Adult

Synchloara cupedinaria cupedinaria (Grote)
- Adult

Synchloara cupedinaria guadelupensis Herbulot
- Adult

Synchloara frondaria frondaria Guenée
- Adult

Synchloara herbaria herbaria (Fabricius)
- Adult

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CHAPTER I
INTRODUCTION

Introduction

The Geometridae are one of the larger families in Lepidoptera and include approximately 23,000 described species (Scoble and Hausmann, 2007). Geometridae have a cosmopolitan distribution with the majority of species found in tropical and subtropical regions (Scoble, 1992; Minet and Scoble, 1998). They occur in a variety of habitats, although many are found commonly in forests (Hausmann, 2001). Many species are habitat-specific, which makes them useful as environmental indicators (Minet and Scoble, 1998). The majority of Geometridae have larvae that are monophagous to polyphagous on shrubs and trees (Stehr, 1987; Hausmann, 2001). A few species are considered serious pests in forests and orchards; however, the family as a whole is not considered a major pest group (Minet and Scoble, 1998; Hausmann, 2001).

Geometrid adults are primarily characterized by a pair of abdominal tympana at the base of the abdomen that are symmetrically positioned, relative to the anterior-posterior axis (Scoble, 1999). Each tympanum is partially covered by a curved sclerotization termed an ansa; the ansa is unique to the family, and subfamilial variation in shape has been noted by Cook and Scoble (1992) and Hausmann (2001). A few species with brachypterous females lack tympana (Minet and Scoble, 1998). Geometridae also can be characterized by the absence of ocelli and the presence of...
Geometridae can be distinguished from most other families of Lepidoptera by the way most species hold their wings while at rest: separated and flat, parallel to the substrate, such that the dorsal scale patterns on both pair of wings are clearly visible (Hausmann, 2001). Some species hold their wings over their body, similar to butterflies, such that the ventral surfaces can be seen.

Geometrid larvae are distinct in having functional prolegs only on abdominal segments 6 and 10; a few taxa have reduced prolegs on segments 3–5 (Stehr, 1987). This arrangement of prolegs causes geometrid larvae to form a sort of loop as they walk; consequently, Geometridae have acquired the common names of measuring worms and inch worms.

Geometridae are currently divided into six subfamilies, five of which are monophyletic (Sihvonen et al., 2011). The monophyletic subfamilies, in order of approximate size, are Archiearinae (12 species), Geometrinae (2300 species), Sterrhinae (2800 species), Larentiinae (5700 species), and Ennominae (9700 species) (Minet and Scoble, 1998). The sixth subfamily, which has approximately 600 species, is a polyphyletic complex containing the Oenochrominae and Desmobathrinae. The subfamilies Alsophilinae and Orthostixinae were formerly part of this complex (Minet and Scoble, 1998), but were recently assigned tribal status within the Ennominae (Sihvonen et al., 2011).

The subfamily Geometrinae has a cosmopolitan distribution with 268 genera recognized worldwide (Scoble, 1999). The highest diversity of species occurs in the Neotropical Region where approximately 470 species in 39 genera have been recorded (Pitkin, 1996). Geometrinae are commonly called emerald moths because adults typically
have predominantly green scales. Other species of Geometridae exhibit a green color, however, Geometrinae are unique in deriving their color from the pigment geoverdin (Cook et al., 1994).

Geometrine larvae have prolegs only on A6 and A10, similar to most other Geometridae. Neotropical Geometrinae exhibit three general larval forms (Ferguson, 1985). The nemoriine form is characterized by abdominal dorsolateral projections; the relative size and quantity of these projections varies among genera. The synchlorine form has similar abdominal projections, albeit less developed. However, the latter is best characterized by the presence of botanical debris: the larva uses silk to attach small bits of plant material to its abdominal chalazae, which serves as camouflage. The hemitheine form is slender and brown, giving it a twig-like appearance. Geometrine larvae are either foliage feeders or flower feeders and generally are not considered major pests (Ferguson, 1985). However, a few species have been reported feeding on mango in Florida and Dominica (Peña et al., 1998).

Pitkin (1996) adopted the five tribes defined by Ferguson (1969, 1985) for classifying Geometrinae in America north of Mexico: Nemoriini, Dichordophorini, Synchlorini, Lophochoristini and Hemitheini. However, Pitkin recognized that Ferguson's concepts of these tribes needed revision when Neotropical taxa were included. For example, of the 39 Neotropical genera recognized by Pitkin, nine were not assigned to a particular tribe (Pitkin, 1996). All Neotropical tribes except Dichordophorini were represented in the geometrid phylogeny proposed by Sihvonen et al. (2011). The phylogeny indicates that Nemoriini and Hemitheini are polyphyletic, although this is not conclusive due to low bootstrap values (Sihvonen et al., 2011).
This thesis concerns the Geometrinae of the Caribbean Region. The morphology of de-scaled adult moths is treated in Chapter II, and the species occurring in the Caribbean Region are treated in Chapter III. The latter chapter includes descriptions of nine new species.
References


CHAPTER II
ANALYSIS OF EXO- AND ENDOSKELETAL MORPHOLOGY OF NEOTROPICAL GEOMETRINAЕ

Introduction

Diagnostic characters of Geometrinae

The subfamily Geometrinae is commonly characterized by its green color, which is derived from the pigment geoverdin. The presence of geoverdin is apomorphic (Cook et al., 1994), but the green color is not unique to the subfamily: other subfamilies have species with green coloration derived from different pigments. An additional external character that defines Geometrinae is hind wing venation with vein M2 arising from the end of the cell closer to M1 than M3 (Ferguson, 1985; Minet and Scoble, 1998). Certain structures in Geometrinae, such as the proboscis, the chaetosemata, and the frenulum, are reduced relative to other geometrids (Minet and Scoble, 1998; Scoble, 1992). Many species of Geometrinae have males with two patches of scales on abdominal sternite A3 (Scoble, 1992; Pitkin, 1996). These scales may have a function related to pheromone production and dissemination. The ansa of the geometrine tympanum is usually broad medially and narrow basally and apically (Pitkin, 1996).

Genera and species of Geometrinae can be differentiated by variation in the shape of certain structures of the male genitalia, such as the uncus, socii, and costal processes of the valvae (Pitkin, 1996). Female genitalia also have diagnostic characters, including
variation in form of the sterigma and relative lengths of both posterior and anterior apophyses (Pitkin, 1996). External characters used to identify taxa of Neotropical Geometrinae include the length of antennal pectination, number of tibial spurs, presence of male sex scales on the third segment of the abdomen, wing color pattern, and wing venation, particularly the fusion of the Sc+R and Rs veins on the hind wing (Pitkin, 1996). However, these external characters are individually unreliable; they should be used in conjunction with other superficial characters as well as genitalic characters (Pitkin, 1996).

External and genitalic characters traditionally have been used for identification of genera and tribes of Geometrinae. With the exception of tympanal organ morphology (Cook and Scoble, 1992), characters of the exo- and endoskeleton have not been analyzed for diagnostic value in defining taxa of Geometrinae.

**Objectives**

The objectives of this study were: (1) to describe the variation of exo- and endoskeletal characters of descaled whole bodies among species, genera, and tribes of Neotropical Geometrinae, with emphasis on Caribbean taxa; (2) to identify any novel morphological skeletal structures of descaled Geometrinae; and (3) to describe the variation of those characters between Geometrinae and selected species in other subfamilies of Geometridae.
Material and Methods

Material Examined

In this study, approximately 1200 pinned specimens of Geometridae were borrowed and examined from the following institutions and private collectors:

CMNH Carnegie Museum of Natural History, Pittsburgh, PA
FLMNH Florida Museum of Natural History, Gainesville, FL
JMC John R. MacDonald Private Collection, Mississippi State University, MS
MEM Mississippi Entomological Museum, Mississippi State University, MS
NYSM New York State Museum, Albany, NY
USNM United States National Museum of Natural History, Washington, D.C.

Of the approximately 1200 specimens, 766 were Geometrinae collected in the Caribbean region. Approximately 404 specimens were Geometrinae in genera with Caribbean distributions that were collected outside of the Caribbean region. Six specimens were representatives of five geometrine genera not found in the Caribbean region. The remaining 24 specimens were representatives of five other subfamilies of Geometridae: Archiearinae, Ennominae, Larentiinae, Oenochrominae, and Sterrhinae.

In addition to the pinned material, slides of whole body dissections of Tortricidae and Pyralidae in the MEM were examined for comparison with Geometridae.

Preparations of Whole Body Mounts

A total of 46 whole bodies, including wings and genitalia, were prepared and slide mounted; these represented fifteen genera of Geometrinae and six 'outgroup' genera from five other geometrid subfamilies (Table 1). Specimens were assigned a unique number for both the slide and the pin that bore the associated data labels. Numbering followed the established guidelines of the institutions from which the specimens were borrowed. Both hard copies and digital records of preparations were maintained, with each record
providing the species name, the sex, the collection locality, the preparer's name and the unique slide number.

The method used for preparation of whole body mounts followed Lee and Brown (2006) with some modifications. The left pair of wings was detached and dry mounted under a coverslip, which was glued to the slide by spots of nail polish on its margins. The right pair of wings was detached and placed in 10% KOH at room temperature for 1–4 hours. The wings were then cleaned of scales in 20% ethanol with a camel's hair brush, stained in eosin for two hours, further descaled in 70% ethanol, and dehydrated overnight in 100% ethanol. The wing venation preparations were mounted in Euparal. The rest of the body was left on the pin and placed in 10% potassium hydroxide (KOH) at room temperature for at least eight hours. The body was then removed from the pin and cleaned of scales in 20% isopropyl alcohol; many sclerotized structures were found to better retain the staining solution when cleaned in isopropyl alcohol as opposed to ethanol. The head and abdomen were separated from the body, and the antennae and labial palpi were detached from the head. The prothorax, mesothorax, and metathorax were separated. The genitalia was separated from the abdomen and prepared following the methods of Clarke (1941) and Robinson (1976), except Chlorazol Black was not used as the stain. All body parts were stained in safranin for at least one hour. Prolonged periods of immersion in safranin were occasionally required in order for the specimen to fully absorb the stain. After staining, the body parts were further cleaned in 70% isopropyl alcohol. During this cleaning, the tegulae and mesonotum were detached from the remainder of the mesonotum, and the abdominal pelt was cut longitudinally along the pleuron. After cleaning, the body parts were transferred from isopropyl alcohol to 100%
ethanol, held in position under chips of glass slides, and dried overnight. The dehydrated body parts were then mounted in Euparal. The whole body, including wings, was mounted on at least two slides under at least four coverslips: one for the head, prothorax, and mesothorax, one for the metathorax, abdomen, and genitalia, one for the dry wings, and one for the stained wings. Some specimens were mounted on three slides, instead of two, with the genitalia and abdomen mounted separately from the remainder of the body under a single coverslip. Some specimens were mounted on four slides due to their large wings, with each pair of wings on its own slide and each individual wing under its own coverslip.

**Preparation of Specimens for Scanning Electron Microscopy (SEM)**

Selected morphological structures on the heads of nineteen specimens representing six subfamilies of Geometridae were prepared for examination with SEM. Antennae and labial palpae were removed from the head, placed in a gelcap, and attached to the specimen's pin. The head was then detached from the thorax and placed on an aluminum stub with silver paste. After drying in a desiccator for at least 24 hours, the stub was coated with two 15 nm layers of platinum in an EMS 150T ES high resolution sputter coater. Selected structures on the hind legs of five male specimens representing two subfamilies of Geometridae (Geometrinae and Ennominae) were also examined with SEM. Hind legs were prepared with the same methods used to prepare the heads. The specimens prepared for SEM were examined and photographed with a JEOL JSM-6500F Field Emission Scanning Electron Microscope at an accelerating voltage of 5kV.
Examination and Measurements of Specimens

Examinations of specimens were made using a Leica MZ125 stereomicroscope and a Bausch & Lomb compound binocular microscope. Measurements were made with an ocular micrometer that was calibrated with a stage micrometer. Some characters were expressed as ratios of measurements. The size of the compound eye was measured by the interocular index, which is the ratio of the vertical eye diameter to the interocular distance between the eyes across the frons (Davis, 1975; Kristensen, 1998) (Fig. 1). The length of the third labial segment (LP3) was measured relative to the length of the second labial segment (LP2), following Ferguson (1969), and variation in length of the third segment was expressed as the LP3/LP2 ratio. The length of the organ of vom Rath (OVR) was measured relative to the length of the second segment of the labial palpus because there is less variation in length in the second segment than the apical segment. The number of styloconic sensilla on the proboscis was recorded as the minimum values in a hypothetical range because it was likely that some styloconic sensilla could not be seen due to the orientation of the proboscis under the slide. The relative epiphysis length was assessed by comparing length of the epiphysis to length of the tibia. The relative length of metatibial spurs was assessed by comparing the length of the longest spur to length of the tibia.

Photographs of morphological structures were made with a Leica stereoscope with Leica Application Suite 3.7.0©, autoformatted with Montage©, Synoptics Ltd. Photographs were edited with Adobe® Photoshop® CS6 Version 13.0 x64.
Terminology


Results

Head

The interocular index of Neotropical Geometrinae ranges 1.8–2.7, with the greater values indicating relatively large eyes, compared to the size of the head. Genera with indices in the upper half of the geometrine range include Chloropteryx (Hemitheini), with an index ranging 2.4–2.6, and Hydata (inc. trib.), with an index of 2.7. Genera with lower interocular indices include Dichorda (Nemoriini), with an index of 1.8, and Tachychlora (Nemoriini), with an index of 1.9. Synchlorella (Synchlorini) has more variation in size of the eye than other geometrine genera; its interocular index ranges from 1.8 in S. frondaria Guenée to 2.4 in S. gerularia (Hübner). The exclusively Nearctic genus Chlorosea and the Old World genus Comibaena have respective indices of 1.6 and 1.7, just outside the range of Neotropical Geometrinae.

The remaining geometrid subfamilies have interocular indices that range 0.7 (Archiearinae) to 2.2 (Ennominae). Ennominae are the only subfamily with an index that falls within the geometrine range. Conversely, Archiearinae are farther outside the
geometrine range than all other examined Geometridae, implying that archiearine eyes are relatively reduced compared to the other subfamilies.

Compound eyes of Geometrinae and Archiearinae also differ in shape, which results in visible differences in the general shape of the head capsule. Archiearine have ovoid eyes (Minet and Scoble, 1998); their shape is attributed to the greatly reduced horizontal eye diameter. These ovoid eyes appear markedly different from the larger, more spherical eyes of Geometrinae (Fig. 2).

The positions of antennal sockets vary among Geometrinae genera. In *Chloropteryx*, *Phrudocentra*, and some *Nemoria*, the sockets are positioned relatively close together, whereas in *Hydata*, they are farther apart (Figs. 3, 4). This may be due to differences in sizes of the sockets, which appear large in *Phrudocentra* and small in *Hydata*. Species of *Nemoria* with closely-positioned sockets include *N. lixaria* (Guenée), *N. bistriaria* (Hübner), and possibly *N. cosmeta* Prout and *N. tickelli* Pitkin. Other *Nemoria*, such as *N. saturiba* Ferguson, have sockets comparatively farther apart.

Many Geometrinae have two pairs of campaniform sensilla on the vertex, posterior to the antennal sockets. These sensilla are close together in *Phrudocentra* and farther apart in *Hydata*, indicating a possible correlation between proximity of sensilla and proximity of antennal sockets.

In Geometrinae, the occipital foramen has a rounded dorsal border and an emarginate ventral border with a pair of rounded, weakly-projecting occipital condyles. The combination of a rounded dorsal border and weakly-projecting condyles is unique to Geometrinae. The occipital foramina of other geometrid subfamilies either have angulate dorsal borders or condyles that project more strongly into the cavity (Fig. 5a). The shape
of the occipital condyles varies within the family, but only Geometrinae and Oenochrominae have condyles that are weakly rounded (Fig. 5b).

The shape of the sitophore, an internal plate above the buccal cavity, is highly variable in some lepidopteran taxa (Kristensen, 1998). This plate is uniformly oblong and quadrilateral with rounded corners in Geometrinae and other geometrid subfamilies.

The posterolateral area of the sitophore usually has two pairs of campaniform sensilla in a symmetrical trapezoidal arrangement, with the more posterior pair positioned farther apart than the anterior pair (Fig. 6). However, in Synchlora herbaria (Fabricius) and Phrudocentra centrifugaria (Herrich-Schäffer), the posterior pair is not in the same horizontal plane, resulting in an asymmetrical trapezoid. One specimen of N. saturiba has only two sensilla, one on each side of the posterior half of the sitophore; but this may be an anomaly because a second specimen of N. saturiba has four sensilla similar to all other examined Nemoria.

Additional campaniform sensilla occur on the anterior area of the sitophore. The number of sensilla varies between species and ranges from three in N. bistriaria to 15 in Dichorda iridaria (Guenée). Distribution of sensilla also varies within species. In many of the examined Geometrinae, the anterior sensilla are separated into two areas, akin to the distribution of the posterolateral campaniform sensilla. The number of sensilla in each area ranges 1–7. The two areas usually have different numbers of sensilla, but areas with equal numbers of sensilla are present in some species, such as Chloropteryx tepperaria (Fig. 6). The anterior sensilla are distributed randomly in some specimens, e.g., N. tickelli. Two other distributional patterns are present in Geometrinae: the anterior
sensilla form a parabola in a specimen of *Hydata insatisfacta* Herbulot, and the three sensilla of *N. bistriaria* are arranged as the points of an equilateral triangle.

Characters of sensilla of the sitophore vary between Geometrinae and some of the other geometrid subfamilies. Archiearinae and Oenochrominae have an individual sensillum on each side of the posterior area of the sitophore and two sensilla on the anterior area of the sitophore. Alsophilini has two pairs of sensilla on the posterior area of the sitophore, but the pairs are positioned asymmetrically. Alsophilini also lacks sensilla on the anterior half of the sitophore.

The heteroneuran labrum is characterized by two lateral lobes, termed pilifers, and one medial lobe (Kristensen, 1998). The medial lobe has been termed the epipharynx in some morphological analyses, e.g., Oseto and Helms (1976), but this term is misleading according to Kristensen (1998). The shape of the medial lobe does not vary within Geometrinae. The pilifers each have a medial cluster of setae, as do genera in other subfamilies. The pilifers are often slightly curved, making them crescent-shaped, but this shape varies among genera of Geometrinae. *Chlorosea nevadaria* Packard and some species of *Synchhora* have shorter pilifers with inner margins that have less curvature than those of other Geometrinae, e.g., *H. insatisfacta*. The pilifers of *H. insatisfacta* (Fig. 7) are also more slender and have finer setae than those of other Geometrinae.

Labral characters vary between Geometrinae and some other subfamilies of Geometridae. Oenochrominae have pilifers with clusters of closely-packed setae. The pilifers and the medial lobe of Alsophilini are greatly reduced compared to those in other Geometrinae.
The geometrine proboscis lacks scales, spines, and specializations that are present in some of the other Glossata (Kristensen, 1998). Proboscis length varies little among Geometrinae, and no taxa exhibit a reduction or loss of the proboscis except Alsophilini. Most species of Geometrinae have both styloconic and campaniform sensilla on the proboscis. Styloconic sensilla are present along the apical eighth of the proboscis in all genera. In some genera, additional styloconic sensilla are found more basally, i.e., the proboscises of Comibaena, Oospila, and Rhodochlora, which have styloconic sensilla along the entire apical third (Fig. 8). These same three genera consequently have greater numbers of styloconic sensilla compared to other Geometrinae. The Comibaena proboscis has at least 27 styloconic sensilla on each galea, the Rhodochlora proboscis has at least 38 sensilla on each galea, and the Oospila proboscis has at least 50 sensilla on each galea. All other geometrine proboscises have no more than 20 visible styloconic sensilla per galea. Phrudocentra pupillata Warren and the genus Chlorosea have no visible styloconic sensilla.

Most Geometrinae have campaniform sensilla distributed along the entire length of the proboscis. Phrudocentra pupillata is the only species that lacks campaniform sensilla. Campaniform sensilla are sparsely distributed on the proboscises of Hemitheini, such as Hethemia pistasciaria (Guenée), in contrast to the more dense distribution of these sensilla on the proboscises of Lophochoristini, such as Eueana niveociliaria (Herrich-Schäffer). Density of campaniform sensilla in Nemoriini and Synchlorini varies among species.

Characters for the proboscis vary greatly between Geometrinae and other geometrid subfamilies. The proboscis is developed in all of the observed tribes of
Geometridae, except Alsophilini, which has a greatly reduced proboscis without any sensilla. Proboscises of Archiearinae and Oenochrominae lack campaniform sensilla, but they have more styloconic sensilla than most Geometrinae. Archiearinae has approximately 50 styloconic sensilla per galea, which is more than is present in all other Geometrinae except *Oospila* (Oenochrominae), which has more than 100 styloconic sensilla per galea.

The labial palpi of the Geometrinae, like those of most Lepidoptera, are each comprised of basal, medial, and apical segments, which are further referred to as first, second, and third segments (Fig. 9). Most of the variation with the labial palpi involves the third segment and its associated organ of vom Rath.

Some of the variation in the third segment of the labial palpus is sexual dimorphism; Ferguson (1969, 1985) noted that female third segments are longer than male third segments of the same species. Consequently, the LP3/LP2 length ratio is greater in female Geometrinae than in conspecific males. The LP3/LP2 length ratio of the female palpus is 2.5–3.0x greater than the male LP3/LP2 length ratio in some species, such as *H. insatisfacta*, but it is only 1.3x greater in others, such as *C. nevadaria*. Thus, the degree of variation between sexes also varies between species.

The LP3/LP2 length ratio ranges 0.2–0.8 in male Geometrinae, although the only genus with a ratio of 0.2 is the Old World *Comibaena*. Male Nemoriini tend to have a comparatively shorter third segment than that in other New World tribes, with a LP3/LP2 ratio ranging 0.3–0.4. *Phrudocentra* is an exception; its LP3/LP2 length ratio ranges 0.5–0.6. The female LP3/LP2 length ratio ranges 0.4–1.4, indicating that geometrine palp length is more variable in females than in males.
The organ of vom Rath is located at the apex of the third segment of the labial palpus (Fig. 9). This organ is comprised of a group of sensilla in an invaginated pit, although a specimen of *D. iridaria* has a bifurcated invagination that gives the appearance of two sensory pits (Fig. 13). The length of the organ of vom Rath, as compared to length of the second segment of the palpus, is sexually dimorphic in some species.

As with the LP3/LP2 length ratio, the OVR/LP2 length ratio is also greater in female Geometrinae than in conspecific males. Interspecific variation of the sexual variation is also present. In *N. saturiba* the OVR/LP2 length ratio in the female is 2.5x that of the male (Figs. 10, 11), but in *D. iridaria*, the female is only 1.1x greater than that of the male (Figs. 12, 13).

The OVR/LP2 length ratio ranges 0.05–0.21 in male Geometrinae; the genera *Comibaena* and *Lissochlora* have the minimum and maximum values, respectively, in that range. Although male Nemoriini tend to have shorter third segments compared to the other New World tribes, the length of the organ of vom Rath is more variable. The Nemoriini OVR/LP2 length ratio ranges 0.07–0.21, which is nearly identical to the range for all Geometrinae. Thus, the length of the organ of vom Rath in males appears to vary at the generic level, not at the tribal level. The female OVR/LP2 ratio ranges 0.08–0.42, indicating that the length of the organ of vom Rath in Geometrinae is more variable in females than in males.

Dimensions of the first segment of the labial palp (LP1) vary among species of Geometrinae, but unlike the third segment, the first segment does not exhibit sexual dimorphism (Ferguson, 1969). It appears to vary more in width than in length, although
its curvature makes it difficult to obtain precise measurements of length. Thus, variation
in first segment width is assessed by comparing it to second segment length; a greater
LP1/LP2 ratio is indicative of a relatively wide first segment. The LP1/LP2 ratio ranges
from 0.2, e.g., *H. insatisfacta*, to 0.5, e.g., *C. nevadaria*.

The labial palpi of Geometrinae differ greatly from those of Archiearinae and
Alsophilini, mainly because the latter two subfamilies have very short palpi (Hausmann,
2001). Archiearinae have reduced third and second segments; their reduction results in a
relatively large LP1/LP2 ratio of 1.7, well outside the geometrine range of 0.2–0.5.
Alsophilini only has two segments, both of which are reduced. None of the palpal ratios
are applicable to Alsophilini, but the variation in size between the palpi of Geometrinae
and Alsophilini is visibly evident.

All Geometrinae have a pair of chaetosemata, (Fig. 14), but the function of these
structures in Lepidoptera is unknown (Kristensen, 1998). Ferguson (1985) mentions that
each chaetosema usually has four or five setae, however, all New World geometrine
tribes include some species with more than five setae per chaetosema. The observed
range among species is 3–13 setae in each chaetosema. Most species differ in the
numbers of setae in their chaetosemata. The bases of the chaetosemata are covered with
numerous microtrichia, which can be seen only at magnifications of at least 100x (Fig.
14).

Geometrine chaetosemata generally have fewer setae than the chaetosemata of
other geometrid subfamilies. Sterrhinae have 4–13 setae per chaetosemata in most of the
species examined, with one species, *Timandra griseata*, having 18 setae. In contrast,
Larentiinae has 21–60 setae for each chaetosema. Larentiinae, Sterrhinae, Archiearinae,
and some Ennominae have chaetosemata that are more elongate and cover a greater percentage of the head than geometrine chaetosemata. Ennominae, Alsophilini, and some species of Larentiinae and Sterrhinae lack microtrichia on the bases of their chaetosemata.

The antennal pectination is well known as a sexually dimorphic character in Geometrinae. Most male Geometrinae have bipectinate antennae, whereas the antennae of most female Geometrinae are either simple or bipectinate with branches shorter than their male counterparts (Ferguson, 1985; Hausmann, 2001; Pitkin, 1995). Hemitheini includes some genera with males that lack bipectinate antennae, such as the Nearctic genus *Hethemia*. However, the most diverse Neotropical hemitheine genera, *Chlorochlamys* and *Chloropteryx*, have males with bipectinate antenna. All other geometrid subfamilies have some representatives with bipectinate male antennae, except Alsophilini, which have males with ciliate antennae.

Male antennal pectination varies among tribes of Geometrinae. In Nemoriini, the base of each pair of the branches is located on the apical end of each flagellomere (Fig. 15), except in *Lissochlora*, which has branches originating from the medial area of each flagellomere (Fig. 16). The origin of the pectination on the medial area of the flagellum in *Lissochlora* is shared with *Hydata (inc. trib.)*, Lophochoristini, Synchlorini and Hemitheini.

Lengths of pectination branches have been used to distinguish Nemoriini from the Synchlorini, Lophochoristini, and Dichordophorini. The latter three tribes have branches at least three times longer than the width of the corresponding flagellomere, whereas Nemoriini has branches that are relatively shorter (Ferguson, 1985). This diagnosis is
valid for Nearctic Geometrinae, but not for Neotropical Geometrinae. Many Neotropical Nemoriini genera, such as *Phrudocentra*, *Lissochlora*, and *Rhodochlora*, have long branches, comparable to those of other tribes.

Pitkin (1996) characterized females of *Hydata* Walker as having antennae that are "pectinate with short broad branches lying close together and forming single loops, not pairs of separate branches." However, the female antennae of *H. insatisfacta* are not pectinate, but rather have an unusual expansion of the ventral surface of each flagellomere, forming a hollow, cup-shaped appendix that is closed basally and medially, but open apically (Fig. 17).

**Prothorax**

The cervical sclerites are a pair of elbowed structures with dorsal and ventral arms that connect the pronotal pleuron to the head (Fig. 18). Relative lengths of these arms can vary among genera. In *Hydata (inc. trib.)*, the dorsal arms of the cervical sclerites are much longer than the ventral arms, but this discrepancy is not as great in other genera of Geometrinae. Relative width of the ventral sclerite arm also varies among genera. The ventral arms in *Chloropteryx paularia* (Möschler) are narrower than the ventral arms of other Hemithiini. Variation in width is also evident between the ventral arms of *Oospila* and *Eueana* (Lophochoristini).

The cervical sclerites, when viewed together, form a diamond shape in all Geometridae. However, some species of Geometrinae have sclerites with ventral margins that are noticeably more rounded; the overall diamond shape is still preserved, but it appears more sub-quadrate. For example, the cervical sclerites of *Synchlora*
*bistriaria* (Packard) are more rounded and appear more sub-quadrate than those of other *Synchlora* (Figs. 18, 19).

Each cervical sclerite has a medial expansion of the dorsal arm bearing a group of proprioreceptive sensilla that has been considered a lepidopteran ground-plan autapomorphy (Kristensen, 1998). These setal plates are prominent in Hemitheini, and they occupy a relatively wider and longer area compared to setal plates of other geometrine tribes. *Dichorda* also has prominent setal plates, but in other Nemoriini, the length of these plates is reduced. In some nemoriine genera, such as *Tachychlora*, the setal plates are so short that they can only be distinguished by the presence of a few sensilla. Some geometrid subfamilies have setal plates shaped differently than those of Geometrinae. Geometrine setal plates are rounded, whereas oenochromine setal plates are pointed apically, so that they appear triangular. The expanded setal plates in Archiearinae extend to the apices of the anterior arms; although the sensilla are only present medially.

The patagia of Geometrinae are rounded and lightly sclerotized, with a balloon-like form comparable to that of other Obtectomera (Kristensen, 1998). This form of patagium differs among species, with variation in basal width and shape of the apex. Much of this variation is represented in *Nemoria*. The patagia of many species, such as *N. cosmeta*, have narrow bases and broadened apices with convex margins. In *N. saturiba*, the base is nearly as wide as the apex, making the patagia roughly rectangular (Fig. 20). In *N. tickelli*, the patagia broaden apically, but the apical regions are flat and have concave dorsal margins. Patagia of other Geometrinae exhibit similar variation, but are still distinct; *S. bistriaria* patagia, for example, resemble those of *N. saturiba*, but are
curved more strongly along the apical margin. In addition to presence of scales and setae, a proprioreceptive campaniform sensillum is present on both the lateral and median areas (Fig. 20).

Patagia of *Alsophila pometaria* (Harris) differ from those of Geometrinae. Each patagium is well sclerotized and has a very narrow base that abruptly broadens and has rounded apical margins. Other subfamilies of Geometridae have similar variations in shape of the patagia as those in Geometrinae.

The shape of the prothoracic furca is highly variable in Geometrinae. The furca has two lateral arms that apically project freely into the prothoracic central cavity (Figs. 21, 22). The arms are connected basally to the endopleuron. In Hemitheini, the arms have rounded medial margins, are subequal in width from base to apex, and have narrowly rounded apices (Fig. 22). This combination of character states is also present in *S. herbaria* (Synchlorini) and *H. insatisfacta* (inc. trib.), although arm width varies apically relative to the width of the endopleuron. In other Neotropical Geometrinae, the lateral arms are narrower apically than basally. In some of these species, the medial margins of the arms are rounded, but in others, this margin is sharply angled, resulting in the arms apically pointing towards the center of the prothorax. In the nemorine genera *Lissochlora* and *Phrudocentra*, the arms notably have falcate apices (Fig. 21).

The freely projecting apices of the lateral arms of the furca also vary in length, relative to the length of the entire lateral arm. The free apices in Hemitheini and Lophochoristini are reduced in length, and the majority of the lateral arm is connected to the endopleuron (Fig. 22). Conversely, the free apices are longer in Nemoriini and Synchlorini, making up at least half of the length of the lateral arm (Fig. 21).
The ventrolateral areas of the furca have two arms that project anteriorly and taper to a point immediately adjacent to the ventral endopleuron. Variation in size and shape of the ventrolateral arms cannot be accurately assessed due to variable orientation of the furca relative to the endopleuron and katepisternum in slide-mounted specimens.

Prothoracic furcal characters vary among other Geometridae. There is no character state that distinguishes Geometrinae from all other geometrid subfamilies, though there appears to be some subfamilial variation in lengths of the projecting apices. The projecting apices of *Dyspteris abortivaria* (Herrich-Schäffer) and *Oenochroma vinaria* Guenée are severely reduced, such that nearly the entire lateral furcae are connected to the endopleura. This reduction is even more pronounced than the reduction observed in Hemitheini and Lophochoristini. The lateral areas are wider relative to endopleural width; the lateral areas of these two species have a stubby appearance easily distinguished from those of Geometrinae. The ventrolateral arms of *O. vinaria* also appear stubby and reduced due to their weak projection into the endopleuron. The reduction of the ventrolateral arms is so great that the observed difference in length cannot solely be attributed to variable orientation of the furca.

Kristensen (1998) discusses variation in the pronotal sclerotization among some Lepidoptera, but there is little variation in Geometrinae. In Geometrinae, the anteromedian pronotal sclerotization is subtriangular and is connected to a relatively narrow posteromedian pronotal sclerotization. The posterior sclerotization of *Chlorosea* is wide compared to the width of the entire anteromedial pronotal sclerotization, but the dimensions are uniform among all other observed Geometrinae genera. Compared to
other subfamilies, the geometrine anteromedial pronotal sclerotization only differs from that of Oenochrominae, which have a pronotum with a subquadrate sclerotization.

Geometrinae also have a pair of anterolateral pronotal sclerotizations that are connected to the anepisternum and the patagium. The sclerotizations can each have a broad, occasionally pointed projection, at the base of the patagium (Fig. 20). These projections are present in the Nemoriine genera *Nemoria*, *Dichorda*, and *Lissochlora*, as well as one species of *Phrudocentra*. Similar projections are also present in the ennomine *Campaea* and the oenochromine *Oenochroma*.

**Mesothorax**

The general shape of the mesoscutum is consistent among Geometrinae. When viewed dorsally, the mesoscutum has a straight anterior margin, rounded lateral margins and a concave to angular posterior margin. The internal surface of the mesoscutum has a medial longitudinal sulcus bordered by internal crests (Figs. 23, 24). The expression of the longitudinal sulcus varies, with it being less pronounced in Sterrhinae, Larentiinae, and Alsophilini.

The mesoscutellum is subquadrate with a rounded posterior margin and an anterior margin that varies in the degree of being rounded, appearing almost angular in some species. Within Geometrinae, there is variation in length:width ratio of the mesoscutellum. Considerable variation in this ratio may occur between congeneric species, e.g., *Dichorda obliquata* Warren and *D. rhodocephala* Prout (Figs. 23, 24).

The tegulae, which are attached to the mesoscutum, are more elongate and apically narrow in Geometrinae than in other subfamilies, especially compared to those of Archiearinae and Alsophilini. When compared to Geometrinae, the longitudinal
length of the tegula in Alsophilini is much less relative to the basal width (Fig. 25a,e). The basal socketed portion of the tegula exhibits variation from being rounded to pointed (Fig. 25).

The pleurosternal section of the mesothorax exhibits little variation in Geometridae, relative to the other thoracic segments; however, a few variable structures are notable. One such structure is the basisternum, which generally is sub-quadrate in shape (Fig. 26). The large posterior part of the basisternum is separated by a transverse sulcus from the mesoclidium, a term referring to the anterior part that is narrow, tapered, and dorsally curved (Kristensen, 1998). However, the shape of the posterior part of the basisternum varies among some subfamilies. Alsophilini and Archiearinae have elliptical posterior parts of the basisternum, with that of Alsophilini being more ovate than that of Archiearinae (Fig. 27). No variation was found with the mesoclidium among the examined Geometridae.

The mesothoracic furca (Fig. 28) has a lower furcal process on each prong that projects posteromedially. Although this process has been reduced to a 'slender tendon' in Heteroneura (Kristensen, 1998), its dimensions still vary among Geometrinae. In Nemoriini, two genera, *Phrudocentra* and *Dichorda*, have long, narrow furcal processes, whereas the other nemoriine genera have very short, stubby furcal processes that are distinctly not 'slender'. These reduced furcal processes are absent from other Neotropical geometrine tribes; however, they are present in genera of other geometrid subfamilies. *Archiearis* (Archiearinae) and *Oenochroma* (Oenochrominae) have shortened furcal processes. *Timandra* (Sterrhinae) has long furcal processes, but they are notably wider, relative to furcal width, than the long furcal processes in Geometrinae.
The mesothoracic phragma is immediately ventrad to the mesoscutellum and extends posteriorly into the metathorax. The phragma has a small posteroventral indentation, but its presence is variable in Geometrinae and most other subfamilies. In *Dyspteris* (Larentiinae) the indentation is deep and wide.

**Metathorax**

The metathorax includes the metascutum and metascutellum, along with appendages that are discussed separately. The metascutum in Geometridae is highly reduced (Fig. 29), especially laterally, compared to that in most other Ditrysia. This reduction of the lateral metascutal area may be related to the absence of a forewing-thorax locking mechanism in many Lepidoptera that involves presence of specialized microtrichia on the metascutum (Scoble, 1992), but these microtrichia are lacking on the metascutum of Geometridae.

The metascutellum varies greatly in Geometridae, with the shapes varying from subquadrate in some species to subtriangular in others. The width of the metascutellum relative to width of the metascutum also varies. However, differences in shape and size vary within genera, tribes and subfamilies.

The posterior area of the metathorax has two pockets, termed laterophragmata (Kristensen, 2003), that project into the thoraco-abdominal opening (Figs. 30, 31). The width and depth of the laterophragmata vary among Geometrinae. They are shallow relative to their width in *Comibaena* (Comibaenini), relatively deep in Nemoriini and *Hydata* (inc. trib.) (Figs. 30, 31), and have medium depth in the other Neotropical tribes. The laterophragmata of *Hydata* are narrower posteriorly compared to other Geometrinae. Other Geometridae have relatively shallow laterophragmata, except
Campaea (Ennominae) and Alsophila (Alsophilini). The laterophragmata of Alsophila are also dorsoventrally flattened.

The euphragma, posterior to the metascutellum, has been considered to be absent in some Old World Geometrinae (Fanger, 1999), however, it was present in all examined Neotropical species, as well as the Old World Comibaena connata (Warren). The euphragma has a medial foramen on the ventral surface that varies in size and shape among species of Geometrinae. The foramen of Phrudentra pupillata is relatively small (Fig. 31), whereas the foramen of Hydata insatisfacta is larger and more elongate (Fig. 30). The foramen of the euphragma varies in other subfamilies. The foramen is absent in Dyspteris abortivaria, although it is present in other Larentiinae (Fanger, 1999). In Alsophila pometaria, the foramen is highly reduced, even compared to the relatively small foramen of P. pupillata.

In Geometrinae the metathoracic furca is divided anteriorly into two furcal apophyses, with each apophysis apically bifurcate with medial and lateral branches (Fig. 29). In Hemiteini and Lophochoristini the median and lateral branches are subequal in length, whereas the medial branch is longer than the lateral branch in other tribes. The apices of the furca apophyses are farther apart, compared to maximal subapical width, in Hemiteini than in other tribes. In other subfamilies, the apophyses are not bifurcate, having a sinuate apical margin in Alsophila (Ennominae) and a reduced medial process in Oenochroma (Oenochrominae).

Legs

The prothoracic tibia has an epiphysis that varies in size and shape among Geometrinae (Fig. 32). The epiphysis can be straight, curved, or sinuate. The shape of
the epiphysis varies within geometrine genera, although sinuate epiphyses are only observed in some species of *Dichorda*. Epiphysis length varies within genera and is sexually dimorphic. The ratio for the relative length of the epiphysis compared to the length of the tibia ranges 0.33–0.47 in Geometrinae females and 0.36–0.81 in Geometrinae males. Within species, male epiphyses are relatively longer than female epiphyses, including some species in which the relative epiphysis length of the male is within the range of relative epiphysis length for females of all species of the subfamily. For example, the minimum epiphysis:tibia ratio for males of Geometrinae is 0.36 in *Chlorosea nevadaria*; the corresponding female relative epiphysis ratio is 0.33, the minimum value in the female range. In other subfamilies of Geometridae, epiphysis:tibia ratios for the non-geometrine males are within the range of geometrine males, but the female *Oenochroma vinaria* has an epiphysis:ratio of 0.50 and is outside the range of geometrine females.

In Geometrinae the relative epiphysis length appears to be correlated with the length of antennal pectination. This is especially evident within species because females have shorter pectination and shorter epiphyses than males. However, this trend is still evident in a male-only comparison of relative epiphysis length and pectination length among geometrine genera. The position of the base of the epiphysis on the tibia also appears to be correlated with length of the epiphysis; the base of a longer epiphysis is located closer to the base of the prothoracic tibia. Thus, epiphysis position is transitively related to pectination length and is also a sexually dimorphic character.

The geometrid mesothoracic tibia has a single pair of spurs at the apex. Most species of Geometridae have mesothoracic tibial spurs of different lengths (Fig. 33a),
although lengths are equal in Alsophilini. Tibial spur length varies among species of Geometrinae. The ratio for the longest tibial spur to length of the tibia ranges 0.18–0.55 in Geometrinae, with Chlorosea nevadaria having the shortest spurs and Hydata insatisfacta having the longest spurs. Among species in other subfamilies of Geometridae, Archiearis infans (Möschler) (Archiearinae) and Oenochroma vinaria (Oenochrominae) have ratios of 0.15 and 0.16, respectively, just outside the range of Geometrinae.

The mesothoracic tibial spurs usually have two rows of dentition in Geometridae (Fig. 33b), but these are lacking in Alsophila pometaria (Ennominae) and Archiearis infans (Archiearinae). This dentition occurs on the apical 1/4 of the spur, except in the Old World geometrine Comibaena connata, which has dentition along the entire length of each spur. The number of teeth in each row ranges 5–30 among various species of Geometrinae, except Chlorosea nevadaria, in which one specimen lacks dentition and a second specimen has dentition with two teeth in one row and four in the other. The precise number of teeth on each spur can vary within species and occasionally between mesothoracic legs of the same specimen. The amount of dentition between the two spurs of each pair varies little, except in Synchlora cupedinaria (Grote), the shorter spur has 2–2.5x more teeth per row than the corresponding longer spur. The dentition of mesothoracic tibial spurs in other subfamilies is similar to that of Geometrinae.

The metathoracic tibia has a hair pencil in males of various Geometridae, arising from near the base of the tibia and often accommodated apically by a swollen area. In Geometrinae, Eueana (Lophochoristini) lack hair pencils, but still have greatly swollen apical areas of tibiae. The microstructure of hair pencils varies between Campaea
perlata (Ennominae) and four species of Geometrinae: Nemoria rectilinea (Nemoriini), Synchlora frondaria (Synchorini), Chloropteryx tepperaria (Hemitheini), and Hydata insatisfacta (inc. trib.).

In C. perlata the hair pencil at mid-length has parallel longitudinal ridges, each composed of a uniform series of scutes, and cross ribs between these ridges (Fig. 34). This microstructure is characteristic of other scales on the leg adjacent to the hair pencil; however, few fenestrae (windows) are present between the cross ribs of the hair pencil, in constrast to those of adjacent leg scales. The hair pencils in S. frondaria and C. tepperaria are similar to those of C. perlata, except many fenestrae are present (Fig. 35). In contrast, the mid-length areas of hair pencils in N. rectilinea and H. insatisfacta have highly modified longitudinal ridges in which the ridges are branched with regularly arranged cross ribs between them (Fig. 36) or are broken into isolated scutes or v- and y-shaped groups of scutes with cavities between irregularly arranged cross ribs (Fig. 37).

Most species of Geometrinae have two pairs of metathoracic tibial spurs, an apical pair and a subapical pair, in both males and females. However, some species have two pairs in females and one pair in males; for these males, the subapical pair is absent. The number of spurs in male Geometrinae is used as a generic and a specific character by Ferguson (1985) and Pitkin (1993). Some male Geometrinae have a terminal extension opposite the tibial spurs; this extension is not found in other geometrid subfamilies (Ferguson, 1985).

In most Geometrinae the individual tibial spurs in each pair are of different lengths. A few species, such as Tachychlora amilletes, have spurs of equal lengths, but these spurs tend to be relatively short compared to the longer tibial spur of a disparate
pair in other species. In *Eueana*, one of the spurs is apically swollen and thus noticeably wider; this is the only observed instance of width variation between paired spurs.

Tibial spur length varies among species of Geometrinae. The ratio of the length of the longest tibial spur to length of the tibia ranges 0.13–0.46 in Geometrinae, with *Eueana niveociliaria* having the shortest spurs and *Tachychloraamilletes* having the longest. Other subfamilies of Geometridae have a similar ratio of tibia spur:tibia length, although *Archiearis infans* has a ratio of 0.12.

The metathoracic tibial spurs have apical dentition that is arranged in two rows, except in the narrow spur of *Eueana* in which it is arranged in an apical ring. Among other Geometrinae, other variation of this character is analogous to variation of the mesothoracic tibial spur dentition. The specimen of *Chlorosea nevadaria* that lacks dentition on its mesothoracic spurs also has none on its metathoracic spurs, whereas the second specimen of *C. nevadaria* has 4 teeth per row. *Comibaena connata* ranges 20–30 teeth per row, a greater number than in all New World Geometrinae. However, this dentition is restricted to the apical area, unlike the dentition on the whole length of mesothoracic spurs.

The precise number of teeth on each spur varies within species and occasionally within metathoracic legs of the same specimen. Among Geometrinae, excluding the three species discussed in the previous paragraph, the number of teeth in each row ranges 4–18. Dentition varies little between spurs on the same leg, except *Synchlora cupedinaria* has both apical spurs and the shorter subapical spur with 2–3x more teeth per row than the longer subapical spur. The dentition of metathoracic tibial spurs in other subfamilies
is similar to that of Geometrinae, although no dentition is present on the spurs of *Alsophila pometaria* (Alsophilini) and *Archiearis infans* (Archiearinae).

The distribution of scale sockets on the metathoracic tibia is similar to that on the tibiae of other legs and varies among the subfamilies of Geometridae. Scale sockets appear randomly distributed in Archiearinae and Alsophilini. In Ennominae, Sterrhinae, and Larentiinae, the sockets are organized into circular clusters, with each cluster having 5–7 sockets. In Geometrinae and Oenochrominae, the sockets are arranged in elongate groups running parallel to the length of the tibia; each elongate group has 4–5 sockets. Consequently, the scales themselves have analogous distribution, although the distributional patterns are not easily observed on a scaled specimen. The geometrid taxa with random hind tibial scale socket distribution also have less sclerotized hind tibiae; in the other Geometridae, the hind tibiae are noticeably more sclerotized.

Geometridae possess numerous spiniform setae, termed macrochaetae by Kristensen (1998) across the venter of each tarsal segment on all legs. The apices of tarsal segments 1–4 have a pair of relatively large spiniform setae. The fifth tarsal segment has a similar apical pair of spiniform setae, but these are the same size as the other setae on the segment. In Geometrinae, the density of spiniform setae is uniform on segments 2–5, but is sparse on the base of segment 1. Density of spiniform setae varies little among Geometrinae, but it does vary among geometrid subfamilies. Sterrhinae and Larentiinae have lower density of spiniform setae than Geometrinae on all legs. Conversely, Archiearinae and Oenochrominae have greater setal density than Geometrinae, with unbroken rows of spiniform setae along the entire ventral side of the tarsus.
The pretarsal claws on all legs of Geometridae are paired and hooked, like those of most other Lepidoptera (Kristensen, 2001). In some Geometridae, the pretarsal claws each have two ventral parallel rows of dentition; this dentition is present in Geometrinae, Oenochrominae, and Ennominae (not including Alsophilini). The number of teeth appears to range 5–9, though it is not always possible to obtain precise counts for all twelve claws on a specimen, due to orientation on the slide. The size of the individual teeth varies among species, often on the same claw, although the largest teeth tend to be in the center of each row. Archiearinae, Oenochrominae, and Ennominae (including Alsophilini) have microtrichia along the basal half of the pretarsal claws on all legs; these microtrichia are absent in Geometrinae and other geometrid subfamilies.

Though all geometrid pretarsal claws have the same general shape, they exhibit some variation in width and curvature. Archiearinae has claws that exhibit a lower degree of curvature and are relatively wide apically. In Geometrinae, the claws taper to a much finer point and have a greater degree of curvature. In some genera, such as Comibaena, the curvature is so great that the claws appear L-shaped, though they still maintain rounded interior margins. Apical width of the pretarsal claw does not vary within Geometrinae, but there is variation in basal width. In some genera, like Chlorosea, the base is much wider than the median, and the claws taper throughout their length. In other genera, like Hydata, the basal width and medial width are equal, thus, the claws only taper on the apical half.

Wings

The geometrine forewing shape varies, but it usually has straight margins with occasional weak curvature of the apical costal margin (Fig. 38). The apex is noticeably
more pointed in some Nemoriini. Geometrinae are distinguished from other geometrids by orientation of the radial veins; Rs\(_{2+3}\) are stalked, and these have a short stalk with Rs\(_1\). The base of the Rs is relatively close to the base of M\(_1\), though this is somewhat variable; M\(_1\) arises farther from Rs\(_1\)-Rs\(_4\) in Hydata (Fig. 39), and in Tachychlora, the bases of the Rs and M\(_1\) are fused.

Most geometrine hind wings have a rounded outer margin with a variable degree of curvature. In some species, portions of the outer margins are angled. Some genera, such as Chloropteryx and Nemoria, have a single point of angulation at the medial outer margin (Fig. 40). Some species of Nemoria and Hydata have multiple angles along the outer margin, providing a scalloped appearance (Fig. 41). Geometrinae are distinguished from other geometrids by position of the bases of the medial veins: the base of M\(_2\) is much closer to the base of M\(_1\) than that of M3. Within Geometrinae, there is variation in the relative positions of Sc+R\(_1\) and Rs. In Nemoriini, the veins are usually touching but not fused (Fig. 42a). In Synchlorini and Hydata, the veins are fused at a single point or over a partial distance; complete fusion never occurs (Fig. 42b). Ferguson (1985) used fusion distance as a diagnostic character, but Pitkin (1996) believes that it is “of little taxonomic value without other more reliable supporting characters”. The development of A\(_3\) varies between tribes, being present in Nemoriini and Dichordophorini and reduced or absent in the other Neotropical tribes. The frenulum is reduced in many Geometrinae. Within a species, reduction can occur either in both genders or only in females.

Geometrinae wing scales are arranged in transverse rows, as evidenced by the scale sockets on both forewings and hind wings. The socket rows closer to the apex are relatively wide and are consequently closer together than the more basal rows. In
contrast, the scale sockets of Archiearinae and Alsophilini are more randomly distributed throughout the entire wing. In these taxa the variable distance between scale sockets makes the precise pattern difficult to discern, although the scales are clearly not arranged in straight transverse rows.

**Abdomen**

Geometridae have a pair of abdominal tympana on the sternum of A2 (Fig. 43). Each tympanum is supported by a surrounding cavus tympani that enables the tympanum to maintain a hemispherical shape. Cook and Scoble (1992) note that geometrine tympanal organs “seem to be the most structurally homogeneous within the Geometridae”, although there is still some minor variation present in Geometrinae. In *Oospila*, the cavi tympani are relatively small compared to the size of the rest of the abdomen. Consequently, the tympana are similarly small and have greater lateral separation than those of other Geometrinae. However, these purportedly reduced tympana may actually be the result of a disproportionately large abdomen. The sternite of A2 is relatively wide in *Oospila* compared to those of other Geometrinae; this increased width thus makes the *Oospila* tympana seem small in comparison.

Geometrid tympanal organs have a unique sclerite, termed the ansa, which projects from the cavus tympani and hangs over the tympanum. Ansal variation among subfamilies is discussed by Cook and Scoble (1992) and Hausmann (2001); each subfamily is associated with a general ansal shape that is present throughout most, but not all, of each subfamily. In Geometrinae, the ansa is narrow basally and proceeds to widen medially before tapering at the apex (Cook & Scoble, 1992; Hausmann, 2001; Pitkin, 1996). The shape of the broad median is variable among some of the Old World tribes,
as illustrated by Hausmann (2001). However, median shape does not vary among Neotropical Geometrinae. The narrow base is relatively short in most genera, though longer bases are present in *PhrudoCENTra, Lissochlora*, and *Hydata*. The apex is consistently narrow in the examined material; however, broad apices were observed by Pitkin (1996) in the Jamaican species *P. kinstonensis* (Butler).

Certain abdominal characters have been used by Pitkin (1996) to characterize Geometrinae at multiple taxonomic levels. Many species have dorsal abdominal spots with varying color, diameter, and distribution that are diagnostically useful. Two genera of Lophochoristini, *Lophochorista* and *Oospila*, also have dorsal crests that easily distinguish them from other Geometrinae.

In many genera, the male abdomen has two patches of needle-shaped sex scales on the A3 sternite. The sex scales are relatively wide basally and have noticeably larger scale sockets than the surrounding abdominal scales. The presence of paired sex scale patches is useful for distinguishing Geometrinae from other Geometridae, although it has been observed in a few ennomines (Pitkin, 1996).

The male A8 sternite is highly variable in Geometrinae and other subfamilies, but it often has a posterior notch of variable dimensions in Geometrinae (Fig. 44). The male A8 sternite may also have a longitudinal sclerotized band, termed a midrib by Pitkin (1996), and this can vary in its degree of sclerotization. This longitudinal band is most commonly found in Nemoriini. The sternite of *Oospila* has a bifurcate posterior projection.

The A8 tergite in most Geometrinae is rectangular and subequal in size to the more anterior tergites, but its degree of sclerotization is variable between congeneric
species. The tergite is subtriangular in Lissochlora and consists of a longitudinal band in *Oospila*, similar to the longitudinal sclerotized band on the sternum of other taxa.

**Genitalia**

The male genitalia of Geometrinae are highly variable, and no individual character will distinguish Geometrinae from other geometrid subfamilies. However, two characters of the phallus are fairly uniform within Geometrinae and are considered apomorphic (Holloway, 1996; Pitkin, 1996). The phallus generally has a ventral longitudinal sclerite and lacks cornuti, although cornuti are present in some Old World genera (Holloway, 1996) as well as in some species of the Neotropical *Oospila*. The phallus is relatively linear in most Geometrinae, but is bifurcated in Synchlorini; the relative orientation of the forking branches varies among species. In some Nemoriini and Synchlorini, dentition is present along the apical margin of the phallus. The nemoriine *Lissochlora* lacks dentition but has a single, large spine, which Pitkin (1996) describes as a “thorn-like projection, bulge or kink”.

Most of the Neotropical tribes can be defined by a combination of characters of the uncus and socii. Holloway (1996) posited an inverse relationship between developments of these two structures in Geometrinae, but this is true for only some tribes. Synchlorini and some Lophochoristini have a reduced uncus and long socii, whereas most Nemoriini and *Hydata (trib. inc.*)* have an elongate uncus and shorter socii. However, both the uncus and socii are equally long in Hemitheini and Dichordophorini.

The uncus radically differs between some of the geometrine tribes. In Hemitheini and most Nemoriini the uncus is broad basally with a narrow and elongate apical 2/3 and sometimes spatulate apex (Fig. 45); *Lissochlora* differs from other Nemoriini in having a
broad, short uncus. The uncus is reduced in Synchlorini and is bifurcate in Dichordophorini.

The base of the nemoriine uncus is sclerotized dorso-laterally, but has a ventral fenestrula that usually extends to 1/3 the length of the uncus. The shape of the basal third of the uncus may vary from triangular to trapezoidal among species of the same genus, e.g., *Nemoria*.

In Geometrinae the socii are membranous and setose in Nemoriini, Hemitheini, Lophochoristini, and *Hydata* (trib. inc.) (Fig. 45). They are sclerotized with fewer setae in Synchlorini, Dichordophorini, and Comibaenini. The sclerotized socii taper in Synchlorini, but have relatively uniform width in Dichordophorini. The membranous socii tend to be relatively short, though they are fairly elongate in Hemitheini.

The gnathos usually is v-shaped with variable width basally. The gnathos has a distal tooth that exhibits slight variation in relative length (Fig. 45). This tooth is absent in Hemitheini and in *Synchlorea cupedinaria*. The *S. cupedinaria* gnathos has been described by Ferguson (1985) as “broken distally, with two separate arms”, however, this may be artifactual; some specimens have been observed with the arms connected posteriorly.

Some species of Geometrinae have a transtilla that is weakly sclerotized and consequently indistinct (Fig. 45). In the species that have sclerotized transtillae, the transtilla is usually bilobate with variable width. It is almost always either narrow or “moderately broad” (Pitkin, 1996), but in *Eueana* (Lophochoristini), the transtilla is wider than it is long, with the posterior margin extending past the gnathos. In other Lophochoristini, such as *Oospila*, the transtilla is fused with the juxta; this fused structure
is termed the anellar complex (Cook and Scoble, 1995). In other Geometrinae the shape of the juxta varies, but it often takes the form of either a flat plate with rounded margins or a pouch with a y-shaped face. The juxta usually varies in shape within genera, but Ferguson (1985) reported interspecific variation in some species of Nearctic Chlorochlamys.

The general shape of the valvae varies between genera. The valvae are usually narrow and somewhat elongate, but shorter, stubbier valvae are present in multiple genera, such as Phrudocentra and Eucrostes. The costa of the valva is occasionally sclerotized. Basal costal processes of varying shape are present in many species of Nemoriini, notably in Nemoria. Lophochoristini is characterized by a modification of the mesal region of the valve. The shape of this modification is highly variable and is often diagnostic within lophochoristine genera (Cook and Scoble, 1995; Pitkin, 1996). Eucrostes (Hemitheini) has a similar medial process that is located closer to the sacculus than the lophochoristine medial process.

The vinculum and extensions of the saccus often form a cruciform shape, and this has been considered a possible apomorphy of the Geometrinae (Holloway, 1996). However, Pitkin (1996) noted that many Neotropical genera do not have saccal extensions. Conversely, the posterior saccal extension of Hydata insatisfacta is over 10 times the length of the anterior extension. Finally, some species have a vinculum that extends ventrally beyond the saccus, giving a notched appearance (Fig. 45). Coremata are present in some species, with varying degrees of development (Fig. 45).

Geometrine female genitalia are characterized by oblique papillae anales that face ventro-laterally, although the Old World tribes Geometrini and Timandromorphini have
papillae anales that face ventrally (Holloway, 1996). The apophyses anteriores vary in length, but they are shorter than the apophyses posteriores (Fig. 46). The apophyses anteriores are widened medially in some taxa, but this variation is not characteristic at the generic or tribal level. The degree of sclerotization of the sterigma varies between species; some species have postostial sclerotized ridges or preostial plates (Fig. 46) whereas others are entirely unmodified.

The bursae copulatrix in most Geometrinae lacks differentiation between the ductus bursae and corpus bursae. *Hydata insatisfacta* is an exception; it has a spherical corpus bursae that is distinct from the elongate, narrow ductus bursae. The ductus bursae can be either membranous or sclerotized; differentiation of the bursa copulatrix is easier when the ductus bursae is sclerotized (Fig. 46). The corpus bursae is elongate in Nemoriini and more globular in the other Neotropical tribes. The geometrine signum is either a small, sclerotized pouch or a thin ridge; the ridge is often bicornute, and is more linear in genera such as *Eueana* and *Oospila*. When present, the signum is most commonly found in the anterior half of the corpus bursae. However, the signum is absent in the hemitheine genera as well as other Neotropical genera, e.g., *Tachychlora*. 

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### Table 1  List of Geometridae used for whole body preparations

<table>
<thead>
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<th>Subfamily</th>
<th>Tribe</th>
<th>Species</th>
<th>Specimens</th>
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<td><em>Dichorda iridaria</em> (Guenée [1858])</td>
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<td></td>
<td><em>Dichorda obliquata</em> Warren 1904</td>
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<td></td>
<td></td>
<td><em>Dichorda rhodocephala</em> Prout 1916</td>
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<td></td>
<td><em>Lissochlora manostigma</em> (Dyar 1912)</td>
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<tr>
<td></td>
<td></td>
<td><em>Nemoria bistriaria</em> Hübner 1818</td>
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<td></td>
<td><em>Nemoria cosmeta</em> (Warren 1901)</td>
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<td></td>
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<td></td>
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<td></td>
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<td><em>Tachychlora amilletes</em> Prout 1932</td>
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<td><em>Synchlora n.sp.1</em></td>
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<td>Möschler 1862</td>
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<td>Alsophilini</td>
<td>Alsophila pometaria (Harris 1841)</td>
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<td>Oenochromini</td>
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<td>Sterrhinae</td>
<td>Timandrini</td>
<td>Timandra amaturaria Walker 1866</td>
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Figures 1-6  Characters of the head.

Notes: 1-2 Head. 1, Syncholora frondaria. 2, Archiearis infans. 3-4 Antennal sockets. 3, Phrudocentra pupillata. 4, Hydata insatisfacta. 5, Occipital foramen. a, Alsophila pometaria. b, Tachychlora amilletes. Scale bar = 0.5mm. 6, Sitophore, Chloropteryx tepperaria. (as) anterior sensilla, (ps) posterior sensilla.
Figures 7-16 Further characters of the head.

Notes: 7, Pilifers, Hydata insatisfacta. 8, Proboscis, Rhodochlora brunneipalpis. 9-13 Labial palpus. 9, Nemoria rectilinea, ♂. 10-11 Nemoria saturiba. 10, ♂. 11, ♀. 12-13 Dichorda iridaria. 12, ♂. 13, ♀. 14, Chaetosema, Synchlora frondaria. 15-16 Male antenna. 15, Phrudocentra pupillata. 16, Lissochlora manostigma. Scale bar = 0.2mm, except Fig. 14. (ch) chaetosema, (ey) eye, (LP1) first segment, (LP2) second segment, (LP3) third segment, (OVR) organ of vom Rath, (se) seta.
Figures 17-22  Characters of the antennae, prothorax, and mesothorax.

Figures 23-28  Characters of the mesothorax.

Figures 29-35 Characters of the metathorax and legs.

Figures 36-41 Characters of the legs and wings.

Figures 42-46 Characters of the wings and abdomen.

Notes: 42, Position of Sc + R1 and Rs. a, Nemoria rectilinea. b, Hydata insatisfacta. 43, Tympana, Nemoria rectilinea. 44, Male A8 sternite, Nemoria rectilinea. 45, Male genitalia, Nemoria toxeres. 46, Female genitalia, Oospila confundaria. (aa) apophyses anteriores, (ap) apophyses posteriores, (bcp) basal costal process, (cb) corpus bursae, (db) ductus bursae, (gn) gnathos, (jx) juxta, (pa) papillae anales, (sa) saccus, (si) signum, (so) socius, (st) sterigma, (tr) transtilla, (un) uncus, (va) valva.
References


CHAPTER III

FAUNISTIC STUDY OF THE GEOMETRINAE OF THE CARIBBEAN REGION

Introduction

Geography of the Caribbean

The Neotropical Region is generally subdivided into South America, Central America, Southern Mexico, and the Caribbean. The term 'Caribbean' has been used to refer to numerous combinations of political and geographical entities. In this study, 'Caribbean' refers to three subdivisions: The Greater Antilles, the Lesser Antilles, and the Bahaman Archipelago (Fig. 47). The Greater Antilles primarily consists of the largest Caribbean islands: Cuba, Hispaniola, Puerto Rico and Jamaica. There are also some smaller Greater Antillean islands such as the Cayman Islands and a few Puerto Rican island municipalities. The Lesser Antilles consists of a chain of smaller volcanic islands that are roughly southeast of the Greater Antilles. Many political organizations include Trinidad and Tobago in their definition of the Lesser Antilles, but these islands are excluded from this study because of their close proximity and faunistic similarity to Venezuela (J. Rawlins, personal communication). The Bahaman Archipelago, also known as the Lucayan Archipelago, consists of the Bahamas and the Turks and Caicos, north of the Greater Antilles.
Based on distributional records of Neotropical Geometrinae, the vast majority of species have been found on the mainland of South America, Central America, and southern Mexico. Very few records of Caribbean Geometrinae are available. Of the 470 Neotropical species in 39 genera, only 24 species in 10 genera have records of Caribbean distributions (Cook and Scoble, 1995; Pitkin, 1996; Scoble, 1999). The relatively low number of species of Geometrinae recorded from this subregion is likely related to the lack of faunistic studies of these islands.
Objectives

The objective of this study was to provide a faunistic treatment of Caribbean Geometrinae. This faunistic treatment includes: (a) definitions of Caribbean Geometrinae species and descriptions of new species with illustrations of adult imagos, male and female genitalia, and other external characters, and (b) a key to the species occurring in the Caribbean.

Material and Methods

Material Examined

In this study, approximately 1200 pinned specimens of Geometridae were borrowed and examined from the following institutions and private collectors:

CMNH Carnegie Museum of Natural History, Pittsburgh, PA
FLMNH Florida Museum of Natural History, Gainesville, FL
JMC John R. MacDonald Private Collection, Mississippi State University, MS
MEM Mississippi Entomological Museum, Mississippi State University, MS
NYSM New York State Museum, Albany, NY
USNM United States National Museum of Natural History, Washington, D.C.

Of the approximately 1200 specimens, 766 were Geometrinae collected in the Caribbean region. The remaining specimens were Geometrinae in genera with Caribbean distribution that were collected outside of the Caribbean region. Additional specimens of Nearctic Geometrinae from the MEM collection were examined for diagnostic purposes.

Type material was unavailable for examination during this study. Identifications and determinations of new species were made by referring to original species descriptions supplemented by figures of adults and genitalia in Herbulot (1986, 1988), Ferguson (1969, 1985), Pitkin (1993, 1996), and Prout (1932), with additional assistance from John Rawlins (personal communication). Photographs from the Moth Photographers Group
and the INRA Catalogue des Lépidoptères des Antilles Françaises were also used to aid with identification.

**Genitalia Preparations**

Genitalia preparations were made for 27 species of Caribbean Geometrinae (Table 2). Genitalia dissections were made for 76 Caribbean and 33 non-Caribbean specimens for a total of 108 preparations. Specimens were assigned a unique number for both the slide and the pin that bore the associated data labels. Numbering followed the established guidelines of the institutions from which the specimens were borrowed. Both hard copies and digital records of preparations were maintained, with each record providing the species name, the sex, the collection locality, the preparer's name and the unique slide number.

Genitalia were prepared following the methods of Clarke (1941) and Robinson (1976) with some modification. The abdomen was detached from the thorax by using forceps to push up its ventral end. The abdomen was submerged and macerated in a vial of 10% potassium hydroxide (KOH) at room temperature for at least eight hours. The abdomen was then placed in a watch glass with 20% isopropyl alcohol and cleaned of scales and extraneous material with a camel's hair brush. The abdomen was then stained in safranin for 1–2 hours, briefly placed in 20% isopropyl alcohol to remove excess stain, and transferred to 70% isopropyl alcohol. Male genitalia were then separated from the abdomen by tearing the intersegmental membrane between the eighth and ninth abdominal segments (A8 and A9). Female genitalia were separated by tearing the membrane between segments A7 and A8, except for *Chlorochlamys chloroleucaria*, which was separated by tearing the A6–A7 intersegmental membrane to avoid damaging
the diagnostic sclerotized region that extends anteriorly into A7. The abdominal pelt of both sexes was cut longitudinally along the pleuron using straight 2.5mm cutting edge spring scissors. After further cleaning, the genitalia and abdomen were transferred to 100% ethanol, positioned under chips of glass slides, and dehydrated overnight. The genitalia and abdomen were mounted in Euparal under a single coverslip.

**Examination of Characters**

Examinations of specimens were made using a Leica MZ125 stereomicroscope. Measurements were made with an ocular micrometer that was calibrated with a stage micrometer. Photographs of imagos and genitalia were made with a Leica stereoscope with Leica Application Suite 3.7.0©, autoformatted with Montage©, Synoptics Ltd. Photographs were edited with Adobe® Photoshop® CS6 Version 13.0 x64.

**Terminology**

Terminology for general lepidopteran adult morphology follows Scoble (1992) as modified by Kristensen (2003), with additional terminology from Ferguson (1969, 1983) and Pitkin (1993, 1996). Terminology for wing venation follows Wootton (1979). Terminology for genitalia follows Klots (1970) as modified by Kristensen (2003), with additional terminology from Cook and Scoble (1995) and Pitkin (1993, 1996). The term ‘maximum’, in the context of chaetosemata, is the greatest observed number of setae on a single chaetosema. Setae are invariably lost or damaged on pinned specimens, so the true maximum cannot be determined. However, the observed maximum is more accurate than the observed minimum, which is often zero.
Results

A Key to the Species and Subspecies of the Caribbean Geometrinae Using Morphological Characters of Adults

This key is most effective for identifying fresh specimens of Geometrinae. Scale color of old specimens tends to fade upon exposure to humid air, resulting in an artifactual beige or yellow color that can drastically alter the specimens’ external appearance and result in a misidentification. Great care should be taken to avoid mistaking artifactual coloration for a diagnostic character.

1  Dorsal abdomen with row of elevated crests...........................................................2
1' Dorsal abdomen without crests............................................................................3

2  Male with pair of elongate sex scale patches on sternite of second abdominal segment; female with smooth antennae.................................................Oospila confundaria
2' Male without sex scale patches on sternite of second abdominal segment; female with bipectinate antennae...........................................................Oospila decoloraria

3  Ground color of forewing green or yellow-green.............................................4
3' Ground color of forewing greyish-green...........................................................34

4  Hind tibia with one pair of spurs......................................................................5
4' Hind tibia with two pairs of spurs.....................................................................7

5  Discal spot present, orange-red.........................................................Eucrostes dominicaria
5' Discal spot absent...................................................................................6

6  Forewing and hind wing with white patches on apex and tornus..............................Eueana niveociliaria
6' Wings without patches..................................................................................Eueana simplaria

7  Hind wing scalloped, with postmedial brown spots..........................Hydata insatisfacta
7' Hind wing not scalloped, without postmedial spots................................................8

8  Costa with transverse brown stripe and longitudinal white striations......................Dichorda rhodocephala
8' Costa not brown or without white striations.........................................................9
9 Abdomen with majority of dorsal spots white, not ringed, small..........................10
9' Abdomen not as described above; majority of dorsal spots either large, brown, green, or with reddish-brown ring, or dorsal spots absent.................................14

10 Wings with row of spots along postmedial line.....................................................11
10' Wings without postmedial spots............................................................................13

11 Spots on postmedial line white..............................................................................12
11' Spots on postmedial line brown, female sometimes with single enlarged, white, reddish-brown ringed spot on forewing and/or hind wing

12 Fringe green, concolorous with rest of wing

12' Fringe pale yellow, not concolorous with rest of wing

13 Discal spot with reddish ring; labial palpi relatively short; male antennal pectination less than 4x longer than width of flagellomere

13' Discal spot not ringed; labial palpi relatively long; male antennal pectination approximately 4x longer than width of flagellomere

14 Hind wing with Sc + R1 and Rs fused; male antennal pectination at least 3x longer than width of flagellomere.................................................................15
14' Hind wing with Sc + R1 and Rs touching but not fused; male antennal pectination less than 3x longer than width of flagellomere......................................................27

15 Thorax with some brown coloration, ranging from violet brown to dark brown...............................................................................................................................16
15' Thorax green or yellowish-green, entirely lacking brown coloration....................19

16 Thorax with white ovate spot; wings with small brown patches on termen........... 17
16' Thorax without white spot; wings with large brown terminal patches that may contain small green spots.................................................................Synchlora xysteraria

17 Thorax with thin longitudinal reddish stripes parallel to violet-brown region, terminal patches narrow, occasionally obscured by concolorous term....................18
17' Thorax without reddish stripes, terminal patches wide, especially the medial terminal patch, never completely obscured by concolorous term

18 Forewing with large discal spot, relatively broad tornal patch

18' Forewing with small discal spot, relatively thin tornal patch

Phrudoentra centrifugaria

Synchlora herbaria sanctaecrucis (♂)

Lissochlora n.sp.

Phrudoentra kinstonensis

Phrudoentra agari

Synchlora xysteraria

Synchlora isolata

Synchlora cupedinaria guadelupensis

Synchlora cupedinaria cupedinaria
19 Wings with waved or dentate antemedial and postmedial lines.........................20
19' Wings with antemedial and postmedial rows of white spots..........................21

20 Wings with termen and fringe green, concolorous with ground color, sometimes with row of faint white patches.................................Synchlorella frondaria frondaria
20' Wings with termen and fringe not concolorous with ground color, termen mostly brown, fringe pastel red..........................Synchlorella n.sp.1

21 Wings with pale yellow fringe........................................................Synchlorella n.sp.2
21' Wing fringe not pale yellow; fringe either green, white, red, or reddish-brown...22

22 Frons red...........................................................................................................23
22' Frons green...........................................................................................................24

23 Subcosta with strong red coloration, antemedial and postmedial spots extremely faint, known only from Jamaica.............................................Synchlorella ephippiaria
23' Subcosta with weaker, pale red coloration, antemedial and postmedial spots more visible, known from Jamaica, the Bahamas, and Turks and Caicos

24 Dorsal abdominal spots present.................................................................25
24' Dorsal abdominal spots absent.............................................................Synchlorella herbaria intacta

25 Termen and fringe green, concolorous with ground color..............................26
25' Termen brown or reddish-brown, fringe white, sometimes pastel red basally, not concolorous with ground color.................................Synchlorella herbaria herbaria

26 Discal spot relatively large, dorsal abdominal spots relatively small, known only from the Virgin Islands........................................Sychnchlorella herbaria sanctaecrucis (♀)
26' Discal spot relatively small, dorsal abdominal spots relatively large, known only from Antigua......................................................Synchlorella herbaria dorsuaria

27 Dorsal abdominal spots present.................................................................28
27' Dorsal abdominal spots absent.............................................................Nemoria n.sp.1

28 Majority of dorsal abdominal spots white (with or without rings)....................29
28' Majority of dorsal abdominal spots brown..................................................32

29 Dorsal abdominal spot on second segment green, with reddish-brown ring
.................................................................Nemoria toxeres
29' Dorsal abdominal spot on second segment white or absent..........................30
30 Antemedial and postmedial lines distinctly waved or dentate with faint brown line on basal border. .......................................................... Nemoria dentilinea dentilinea
30' Antemedial and postmedial lines not dentate, only slightly waved, without brown line on basal border. ..........................................................31

31 Termen with thin reddish-brown lunules, base of fringe uniformly reddish-brown, ........................................................................................................31 Nemoria n.sp.3
31' Termen with thick red line, fringe pale with reddish-brown areas corresponding to venation.......................................................... Nemoria lixaria

32 Antemedial and postmedial lines white and brown, extremely waved, or occasionally a disconnected series of points; wing fringe pale green ........................................................................................................33 Nemoria punctilinea
32' Antemedial and postmedial lines white, not waved or only slightly waved, never a series of points; wing fringe not green.........................................................................................33

33 Termen with reddish-brown lunules; base of fringe reddish-brown. ........................................................................................................33 Nemoria n.sp.2
33' Termen green, without lunules; fringe pale yellow................. Nemoria rectilinea

34 Costa orange-yellow with dark green striations..........................................................35
34' Costa without dark green striations, uniformly orange-yellow or pale yellow.....36

35 Hind wing strongly angled at M3; known only from Puerto Rico ........................................................................................................35 Chloropteryx n.sp.
35' Hind wing weakly angled at M3; known only from the Lesser Antilles ........................................................................................................35 Chloropteryx glauciptera

36 Wings with row of white spots along postmedial line, occasionally connected by faint line.................................................. Chloropteryx paularia
36' Wings with postmedial line, either straight or waved, sometimes faint but never with row of white spots..................................................37

37 Postmedial lines pale yellow, broad, not waved; frons brownish orange........................................................................ Chlorochlamys chloroleucaria
37' Postmedial lines white, thin, waved; frons with brown coloration but no orange coloration..................................................38

38 Male genitalia with coremata immediately ventral to bases of valvae ......................................................................................... Chlorochlamys n.sp.1
38' Male genitalia with coremata closer to saccus, anterior to bases of valvae ......................................................................................... Chlorochlamys n.sp.2

62
Species of Caribbean Geometrinae

Nemoriini

Dichorda rhodocephala Prout

(Figs. 48, 78)

Dichorda rhodocephala Prout, 1916: 169

Adult

Head: frons with two dorso-lateral green patches, a medial orange-red patch, and a broad horizontal, pinkish-white stripe near clypeus; vertex green with dorsal pastel red stripe; interantennal fillet white; chaetosemata with circular base and maximum of five setae; antennae with scape and pedicel white, flagellum with alternating transverse rows of red and white on each flagellomere but basal flagellomeres sometimes predominantly red, male pectinate basally, simple apically, female not examined; labial palpi brown or brownish-red, first segment with specks of red, second segment orange-white dorsally; third segment with specks of orange-white.

Thorax: green; front of tibial apex and femurs of foreleg and midleg reddish-brown; tibial spur formula 0–2–4.

Forewing (Fig. 48): length 11.8–13.5 mm in male; green; costa with narrow brown stripe tapering apically, with white striations in basal half; antemedial line extremely faint, greenish-white, mostly straight with one curve inside discal cell; postmedial line straight, oblique, white with grayish-green stripe bordering inner margin; discal spot small, yellowish-brown; termen and fringe concolorous with rest of forewing.
Hind wing: color similar to that of forewing; antemedial line absent; discal spot absent.

Abdomen: dorsum green with white spots ringed by brownish-red on A1 and A2, A1 spot larger than A2; sternal sex-scale patches absent; male with tergite and sternite of A8 slightly notched posteriorly.

Male genitalia (Fig. 78): uncus slightly spatulate, base of uncus 6.0x wider than middle of apical portion; socii semi-membranous, relatively short; gnathos v-shaped, apical tooth relatively short, broad; valva broad, slightly tapered apically, basal costal margin sclerotized; transtilla lightly sclerotized, narrowed medially; juxta narrow, crescent-shaped; saccus with broad, rounded posterior projection; phallus broad, rounded basally, apex straight, dentate; vesica with bifurcate process, dorsal branch 2x length of ventral branch, both branches apically rounded.

Female genitalia: not examined.

Diagnosis: *Dichorda rhodocephala* is the only species of *Dichorda* Warren in the Caribbean region, but it is superficially similar to Caribbean species in other genera of Nemoriini, e.g., *Nemoria* Hübner and *Phrudocentra* Warren. *Dichorda rhodocephala* can be distinguished from these other genera by its costa, which is brown with white striations, and by its straight, relatively thick postmedial lines. *Dichorda rhodocephala* can be distinguished from other *Dichorda* by frons color and by the extremely faint antemedial line. Male genitalia of both *Dichorda* and *Phrudocentra* have broad valvae and an elongate vinculum. *Dichorda rhodocephala* lacks coremata, which distinguishes it from *Phrudocentra*, and has a broad posterior projection on the saccus that is wider than the saccal projections of other *Dichorda*. 
Type: *Dichorda rhodocephala*—lectotype, ♂, Jamaica. Deposited in British Museum of Natural History (BMNH).

Distribution and flight times: collected in Jamaica at unknown elevations. The six specimens examined were collected between June and October.

*Lissochlorella* n.sp.

(Figs. 49, 79, 108)

**Adult**

Head: frons and vertex green; interantennal fillet white; chaetosemata with circular base and maximum of eight setae; antennae with scape and pedicel white, flagellum white basally, reddish-brown apically, male pectinate basally, simple apically, female simple; labial palpi grayish green, palpi longer in female than in male.

Thorax: green; inner foretibia brown, front of forefemur green; tibial spur formula 0–2–4.

Forewing (Fig. 49): length 9.0–9.9 mm in male, 10.5 mm in female; green; costa mostly white, with light red base and brown apex; antemedial and postmedial lines a series of small white spots; discal spot brown; termen reddish brown with small, dark brown spots corresponding to venation, with light yellow fringe.

Hind wing: color similar to that of forewing.

Abdomen: green; small, brown dorsal spot on A1, small, white dorsal spots on A2–A5; male A8 sternite sclerotized, slightly notched.

Male genitalia (Fig. 79): uncus short, apical portion wide compared to other Nemoriini, base 2.5x wider than middle of apical portion; socii elongate, narrow, slightly longer than uncus; gnathos v-shaped; valva narrowed basally and apically, with
weakly developed mesial ridge, apex with rounded spinulose process; transtilla
arched; juxta wishbone-shaped, with arms diverging; vinculum angular, roughly
shaped as a dorsally open hexagon; saccus with broad triangular anterior
projection and narrower posterior projection; phallus narrow basally, broad
apically, with vesica bearing sclerotized, apical projection.

Female genitalia (Fig. 108): apophyses posteriores 3.5x longer than apophyses
anteriores; posterior of A7 sternite large, sub-trapezoidal, lightly sclerotized;
ostial region unsclerotized; ductus bursae long, with lightly sclerotized ring
posteriorly; signum absent; corpus bursae long, very narrow.

Diagnosis: *Lissochlora* n.sp. is very similar to the Central American *Lissochlora ronaldi*
Pitkin; both species have the same patterns of wing spots and dorsal abdominal
spots. *Lissochlora*. n.sp. is slightly larger and has a reddish-brown termen,
whereas *L. ronaldi* has a brown termen. In males, the notch of the A8 sternite is
shallower in *L. n.sp.* than in *L. ronaldi*. The valvae of both *L. n.sp.* and *L. ronaldi*
have a spinulose process, but this process extends past the apex of the valva in *L.
ronaldi* and terminates before the apex in *L. n.sp.* The female genitalia of *L. n.sp.*
is very similar to that of *L. ronaldi*, but *L. n.sp.* has a lightly sclerotized plate
anterior to the ostium, and the corpus bursae appears slightly narrower, although
this may vary with mating condition. Compared to other Caribbean Geometrinae,
*Lissochlora* n.sp. is superficially similar to *Synchlora herbaria*, but can be
distinguished by its larger size and its dorsal abdominal spots, which do not have
reddish-brown rings. Additionally, *L. n.sp.* males have shorter antennal
pectination than males of *S. herbaria*. *Lissochlora* n.sp. also is superficially
similar in color and pattern of the wings to some forms of *Phrudocentra centrifugaria*, but can be distinguished by the color of the spots that make up the antemedial and postmedial lines; they are white in *L*. n.sp. and brown in *P*. *centrifugaria*. The apical portion of the uncus is broader than that of other Caribbean Geometrinae. The female genitalia have the A7 sternite with a sub-trapezoidal, lightly sclerotized, posteromedial area and a long corpus bursae. This distinguishes *L*. n.sp. from other Caribbean Geometrinae, although not from *L. ronaldi*.


Distribution and flight times: known from three specimens collected in the Barahona province of the Dominican Republic at unknown elevations in July.

*Nemoria* n.sp.1

(Figs. 50, 80, 105)

**Adult**

Head: frons and vertex green; interantennal fillet white; chaetosemata with circular base and maximum of 13 setae; antennae white, male pectinate basally, simple apically, not examined in female; labial palpi green.
Thorax: green with white specks; front of forefemur and foretibia green, without transverse bar; tibial spur formula 0–2–4.

Forewing (Fig. 50): length 15.6–16.6 mm in male; green; antemedial and postmedial lines slightly waved; costa yellowish-green; termen yellowish-green; discal spot grayish-green.

Hind wing: color similar to that of forewing; veins M3 and CuA1 on very short stalk.

Abdomen (Fig. 105): green, dorsum without spots; male A8 tergite slightly concave posteriorly, A8 sternite notched posteriorly, with medial sclerotized band.

Male genitalia (Fig. 80): uncus with base 5.0x wider than apical portion, 2x length of socii; socii broad, membranous; valva with basal costal process bifurcate, basal branch longer than dorsal branch; with mesial ridge sclerotized from base to apex; transtilla a lightly sclerotized band of even width, without projections; juxta wishbone-shaped, with broad median papilla; coremata absent; arms of vinculum extend beyond saccus; saccus with tapering anterior and posterior projections; phallus broad basally and medially, tapering apically.

Female genitalia: Not examined.

Diagnosis: *Nemoria* n.sp.1 can be distinguished from other Caribbean *Nemoria* by the color of the discal spots, which are grayish-green. The male genitalia of *N. n.sp.1* can be distinguished from other *Nemoria*, including *N. remota*, by the bifurcate costal process with the basal most projection being longer than the apical part of projection.

Holotype: ♂, DOMINICAN REPUBLIC: La Vega, 5.2 km ESE Valle Nuevo, Valle Nuevo Field Station, 18°46′–40′ N, 70°38′-22′ W, 2120 m, 12–13
November 2002; W. A. Zanol, C. W. Young, C. Staresinic, J. Rawlins, pine forest and grassland, UV light, Sample 22119; Carnegie Museum Specimen Number CMNH-290,175. Deposited in CMNH.

Paratypes: DOMINICAN REPUBLIC: La Vega, 5.2 km ESE Valle Nuevo, Valle Nuevo Field Station, 18°46'40"N 70°38'26"W, 2288 m., 23 May 2003, C. Young, J. Rawlins, C. Nunez, R. Davidson, P. Acevedo, open pine forest on slope, sample 23112, Carnegie Museum Specimen Number CMNH-571434 (1♂), 18°46'42"N 70°38'22"W, 2277 m., open pine-shrub woodland, sample 23212, Carnegie Museum Specimen Number CMNH-571433, 571437 (2♂); 15.6 km SE Valle Nuevo, 18°41'30"N 70°35'24"W, 2193 m., 3 June 2003, R. Davidson, C. Young, C. Nunez, J. Rawlins, P. Acevedo, M. de la Cruz, dense cloud forest with pines, sample 24612, Carnegie Museum Specimen Number CMNH-571474 (1♂). [Deposited in the CMNH].

Distribution and flight times: *Nemoria* sp. 1 is represented by five specimens that were collected in La Vega Province in Dominican Republic during May-June and November at elevations of 2120–2288 m.

Notes: Two additional specimens, a male [CMNH] and a female [FMNH], were collected in the same province of the Dominican Republic at lower elevations. These specimens are superficially different from *Nemoria* n.sp. 1 in having reddish-brown dorsal abdominal spots and green and dark brown wings. However, the male genitalia appear nearly identical to those of *N. n.sp. 1*; the only difference is reduced apical sclerotization of the valva. It is possible that these two specimens are a form of *N. n.sp. 1*. However, both specimens are in poor
condition, and there is no female *N. n*.sp. 1 available to compare to the female specimen. Thus, the conspecificity of these two specimens with *N. n*.sp. 1 cannot be determined until more material is available.

*Nemoria* n.sp. 2

(Figs. 51, 81, 106, 109)

**Adult**

Head: frons reddish-brown with white spot in each of four corners; vertex green; interantennal fillet white; chaetosemata with circular base and maximum of 8 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red or reddish-brown dorsally, white ventrally, male and female palpi subequal in length.

Thorax: green; front of foretibia reddish-brown, transverse bar absent; tibial spur formula 0–2–4.

Forewing (Fig. 51): length 12.4–14.8 mm in male, 15.1–16.4 mm in female; green; sometimes appearing grayish-green due to scattered individual brown scales; costa white, occasionally pale yellow at base; antemedial and postmedial lines faint, white, slightly waved; discal spot reddish-brown; termen with reddish-brown lunules, fringe reddish-brown basally, white apically.

Hind wing: color similar to that of forewing; veins M3 and CuA1 on very short stalk.

Abdomen (Fig. 106): green, dorsum with small, reddish-brown spots on A1, A3, and A4; sternite of male A3 with pair of sex scale patches; sternite of male A8 deeply notched, with medial sclerotized band.
Male genitalia (Fig. 81): uncus with base 5.0x wider than middle of apical portion, 2x length of socii; socii broad, membranous; valva with basal costal process short, not tapered, with small apical notch; mesial ridge sclerotized from base to apex, terminating in a tooth extending beyond apical margin of valva; transtilla a lightly sclerotized band of even width, without projections; juxta v-shaped, with very broad medial papilla; coremata absent; arms of vinculum extend beyond saccus; saccus with tapering anterior projection; phallus broad medially, tapering apically with acute apical process.

Female genitalia (Fig. 109): apophyses posteriores 1.5x longer than apophyses anteriores; sterigma broad laterally, pre-ostial region with sclerotized fold; ductus bursae denticulate posteriorly, relatively narrow, lacking differentiation from corpus bursae; corpus bursae elongate, signum a small subtriangular pouch.

Diagnosis: Nemoria n.sp. 2 is superficially similar to Nemoria n.sp. 3, but has multiple diagnostic characters, most notably the reddish-brown dorsal abdominal spots. Nemoria n.sp. 2 also lacks a reddish-brown stripe on the vertex that is present in N. n.sp. 3, and the sternite of the male A8 has a deeper notch than in N. n.sp. 2. Other Caribbean Nemoria with reddish-brown or brown abdominal spots, e.g., Nemoria punctilinea, can be distinguished from N. n.sp. 2 by the fringe; N. n.sp. 2 has a reddish-brown basal fringe, as opposed to the green fringe of N. punctilinea or the uniformly pale yellow fringe of Nemoria rectilinea. Male genitalia are characterized by valvae with short, notched basal costal processes and a juxta with a very broad medial papilla that renders the juxta v-shaped as opposed to
wishbone-shaped. Female genitalia are nearly identical to those of _N_. n.sp. 3, but can be distinguished by the shape of the subtriangular signum.


Paratypes: DOMINICAN REPUBLIC: Independencia, Sierra de Bahoruco, north slope, 18°41'31"N 71°35'35"W, 2116 m., 8 November 2002, W. A. Zanol, C. W. Young, C. Staresinic, J. Rawlins broadleaf forest with pine UV light, Sample 40219, Carnegie Museum Specimen Number CMNH-288826, 291951 (1♂, 1♀); 3 km ESE El Aguacate, 18°18'N 71°42'W, 1980 m., 28-29 September 1991, J. Rawlins, R. Davidson, C. Young, S. Thompson, pine woodland, Carnegie Museum Specimen Number CMNH-496421, 534310, 534335 (3♂); Sierra de Neiba, near crest, 5.5 km NNW Angel Feliz, 18°41'N 71°47'W, 1750 m., 21–22 July 1992, J. Rawlins, S. Thompson, C. Young, R. Davidson, dense cloud forest, Carnegie Museum Specimen Number CMNH-571625 (1♂); Elias Pina, 9.0 km WSW Hondo Valle, 18°41'34"N 71°46'52"W, 1843 m., 25 June 2003, J. Rawlins, C. Young, R. Davidson, C. Nunez, P. Acevedo, M. de la Cruz, disturbed montane woodland with pine, UV light, sample 31312, Carnegie Museum Specimen Number CMNH-571496, 571702 (1♂, 1♀); Barahona, Eastern Sierra Bahoruco, Reserva Cachote, 11.4 km NNW Paraiso, 18°05'58"N 71°11'26"W, 1219 m., 3 May 2006, R. Davidson, C. Nunez, D. Koenig, J. Hyland, J. Fetzner, C. Young, J. Rawlins, disturbed cloud forest on road, sample 44116, Carnegie Museum Specimen Number CMNH-571496.
Specimen Number CMNH-571791 (1♂); 12.8 km NE Paraiso, 19-21 May 2004, C. Young, C. Nunez, J. Rawlins, J. Fetzner, sample 44114, Carnegie Museum Specimen Number CMNH-571698 (1♂); Pedernales, 8 km NE Los Arroyos, 18°16'N 71°44'W, 1940 m., 14 July 1990, J. Rawlins, C.W. Young, S.A. Thompson, GD033.14, GD036.14, GD033.11, Carnegie Museum Specimen Number CMNH-520260, 534853, 571653 (3♂, LMP ♂ Genitalia Slide No. 232); 5 km NE Los Arroyos, 18°15'N 71°45'W, 1680 m., 30 September 1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, cloud forest, Carnegie Museum Specimen Number CMNH-571747 (1♀), 18°15'N 71°18'W, 17–18 July 1990, C. Young, J.E. Rawlins, S. Thompson, LMP ♀ Genitalia Slide No. 233, GD033.06, Carnegie Museum Specimen Number CMNH-571531 (1♀). Deposited in the CMNH.

Distribution and flight times: *Nemoria* n.sp.2 is represented by twelve males and four females, including type material, that were collected from southwestern provinces of the Dominican Republic in May-July, September, and November. Elevations of collection sites range 1219–2116 m.

* Nemoria n.sp. 3

(Figs. 52, 82, 106, 110)

**Adult**

Head: frons reddish-brown with white spot on each corner; vertex green with dorsal reddish-brown stripe; interantennal fillet white; chaetosemata with circular base and maximum of 12 setae; antennae white, male pectinate basally, simple
apically, female simple; labial palpi reddish-brown dorsally, male and female palpi subequal in length.

Thorax: green; front of foretibia reddish-brown, without transverse bar; tibial spur formula 0–2–4.

Forewing (Fig. 52): length 13.1–14.8 mm in male, 15.6 mm in female; green; costa white, occasionally pale yellow at base; antemedial and postmedial lines faint, white, slightly waved; discal spot reddish-brown; termen with reddish-brown lunules, fringe reddish-brown basally, white apically.

Hind wing: color similar to that of forewing; veins M3 and CuA1 on very short stalk.

Abdomen (Fig. 106): green, dorsum with white spots ringed by brown on A1, A3, and A4; Sternite of male A3 with pair of sex scale patches; sternite of male A8 notched, with medial sclerotized band.

Male genitalia (Fig. 82): uncus with base 5.0x wider than middle of apical portion, 2x length of socci; socci broad, membranous; valva with basal costal process and mesial ridge subequal in length, process tapered apically, mesial ridge sclerotized from base to apex and projecting above costal margin apically; transtilla a lightly sclerotized band, narrowed medially, without projections; juxta wishbone-shaped, with broad medial papilla; coremata absent, though sparse clusters of setae on opposite sides of vinculum; arms of vinculum extend beyond saccus; saccus with tapering anterior projection; phallus broad basally, tapering beyond middle.

Female genitalia (Fig. 110): apophyses posteriores 1.5x longer than apophyses anteriores; ostium surrounded by sterigma, wide laterally, narrow posteriorly;
ductus bursae denticulate, lacking differentiation from corpus bursae; corpus bursae elongate, signum a small ovate pouch.

Diagnosis: *Nemoria* n.sp. 3 is superficially similar to *Nemoria* n.sp. 2, but has multiple diagnostic characters, most notably the brown-ringed, white dorsal abdominal spots. Other Caribbean *Nemoria* with white abdominal spots, e.g., *Nemoria toxeres*, can be distinguished from *N*. n.sp. 3 by the fringe; *N*. n.sp. 3 has a basal fringe that is uniformly reddish-brown, as opposed to white with alternating reddish-brown patches corresponding to venation. *Nemoria* n.sp. 3 also has a reddish-brown stripe on the vertex that is absent in *N*. n.sp. 2. The sternite of the male A8 has a shallower notch in *N*. n.sp. 3 than in *N*. n.sp. 2. Male genitalia have valvae with very long basal costal processes, distinguishing them from other Caribbean *Nemoria* except *Nemoria toxeres*. Male genitalia of *N*. n.sp. 3 can be distinguished from *N.* toxeres by the absence of coremata. Female genitalia are nearly identical to those of *N*. n.sp. 2, but can be distinguished by the shape of the ovate signum.

Holotype: ♂, DOMINICAN REPUBLIC: Barahona. Eastern Sierra Bahoruco. Reserva Cachote 12.8 km NE Paraiso. 18°05’–52”N, 71°11’–19”W, 1198 m, 21–23 Mar 2004; J. Rawlins, C. Young, R. Davidson, C. Nunez, M. Rial, semi-disturbed wet broadleaf. UV light, Sample 44313; Carnegie Museum Specimen Number CMNH-497,659. Deposited in the CMNH.

Paratypes: DOMINICAN REPUBLIC: Elias Pina, Sierra de Neiba, 9.0 km WSW Hondo Valle, 18°41’34”N 71°46’52”W, 1843 m., 25 June 2003, J. Rawlins, C. Young, R. Davidson, C. Nunez, P. Acevedo, M. de la Cruz, disturbed montane
wood-land with pine, UV light, Sample 31312, Carnegie Museum Specimen Number CMNH-571457 (1♀); 9.2 km WSW Hondo Valle, 18°41'37"N 71°46'59"W, 1874 m., 30 April 2006, J. Rawlins, J. Hyland, R. Davidson, C. Young, D. Koenig, J. Fetzner, wet montane forest, pine, sample 31216, Carnegie Museum Specimen Number CMNH-571457 (1♂); Sierra de Neiba, at crest, 5.5 km NNW Angel Feliz, 1800 m., 18°41'N 71°47'W, 15 October 1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, cloud forest, Carnegie Museum Specimen Number CMNH-571503 (1♂); Barahona, Eastern Sierra Bahoruco, Reserva Cachote, 11.3 km NNW Paraiso, 18°05'54"N 71°11'21"W, 1230 m., 3 May 2006, R. Davidson, C. Nunez, D. Koenig, J. Hyland, J. Fetzner, C. Young, J. Rawlins, cloud forest with tree ferns, UV light, sample 44216, Carnegie Museum Specimen Number CMNH-571478 (1♂); 12.8 km NE Paraiso, 18°05'58"N 71°11'26"W, 1219 m., 19-21 May 2004, C. Young, C. Nunez, J. Rawlins, J. Fetzner, disturbed cloud forest on road, sample 44114, Carnegie Museum Specimen Number CMNH-571504 (1♂); 11.4 km NNW Paraiso, 18°05'58"N 71°11'26"W, 3 May 2006, R. Davidson, C. Nunez, D. Koenig, J. Hyland, J. Fetzner, C. Young, J. Rawlins, sample 44116, Carnegie Museum Specimen Number CMNH-571442 (1♂). Deposited in the CMNH.

Distribution and flight times: *Nemoria* n.sp.3 is represented by six males and one female, including type material, that were collected in southwestern provinces of the Dominican Republic, in April-June and October. Elevations of collection sites range 1198–1843 m.
Nemoria punctilinea (Dognin)

(Figs. 53, 83, 111)

Miantonota punctilinea Dognin, 1902: 337
Racheospila punctilinea, Prout, 1932: 29
Nemoria punctilinea, Pitkin, 1993: 69

Adult

Head: frons brownish-red or reddish-brown with white spot on each lower corner; vertex and interantennal fillet green; chaetosemata with circular base and maximum of 4 setae; antennae with scape and pedicel green, flagellum reddish-brown, male pectinate basally, simple apically, female simple; labial palpi reddish-brown or brown dorsally, third segment longer in female than male.

Thorax: green; inner apex of forefemur with dark brown or reddish-brown patch; foretibia concolorous with forefemur patch, without transverse bar; tibial spur formula 0–2–4.

Forewing (Fig. 53): forewing length 15.6 mm in male, 17.9 mm in female; green with antemedial and postmedial lines brown and margined with white outwardly, postmedial line deeply dentate; discal spot reddish-brown; fringe pale green.

Hind wing: color similar to that of forewing; veins M3 and CuA1 on very short stalk.

Abdomen: green; A1 with small, dark brown dorsal spot, A4 with large, dark brown dorsal spot; Sternite of male A3 with pair of sex scale patches; sternite of male A8 notched, with medial sclerotized band.

Male genitalia (Fig. 83): uncus with base 5.0x wider than middle of apical portion, apical portion spatulate; socii short, membranous; valva with basal costal process extremely short, visible only at high magnification, triangular, mesial ridge
weakly developed, extending to 0.75 length of valve, with ventral margin curved and sinuate near middle, apex expanded into a dorsal lobe; juxta crescent shaped; transtilla arched, with uniform width; coremata present, relatively long; vinculum with uniform width; saccus with short anterior and posterior projections; phallus narrow basally.

Female genitalia (Fig. 111): apophyses posteriores and apophyses anteriores subequal in length; sterigma broad anterior to ostium, reduced posteriorly; ductus bursae short, not extending past anterior of A7; signum long, crescent-shaped; corpus bursae short, globular.

Diagnosis: the brown and white color of the antemedial and postmedial lines of *Nemoria punctilinea* distinguish it from other Caribbean *Nemoria*. Although the postmedial line was continuous and deeply waved in examined material, Pitkin (1993) noted that the line could be an interrupted series of spots in some specimens. Brown and white spots on the antemedials and postmedials are often cited as a character of *Lissochlora*. *Nemoria punctilinea* differs from *Lissochlora* by having only brown dorsal abdominal spots, whereas *Lissochlora* have at least one white spot. *Nemoria punctilinea* has male genitalia with short socii and long coremata, in contrast to the long socii and absence of coremata in *Lissochlora*. The male genitalia also are characterized by a spatulate uncus and extremely short, barely visible, basal costal processes. The female genitalia are characterized by a long, crescent-shaped signum and a sterigma with that is wide anterior to the ostium.

Type: *Miantonota punctilinea*—Holotype, ♂, Venezuela: Mérida. Genitalia slide no.
57,600; Type No. 32594. Deposited in USNM.

Distribution and flight times: examined material was collected in the Greater Antilles (Jamaica) and Brazil. Pitkin (1993) reported additional records from Mexico, Costa Rica, Trinidad, and South America (French Guiana, Venezuela, Colombia, Ecuador, Peru, Bolivia), at elevations ranging from sea level to 1400m, in every month except February, July, and December.

*Nemoria rectilinea* (Warren)

(Figs. 54, 84, 112)

*Miantonota rectilinea* Warren, 1906: 420
*Racheospila rectilinea*, Prout, 1932: 28
*Nemoria rectilinea*, Pitkin, 1993: 94

**Adult**

Head: frons reddish-brown with white spot on each of four corners; vertex green; interantennal fillet white; chaetosemata with circular base and maximum of 11 setae; antennae white, male pectinate basally, simple apically, female simple; dorsum of labial palpi red basally, changing to brownish-red apically, third segment longer in female than male.

Thorax: green; inner apex of femur with red and white patch; foretibia reddish-brown or brown, with transverse white bar; tibial spur formula 0–2–4.

Forewing (Fig. 54): length 13.3–14.9 mm in male, 14.8–15.5 mm in female; green; costa white, with small, reddish-brown spot at apex, antemedial and postmedial lines white, antemedial line curved, waved, postmedial line straight, smooth; discal spot brown; fringe pale yellow.
Hind wing: color similar to that of forewing; antemedial line gently curved, postmedial line bent at CuA1; veins M3 and CuA1 on stalk. Abdomen: green; A1 and A4 with large, violet brown dorsal spots, A1 spot slightly larger than A4 spot; Sternite of male A3 with pair of sex scale patches; male A8 with wide, shallow notch on tergite and narrower, deeper notch and medial sclerotized band on sternite.

Male genitalia (Fig. 84): uncus with base 3.0x wider than middle of apical portion, 2x length of socii, somewhat spatulate; valva with basal costal process short and tapered, mesial ridge extending to apex, with subapical area ridged, apex of valve with spherical lobe covered by dense spinules; transtilla arched; juxta funnel-shaped, with small papilla; coremata present; arms of vinculum extend beyond saccus; saccus with short, tapered anterior and posterior projections; phallus tapered beyond middle to acute apex.

Female genitalia (Fig. 112): apophyses posteriores 1.5x longer than apophyses anteriores; sterigma wide anteriorly, reduced and lightly sclerotized posteriorly; ductus bursae long, not well differentiated from posterior area of corpus bursae; corpus bursae elongate, pear-shaped, with crescent-shaped signum.

Type: *Miantonota rectilinea*—Holotype, ♀, Cuba: [Oriente,] Baracoa, xii.1902. Genitalia slide no. 37,567; Type No. 9185. Deposited in USNM.

Diagnosis: *Nemoria rectilinea* can be distinguished by its smooth, distinct antemedial and postmedial lines, as opposed to the waved or dentate lines, often faint, of other *Nemoria*. *Nemoria rectilinea* is superficially similar to many species in Central and South America, most notably *N. carolinae*, *N. remota*, and *N. karlae*.
*Nemoria rectilinea* has a reddish-brown frons that distinguishes it from *N. carolinae* and *N. remota*, which have a green frons. *Nemoria rectilinea* and *N. karlae* exhibit slight differences between relative sizes of the dorsal abdominal spots. The A1 spot is slightly larger than the A4 spot in *N. rectilinea*, whereas the A1 spot is slightly smaller than the A4 spot in *N. karlae*. The male genitalia of *N. rectilinea* have a diagnostic tuft of spinules at the apex of each valva.

Distribution and flight times: examined material was collected in the Greater Antilles (Dominican Republic) and Lesser Antilles (Dominica) from February-December at elevations ranging 20–2288 m. Pitkin (1993) and Zagatti et al. (1995–2006) reported additional records from the Greater Antilles (Cuba), the Lesser Antilles (Guadeloupe), Mexico, and Central America (Guatemala, Costa Rica, Panama).

*Nemoria toxeres* (Prout)

(Figs. 55, 85, 113)

*Racheospila lixaria toxeres* Prout, 1932: 25
*Nemoria toxeres*, Ferguson, 1969: 78

**Adult**

Head: frons brownish-red with white spot in each of four corners; vertex brownish-red; interantennal fillet white; chaetosemata with circular base and maximum of 9 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red dorsally, third segment longer in female than male.

Thorax: green; foretibia and foretarsus red or brownish-red, foretibia with transverse white bar; tibial spur formula 0–2–4.
Forewing (Fig. 55): length 14.4–14.8 mm in male, 15.5 mm in female; green; dorsal and ventral costa white medially with reddish-brown at base and apex, antemedial and postmedial lines white, straight, extremely faint; discal spot brownish-red; termen reddish-brown, fringe white with small, reddish-brown areas corresponding to venation.

Hind wing: color similar to that of forewing; veins M3 and CuA1 on very short stalk.

Abdomen: green; dorsum of spots ringed by reddish-brown on A1-A4, A2 spot green, other spots white and larger than A2. Sternite of male A3 with pair of sex scale patches; male A8 sclerotized, with wide, shallow notch on tergite and narrower, deeper notch and medial sclerotized band on sternite.

Male genitalia (Fig. 85): uncus with base 4.0x wider than middle of apical portion, apical portion 1.5x longer than socii; socii membranous, ovate; gnathos v-shaped h; valva with basal costal process of valva extending dorsally to base of uncus, mesial ridge extending to near apex and with flat expansions extending beyond costa; transtilla arched, narrowed medially; juxta subtriangular, with broad medial papilla; coremata present; arms of vinculum extend beyond saccus; saccus with short anterior projection; phallus narrow, tapering apically to a point.

Female genitalia (Fig. 113): apophyses posteriores and apophyses anteriores sub-equal in length; sterigma wide anteriorly and posteriorly, lateral margins widened posteriorly; ductus bursae, not extending beyond A7, with weak differentiation from corpus bursae; corpus bursae with crescent shaped signum.

Diagnosis: Nemoria toxeres is superficially similar to N. lixaria, but can be distinguished by its larger dorsal abdominal spots and a more distinct reddish-brown ring on the
A2 spot. *Nemoria toxeres* also is superficially similar to *Nemoria* n.sp. 3 due to the similar dorsal abdominal spots, but *N. toxeres* can be distinguished by the fringe, which is white with reddish-brown patches corresponding to venation. Male genitalia can be distinguished from *N. lixaria* by the long basal costal processes, and from *N. n.sp. 3* by the presence of coremata. Female genitalia have a signum with a different shape than that of *N. n.sp. 3*.

Type: *Racheospila lixaria toxeres*—Holotype, ♂, Costa Rica: [Cartago Province,] Juan Viñas, ii. Genitalia slide Geom. 5697. Deposited in BMNH.

Distribution and flight times: examined material was collected in the Greater Antilles (Jamaica, Dominican Republic) in May and October-December at elevations ranging 791–2009 m. Pitkin (1993) and Ferguson (1969) reported additional records from Mexico and Central America (Costa Rica) in December-September at elevations ranging 650–1500 m.

**Phrudocentra centrifugaria** (Herrich-Schäffer)

(Figs. 56-57, 86-87, 114)

*Geometra centrifugaria* Herrich-Schäffer, 1870: 182
*Geometra protractaria* Herrich-Schäffer, 1870: 182
*Eucrostis hollandaria* Hulst, 1886: 123
*Eucrostis jaspidaria* Hulst, 1886: 123
*Cambogia stellataria* Möschler, 1886: 68
*Racheospila anomalaria* Möschler, 1890: 243
*Racheospila concentrata* Warren, 1897: 430
*Synchlorella viridipurpurea* Hulst, 1898: 159
*Racheospila hollandaria*, Holland, 1903: 336
*Euchloris heterospila* Hampson, 1904: 178
*Lissochlora punctata* Warren, 1904: 504
*Rhodochlora albimacula* Warren, 1904: 506
*Phrudocentra centrifugaria*, Dyar, 1908: 171
*Nesipola impunctata* Warren, 1909: 82
*Phrudocentra impunctata*, Prout, 1912: 121
Phrudocentra centrifugaria stellataria ab. meceospila Prout, 1932: 49
Phrudocentra centrifugaria stellataria, Prout, 1932: 49
Phrudocentra centrifugaria impunctata, Prout, 1932: 49
Phrudocentra centrifugaria punctata ab. catenata Prout, 1932: 49
Phrudocentra centrifugaria punctata, Prout, 1932: 49
Phrudocentra centrifugaria centrifugaria, Prout, 1932: 49

Adult

Head: frons green, bordered laterally and anteriorly by white, with a few sparse red scales; vertex green; interantennal fillet white, sometimes with posterior red stripe; chaetosemata with circular base and maximum of 4 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red, second segment suffused with dark brown, second and third segment with white apex, third segment longer in female than male.

Thorax: green; foretibia reddish-brown; front of male hind tibia with extended apical process, broader than tibial spurs, projecting to middle of basal tarsal segment; tibial spur formula 0–2–4.

Forewing (Figs. 56, 57): length 11.6–12.6 mm in male, 11.2–13.5 mm in female; green; costa white, subcosta yellowish-green; antemedial and postmedial lines forming waved rows of small brown spots, sometimes connected by very faint green line, postmedial line of females with or without large spot spanning median and cubitus veins, spot white, ringed with reddish-brown, sometimes split by transverse reddish-brown line; discal spot dark brown, sometimes with narrow brown ring; apex with dark brown or reddish-brown spot; termen with brown spots at ends of veins; apex with dark brown spot on dorsal and ventral sides; fringe pastel red.
Hind wing: color and postmedial line of spots similar to that of forewing; some females with large, reddish-brown spot in anal area, with or without white center; Sc + R₁ and Rs touching but not fused.

Abdomen: green; dorsum with small white spots on A1-A5, spots sometimes ringed with reddish-brown; sternite of A3 with pair of sex scale patches; male A8 tergite lightly sclerotized posteriorly; male A8 sternite with subtriangular sclerite, notched posteriorly, medial sclerotized band absent.

Male genitalia (Fig. 86): uncus with base 4.0x wider than middle of apical portion, apically spatulate; socii short, membranous; gnathos v-shaped, long, apical hook directed dorsally; valva broad basally, tapered apically; transtilla narrowed medially; juxta shield-shaped with small papilla; coremata present; vinculum 2.0x longer than tegumen; saccus with narrow, long anterior projection and shorter, broader posterior projection, phallus straight, with sclerotized plate extending from middle to subapex, forked at ¼ length of phallus.

Female genitalia (Fig. 114): apophyses posteriores 1.5x longer than apophyses anteriores; ostial region without sclerotized sterigma; ductus bursae lightly-sclerotized; separation between ductus bursae and corpus bursae poorly defined, signum absent.

Diagnosis: *Phrudocentra centrifugaria* can be distinguished from other Caribbean *Phrudocentra* (*P. agari* and *P. kinstonensis*) by the postmedial line, which is a row of brown spots occasionally connected by a very faint green line. *Phrudocentra agari* and *P. kinstonensis* have more visible postmedial lines that lack spots. Males of *P. centrifugaria* can be distinguished by the extended apical
process on the hind tibia, which does not extend past the tibia in other Caribbean Phrudocentra. Females of *P. centrifugaria* have a single large spot on the postmedial and anal areas of the forewing and hind wing, respectively, and these spots are always absent from other species of Caribbean *Phrudocentra*.

**Type:** *Geometra centrifugaria*—Syntypes, 3♀, Cuba. Deposition unknown.

**Distribution and flight times:** Examined material was collected in the U.S. (Florida), the Bahamas, the Greater Antilles (Jamaica, Dominican Republic, Puerto Rico), and the Lesser Antilles (U.S. Virgin Islands) in January, April, June-July, September, and November-December at elevations ranging 10–640 m. Pitkin (1996) and Ferguson (1985) reported additional records from the Greater Antilles (Cuba) and the Lesser Antilles (St. Lucia, Guadeloupe, Dominica, Martinique), collected year round.

**Notes:** *Phrudocentra centrifugaria* is currently divided into four subspecies: *P. c. centrifugaria*, *P. c. stellataria* (Möschler), *P. c. impunctata* (Warren), and *P. c. punctata* (Warren). There is extensive wing pattern variation both among and within these subspecies, as well as slight variation in male genitalia among subspecies. There was insufficient material available to make reliable subspecific identifications. Consequently, *P. centrifugaria* is treated as a single species in this study, with subspecific variation discussed below.

*Phrudocentra centrifugaria stellataria* is most similar to *P. c. centrifugaria*. The presence of the large postmedial spot is highly variable in females: it can be absent, present only on the forewing, present only on the hind wing, or present on all wings. The spots, when present, are white with a reddish-brown ring. The hind
wing spot is slightly smaller than that of *P. c. centrifugaria*, with the basal margin closer to the termen. Some aberrant forms have dark-purple spots (Prout, 1932). In males, the branches on the forked process of the phallus are 1/14 the length of the entire phallus, half as long as those in *P. c. centrifugaria* (Fig. 87). *Phrudo
centra centrifugaria impunctata* have a characteristic termen and fringe that lack spots and patches and are concolorous with the wing. The large postmedial spots found on females are only present on the forewings, not on the hind wings.

In *Phrudo
centra centrifugaria punctata*, the large postmedial spot of the female forewing is white with a reddish-brown ring and ismerged with a smaller posterior reddish-brown spot. The large hind wing spot is similar to that of the forewing, but lacks an additional reddish-brown spot (Warren, 1904). Prout (1932) describes an aberrant form with postmedial spots partially connected “but divided at least by red lines on the veins”.

**Synchlorini**

*Synchlora* n.sp.1

(Figs. 58, 88, 115)

**Adult**

Head: frons red, with wide, transverse white stripe near clypeus; vertex red; interantennal fillet white, sometimes extending posteriorly into vertex; chaetosemata with circular base and maximum of 11 setae; antennae white, male pectinate basally and simple apically, female simple; labial palpi red, apex of third segment white or orange-white, third segment longer in female than male.
Thorax: green; front of foretibia and forefemur red; tibial spur formula 0–2–4.

Forewing (Fig. 58): length 9.4–10.1 mm in male, 10.4–11.3 mm in female; green; costa red basally, becoming white distally; subcosta pale red; antemedial and postmedial lines white, waved, very faint; discal spot small; termen brown with small, light brown areas corresponding to venation; fringe pastel red.

Hind wing: hind wing similar in color to that of forewing.

Abdomen: green; dorsum of A2-A4 with white spots surrounded by thick reddish-brown rings, ring of A2 spot extending to A1 in some specimens, faint traces of similar spots on A5-A7 sometimes visible; male A8 sternite notched, with medial sclerotized band.

Male genitalia (Fig. 88): uncus reduced, not extending beyond base of socii; socii sub-triangular, broad basally tapering apically; gnathos ovate, with maximum width greater than length, apical tooth small, curved upward; valva with costa expanded at middle, mesial ridge weakly developed, extending to apex; juxta flat, quadrangular; transtilla narrowed medially; coremata present; saccus with tapered, elongate posterior projection and sub-triangular anterior projection; phallus with sclerotized plate medially bifurcate, apical prongs smooth.

Female genitalia (Fig. 115): apophyses posteriores 2.5x longer than apophyses anteriores; sterigma well developed posteriorly, forming subquadrate plate, reduced anteriorly; ductus bursae short, denticulate; corpus bursae relatively small, pear-shaped, signum absent.

Diagnosis: *Synchlora* n.sp. 1 and *Synchlora* n.sp. 2 are superficially similar, but they can be reliably distinguished by the color of the frons and the wing fringe. *S. n.sp. 1*
has a predominantly red frons and a pastel red fringe in contrast to the green frons and yellow fringe in n.sp. 2. *Synchlora* n.sp. 1 is also similar to *Synchlora herbaria*, but can be distinguished by its waved antemedial and postmedial lines; the antemedian and postmedian of *S. herbaria* have rows of small disconnected spots. *Synchlora irregularia*, which occurs in Texas, has similar waved lines and similar fringe color. However, the antemedial and postmedial lines are more visible in *S. irregularia*, and the portions of the lines that span M3 and CuA1 extend farther distally, compared to those of *S.* n.sp. 1. In the male genitalia, *S.* n.sp. 1 has a subrectangular vinculum that distinguishes it from *S. irregularia*, a sub-triangular anterior saccal projection that distinguishes it from *S.* n.sp. 2, and a rounded costal valval expansion that distinguishes it from *S. herbaria*. The female genitalia has a denticulate ductus bursae and apophyses posteriores that are slightly longer than those of *S.* n.sp. 2 and *S. herbaria*. The female genitalia of *S. irregularia* have two postostial plates that are absent in *S.* n.sp. 1.

Holotype: ♂, DOMINICAN REPUBLIC: Independencia. Sierra de Bahoruco, north slope, 13.5 km SE Puerto Escondido. 18°12′–12′–33′′N, 71°30′–47′′W, 1812 m. 24–26 Mar 2004; R. Davidson, J. Rawlins, C. Young, C. Nunez, M. Rial, Pinus, Rubus, Garrya, open. UV light. Sample 41313; Carnegie Museum Specimen Number CMNH-502,021. Deposited in CMNH.

Paratypes: DOMINICAN REPUBLIC: Independencia, Sierra de Bahoruco, north slope, 13.5 km SE Puerto Escondido, 18°12′24″N, 71°30′54″W, 1807 m., 24–26 March 2004, R. Davidson, J. Rawlins, C. Young, C. Nunez, M. Rial, broadleaf *Pinus* dense woodland, UV light, sample 41213, Carnegie Museum Specimen Number
CMNH-524125, 492414 (1♂, 1♀), 18°12'18"N 71°31'08"W, 1789 m., 24-26 March 2004, ecotonal *Pinus* grassland, sample 41113, Carnegie Museum Specimen Number CMNH-497424 (1♂); Pedernales, 5 km NE Los Arroyos, 1680 m., 18°15'N 71°45'W, 20 October 1991, J. Rawlins, R. Davidson, C. Young, S. Thompson, cloud forest, Carnegie Museum Specimen Number CMNH-533582 (1♀); 17-18 July 1990, C. Young, J.E. Rawlins, S. Thompson, GD036.15, Carnegie Museum Specimen Number CMNH-541817 (1♂); Barahona, Eastern Sierra Bahoruco, Reserva Cachote, 11.3 km NNW Paraiso, 18°05'54"N 71°11'21"W, 1230 m., 3 May 2006, R. Davidson, C. Nunez, D. Koenig, J. Hyland, J. Fetzner, C. Young, J. Rawlins, cloud forest with tree ferns, UV light, sample 44216, Carnegie Museum Specimen Number CMNH-520275, 526797, 541321, 495280, 496035, 497192 (3♂, 3♀); 11.2 km NNW Paraiso, 18°05'52"N 71°11'19"W, 1198 m., 3 May 2006, semi-disturbed wet broadleaf, sample 44326, Carnegie Museum Specimen Number CMNH-498731, 512509, 517150 (3♂); 12.8 km NE Paraiso, 18°05'58"N 71°11'26"W, 1219 m., 19–21 May 2004, C. Young, C. Nunez, J. Rawlins, J. Fetzner, disturbed cloud forest on road, sample 44114, Carnegie Museum Specimen Number CMNH-512853, 520839, 538043, 540824, 502254 (4♂, 1♀), 22–23 November 2004, J. Rawlins, C.W. Young, V. Verdecia, C. Nunez, W. Zanol, sample 44115, Carnegie Museum Specimen Number CMNH-537621 (1♂), 18°05'54"N 71°11'21"W, 1230 m., 21–23 March 2004, J. Rawlins, C. Young, R. Davidson, C. Nunez, M. Rial, cloud forest with tree ferns, sample 44213, Carnegie Museum Specimen Number CMNH-513497 (1♂); 11.4 km NNW Paraiso, 18°05'58"N 71°11'26"W, 1219 m., 3 May 2006, R.
Davidson, C. Nunez, D. Koenig, J. Hyland, J. Fetzner, C. Young, J. Rawlins, disturbed cloud forest on road, sample 44116, Carnegie Museum Specimen Number CMNH-538416 (1♂). Deposited in the CMNH.

Distribution and flight times: Synchlora n.sp. 1 is represented by 17 males and 6 females, including type material, that were collected in the Dominican Republic in March, May, July, October, and November. Elevations of collection sites range 1198–1812 m.

Synchlora n.sp.2
(Figs. 59, 89, 116)

Adult

Head: frons green; vertex green, sometimes with narrow red stripe between vertex and interantennal fillet; interantennal fillet white, sometimes extending posteriorly onto vertex; chaetosemata with circular base and maximum of 8 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red, apex of third segment white or orange-white, longer in female than male.

Thorax: green; front of foretibia and forefemur red; tibial spur formula 0–2–4.

Forewing (Fig. 59): length 6.5–10.6 mm in male, 7.9–11.0 mm in female; green; antemedial and postmedial lines consisting of white, disconnected dots; discal spot small, brown; costa white with red patches at base and apex; subcosta pale red; termen brown with small, pale yellow areas corresponding to venation; fringe pale yellow.

Hind wing: hind wing similar in color to that of forewing.
Abdomen: green; white spots with thick reddish-brown ringed on dorsum of A2-A4, faint traces of concolorous spots on A5-A7 sometimes visible; male A8 sternite notched, with medial sclerotized band.

Male genitalia (Fig. 89): uncus reduced, barely extending past base of socii; socii subtriangular, tapering apically; gnathos ovate, with maximum width between arms greater than length, with elongate apical tooth; valve with costa slightly expanded basally, mesial ridge with projection basally; juxta flat, quadrangular; transtilla narrowed medially; coremata short, not extending past base of valva; vinculum with arched arms; saccus with subtrapezoidal anterior projection and narrow, tapered posterior projection; phallus with sclerotized plate medially bifurcate, both apical prongs smooth.

Female genitalia (Fig. 116): apophyses posteriores 2.0x longer than apophyses anteriores; sterigma with semicircular posterior plate, reduced anteriorly; ductus bursae short, not denticulate; corpus bursae wide, without signum.

Diagnosis: *Synchlora* n.sp. 2 and *S*. n.sp. 1 can be distinguished by the antemedial and postmedial lines that are a series of disconnected spots in *S*. n.sp. 2, and faint waved lines in *S*. n.sp. 1. This character also distinguishes *S*. n.sp. 2 from *Synchlora irregularia*, which has waved, dentate antemedial and postmedial lines. *Synchlora* n.sp. 2 has a pale yellow fringe that distinguishes it from *Synchlora herbaria*. The male genitalia has a vinculum with arched arms and without an anterior saccal projection and a rounded, basal costal valval expansion, which distinguishes it from *S*. n.sp. 1 and *S. herbaria*. The female genitalia have a non-
denticulate ductus bursae, which distinguishes it from *S*. n.sp. 1 and *S*. *herbaria*.

The crescent shape of the female sterigma is also characteristic.


Paratypes: DOMINICAN REPUBLIC: San Juan, 7 km N Arroyo Cano, 1 km S Los Frios, 18°52'N, 71°01'W, 1120 m., 1 September 1995, J. Rawlins, G. Onore, R. Davidson, pine forest, second-growth, Carnegie Museum Specimen Number CMNH-531020, 571710 (1♂, 1♀); 8 km NE Vallejuelo, 690 m., 18°42'N, 71°16'W, 30 August 1995, arid thornscrub/woodland, Carnegie Museum Specimen Number CMNH-571744 (1♀); Sierra de Neiba, 9.4 km SSW El Cercado, 18°39'18˝N 71°32'51˝W, 1973 m., 22 June 2003, C. Young, J. Rawlins, P. Acevedo, M. de la Cruz, meadow near mature pine forest, UV light, sample 32212, Carnegie Museum Specimen Number CMNH-571577 (1♂);

Independencia, Sierra de Neiba just south of crest, 5 km NNW Angel Feliz, 18°41'N, 71°47'W, 13–15 October 1991, J. Rawlins, R. Davidson C. Young, S. Thompson, cloud forest, Carnegie Museum Specimen Number CMNH-571630 (1♂); south slope near summit, 4.0 km N Angel Feliz, 18°40'21˝N 71°46'05˝W, 1825 m., 1-2 April 2004, J. Rawlins, C. Young, R. Davidson, broadleaf cloud forest without pine, UV light, sample 34213, Carnegie Museum Specimen Number CMNH-571797 (1♀); 4.1 km N Angel Feliz, 18°40'24˝N 71°46'04˝W, 1851 m., 1 May 2006, J. Hyland, C. Young, R. Davidson, D. Koenig, J. Fetzner,
J. Rawlins, cloud forest near summit, sample 34116, Carnegie Museum Specimen Number CMNH-571688, 571850 (2♂); 4 km S Los Pinos, Loma de Vientos, 18°35'N 71°46'W, 455 m., 23 July 1992, R. Davidson, J. Rawlins, S. Thompson, C. Young, semiarid deciduous forest with pastures, Carnegie Museum Specimen Number CMNH-571612 (1♂); Sierra de Bahoruco, north slope, 13.5 km SE Puerto Escondido, 18°12'24"N 71°30'54"W, 1807 m., 24-25 November 2004, J. Rawlins, V. Verdecia, C. Young, C. Nunez, W. Zanol, broadleaf *Pinus* dense woodland, UV light, sample 41215, Carnegie Museum Specimen Number CMNH-571792 (1♂), 18°12'18"N 71°31'08"W, 1789 m., ecotonal *Pinus* grassland, sample 41115, Carnegie Museum Specimen Number CMNH-571536, 571558, 571761 (3♂), 18°41'31"N 71°35'35"W, 2116 m., 8 November 2002, W.A. Zanol, C.W. Young, C. Staresinic, J. Rawlins, broadleaf forest with pine, sample 40219, Carnegie Museum Specimen Number CMNH-289759, 292082, 293295 (3♂); Azua, 8 km NE Padre Las Casas, Rio Las Cueva, 580 m., 18°46'N 70°53'W, 3-4 October 1991, C. Young, S. Thompson, R. Davidson, J. Rawlins, riparian growth in arid thornscrub, Carnegie Museum Specimen Number CMNH-571557 (1♂); 7 August 1990, J. Rawlins, S. Thompson, GD010.23, GD036.01, Carnegie Museum Specimen Number CMNH-571749, 571567 (1♂); Duarte, Reserva Loma Quita Espuela El Cadillar, 6.7 km NE San Francisco de Macoris, 19°20'12"N 70°08'59"W, 280 m., 5 April 2004, R. Davidson, J. Rawlins, C. Young, weedy regrowth with coffee, cacao, UV light, sample 50313, Carnegie Museum Specimen Number CMNH-571481, 571664, 571729 (3♂); Canelo, 13.2 km NNE San Francisco de Macoris, 19°24'47"N 70°09'54"W, 523 m., 6 April
2004, disturbed field near wet forest fragment, sample 11113, Carnegie Museum Specimen Number CMNH-572787 (1♂); Puerto Plata, Pico El Murazo, north slope near summit, 19°41'N 70°57'W, 910 m., 28 November 1992, J. Rawlins, R. Davidson, M. Klingler, S. Thompson, mesic deciduous forest, Carnegie Museum Specimen Number CMNH-571556, 571658 (2♀); Samana, Samana Peninsula, 8 km S Las Galeras, Punta Balandra, 19°11'N 69°14'W, 35 m., 10 October 1991, C. Young, S. Thompson, R. Davidson, J. Rawlins, semiarid scrub forest on limestone bluffs, Carnegie Museum Specimen Number CMNH-571856 (1♀); Hato Mayor, Parque Los Haitises, E of Trepada Alta, 12 km W El Valle, 18°59'N 69°30'W, 145 m., 6 July 1992, mesic forest on limestone, Carnegie Museum Specimen Number CMNH-571559 (1♂); Elias Pina, Sierra de Neiba at crest, 5.5 km NNW Angel Feliz, 18°41'N 71°47'W, 1800 m., 15 October 1991, cloud forest, Carnegie Museum Specimen Number CMNH-571713 (1♂); La Altagracia, 2 km N Bayahibe, 18°23'N 68°51'W, 10 m., 3 July 1992, dry seasonal forest on limestone, Carnegie Museum Specimen Number CMNH-571675 (1♂); Monte Cristi, 5 km NNE Botoncillo, 19°46'N 71°24'W, 50 m., 29-30 November 1992, R. Davidson, M. Klingler, S. Thompson, J. Rawlins, arid thornscrub, Carnegie Museum Specimen Number CMNH-571740 (1♀); Pedernales, 23.5 km N Cabo Rojo, 18°06'N 71°38'W, 540 m., 20 July 1990, C.W. Young, J.E. Rawlins, S. Thompson, GD010.16, Carnegie Museum Specimen Number CMNH-571586 (1♂); 26 km N Cabo Rojo, 730 m., 26-27 September 1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, wet deciduous forest, Carnegie Museum Specimen Number CMNH-571602 (1♀); 13 July 1990, J. Rawlins, C. Young, S.
Thompson, GD010.09, Carnegie Museum Specimen Number CMNH-571601 (1♂); 760 m., 17 July 1987, J. Rawlins, R. Davidson, GD008.04, Carnegie Museum Specimen Number CMNH-572768 (1♂); 30 km N Cabo Rojo, 18°07'N 71°39'W, 1070 m., 27 September 1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, reservoir, pine woods, Carnegie Museum Specimen Number CMNH-527054 (1♂); Barahona, Eastern Sierra Bahoruco, Reserva Cachote, 12.8 km NE Paraiso, 18°05'58"N 71°11'26"W, 1219 m., 21–23 March 2004, J. Rawlins, C. Young, R. Davidson, C. Nunez, M. Rial, disturbed cloud forest on road, UV light, sample 44113, Carnegie Museum Specimen Number CMNH-572562 (1♂); La Vega, 15 km N Jarabacoa, 240 m., 21 July 1987, J. Rawlins, R. Davidson, GD008.01, Carnegie Museum Specimen Number CMNH-571451 (1♀); Bayacanes, 120 m., 24 July 1987, GD008.11, Carnegie Museum Specimen Number CMNH-571555 (1♂); Cordillera Central, 4.1 km SW El Convento, 18°50'33"N 70°42'44"W, 1729 m., 24 April 2006, C. Young, C. Nunez, J. Fetzner, J. Rawlins, disturbed evergreen forest with pine, UV light, sample 22316, Carnegie Museum Specimen Number CMNH-571604 (1♂); 2.5 km SW Pinar Bonito, 18°51'N 70°43'W, 1430 m., 26 November 1992, J. Rawlins, R. Davidson, M. Klingler, S. Thompson, riparian vegetation near stream in pine woodland, Carnegie Museum Specimen Number CMNH-571604 (1♂). Deposited in the CMNH.

Distribution and flight times: *Synchlora* n.sp. 2 is represented by 33 males and 8 females that were collected in the Dominican Republic in May, June, July, September, and November. Elevations of collection sites range 1219–2116 m.
Synchlora cupedinaria cupedinaria (Grote)

(Figs. 60, 90, 117)

Racheospila cupedinaria Grote, 1880: 218
Synchlora louisa Hulst, 1898: 159
Synchlora cupidenaria Dyar, 1908: 171
Synchlora cupedinaria cupedinaria, Pitkin, 1996: 395

Adult

Head: frons brownish-red; interantennal fillet white, extends posteriorly into vertex, remainder of vertex reddish-brown; chaetosemata with circular base and maximum of 8 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red, longer in female than male.

Thorax: tegulae and lateral thorax green, dorsal thorax violet-brown, violet-brown area bordered by narrow orange stripes; dorsal mesoscutellum with white ovate spot; front of foretibia red, coloration extends to apical femur and basal tarsus; tibial spur formula 0–2–4.

Forewing (Fig. 60): length 7.1–7.6 mm in male, 7.0–10.9 mm in female; green; dorsal and ventral costa violet-brown with narrow yellowish border, dorsal costa merges with small violet-brown patches at the basal and medial subcosta, patches sometimes obscured entirely; antemedial and postmedial lines faint, white, waved; discal spot brown; termen violet-brown, merges with small concolorous patches at subterminal median and tornus, patches sometimes obscured entirely by termen, termen sometimes with very narrow yellowish border; fringe purplish white with violet-brown areas corresponding to venation.

Hind wing: color similar to that of forewing.
Abdomen: a mix of violet-brown and reddish-brown; dorsum of A2 with large white spot, A3 and A4 with smaller white spots; sternum of A3 without sex scales; male A8 with sclerotized tergite and sternite, tergal sclerite slightly broader posteriorly, sternite not notched but with slight rounded concavity, without medial sclerotized band.

Male genitalia (Fig. 90): uncus reduced; socii sclerotized, with tapered, hooked apex; basal gnathos subquadrate, apical gnathos with two rounded lobes instead of tooth; valva short, slightly tapered; juxta flat; coremata absent, though small scale patches present on opposite sides of vinculum; transtilla a lightly sclerotized band of even width, without projections; saccus with elongate, sclerotized posterior projection and short, membranous anterior projection; phallus bifurcated, branches parallel, narrow, with lateral row of dentition, 3 or 4 teeth noticeably larger in each row.

Female genitalia (Fig. 117): apophyses posteriores 3.0x longer than apophyses anteriores, both pairs of apophyses relatively short; postostial plate present on A8 sternite, subtriangular, sclerotized, denticulate; ostial region sclerotized, more heavily sclerotized laterally; ductus bursae short, sclerotized; signum absent; corpus bursae elongate.

Diagnosis: *Synchlora cupedinaria cupedinaria* can be distinguished from *Synchlora cupedinaria guadelupensis* by the relatively small discal spots on both pairs of wings and by the relatively narrow forewing tornal patch. It can be distinguished from other Caribbean *Synchlora* Guenée by the single white spot on the dorsal thorax and by the small violet brown patches on the termen *Synchlora isolata* has
similar patches, but the medial patch of *S. isolata* is relatively wide, extending well into the subterminal fascia. In contrast, the patches of *S. c. cupedinaria* are narrow and occasionally partially obscured by the concolorous termen. The patches of *S. c. cupedinaria* may resemble those of the Caribbean *Oospila*, but *S. c. cupedinaria* is noticeably smaller and lacks abdominal crests. Male genitalia can be distinguished by the sclerotized socii, which have characteristic hooked apices. Female genitalia can be distinguished by the subtriangular, sclerotized poststrial plate.


Distribution and flight times: examined material was collected in the U.S. (Florida), the Bahamas, Turks and Caicos, the Greater Antilles (Dominican Republic, Puerto Rico), and the Lesser Antilles (U.S. Virgin Islands, St. Kitts and Nevis) from April-August and October-January at elevations ranging 1-1160 m. Pitkin (1996) and Ferguson (1985) reported additional records from the Greater Antilles (Cuba) and the Lesser Antilles (Virgin Islands, Dominica, St. Lucia, St. Vincent) in every month except August.

_Synchlora cupedinaria guadelupensis* Herbulot

*Synchlora cupedinaria guadelupensis* Herbulot, 1988: 103

Adult

Similar to *S. c. cupedinaria* except:
Wing: discal spots on both pairs of wings relatively large, forewing tornal patch relatively broad.

Type: *Synchlora cupedinaria guadelupensis*—Holotype, ♂, Guadeloupe: Acomat, 8.i.1986 (*Lalanne-Cassou*). Deposited in Herbulot collection, France.

Distribution and flight times: this subspecies has only been collected in the Lesser Antilles (Guadeloupe, Martinique) in March at unknown elevations (Herbulot, 1988).

Note: specimens were not examined. The preceding description is based on the description of Herbulot (1988) and examination of a photograph of the holotype (*Zagatti et al.*, 1995–2006)

*Synchlora frondaria frondaria* Guenée

(Figs. 61, 91, 118)

*S. frondaria* Guenée, 1857: 376
*Nemoria? denticularia* Walker, 1861: 536
*Thalera minuata* Walker, [1866]: 1613
*Eucrostis albicostaria* Herrich-Schäffer, 1870: 181
*Synchlora excurvaria* Packard, 1873: 76
*Nemoria denticularia*, Hulst, 1895: 71
*Aplodes pallida* Warren, 1900: 131
*S. frondaria*, Prout, 1912: 115
*S. frondaria frondaria*, Prout, 1932: 41
*S. merlinaria* Schaus, 1940: 306

**Adult**

Head: frons and vertex green; interantennal fillet white with narrow red stripe bordering vertex; chaetosemata with circular base and maximum of 6 setae; white, male pectinate basally, simple apically, female simple; labial palpi red, longer in female than male.
Thorax: green; front of foretibia reddish-brown, femur green; tibial spur formula 0–2–4.

Forewing (Fig. 61): length 6.3–8.5 mm in male, 7.3–9.6 mm in female; green; costa white; antemedial and postmedial lines white, dentate; discal spot absent; termen and fringe green, termen sometimes with row of faint white patches.

Hind wing: color similar to that of forewing.

Abdomen: green; sometimes with narrow white dorsal stripe; sternite of A3 with pair of sex scale patches; male A8 sternite with small notch, medial sclerotized band.

Male genitalia (Fig. 91): uncus reduced, apex of uncus below costal margin of socii, base of uncus sclerotized only laterally; socii sclerotized, tapered apically; maximum width of gnathos greater than length, gnathos v-shaped, elongate; juxta flat; coremata present, relatively long; transtilla a lightly sclerotized band of even width, without projections; saccus with short, membranous anterior projection; phallus bifurcated, branches parallel, narrow, smooth, pointed apically.

Female genitalia (Fig. 118): apophyses posteriores 2.0x longer than apophyses anteriores; ostial region without sclerotized sterigma; ductus bursae short, lightly sclerotized; signum a flattened pouch, subtriangular; corpus bursae elongate.

Diagnosis: Synchlora frondaria has a green termen that is concolorous with the rest of the wing. This distinguishes it from all Caribbean Synchlora except for some subspecies of S. herbaria. However, these subspecies (S. h. dorsuaria, S. h. intacta, S. h. sanctaecrusis) have antemedial and postmedial lines consisting of disconnected white spots. In contrast, the antemedial and postmedial lines of S. frondaria are dentate. Synchlora frondaria appears very similar to the U.S. species Synchlora aerata; they both have dentate lines, though the lines S.
frondaria are significantly more sharply dentate. The male genitalia have coremata that are relatively long compared to other Caribbean Synchlora, although the coremata of the mainland Synchlora gerularia are significantly longer. The female genitalia can be identified by the relatively small, flat signum.

Deposited in BMNH.

Distribution and flight times: examined material was collected in the southeastern and southwestern U.S., Central America (Panama), the Bahamas, the Greater Antilles (Jamaica, Dominican Republic), and the Lesser Antilles (St. Lucia) in every month except February at elevations ranging 50–1070 m. Pitkin (1996) and Ferguson (1985) reported additional records from Mexico, Central America (Guatemala, Costa Rica), South America (every country except Chile and Suriname), the Greater Antilles (Cuba, Haiti, Puerto Rico, Cayman Islands), the Lesser Antilles (Virgin Islands, St. Kitts and Nevis, Dominica, St. Vincent, Barbados, Grenada), and the Leeward Antilles (Bonaire) collected year round.

Note: the nominal subspecies of S. frondaria is the only one with Caribbean distribution; the only other subspecies, S. f. avidaria, is found in the southwestern United States and northern Mexico.

Synchlora herbaria herbaria (Fabricius)
(Figs. 92, 119)

Phalaena herbaria Fabricius, 1794: 162
Racheospila sitellaria Guenée, 1857: 374
Geometra congruata Walker, 1861: 511
Iodis indeclararia Walker, 1861: 541
Geometra croceofimbriata Herrich-Schäffer, 1870: 182
**Geometra attendaria** Möschler, 1890: 243  
**Synchlora louisa** var.? **hulstiana** Dyar, 1901: 457  
**Racheospila sitellaria**, Prout, 1912: 109  
**Racheospila herbaria herbaria**, Prout, 1932: 40  
**Synchlora herbaria**, Ferguson, 1985: 89

**Adult**

**Head:** frons predominantly green, sometimes with specks of red, with thick white stripe near clypeus; vertex red or green with narrow red stripe between green vertex and interantennal fillet; interantennal fillet white; chaetosemata with circular base and maximum of 7 setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi red, longer in female than male.

**Thorax:** green; front of foretibia red, coloration extends to apical femur and basal tarsus; tibial spur formula 0–2–4.

**Forewing:** length 5.9–9.8 mm in male, 8.1–9.9 mm in female; green; antemedial and postmedial lines consist of white, disconnected spots; discal spot small, brown; costa white; subcosta yellowish; anterior wing base with red patch, color of patch becomes lighter distally until concolorous with costa and subcosta; termen brown or reddish-brown with paler areas corresponding to venation; fringe white, base of fringe sometimes pastel red.

**Hind wing:** hind wing similar in color to that of forewing.

**Abdomen:** green; dorsum with row of white spots surrounded by narrow reddish-brown rings along A1-A6; pleural and ventral abdomen white; male A8 sternite with small notch, lightly sclerotized medial sclerotized band.

**Male genitalia (Fig. 92):** uncus reduced, not extending past base of socii; socii sclerotized, tapering apically; maximum width of gnathos greater than length,
tooth small, crescent-shaped; costa of valva with narrow triangular expansion, extends to base of uncus but not connected with uncus; juxta flat, equally as wide as transtilla; transtilla a lightly sclerotized band of even width, without projections; coremata present; saccus with rounded posterior projection and tapered anterior projection; phallus with medial bifurcation, both prongs smooth, tapered.

Female genitalia (Fig. 119): apophyses posteriores 1.5x longer than apophyses anteriores; semicircular sclerotization surrounding half of ostium; A7 sternite with light sclerotization immediately ventrad to ostium; ductus bursae short, denticulate; signum absent; corpus bursae relatively short, roughly pear-shaped.

Diagnosis: *Synchlora herbaria herbaria* can be distinguished from most other Caribbean *Synchlora* by the antemedial and postmedial lines, which are a series of disconnected white spots. *Synchlora* n.sp. 2 has similar rows of white spots, but can be distinguished from *S. h. herbaria* by its pale yellow fringe; none of the subspecies of *S. h. herbaria* have fringe of that color. *Lisochlora* sp. has similar rows of white spots. *Synchlora h. herbaria* can be distinguished from *L. sp.* by the long antennal pectination in males or by the long labial palpi in females. The costal valva of the male genitalia has a narrow triangular expansion. This sort of expansion is only present in two other species, *Synchlora* n.sp. 1 and *Synchlora* n.sp. 2, and the expansion is distinctly not triangular in either.

Type: *Phalaena herbaria*—Type, W Indies [‘in Americae meridionalis Insulis’]. Deposition unknown.
Distribution and flight times: examined material was collected in the U.S. (Florida), the Greater Antilles (Cuba, Jamaica, Puerto Rico) and the Lesser Antilles (St. Lucia) from June-July at elevations ranging 18–1120 m. Pitkin (1996) and Ferguson (1985) reported additional records from the Greater Antilles (Haiti) collected year round.

_Synchlora herbaria bonhotei_ (Prout)

(Fig. 62)

_Racheospila bonhotei_ Prout, 1912: 110
_Racheospila herbaria bonhotei_ Prout, 1932: 40
_Synchlora herbaria bonhotei_, Pitkin, 1996: 398

Adult

Similar to _S. h. herbaria_ except:

Head: frons predominantly red, sometimes with specks of green.

Wing (Fig. 62): termen red with pale red areas corresponding to venation, white color of fringe sometimes extends to termen.


Type: _Racheospila bonhotei_—Lectotype, ♂, Bahamas: Andros, 11.i.1902 (Bonhote).

Deposited in BMNH.

Distribution and flight times: This subspecies has been collected in the Bahamas, Turks and Caicos, and the Greater Antilles (Jamaica) in January, March-August, and October-November. Elevations of collection sites largely unknown, but two Jamaican specimens are known from 150–180 m.
Synchlora herbaria dorsuaria (Prout)

Synchlora dorsuaria Prout, 1912: 116
Racheospilia herbaria dorsuaria Prout, 1932: 40
Synchlora herbaria dorsuaria, Pitkin, 1996: 398

Adult

Similar to S. h. herbaria except:

Wing: discal spot small, termen concolorous with rest of wing.

Abdomen: dorsal abdominal spots congruent or larger than those of S. herbaria herbaria (Prout, 1932).

Type: Synchlora dorsuaria—Holotype, ♂, Antigua. Deposition unknown.

Distribution and flight times: Pitkin (1996) reported that this subspecies was only collected in Antigua.

Note: specimens were not examined. The preceding is based on descriptions by Prout (1912, 1932)

Synchlora herbaria intacta (Warren)

(Fig. 63)

Lissochlora intacta Warren, 1905: 318
Racheospilia herbaria intacta Prout, 1932: 40
Synchlora herbaria intacta, Pitkin, 1996: 398

Adult

Similar to S. h. herbaria except:

Wing (Fig. 63): termen usually concolorous with rest of wing, sometimes with specks of reddish-brown.
Abdomen: dorsum green with transverse white stripes between segments, abdominal spots absent.

Type: *Lissochlora intacta* – Holotype, ♂, Dominica. Deposited in BMNH.

Distribution and flight times: the two examined specimens were collected in Dominica in June at 450 m. Zagatti et al. (1995-2006) reported additional records from Guadeloupe.

*Synchlora herbaria sanctaecrucis* (Prout)

(Fig. 64)

*Racheospila herbaria sanctae-crucis* Prout, 1932: 40

*Synchlora herbaria sanctaecrucis*, Pitkin, 1996: 398

Adult

Similar to *S. h. herbaria* except:

Wing (Fig. 64): termen and fringe concolorous with rest of wing.

Abdomen: dorsal abdominal spots small, white in male, similar to *S. h. herbaria* in female.

Type: *Racheospila herbaria sanctae-crucis*—Syntypes, 1♂, 1♀, Virgin Is: Ste Croix (Santa Cruz), 1894 (*Hedemann*). Deposited in Naturhistorisches Museum, Vienna, Austria (NHMV).

Distribution and flight times: The six examined specimens were collected in the U.S. Virgin Islands in January and April at elevations ranging 80–100 m.
Synchlorella isolata (Warren)

(Figs. 65, 120)

Racheospila isolata Warren, 1900: 138
Synchlorella isolata, Pitkin, 1993: 112

Adult

Head: frons pastel red; interantennal fillet white, extending posteriorly onto vertex, remainder of vertex red; chaetosemata with circular base and maximum of 9 setae; antennae white, female simple, not examined in male; labial palpi pastel red, female apical segment relatively long.

Thorax: tegulae and anterior thorax yellowish-green, posterior thorax with large violet brown subtriangular patch; apex of femur and front of foretibia red; tibial spur formula 0–2–4.

Forewing (Fig. 65): forewing length 11.5 mm in female; yellowish-green; costa and subcosta violet brown, with narrow white stripe on costal margin, apex of costa violet brown dorsally and ventrally; antemedial and postmedial lines waved, white, very faint or absent; discal spot red; termen with violet-brown lunules, apex and tornus of termen with thicker violet brown border, medial lunule merged with small concolorous patch, patch wider than apical and tornal border.

Hind wing: color similar to that of forewing.

Abdomen: Abdomen with large dorsal violet brown stripe, contiguous and concolorous with thoracic subtriangular patch, dorsal stripe tapering posteriorly; A2-A4 with small white dorsal spots, trace of white spots on A5-A6.

Male genitalia: not examined.
Female genitalia (Fig. 120): apophyses posteriores 2.0x longer than apophyses anteriores; ostial region without sclerotized sterigma; ductus bursae relatively short, with lightly sclerotized, funnel-shaped antrum; corpus bursae pear shaped, with large crescent-shaped signum.

Diagnosis: *Synchlora isolata* can be distinguished from other Caribbean *Synchlora* by the small violet brown patches on the termen, particularly the wide medial patch that spans most of the subterminal fascia. *Synchlora cupedinaria* has similar patches, but none of them extend as far into the subterminal fascia. These patches somewhat resemble those of the Caribbean *Oospila*; *S. isolata* can be distinguished from those species by its lack of abdominal crests. The female genitalia have a characteristic crescent-shaped signum that is noticeably larger than the signa of other Caribbean *Synchlora*.

Type: *Racheospila isolata*—Lectotype, ♀, Grenada. Deposited in BMNH.

Distribution and flight times: the four examined specimens were collected in the Lesser Antilles (Dominica, St. Lucia) in June at elevations ranging 50–560 m. Pitkin (1996) and Zagatti et al. (1995–2006) reported additional records from the Lesser Antilles (Guadeloupe, Grenada). Pitkin (1996) and Prout (1932) reported possible records from St. Vincent and Puerto Rico (Prout, 1932).

*Synchlora xysteraria* (Hulst)

(Figs. 66, 93, 121)

*Racheospila gerularia* ab. *marginiplaga* Walker, 1861: 583
*Racheospila xysteraria* Hulst, 1886: 121
*Synchlora xysteraria*, Ferguson, 1985: 87
Adult

Head: frons red or reddish-brown with broad white stripe near clypeus; interantennal fillet white, extending posteriorly onto vertex, remainder of vertex concolorous with frons; chaetosemata with circular base and maximum of seven setae; antennae white, male pectinate basally, simple apically, female simple; first and second segments of labial palpi red dorsally, yellowish-white ventrally, third segment entirely red, longer in female than male.

Thorax: tegulae and anterior half of thorax green, posterior half of thorax brown or dark brown; apex of femur and front of foretibia red; tibial spur formula 0–2–4.

Forewing (Fig. 66): length 7.4–8.0 mm in male, 8.0–10.3 mm in female; green; costa reddish-brown at base and apex, with narrow white stripe in-between; subcosta light yellow; discal spot brown, variable in size, larger in some Bahamanian specimens; antemedial and postmedial lines faint, white, waved; termen with brown lunules; subterminal patches present at median and tornus, patches brown or violet-brown, sometimes with small green spots; terminal and subterminal patches with narrow orange-yellow border; fringe yellowish with brown areas corresponding to venation.

Hind wing: color similar to that of forewing; with third subterminal patch near apex, concolorous with medial and tornal patches; anal margin brown.

Abdomen: brown; dorsum with white spots on A2-A4, sometimes on A5, spot on A2 usually larger than others; sternite of A3 with pair of sex scale patches; male A8 sternite with small notch, medial sclerotized band.
Male genitalia (Fig. 93): uncus reduced, not extending past base of socii; socii sclerotized, tapering apically; maximum width of gnathos greater than length; width of valva relatively uniform; juxta flat, without processes; transtilla a lightly sclerotized band of even width, without projections; coremata present; saccus with membranous, elongate anterior projection and sclerotized, short posterior projection; phallus with subbasal bifurcation, both branches tapered, one branch relatively wide; wider branch with single hook-shaped spine, narrower branch with single straight spine.

Female genitalia (Fig. 121): apophyses posteriores 2.0x longer than apophyses anteriores; ostial region without sclerotized sterigma; ductus bursae short, with sclerotized funnel-shaped antrum; corpus bursae elongate, with curved, signum that is wide medially.

Diagnosis: *Synchlora xysteraria* is most similar to the mainland species *S. gerularia*. Males of *S. xysteraria* can be distinguished by their relatively long hind tibial spurs. Males and females of *S. xysteraria* can be diagnosed by the white spot on the dorsum of A2: it is larger than the other abdominal spots in *S. xysteraria*, and congruent with the other spots in *S. gerularia*. The male genitalia are more easily identified. *S. xysteraria* has a juxta without processes, short coremata, and a phallus with two spines arising at different points; in *S. gerularia*, the juxta has two posterolateral processes, the coremata are very long, and the phallus has two spines that both arise medially. The female genitalia of *S. xysteraria* has a larger signum and smaller ostium than that of *S. gerularia*. The distributions of *S. xysteraria* and *S. gerularia* do not overlap; Águila (2004) reports a record of *S. 
gerularia from Cuba, but this is likely a misidentification. *Synchlora xysteraria* is also somewhat similar to the Caribbean *Synchlora cupedinaria* and *Synchlora isolata*, but those two species have smaller wing patches that always lack green spots.


Distribution and flight times: examined material was collected in the U.S. (Florida), the Bahamas, and the Greater Antilles (Jamaica, Dominican Republic,) collected from April-July at elevations ranging 120–1070 m. Pitkin (1996) and Ferguson (1985) reported additional records from the Greater Antilles (Cuba, Puerto Rico) collected year-round. A single U.S. specimen has been collected in Georgia (J. Adams, personal communication), but the identification of this specimen has not been confirmed.

**Lophochoristini**

*Eueana niveociliaria* (Herrich-Schäffer)

(Figs. 67, 94, 122)

*Eucrostis niveociliaria* Herrich-Schäffer, 1870: 182
*Eucrostis saltusaria* Hulst, 1886: 123
*Racheospila saltusaria*, Dyar, 1900: 118
*Eueana niveociliaria* Prout, 1933: 69

**Adult**

Head: frons green with row of white and red specks on clypeus; vertex green; interantennal fillet white with red stripe anteriorly; chaetosemata with circular base and maximum of five setae; antennae white, sometimes with specks of red
on scape, pedicel, and some flagellomeres, male pectinate basally, simple
apically, female simple; labial palpi red, with white on underside of second and
third segments, palpi longer in female than male.

Thorax: green; mesothorax with three ovate green spots surrounded by white rings, with
outer ring sometimes extending to metathorax; front of foretibia reddish-brown;
tibial spur formula 0–2–2.

Forewing (Fig. 67): length 8.6–10.8 mm in male, 11.1–14.6 mm in female; green; costa
mostly brown with some red and white; antemedial and postmedial lines white, wavy; area between postmedial line and termen sometimes pale; sub-apical area with white, oblong, irregular patch on termen; tornus with irregular patch, white with some brown and red on postmedial line; termen brown and white.

Hind wing: color similar to that of forewing, but with less expression of white patch in subapical area.

Abdomen: dorsum of A1 green with central white patch, dorsum of A2-A4 white with scattered red scales and central green patches.

Male genitalia (Fig. 94): uncus sub-triangular, with short apical portion, approximately half as long as socii; gnathos v-shaped, somewhat broad, rounded; mesial region of valve with projecting lobe lined with apical rows of dentition, margins of lobe straight, without rounded bulge near costal margin of valva; juxta subquadrate, transtilla medially expanded into large, quadrate, dorsal plate, with ventrolateral triangular projections; saccus with rounded, slightly tapered posterior projection; phallus slightly curved in basal half, apical half narrow with parallel margins.
Female genitalia (Fig. 122): apophyses posteriores 2.0x longer than apophyses anteriores; sterigma with lightly sclerotized ridge anterior to ostium, sometimes with row of longitudinal striations; ductus bursae sclerotized, short, does not extend past spiracles of A7; corpus bursae short, with small, slightly crescent-shaped signum.

Diagnosis: *Eueana niveociliaria* has a distinctive wing pattern, with mostly white apical and tornal patches, that is unlike that of any other Caribbean geometrine, including its congener *Eueana simplaria*. This wing pattern is reminiscent of some mainland *Oospila*, but *E. niveociliaria* can be distinguished from that genus by its lack of abdominal crests.

Type: *Eucrostis niveociliaria*—Type, ♂, Cuba. Deposition unknown.

Distribution and flight times: examined material was collected in the Bahamas and the Greater Antilles (Jamaica, Dominican Republic) in May, July, August, and October-January at elevations ranging 3–475 m. Pitkin (1996) and Ferguson (1985) reported additional records from Florida and Cuba collected in every month except March and June at unknown elevations.

*Eueana simplaria* Herbulot

(Figs. 68, 95, 123)

*Eueana simplaria* Herbulot, 1986: 82

Adult

Head: frons green; vertex white with dorsal green stripe; interantennal fillet white; chaetosemata with circular base and maximum of four setae; antennae white,
sometimes with specks of red on scape, pedicel and flagellomeres; male pectinate basally, simple apically, female simple; labial palpi red, with white on underside of second and third segments, third segment longer in female than male.

Thorax: green; front of foretibia reddish-brown; tibial spur formula 0–2–2.

Forewing (Fig. 68): length 9.0–10.4 mm in male, 12.8 mm in female; green, sometimes with specks of white; antemedial and postmedial lines white, wavy, weakly-defined; costa red with some brown, subcostal yellowish.

Hind wing: color similar to that of forewing.

Abdomen: Dorsum of abdomen green, with white terminal segment.

Male genitalia (Fig. 95): uncus with triangular base, apical portion of uncus short, approximately half as long as socii; gnathos v-shaped, somewhat broad, rounded; mesial region of valva with projecting lobe lined with apical rows of dentition, lobe with rounded bulge near costal margin of valva; juxta subquadrate; transtilla forming large quadrate plate mediodorsally, with apical medial indentation and two short lateroventral projections; saccus with rounded, slightly tapered posterior projection; phallus slightly curved basally, narrow apically.

Female genitalia (Fig. 123): apophyses posteriores 2.0x longer than apophyses anteriores; sterigma with lightly sclerotized ridge posterior to ostium; ductus bursae sclerotized, short, not extending past spiracles of A7; corpus bursae short, expanding anteriorly, with small, slightly crescent-shaped signum.

Diagnosis: *Eueana simplaria* can be distinguished from other Geometrinae by the red and brown costa. *Eueana niveociliaria* is the only species with a similar costa, but it also has apical and tornal patches that are not present in *E. simplaria*. Both
male and female genitalia of the two *Eueana* Prout species are very similar, but
the male genitalia differ in the shape of the valval mesial projection. The
projection has a single lateral rounded bulge near the costal margin of the valva in
*E. simplaria* that is absent in *E. niveociliaria*.

Type: *Eueana simplaria*—Holotype, ♂, Guadeloupe: Le Moule, Portes d’Enfer,
19.v.1985 (*Lalanne-Cassou*). Deposited in HERB.

Distribution and flight times: examined material was collected in Turks and Caicos, the
Greater Antilles (Puerto Rico) and the Lesser Antilles (U.S. Virgin Islands,
British Virgin Islands, Dominica), in May, June, October, November, and January
at elevations ranging 100–550 m. Herbulot (1986) reported additional records
from Guadeloupe at unknown elevations.

*Oospila confundaria* (Möschler)

(Figs. 69, 96, 124)

*Racheospila confundaria* Möschler, 1890: 242
*Oospila confundaria*, Prout, 1912: 133
*Racheolophia coerulea* Warren, 1906: 421
*Oospila coerulea*, Prout, 1912: 134
*Oospila coerulea aphenges* Prout, 1932: 55
*Racheolophia derasa* Warren, 1906: 422
*Oospila derasa*, Prout, 1912: 134
*Oospila sesquiplaga* Prout, 1912: 135
*Oospila confundaria*, Cook and Scoble, 1995: 66

**Adult**

Head: frons and vertex reddish-brown; interantennal fillet white; chaetosemata with
circular base and maximum of seven setae; antennae with white dorsal line on
basal half, scape and pedicel white, male pectinate, female simple; labial palpi reddish-brown, palpi longer in female than male.

Thorax: grayish-green; front of foretibia reddish-brown, hind tibia with long hairpencil; tibial spur formula 0–2–2.

Forewing (Fig. 69): forewing length 13.0 mm in male, 13.5–15.4 mm in female; grayish-green; costa pale yellow; termen red and dark brown, sometimes with small, concolorous apical and tornal spots; small, brown discal spot sometimes present.

Hind wing: color similar to that of forewing, except discal spot white, somewhat reniform.

Abdomen: grayish-green; dorsum with crests of elevated scales arising from medial elevations corresponding to crests on A2-A6, crests on A2-A4 red, white, and dark brown, surround by white rings, with both broad and elongate scales, crests on A5-A6 smaller, light brown, with only elongate scales; male A3 sternite with elongate sex-scale patches; male abdomen with elliptical sclerite between sternites of A2 and A3; male A8 sternite sclerotized, notched posteriorly.

Male genitalia (Fig. 96): uncus short, wide; socii membranous, curved medially; gnathos consisting of two hook-shaped processes that taper apically; basal costal process long, hook-shaped, slightly tapered apically, subequal in length with valva; valva deeply notched on saccular margin, broadening apically; anellar complex [fusion of juxta and transtilla] connected to both costal and ventral margins of valval base, completely surrounding phallus; saccus with rounded posterior projection, coremata absent; phallus sharply curved medially, with one cornutus
Female genitalia (Fig. 124): apophyses posteriores 2.0x longer than apophyses anteriores; sterigma ovate, invaginated posterolaterally; ductus bursae sclerotized, with longitudinal striations, slightly longer than corpus bursae; corpus bursae ovate, broad, with relatively large, crescent-shaped signum.

Diagnosis: the wing pattern of *Oospila confundaria* is superficially similar to that of *Oospila decoloraria*, the only other Caribbean *Oospila* Warren. *Oospila decoloraria* was not examined, but based on the description of Cook and Scoble (1995), *O. decoloraria* can be reliably distinguished from *O. confundaria* with characters of the tibiae and antennae. A long tibial hairpencil is present on the hindtibia of male *O. confundaria*, but not on male *O. decoloraria*. Female antennae are simple in *O. confundaria* and bipectinate in *O. decoloraria*. Both species of *Oospila* can be distinguished from other Caribbean Geometrinae by their elevated dorsal abdominal crests. Male genitalia of *O. confundaria* have basal costal processes with a characteristic hook-shape. Female genitalia are characterized by the combination of a striated ductus bursae and an ovate sterigma.

Type: *Racheospila confundaria*—Lectotype, ♀, Puerto Rico; MAC genitalia slide No. 018. Deposited in MNHU.

Distribution and flight times: the three examined specimens were collected in the Greater Antilles (Jamaica) and the Lesser Antilles (St. Lucia) in June and October at elevations ranging 50-1400 m. Cook and Scoble (1995) and Zagatti et al. (1995-2006) reported additional material from the Greater Antilles (Cuba, Dominican Republic, Puerto Rico), Lesser Antilles (St. Kitts and Nevis, Guadeloupe,
Martinique), Trinidad, and “throughout the tropical areas of Central and South America” in every month except September.

**Hemitheini**

*Chlorochlamys* n.sp. 1

(Figs. 70, 97)

**Adult**

Head: frons reddish brown; vertex grayish-green; interantennal fillet white; chaetosemata with circular base and maximum of five setae; antennae white, male pectinate basally, simple apically, pectination white and reddish-brown, not examined in female; labial palpi reddish brown dorsally.

Thorax: grayish-green; front of foreleg and midleg reddish-brown, male tibial spur formula 0-2-2.

Forewing (Fig. 70): forewing length 7.5 mm in male; grayish-green; costa light yellow dorsally and ventrally, antemedial and postmedial faint, lines white, waved; discal spot absent; termen and fringe concolorous with rest of wing.

Hind wing: color similar to that of forewing, without antemedial line and with broad postmedial line.

Abdomen: grayish green; dorsum of tergites without spots, sternite of male A3 with pair of sex scale patches; male A8 sclerotized, slightly concave.

Male genitalia (Fig. 97): uncus with base 2.0x wider than middle of apical portion, apex tapered to a sharp point, subequal in length with socii; socii membranous, with tapered apices; gnathos lightly sclerotized, wide, tooth broad and rounded; valva with sub-parallel costal and saccular margins, tapering to rounded apex; juxta
crescent-shaped; transtilla medially expanded, with subquadrate dorsal projection; coremata present, on ventral side of base of sacculus; saccus with broad subtriangular anterior projection; phallus narrow basally with slight medial bend and broadened apically.

Female genitalia: unknown.

Diagnosis: The male genitalia of *C. n.sp. 1* have coremata on the ventral side of the base of the sacculus, in contrast to the coremata of *C. n.sp. 2* that are between the ventral base of the valve and the vinculum. The transtilla is subquadrate in *C. n.sp. 1* and subtriangular in *C. n.sp. 2*. The shape of the transtilla also distinguishes *C. n.sp. 1* from *Chloropteryx paularia*.

The shape of the socii, which do not have sinuate apices, distinguishes this new species from *C. chloroleucaria*.


Distribution and flight times: known from one male specimen collected in the Bahamas on North Andros Island, in October.

*C. chlorochlamys* n.sp. 2

(Figs. 71, 98, 125)

**Adult**

Head: frons light brown; vertex grayish-green; interantennal fillet white or greenish white; chaetosemata with circular base and maximum of 6 setae; antennae with
scape and pedicel concolorous with interantennal fillet, flagellum white basally, reddish brown apically, male pectinate basally, simple apically, all pectinations reddish-brown, female simple; labial palpi with light red dorsum.

Thorax: grayish-green; foreleg light red; tibial spur formula 0–2–2 in male, 0–2–4 in female.

Forewing (Fig. 71): length 6.6–7.5 mm in male, 7.4–8.3 mm in female; grayish-green; costa orange-yellow dorsally and ventrally, antemedial and postmedial lines faint, white, waved, with dark green border basally; discal spot absent; termen and fringe concolorous with rest of wing, some specimens with very faint white spots at ends of veins.

Hind wing: color similar to that of forewing, without antemedial line.

Abdomen: sternite of male A3 with pair of sex scale patches; male A8 lightly sclerotized, with concave posterior margin.

Male genitalia (Fig. 98): uncus with base 2.0x wider than middle of apical portion, apex subequal in length with socii; socii membranous with rounded apices; gnathos lightly sclerotized, apical tooth broad and rounded; valve with sub-parallel costal and saccular margins; juxta consisting of two symmetrical, subtriangular plates connected at a single point; transtilla medially expanded, with subquadrate projection that tapers dorsally, dorsal margin slightly concave; coremata present, between ventral base of valve and vinculum; saccus with short posterior projection and slightly longer and narrower anteriorly; phallus narrow basally, broadening medially, and tapering to apex.
Female genitalia (Fig. 125): apophyses posteriores 2.5x longer than apophyses anteriores; sterigma lightly sclerotized posteriorly, with concave posterior margin; ductus bursae short, unsclerotized; corpus bursae without signum.

Diagnosis: *Chlorochlamys* n.sp. 2 is superficially similar to other Caribbean *Chlorochlamys*, as well as the mainland species *Chlorochlamys phyllinaria*.

*Chlorochlamys* n.sp. 2 can be distinguished by its waved, somewhat faint antemedial and postmedial lines; the lines of *C. chloroleucaria* and *C. phyllinaria* are straight or only slightly waved, and are much more visible, even in faded specimens. *Chlorochlamys* n.sp. 2 also is superficially similar to *Chloropteryx paularia*, but lacks an antemedial line on the hind wing. The abdomen color of *C*. n.sp. 2 is faded in all available specimens. However, based on the morphology of its congeners, the abdomen of *C*. n.sp. 2 is most likely a shade of grayish-green, concolorous with the thorax, without any dorsal spots. *Chlorochlamys* n.sp. 2 is best distinguished from *C*. n.sp. 1 by comparison of the male genitalia.

*Chlorochlamys* n.sp. 2 has coremata that close to the saccus and anterior to the bases of the valvae, in contrast, *C*. n.sp. 1 has coremata immediately ventral to the bases of the valvae. The shape of the socii, which do not have sinuate apices in *C*. n.sp. 2, distinguishes *C*. n.sp. 2 from *C. chloroleucaria* and *C. phyllinaria*.

Female genitalia of *C*. n.sp. 2 lack the preostial modifications of *C. chloroleucaria* and *C. phyllinaria*.

Holotype: ♂, DOMINICAN REPUBLIC: La Altagracia. 2 km N Bayahibe,18[°]–23[']N,68[']–51[']W 10 m. 3 July 1992; C. Young, R. Davidson, S. Thompson,
J. Rawlins  Dry seasonal forest on limestone; Carnegie Museum Specimen Number CMNH-525,027. Deposited in the CMNH.

Paratypes: DOMINICAN REPUBLIC: Pedernales, 30 km N Cabo Rojo, 18°02'N, 71°39'W, 1070 m., 23—24 July 1990, C. Young, J.E. Rawlins, S. Thompson, GD numbers 010.08, 010.05, 010.03, Carnegie Museum Specimen Numbers CMNH-495448, 501252, 527352 (3♀); 9.5 km N Cabo Rojo, 18°02'N 71°39'W, 35 m., 19 July 1990, GD numbers 010.02,010.07, Carnegie Museum Specimen Numbers CMNH-492784, 498287, 516920, 526691 (2♂, 2♀); 1 km W Cabo Rojo, 17°55'N 71°39'W, 10 m., 30 July 1990, GD010.04, Carnegie Museum Specimen Number CMNH-521977 (1♀); 17 km N Cabo Rojo, 18°04'N 71°39'W, 255 m., 21 October 1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, dry deciduous forest, Carnegie Museum Specimen Number CMNH-534372 (1♂); 8 km N Cabo Rojo, 30 m., 18 July 1987, R. Davidson, J. Rawlins, GD008.23, Carnegie Museum Specimen Number CMNH-513964 (1♂); Sierra de Baoruco, Aceitillar, 25.2 km ENE Pedernales, 18°05'29˝N 71°31'16˝W, 1272 m., 14 June 2003, C. Young, J. Rawlins, C. Nunez, R. Davidson, P. Acevedo, M. de la Cruz, dense broadleaf forest, pine, UV light, sample 42212, Carnegie Museum Specimen Number CMNH-497175, 526104, 499397, 510623, 516881 (2♂, 3♀), 6 May 2006, C. Young, J. Hyland, D. Koenig, R. Davidson, J. Fetzner, C. Nunez, J. Rawlins, sample 42216, Carnegie Museum Specimen Number CMNH-529211 (1♂); La Altagracia, Parque del Este, Caseta Guaraguao, 4.4 km SE Bayahibe, 18°19'59˝N 68°48'42˝W, 3 m., 26—27 May 2004, C. Young, J. Rawlins, J. Fetzner, C. Nunez, semihumid forest near sea, limestone, sample 51114, Carnegie Museum Specimen
Number CMNH-496908, 521345, 499664, 526399 (2♂, 2♀); 2.9 km SW Boca de Yuma, 18°21'51"N 68°37'05"W, 11m., 28 May 2004, J. Rawlins, C. Young, C. Nunez, J. Fetzner, semihumid dry forest, sample 52114, Carnegie Museum Specimen Number CMNH-523507 (1♂); 2 km N Bayahibe, 18°23'N 68°51'W, 10 m., 3 July 1992, C. Young, R. Davidson, S. Thompson, J. Rawlins, dry seasonal forest on limestone, Carnegie Museum Specimen Number CMNH-512616, 541835 (2♂); Santiago, 1 km NE San Jose de Las Matas, 19°21'N 70°56'W, 540 m., 11 July 1992, disturbed woodland, Carnegie Museum Specimen Number CMNH-510520 (1♀); Monte Cristi, 5 km NNE Botoncillo, 50 m., 19°46'N 71°24'W, 50 m., 29-30 November 1992, R. Davidson, M. Klingler, S. Thompson, J. Rawlins, arid thornscrub, Carnegie Museum Specimen Number CMNH-536884 (1♀); Barahona, 4 km NE Polo, 1260 m., 9 July 1987, R. Davidson, J. Rawlins, GD008.02, Carnegie Museum Specimen Number CMNH-496328 (1♂); 5.8 km SW Neiba, eastern playa of Lago Enriquillo, 18°25'17"N 71°26'38"W, -5 m., 3 April 2004, J. Rawlins, R. Davidson, C. Young, salt scrub on sandy playa, UV light, sample 50113, Carnegie Museum Specimen Number CMNH-539831, 542327 (2♂); Independencia, 4 km S Los Pinos, Loma de Vientos, 18°35'N 71°46'W, 455 m., 23 July 1992, R. Davidson, J. Rawlins, S. Thompson, C. Young, semiarid deciduous forest with pastures, Carnegie Museum Specimen Number CMNH-494485 (1♂), 475 m., 12 October 1991, Carnegie Museum Specimen Number CMNH-502764, 524629 (2♂); San Juan, 8 km NE Vallejuelo, 18°42'N 71°16'W, 690 m., 30 August 1995, J. Rawlins, G. Onore, R. Davidson, arid thornscrub/woodland, Carnegie Museum Specimen Number CMNH-497416,
522160, 522803, 518486 (3♂, 1♀). JAMAICA: St. Thomas, Morant Bay, 12 July 1933, A. Avinoff, N. Shoumatoff, Carnegie Museum Specimen Number CMNH-493246, 513009 (2♂); Constant Spring, 25 June 1936, Avinoff & Shoumatoff, Carnegie Museum Specimen Number CMNH-494691 (1♀), Baker, Holland Collection, Carnegie Museum Specimen Number CMNH-532662 (1♀). Deposited in the CMNH.

Distribution and flight times: *Chlorochlamys* n.sp. 2 is represented by 25 males and 16 females collected in the Greater Antilles (Jamaica, Dominican Republic) from April-August at elevations ranging 3–1272m.

*Chlorochlamys chloroleucaria* (Guenée)

(Figs. 72, 99, 126)

* Nemoria chloroleucaria* Guenée, 1857: 351
* Nemoria indiscriminata* Walker, [1863]: 1556
* Nemoria? densaria* Walker, [1863]: 1557
* Thalassodes deprivata* Walker, [1863]: 1559
* Geometra desolataria* Herrich-Schäffer, 1870: 182
* Aplodes flavilineata* Riley, 1870: 205
* Eucrostis rectilinea* Zeller, 1872: 480
* Eucrostis chloroleucaria*, Packard, 1876: 370
* Chlorochlamys chloroleucaria*, Hulst, 1896: 312

**Adult**

Head: frons brownish orange; vertex grayish-green; interantennal fillet white or greenish white; chaetosemata with circular base and maximum of six setae; antennae with scape and pedicel concolorous with interantennal fillet, flagellum white, male pectinate basally, simple apically, pectination reddish-brown, but color often
faded, female simple; labial palpi with light red dorsum, third segment longer in female than male.

Thorax: grayish-green; foreleg reddish brown.

Forewing (Fig. 72): length 7.3–9.4 mm in male, 7.8–10.9 mm in female; grayish-green; dorsal and ventral costa pale yellow, antemedial and postmedial lines pale yellow, broad, antemedial curved, slightly waved, postmedial straight; discal spot absent; termen pale yellow, fringe pale yellow with some grayish-green.

Hind wing: color similar to that of forewing, without antemedial line.

Abdomen: grayish-green; dorsum sometimes with pale yellow stripe; tergite of male A3 with pair of sex scale patches; male A8 lightly sclerotized.

Male genitalia (Fig. 99): uncus with base 3.0x wider than middle of apical portion, apical portion tapered; socii sclerotized, sinuate, apically pointed, and not extending beyond apex of uncus; gnathos forming lightly sclerotized, narrow band; valva narrow basally, broader medially; juxta flattened, subtrapezoidal; transtilla medially expanded, with short, quadrat, dorso-medial projection and long, sub-triangular ventral projection; coremata present; saccus with anterior project narrowed apically, posterior projection broad, apically rounded; phallus narrow basally, broadened medially, tapered apically.

Female genitalia (Fig. 126): apophyses posteriores 2.0x longer than apophyses anteriores; sterigma divided into circular post-ostial plate and invaginated crescent-shaped anterior plate; ductus bursae short, unsclerotized; corpus bursae short, pear-shaped, without signum.
Diagnosis: the broad, straight, pale yellow postmedial lines, along with the brownish orange frons, can be used to distinguish *C. chloroleucaria* from other Caribbean *Chlorochlamys*, as well as similar mainland species e.g., *Chlorochlamys triangularis*. Male genitalia have sinuate socii with pointed apices; *C. triangularis* has similar socii but can be distinguished by its shorter uncus and longer posterior projection on the saccus. Female genitalia have a large sclerotized plate that distinguishes them from other *Chlorochlamys*.

Type: *Nemoria chloroleucaria*—Syntypes, 2♂, 2♀, North America (‘Coll. Mus. et Gn’). Deposition unknown.

Distribution and flight times: examined material was collected in the U.S., Canada, and the Bahamas from May-September at unknown elevations. Pitkin (1996) and Ferguson (1985) reported additional material from Mexico and the Greater Antilles (Cuba) collected year round at unknown elevations.

*Chloropteryx* n.sp.

(Figs. 73, 100, 127)

**Adult**

Head: vertex grayish-green; interantennal fillet white; chaetosemata with circular base and maximum of four setae; antennae white, male pectinate basally, simple apically, female simple; labial palpi reddish-brown dorsally, third segment longer in female than male.

Thorax: grayish-green; foretibia and foretarsus brownish red; tibial spur formula 0-2-2 in both genders.
Forewing (Fig. 73): length 7.5–8.0 mm in male, 7.5–8.8 mm in female; grayish-green; dorsal and ventral costa orange-yellow, dorsal costa with dark green striation; subcosta dark green; antemedial and postmedial white spots form waved rows, with dark green border; discal spot dark green; termen and fringe dark green with small white areas corresponding to venation.

Hind wing: color similar to that of forewing; discal spot more elongate; significantly angled at M3.

Abdomen: grayish-green; sternite of male A3 with pair of sex scale patches; male A8 lightly sclerotized.

Male genitalia (Fig. 100): uncus with base 2.5x wider than middle of apical portion, apical portion and socii subequal in length; socii sclerotized, apically pointed, sinuate, long but not extending past uncus; gnathos basally fused with tegumen, a lightly-sclerotized loop, without tooth; valva with relatively setose median ridge; juxta small, flattened, rounded; transtilla medially expanded, with subquadrate projection with concave dorsal margin; coremata present; vinculum subquadrate, saccus somewhat cruciform, posterior projection nodular but somewhat long, broadens apically, anterior projection slightly longer but more narrow; phallus narrow basally, broadens medially.

Female genitalia (Fig. 127): apophyses posteriores 3.5x longer than apophyses anteriores; ostial region with lightly sclerotized ring; ductus bursae short, unsclerotized; corpus bursae short, tapered medially, with linear signum.

Diagnosis: *Chloropteryx* n.sp. is superficially similar to its Caribbean congeners *Chloropteryx glauciptera* and *Chloropteryx paularia*. It is most easily identified
by the significant angulation of the hind wing at M3; *C. glauciptera* only has a slightly angled hind wing, and *C. paularia's* hind wing is not angled at all. The male genitalia of *C. n.sp.* can be identified by the shape of the medially expanded transtilla and the sinuate socii. However, when compared to *C. glauciptera*, the most noticeable diagnostic character is vinculum shape; the vinculum is subquadrate in *C. n.sp.* and subtriangular in *C. glauciptera*. The female genitalia has a signum, which distinguishes *C. n.sp.* from all other *Chloropteryx* Hulst.

Holotype: ♂, PUERTO RICO: Maricao Bosque Estatal de Maricao, 3.3 km SW Maricao, 18[°]–09[”]–39[”]N, 67[°]–00[”]–05[”]W, forest; 550m, 10–11 June 1996  J. Rawlins, C. Young, R. Davidson, W. Zanol S. Thompson, M. Klingler; Carnegie Museum Specimen Number CMNH-62,901. Deposited in CMNH.

Paratypes: PUERTO RICO: Rio Grande, El Verde Station, 3.1 km WNW Pico El Yunque, Sierra de Luquillo, 18°19'15”N, 65°49'15”W, 3-6 June 1996, C. Young, R. Davidson, M. Klingler, W. Zanol, J. Rawlins, S. Thompson, Carnegie Museum Specimen Number CMNH-60960 (1♀); Orocovia, Bosque Estatal del Toro Negro, 1.2 km W Cerro Dona Juana, Cordillera Central, 18°10'30”N 66°29'33”W, 600 m., 8 June 1996, Carnegie Museum Specimen Number CMNH-66604 (1♂); Loiza, Bosque Estatal de Pinones, 7.5 km WNW Loiza, 18°28'10”N 65°56'27”W, mangroves, 0 m., 18 June 1996, Carnegie Museum Specimen Number CMNH-68341 (1♀). Deposited in CMNH.

Distribution and flight times: *Chloropteryx* n.sp. is represented by two males and two females, collected in Puerto Rico in June at elevations ranging 0–600 m.
**Chloropteryx glauciptera** (Hampson)

(Figs. 74, 101, 128)

*Nemoria glauciptera* Hampson, 1895: 333

*Chloropteryx glauciptera*, Prout, 1933: 63

**Adult**

Head: frons brown [but reportedly concolorous with reddish-brown foretibia (Hampson, 1895)]; vertex grayish-green; interantennal fillet white; chaetosemata with circular base and maximum of six setae; antennae with scape and pedicel white, flagellum white basally, transitioning to red medially and brownish red apically, male pectinate basally, simple apically, all pectination brownish red, female simple; labial palpi reddish-brown dorsally, elongate in female.

Thorax: grayish-green; foretibia red, coloration extends to forefemur and basal tarsus; tibial spur formula 0–2–2 in male, 0–2–4 in female.

Forewing (Fig. 74): length 6.4–9.0 mm in male, 7.5–7.9 mm in female; grayish-green; dorsal and ventral costa orange-yellow, dorsal costa with dark green striation; subcosta dark green, antemedial and postmedial lines waved, white with dark green border basally; discal spot usually absent, occasionally a faint, slightly darker shade of grayish-green; termen and fringe dark green with small grayish green spots corresponding to venation.

Hind wing: color similar to that of forewing; discal spot more elongate when present; slightly angled at M3.
Abdomen: grayish-green; dorsum without spots, sometimes with thin, white, transverse stripes across intersegmental borders; sternite of male A3 with pair of sex scale patches; male A8 lightly sclerotized.

Male genitalia (Fig. 101): uncus with bell-shaped base, 2.0x wider than middle of apical portion, apical portion slightly shorter than socii; socii sclerotized, sinuate, apically pointed; gnathos basally fused with tegumen and bases of socii, with two very long pointed teeth, approximately half as long as valva; valva with crescent-shaped basal costal process, cusps of process pointed anteriorly, parallel to valva; juxta flattened, rounded, subquadrate; transtilla expanded medially, with concave dorsomedial margin; coremata present; vinculum subtriangular; saccus with short, nodular posterior projection and narrow elongate anterior projection; phallus narrow basally, broadens medially.

Female genitalia (Fig. 128): apophyses posteriores 3.0x longer than apophyses anteriores; sterigma with y-shaped sclerotization, posterior branches broaden into rounded plates; u-shaped post-ostial plate present; ductus bursae short, sclerotized; corpus bursae short, pear-shaped, without signum.

Diagnosis: *Chloropteryx glauciptera* is easy to distinguish from most other Caribbean Hemitheini; its orange-yellow, striated costa is diagnostic. However, *Chloropteryx* sp. has a similar costa. *Chloropteryx glauciptera* differs from *C. sp.* in hind wing shape: the *C. glauciptera* hind wing is only slightly angled at M3, whereas the hind wing of *C. sp.* is angled to a significantly greater degree. The male genitalia of *C. glauciptera* has a diagnostic subtriangular vinculum. In the female genitalia, the ostial region has a diagnostic y-shaped sclerotization.
Type: *Nemoria glauciptera*—Lectotype, ♂, St. Vincent: Windward side (*Smith*).

Genitalia slide Geom. 10927. Deposited in BMNH.

Distribution and flight times: examined material was collected in the Lesser Antilles (Dominica, St. Lucia) in June at elevations ranging 50–560 m. Pitkin (1996) and Zagatti et al. (1995–2006) reported additional records from the Lesser Antilles (Guadeloupe, St. Vincent) collected in April and possible records from Grenada and Venezuela.

*Chloropteryx paularia* (Möschler)

(Figs. 75, 102, 129)

*Nemoria paularia* Möschler, 1886: 68
*Aplodes punctata* Warren, 1904: 19
*Chloropteryx paularia*, Prout, 1912: 178

**Adult**

Head: frons brown or greenish-brown; vertex grayish-green; interantennal fillet yellowish-white; chaetosemata with circular base and maximum of five setae; antennae with scape and pedicel yellowish-white, flagellum yellowish-white basally, transitioning to brownish red line apically, male pectinate basally, simple apically, all pectination brownish red, concolorous with apical flagellum, female simple; labial palpi reddish-brown dorsally, longer in female than male.

Thorax: grayish-green; foretibia reddish-brown; tibial spur formula 0–2–2 in male, 0–2–4 in female.

Forewing (Fig. 75): length 6.4–9.1 mm in male, 8.3–9.3 mm in female; grayish-green; dorsal and ventral costa orange-yellow; antemedial and postmedial lines faint,
waved, white, bordered distally by dark grayish-green, with distinct white spots on veins; discal spot faint, slightly dark grayish-green; termen and fringe concolorous with rest of forewing, sometimes with faint white spots at ends of veins.

Hind wing: color similar to that of forewing; discal spot more elongate, somewhat crescent-shaped.

Abdomen: grayish-green; dorsum without spots, sometimes with thin, white, transverse stripes across intersegmental borders; sternite of A3 with pair of sex scale patches.

Male genitalia (Fig. 102): uncus with bell-shaped base, 3.0x wider than middle of apical portion, apical portion falcate, slightly shorter than socii; socii semi-membranous, hooked; gnathos flattened, without tooth, basally fused with tegumen; valva relatively narrow, slightly tapered apically, with medial ridge setose basally; juxta small, wishbone-shaped; transtilla expanded medially, with tapered dorsal and ventral projections; coremata present; saccus with broad subtriangular anterior projection and shorter, rounded posterior projection; phallus narrow basally, widened medially, apex with small cluster of spines.

Female genitalia (Fig. 129): apophyses posteriores approximately 7.0x longer than apophyses anteriores; sterigma with large posterior elevated plate with posterolateral margins forming ridges, anterolateral arms asymmetrical, heavily sclerotized; ductus bursae short, sclerotized; corpus bursae short, pear-shaped, without signum.
Diagnosis: unlike most *Chloropteryx*, *C. paularia* does not have an angled hind wing or a striated forewing costa; it is thus relatively easy to distinguish *C. paularia* from its Caribbean congeners *Chloropteryx* sp. and *Chloropteryx glauciptera*. However, *C. paularia*’s rounded hind wing makes it look more similar to some species of *Chlorochlamys*. The postmedial line of *C. paularia* consists of small white spots that may be connected by a faint line, whereas species of *Chlorochlamys* have stronger postmedial lines without white spots. Male genitalia have socii that are membranous, as opposed to the sclerotized socii of *C. sp.*, *C. glauciptera*, and *Chlorochlamys chloroleucaria*. The socii of *C. paularia* also hooked, but not sinuate, which distinguishes them from the sinuate socii of the other Caribbean *Chloropteryx*. In the female genitalia, the asymmetrical anterolateral arms of the sterigma are diagnostic. Female genitalia also lack a signum and a y-shaped sclerotization, which distinguishes *C. paularia* from *C. sp.* and *C. glauciptera*, respectively.

Type: *Nemoria paularia*—Syntypes, ♂, ♀, [several specimens], Jamaica. Deposition unknown, possibly MNHU.

Distribution and flight times: examined material was collected in the U.S. (Florida), the Bahamas, Turks and Caicos, the Greater Antilles (Jamaica, Dominican Republic), and the Lesser Antilles (U.S. Virgin Islands) from March-April, June-August, and October-January at elevations ranging 3–1272 m. Pitkin (1996) and Ferguson (1985) reported additional records from the Greater Antilles (Cuba, Puerto Rico) and the Lesser Antilles (Martinique) collected year round.
**Eucrostes dominicaria** (Guenée)

(Figs. 76, 103)

*Eucrostis dominicaria* Guenée, 1857: 367
*Eucrostes dominicaria*, Prout, 1933: 71

**Adult**

Head: frons reddish-brown; vertex yellow; interantennal fillet white; chaetosemata with circular base and maximum of four setae; antennae with white dorsal line, with specks of red, scape and pedicel white, male and female pectinate, pectination brown; labial palpi reddish brown.

Thorax: yellowish green, patagia yellow; front of foretibia reddish-brown, coloration extending to apex of femur and basal tarsomere; tibial spur formula 0–2–2.

Forewing (Fig. 76): length 6.1–6.6 mm in male, 7.1 mm in female; yellowish-green; costal margin reddish-brown, remainder of costa and subcosta yellow; discal spot orange-red; postmedial line white, slightly waved; subterminal fascia pale yellow; termen with reddish-brown lunules; fringe pastel red; underside of forewing with large reddish-brown patch extending from base to slightly beyond discal cell.

Hind wing: color similar to that of forewing; discal spot larger than that of forewing; underside of hind wing without reddish-brown patch.

Abdomen: yellowish-green; dorsum without spots; A3 sternite without sex-scale patches.

Male genitalia (Fig. 103): uncus with triangular base, 5.0x wider than middle of apical portion, apex notched, approximately half as long as socii; socii membranous, broad apically; gnathos v-shaped, elongate, slightly tapered apically; valva relatively broad, widest mesially; valva with rounded, spinose basal and medial
saccular processes; juxta subtriangular, with concave dorsal margin; transtilla
narrowed and lightly sclerotized medially, more heavily sclerotized laterally; arms
of vinculum connected near base of saccus; saccus without projections; phallus
relatively narrow, with medio-ventral patch of spines.

Female genitalia: not examined.

Diagnosis: *Eucrostes dominicaria* can be distinguished from other species of Caribbean
Geometrinae by the pale yellow subterminal fascia, which contrasts sharply with
the yellowish-green ground color. Artifactual pale yellow coloration may be
visible in poor specimens of other Caribbean Geometrinae, but such coloration
will be less vivid and will usually extend beyond the subtermen. Male genitalia
are characterized by a notched uncus and by spinose basal and medial processes
of the valval sacculus.

Type: *Eucrostis dominicaria*—Holotype, ♂, Haiti (coll. Guenée). Deposited in BMNH.

Distribution and flight times: the two examined specimens were collected in the Greater
Antilles (Jamaica, Dominican Republic). The Dominican Republic specimen was
collected in April at 45 m and the Jamaican specimen has no date or elevation
data. Pitkin (1996) reported additional records from the Greater Antilles (Haiti)
and South America (Venezuela, Brazil, Bolivia, Paraguay) collected at unknown
times and elevations.

**Tribus incertus**

*Hydata insatisfacta* Herbulot

(Figs. 77, 104, 130)

*Hydata insatisfacta* Herbulot, 1988: 103
**Adult**

Head: frons and vertex yellowish-green; interantennal fillet white; chaetosemata with circular base and maximum of 4 setae; antennae with white dorsal line, scape and pedicel white, male pectinate, female with broad pectination that curves around antennae, giving appearance of ventral loops; labial palpi brownish-red, third segment longer in female than male.

Thorax: yellowish-green; front of foretibia brown; tibial spur formula 0–2–4.

Forewing (Fig. 77): length 9.6–12.1 mm in male, 10.6–11.4 mm in female; yellow-green; costa golden yellow; antemedial and postmedial lines light brown, dentate, sometimes absent; termen brownish yellow, sometimes with light brown spots at ends of veins; discal spot light brown or dark purple, somewhat reniform; wing base with small, dark brown spot; apex with larger, dark brown spot; postmedial subcosta with two spots, concolorous with discal spot, often merged to form backwards L-shaped patch; additional spots usually present on antemedial and postmedial fascia, spots concolorous with discal spot, usually separate but sometimes merged.

Hind wing: color similar to that of forewing; discal spot slightly smaller than that of forewing; medial fascia with large patch on anal margin, patch concolorous with discal spot, sometimes with yellowish border; additional spots present on antemedial and postmedial fascia, usually separate but sometimes merged; outer margin of hind wing scalloped, most prominently extended at M1 and M3; Sc+R$_1$ fused with Rs along approximately half the length of the discal cell.
Abdomen: abdomen yellowish green with transverse white rows on posterior margins of segments; dorsum without spots; male A3 sternite with pair of sex-scale patches; male A8 sternite lightly sclerotized, notched.

Male genitalia (Fig. 104): base of uncus with rounded lateral margins, 5.5x wider than middle of apical portion, apex slightly spatulate, subequal in length with socii; socii membranous, elongate; gnathos Y-shaped, with apical portion fused, narrow, nearly as long as remainder of gnathos; valva relatively narrow basally, broad apically, medial ridge with tooth-shaped projection and small setose nodule basally; juxta u-shaped; transtilla lightly sclerotized medially, more heavily sclerotized laterally; saccus with short anterior projection and rounded, posterior projection 1.3x length of valva; phallus 1.5x longer than posterior projection of saccus.

Female genitalia (Fig. 130): apophyses posteriores 1.5x longer than apophyses anteriores; sterigma forming ovate plate around ostium; ductus bursae 2x length of seventh sternite, sclerotized; corpus bursae globular, without signum.

Diagnosis: *Hydata insatisfacta* is readily identified by its wing shape and pattern. The scalloped hind wings distinguish *H. insatisfacta* from other Caribbean Geometrinae, and the arrangement of brown subterminal spots distinguishes it from mainland species of *Hydata* Walker. Females have antennae with hollow, cup-shaped expansions under the flagellomeres, which is unique among Caribbean Geometrinae. Male genitalia are easily identified by the very long anterior extension of the saccus. Female genitalia have a globular corpus bursae;
this is superficially similar to the genitalia of *Oospila decoloraria* but is
distinguished by its lack of a signum.

Type: *Hydata insatisfacta*—Holotype, ♂, Guadeloupe: Bouillante, Crête de Village,
15.vi.1986 (*Lalanne-Cassou*). Deposited in HERB.

Distribution and flight times: examined material was collected in the Bahamas and the
Greater Antilles (Jamaica, Dominican Republic) in every month except February
and March at elevations ranging 18–2288 m. *Herbulot* (1988) reported additional
records from Guadeloupe collected in March.

**Notes on Unexamined Species with Caribbean Distribution**

*Nemoria dentilinea* (Warren)

*Racheospila dentilinea* Warren, 1897: 430
*Nemoria dentilinea dentilinea* Pitkin, 1993: 108

Type: *Racheospila dentilinea*—Holotype, ♀, Guyana. Deposited in BMNH.

Notes: Pitkin (1993) listed *N. d. paurocaula* (Prout) and *N. d. tenuilinea* (Kaye) as
subspecies of *N. dentilinea*, but noted that both of these subspecies may be
conspecific and distinct from the nominal species. Pitkin (1993, 1996) reported
these taxa only from Central and South America. *Aguila* (2004) included *N.
dentilinea* in his checklist of Lepidoptera from the Topes de Collantes region of
Cuba (*Águila*, 2004). The specimens from Cuba were not examined, and it is
unknown if this is a valid record or a misidentification. *Nemoria dentilinea* can
be distinguished from other Caribbean *Nemoria* by the combination of dentate
antemedial and postmedial lines with a faint brown line on the basal border and
white dorsal abdominal spots.
**Nemoria lixaria** (Guenée)

*Racheospila lixaria* Guenée, 1857: 374  
*Geometra inclusaria* Walker, 1861: 508  
*Synchloara texana* Hulst, 1898: 160  
*Racheospila associaria* Barnes and McDunnough, 1917: 219  
*Racheospila knobelaria* Cassino, 1927: 66  
*Racheospila lixaria* Prout, 1932: 25  
*Nemoria lixaria*, Ferguson, 1969: 68

Type: *Racheospila lixaria*—Holotype, ♂, ‘Amérique septentrionale’ (coll. Guenée). Deposited in USNM.

Notes: Aguila (2004) included *N. lixaria* in his checklist of Lepidoptera from the Topes de Collantes region of Cuba (Águila, 2004). The specimens from Cuba were not examined, and it is unknown if this is a valid record or a misidentification.

Ferguson (1985) reported *N. lixaria* as a Nearctic species found primarily in the southeastern United States and less commonly in the northern United States.

Pitkin (1993) reported that *N. pescadora* is the only Nearctic *Nemoria* that is also found in the Neotropical Region, implying *N. lixaria* has a strictly Nearctic distribution.

*Nemoria lixaria* is similar to both *Nemoria* n.sp.3 and *Nemoria toxeres*. Based on examinations of Nearctic specimens of *N. lixaria*, this species is characterized by the dorsal abdominal spots being white with red rings and the color pattern of the fringe, the latter distinguishing it from *N. n.sp. 3*. *N. lixaria* can be distinguished from *N. toxeres* by the dorsal A2 spot. This spot is green with a reddish-brown ring in *N. toxeres*, and either white with a red ring or absent in *N. lixaria*. The male genitalia of *N. lixaria* has short, curved basal costal processes and a concave apex of the uncus, which distinguishes it from other Caribbean *Nemoria*. 

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Phrudocentra agari Prout

Phrudocentra agari Prout, 1916: 167

Type: Phrudocentra agari—Holotype, ♂, Dominica (Agar). Deposited in BMNH.

Notes: Phrudocentra agari has been described by Prout (1916) as being very similar to the mainland species Phrudocentra pupillata. P. agari lacks a row of spots along the postmedial line, which distinguishes it from Phrudocentra centrifugaria. It can be distinguished from the Caribbean Phrudocentra kinstonensis and the mainland P. pupillata by its relatively long labial palpi. Additionally, males have relatively long antennal pectination compared to that of P. kinstonensis. Pitkin (1996) reported P. agari only from Dominica.

Phrudocentra kinstonensis (Butler)

Jodis kinstonensis Butler, 1878: 490
Iodis kin[g]stonensis Kirby, 1880: 221
Phrudocentra kinstonensis, Prout, 1932: 49

Type: Jodis kinstonensis—Lectotype, ♂, Jamaica: ‘Kingstown area’ (Bowrey). Deposited in BMNH.

Notes: Phrudocentra kinstonensis can be distinguished from the other two species of Caribbean Phrudocentra by its lack of postmedial spots, its relatively short palpi, and its discal spot, which has a reddish ring (Butler, 1878). The tympanal organ is also diagnostic, which is rare among species of Geometrinae: the apex of the ansa is broader than that of other Caribbean Phrudocentra (Pitkin, 1996). Pitkin (1996) reported P. kinstonensis only from Jamaica.
**Synchlora ephippiaria** (Möschler)

*Cambogia ephippiaria* Möschler, 1886: 68  
*Racheospila ephippiaria*, Prout, 1932: 39  
*Synchlora ephippiaria*, Pitkin, 1993: 111

**Type:** *Cambogia ephippiaria*—Lectotype, ♂, Jamaica. Deposited in MNHU.

**Notes:** *Synchlora ephippiaria* is characterized by strong red coloration of the subcosta, termen, and fringe (Prout, 1932), as well as a red 'saddle' that surrounds the white dorsal abdominal spots (Möschler, 1886). However, these descriptions also apply to *Synchlora herbaria bonhotei* (Fig. 10(59)). Pitkin (1996) reported *S. ephippiaria* only from Jamaica. *Synchlora herbaria bonhotei* is also from Jamaica. Genitalia of specimens matching the external descriptions of *S. ephippiaria* were identical to genitalia of *S. herbaria* and were thus identified in this study as *S. h. bonhotei*. Type material was not examined, so it is unknown if *S. ephippiaria* and *S. h. bonhotei* are truly synonyms. Möschler's description of *S. ephippiaria* precedes Prout's description of *S. h. bonhotei*, but succeeds Fabricius' description of *S. herbaria*. If *S. ephippiaria* and *S. h. bonhotei* are synonyms, the new name of the taxon would be *Synchlora herbaria ephippiaria*.

*Oospila decoloraria* (Walker)

*Iodis decoloraria* Walker, 1861: 541  
*Oospila decoloraria*, Prout, 1912: 133

**Type:** *Iodis decoloraria*—Holotype, ♀, Jamaica. Geom. genitalia slide No. 15703. Deposited in BMNH. Reported erroneously as ♂ in original description (Cook and Scoble, 1995).
Notes: the wing pattern of *Oospila decoloraria* is similar to that of *Oospila confundaria*, the only other Caribbean *Oospila*. *Oospila decoloraria* was differentiated from *O. confundaria* by Cook and Scoble (1995) as follows. Male *O. decoloraria* lack the long hind tibial hairpencil that is present in male *O. confundaria*. Female antennae are bipectinate in *O. decoloraria* and simple in *O. confundaria*. Male genitalia of *O. decoloraria* have characteristic hook-shaped projections at the apex of the sacculus. Female genitalia are characterized by a sterigma with a semicircular plate that is deeply notched posteriorly (Cook and Scoble, 1995). Both species of *Oospila* can be distinguished from other Caribbean Geometrinae by the elevated crests on the dorsum of the abdomen. Cook and Scoble (1995) reported *O. decoloraria* from Cuba and Jamaica.
Table 2  List of Caribbean Geometrinae species used for genitalia preparations

<table>
<thead>
<tr>
<th>Tribe</th>
<th>Species</th>
<th>Specimens</th>
</tr>
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<tbody>
<tr>
<td>Nemoriini</td>
<td><em>Dichorda rhodocephala</em> Prout 1916</td>
<td>1 (1♂)</td>
</tr>
<tr>
<td></td>
<td><em>Lissochlora</em> n.sp.</td>
<td>3 (2♂,1♀)</td>
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<td></td>
<td><em>Nemoria punctilinea</em> (Dognin 1902)</td>
<td>2 (1♂,1♀)</td>
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<td></td>
<td><em>Nemoria rectilinea</em> (Warren 1906)</td>
<td>5 (4♂,1♀)</td>
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<tr>
<td></td>
<td><em>Nemoria toxeres</em> (Prout 1932)</td>
<td>2 (1♂,1♀)</td>
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<td></td>
<td><em>Nemoria</em> n.sp.1</td>
<td>4 (3♂,1♀)</td>
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<tr>
<td></td>
<td><em>Nemoria</em> n.sp.2</td>
<td>2 (1♂,1♀)</td>
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<tr>
<td></td>
<td><em>Nemoria</em> n.sp.3</td>
<td>2 (1♂,1♀)</td>
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<tr>
<td></td>
<td><em>Phrudoecentra centrifugaria</em> (Herrich-Schäffer 1870)</td>
<td>4 (3♂,1♀)</td>
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<tr>
<td>Synchlorini</td>
<td><em>Synchlora cupedinaria</em> (Grote 1880)</td>
<td>4 (2♂,2♀)</td>
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<td></td>
<td><em>Synchlora frondaria</em> Guenée 1857</td>
<td>5 (4♂,1♀)</td>
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<td></td>
<td><em>Synchlora herbaria</em> (Fabricius 1794)</td>
<td>5 (2♂,3♀)</td>
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<td></td>
<td><em>Synchlora isolata</em> (Warren 1900)</td>
<td>1 (♀)</td>
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<td></td>
<td><em>Synchlora xysteraria</em> (Hulst 1886)</td>
<td>5 (2♂,3♀)</td>
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<td></td>
<td><em>Synchlora</em> n.sp.1</td>
<td>3 (2♂,1♀)</td>
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<td></td>
<td><em>Synchlora</em> n.sp.2</td>
<td>3 (2♂,1♀)</td>
</tr>
<tr>
<td>Lophochoristini</td>
<td><em>Eueana niveociliaria</em> (Herrich-Schäffer 1870)</td>
<td>3 (1♂,2♀)</td>
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<tr>
<td></td>
<td><em>Eueana simplaria</em> Herbulot 1986</td>
<td>2 (1♂,1♀)</td>
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<tr>
<td></td>
<td><em>Oospila confundaria</em> (Möschler 1890)</td>
<td>2 (1♂,1♀)</td>
</tr>
<tr>
<td>Hemitheini</td>
<td><em>Chlorochlamys chloroleucaria</em> (Guenée 1857)</td>
<td>3 (2♂,1♀)</td>
</tr>
<tr>
<td></td>
<td><em>Chlorochlamys</em> n.sp.1</td>
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</tr>
<tr>
<td></td>
<td><em>Chlorochlamys</em> n.sp.2</td>
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<td></td>
<td><em>Chloropteryx glauciptera</em> (Hampson 1895)</td>
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<td></td>
<td><em>Chloropteryx paularia</em> (Möschler 1886)</td>
<td>4 (2♂,2♀)</td>
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<td><em>Chloropteryx</em> n.sp.1</td>
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<td></td>
<td><em>Eucrostes dominicaria</em> Guenée 1857</td>
<td>1 (1♂)</td>
</tr>
<tr>
<td>Tribus incertus</td>
<td><em>Hydata insatisfacta</em> Herbulot 1988</td>
<td>4 (2♂,2♀)</td>
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Figures 48-53 Images of Nemoriini imagos.

Figures 54-59 Images of Nemoriini and Synchlorini imagos.

Notes: 54, Nemoria rectilinea. 55, Nemoria toxeres. 56, Phrudenocentra centrifugaria centrifugaria (♂). 57, Phrudenocentra centrifugaria centrifugaria (♀). 58 Synchlera n.sp.1. 59, Synchlera n.sp.2. Scale bar = 5mm.
Figures 60-65 Images of Synchlorini imagos.

Figures 66-71 Images of Synchlorini, Lophochoristini, and Hemitheini imagos.

Figures 72-77 Images of Hemitheini and Hydata imagos.

Notes: 72, Chlorochlamys chloroleucaria. 73, Chloropteryx n.sp.1. 74, Chloropteryx glauciptera. 75, Chloropteryx paularia. 76, Eucrostes dominicaria. 77, Hydata insatisfacta. Scale bar = 5mm.
Figures 78-83 Male genitalia of Nemoriini.

Notes: 78, *Dichorda rhodocephala*. 79, *Lissochlora* n.sp. 80, *Nemoria* n.sp.1. 81, *Nemoria* n.sp.2. 82, *Nemoria* n.sp.3. 83, *Nemoria punctilinea*. Scale bar of phallus = 0.5mm.
Figures 84-89  Male genitalia of Nemoriini and Synchlorini.

Figures 90-95 Male genitalia of Synchlorini and Lophochoristini.

Figures 96-101 Male genitalia of Lophochoristini and Hemitheini.

Notes: 96, *Oospila confundaria*. 97, *Chlorochlamys* n.sp.1. 98, *Chlorochlamys* n.sp.2. 99, *Chlorochlamys chloroleucaria*. 100, *Chloropteryx* n.sp. 101, *Chloropteryx glauciptera*. Scale bar of phallus = 0.5mm.
Figures 102-107 Male genitalia and eighth abdominal sternite.

Notes: 102-104. Genitalia. 102, _Chloropteryx paularia_. 103, _Eucrostes dominicaria_. 104, _Hydata insatisfacta_. 105-107. A8 sternite. 105, _Nemoria n.sp.1_. 106, _Nemoria n.sp.2_. 107, _Nemoria n.sp.3_. Scale bar of phallus and sternite = 0.5mm.
Figures 108-112  Female genitalia of Nemoriini.

Figures 113-118  Female genitalia of Nemoriini and Synchlorini.

Figures 119-124  Female genitalia of Synchlorini and Lophochoristini.

Notes:  119, Synchlora herbaria. 120, Synchlora isolata. 121, Synchlora xysteraria. 122, Eueana niveociliaria. 123, Eueana simplaria. 124, Oospila confundaria. Scale bar = 1mm.
Figures 125-130  Female genitalia of Hemitheini and Hydata.

Notes: 125, Chlorochlamys n.sp.2. 126, Chlorochlamys chloroleucaria. 127, Chloropteryx n.sp. 128, Chloropteryx glauciptera. 129, Chloropteryx paularia. 130, Hydata insatisfacta. Scale bar = 1mm.
References


APPENDIX A

ADDITIONAL TABLES DETAILING VARIATION OF SELECTED SKELETAL CHARACTERS OF GEOMETRIDAE
## Table 3  
Variation of Selected Skeletal Characters of the Head of Geometridae Genera

<table>
<thead>
<tr>
<th>Subfamily/tribe</th>
<th>Genus</th>
<th># of specimens examined</th>
<th>Interocular index</th>
<th>Campaniform sensilla on posterolateral stipophore</th>
<th>Campaniform sensilla on anterior stipophore</th>
<th>Male LP3/LP2 ratio</th>
<th>Female LP3/LP2 ratio</th>
<th>Male OVR/LP2 ratio</th>
<th>Female OVR/LP2 ratio</th>
<th>Male pectination/flagellomere ratio</th>
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<td>–</td>
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<td>–</td>
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<td>2.1-2.2</td>
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<td>0.49-0.80</td>
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<td>0.09</td>
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Notes: The tribal name is given for genera in the subfamily Geometrinae. The subfamily name is given for genera that are not in Geometrinae. An en dash indicates that a specimen of the specified gender was not studied, or that the character could not be accurately measured due to damage.
Table 4   Variation of Selected Skeletal Characters of the Legs of Geometridae Genera

<table>
<thead>
<tr>
<th>Subfamily/tribe</th>
<th>Genus</th>
<th># of specimens examined</th>
<th>Male relative epiphysis length</th>
<th>Female relative epiphysis length</th>
<th>Mesothoracic spur/tibia length ratio</th>
<th>Metathoracic spur/tibia length ratio</th>
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<td>Dichorda</td>
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Notes: The tribal name is given for genera in the subfamily Geometrinae. The subfamily name is given for genera that are not in Geometrinae.

An en dash indicates that a specimen of the specified gender was not studied, or that the character could not be accurately measured due to damage.
APPENDIX B

ADDITIONAL TABLES DETAILING DISTRIBUTION OF CARIBBEAN GEOMETRINAE
Table 5  Distributional Records of Caribbean Synchlorini and Hemitheini

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<th>Species</th>
<th>Bahamas</th>
<th>Synchlora epiphtharia</th>
<th>Synchlora frondaria</th>
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<th>Synchlora isodata</th>
<th>Synchlora xysteraria</th>
<th>Synchlora n. sp. 1</th>
<th>Synchlora n. sp. 2</th>
<th>Chrorochlamys chloroleucaria</th>
<th>Chrorochlamys n. sp. 1</th>
<th>Chrorochlamys n. sp. 2</th>
<th>Chloropteryx glauciptera</th>
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Notes: ✓ represents a locality record from the data label of a pinned specimen. L represents a locality record from the literature. ? represents a questionable record from the literature. All species with Hispaniolan distribution have records from the Dominican Republic, but only three Hispaniolan species (Synchlora frondaria, Synchlora herbaria, Eucrostes dominicaria) have records from Haiti.
Table 6  Distributional Records of Caribbean Nemorini, Lophochoristini, and *Hydata*

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