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Rare, Declining, and Poorly Known Butterflies and Moths (Lepidoptera) of Forests and Woodlands in the Eastern United States

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COVER: Design and artwork by Sheryl Romero, contractor for the U.S. Forest Service, Forest Health Technology Enterprise Team. Romero's work is of a stylized top view of a female Diana fritillary *(Speyeria diana)* photographed by Mark C. Minno, blending in stages into the sky above its natural habitat, the Appalachians. See page 210.

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Rare, Declining, and Poorly Known Butterflies and Moths (Lepidoptera) of Forests and Woodlands in the Eastern United States

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Acknowledgments & dedication

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In appreciation for these and other contributions and accomplishments, the authors dedicate this book to Dick Reardon.

Introduction

Figure 1. Deciduous forest in the Blue Ridge Mountains viewed from Black Rock Mountain State Park, Rabun County, Georgia (Maria Minno photo).

The eastern United States is rich in both plant and animal diversity relative to other temperate regions. Vankat (1990) identified nearly 30 types of eastern forests. Forest types were delineated based on soils, rainfall, temperature, latitude/elevation, fire frequency, and physiognomic characteristics such as deciduous versus evergreen. This region encompasses wide-ranging environmental gradients varying from tropical conditions in the Florida Keys to alpine mountaintops in New York and New England. The Appalachians (Figure 1) and other mountains from Georgia to Maine provide a myriad of landscape complexities and microclimates that allow many different species to live in this region, sometimes in areas far removed from their normal ranges. The relatively flat, sandy soils of the Atlantic and Gulf coastal plains support distinct forests and open woodlands, such as pinelands, oak scrub, and cypress swamps. The eastern United States also has a number of specialized natural communities, such as barrens, white cedar swamps, and savannas, that often harbor rare species of plants and animals. Good overviews of the biodiversity and ecology of forests in the eastern United States are provided in Vankat (1979), Sutton and Sutton (1985), Christensen (1988), Greller (1988), Kricher and Morrison (1988), Barbour and Christensen (1993), and Fralish and Franklin (2002).

Lepidoptera are the butterflies and moths. These insects are characterized by having the legs, wings, and body covered with scales. The terms Macrolepidoptera and Microlepidoptera are used in a couple of different ways. Informally, as the words indicate, these terms are used to differentiate the larger moths and butterflies from the very small, sometimes tiny, moths. The designations Microlepidoptera and Macrolepidoptera also have a more formal taxonomic definition that does not always conform with size. They differentiate the more primitive and primarily smaller moths from the more advanced and generally larger moths and butterflies.

Although out of date, the Check List of the Lepidoptera of America North of Mexico (Hodges *et al.* 1983) is still widely used today because it is the most comprehensive checklist available. This publication did not define micro and macro moths, but this list can be used to delineate these groups. The Macrolepidoptera are numbered from 6235 to 11233. Microlepidopterans are numbers 1 through 6234, but the butterflies (numbers 3864 to 4617), which are actually macros, are embedded within the micros. At the time of publication, Hodges *et al.* considered butterflies to be more closely related to the Cossoidea, and placed them within what lepidopterists would call the Microlepidoptera. Systematists now include butterflies within the Macrolepidoptera (Arnett 2000).

Although sometimes beautifully colored, very small Microlepidoptera tend to be overlooked by collectors, and therefore are often underrepresented in faunal surveys. As a result of this discrepancy, they are less well known, and we include only a few in this book.

The Order Lepidoptera is one of the most species-rich groups of living animals. Arnett (2000) estimates there are likely to be more than 146,000 species of moths and butterflies worldwide, whereas Wagner (2000) suggests closer to 250,000. Hodges *et al.* (1983) list nearly 11,500 species of Lepidoptera in the United States and Canada, of which about half are Macrolepidoptera and about 760 are butterflies. We suspect there are around 4,000 species of Lepidoptera east of the Mississippi River in the United States. Most states in our coverage area seem to have between 2,000 and 3,000 species of Lepidoptera.

New Jersey has about 1,350 species of Macrolepidoptera, and the total number of lepidopterans in the state is probably around 2,500 species, based on evidence provided in Smith (1910), Muller (1965, 1973, 1976, 1979), Moulding and Madenjian (1979), and records compiled by Dale Schweitzer. Scholtens and Wagner (2007) list 2,209 species from Connecticut, and less than half of these are microlepidopterans (1,022). Brower (1974) recorded 1,267 species of Macrolepidoptera in Maine. Grehan *et al.* (1995) report only 1,779 species for Vermont, of which 1,044 are Macrolepidoptera (including 89 butterflies and skippers). These low totals are consistent with generally reduced species richness northward.

In the northwestern portion of our coverage area, upper Midwestern states have relatively high numbers of butterflies and moths because they are enriched by species from different faunas to the north, east, south, and west. Covell (1999) estimates there are at least 2,450 species of Lepidoptera in Kentucky. Hugo Kons estimates the Macrolepidoptera fauna of Wisconsin to be about 1,449 species, based on Scott (1986), Ferge and Balogh (2000), and surveys by Hugo Kons, Robert J Borth, and Thomas Barina mostly between 1991 and 1995. Wisconsin has a latitudinal range similar to Vermont and Maine, but lacks the high elevations found in the other two states.

Southern states are expected to have more species than those far to the north. Those with high mountains and coastal plain pinelands have relatively rich lepidopteran faunas. North Carolina has an exceptionally diverse coastal plain fauna and the highest elevations in the east, with several peaks over 6,000 ft (1,818 m). Steve Hall reports (personal communication with Dale Schweitzer in July 2008) a total of 1,922 species for North Carolina. This includes 173 butterflies and skippers, 1,379 species of Macrolepidoptera, and 370 species of Microlepidoptera. James Adams estimates that more than 3,000 species of Lepidoptera occur in Georgia.

Although Florida does not have mountains, it has the richest diversity of moths and butterflies reported so far for any state in the eastern United States. Heppner (2003) lists 2,940 species of Lepidoptera from Florida. Although the subtropical fauna of southern Florida is relatively depauperate, it contributes several hundred species of West Indian affinity to the state total that otherwise do not occur in our coverage area.

Eastern moths range in size from just a few millimeters to the giant silkmoths that are 6 inches (154 millimeters) or more from wing tip to wing tip. The larval stages of moths and butterflies occupy numerous ecological niches, from gilled caterpillars that live underwater to wood borers. Most feed on the leaves of living vascular plants. However, various species feed on such diverse items as lichens, ferns, seeds, flowers, roots, beeswax, detritus, dead leaves, and animal hair, and a few are insectivorous. Almost every kind of vascular plant has some kind of caterpillar that eats it, and common trees such as pines, birches, oaks, and hickories are hosts to many kinds of Lepidoptera.

The world is changing at a rapid pace. On a global scale, natural areas are being converted at an unprecedented rate to agricultural, industrial, and urban uses. Climate change, invasive exotic species, overly abundant deer, altered fire regimes, and other factors are threatening the remaining natural areas and preserves in our region. Edward O. Wilson (2002) has predicted that half of all living species will be extinct within 100 years. While this rate of loss is unlikely for the eastern United States, the conservation of rare species will be an increasingly important challenge. Southern Florida has more imperiled species of butterflies than any other region of the United States and two skippers endemic to that region, *Hesperia meskei pinocayo* (Figure 2) and *Epargyreus zestos oberon* (Figure 3), are now presumed to be extinct (Minno 2010a). Eleven moths from the eastern United States, including five Microlepidoptera that were apparently specialists on American chestnut (*Castanea dentata*) (Opler 1978), have not been collected in more than 30 years, as far as

Figure 2. *Hesperia meskei pinocayo* (underside view) was known only from the pine rocklands of Big Pine Key and a few sites in southern Miami-Dade County, Florida, but is now presumed to be extinct (Marc Minno photo).

Figure 3. *Epargyreus zestos oberon* (underside view) was once common in the Florida Keys and coastal areas of the southern Florida mainland, but now appears to be extinct (Marc Minno photo).

we know, and as of June 2008 are ranked as globally historic (GH) by NatureServe. In addition to the chestnut specialists, other moths that have not been collected anywhere recently and may be extinct include *Holomelina nigricans*, *Apamea smythi*, *Papaipema aerata*, and the taxonomically questionable *Lambdina canitiaria* (Appendix 2). We discuss *Holomelina nigricans* briefly in the context of its association with the Arogos skipper (*Atrytone arogos arogos*) in New Jersey and Pennsylvania. *Papaipema aerata* does not seem to have inhabited wooded areas, and the habitat for *Apamea smythi*, while probably forested, is unknown. The eastern arctic-alpine moth *Agrotiphila staudingeri* also is ranked GH, but this ranking probably reflects primarily its remote range. It is unlikely that this species is actually rare, let alone extinct, although surveys into its range should be done to determine whether it is extant or extinct.

SCOPE OF THIS BOOK

In this book we discuss rare moths and butterflies in hope that our forests and woodlands can be managed for their continued existence and the enjoyment of many generations to come. While it is impossible to manage for everything, we suggest habitats that are managed appropriately to maintain their indigenous Lepidoptera are likely to retain more of their specialized fauna, than are places managed solely for flora or for single species of charismatic animals, such as the red-cockaded woodpecker (*Piciodes borealis*). Lepidoptera and insect populations are sometimes more sensitive indicators of habitat quality than plants or vertebrates alone, because, unlike most plants or vertebrates, they must reproduce one or more times every year in order to persist in an area. Also, many Lepidoptera have more exacting habitat needs than merely the presence of their food plant.

This book addresses globally or regionally, rare and declining moths and butterflies of wooded communities found in states east of the Mississippi River, as well as a few from the Missouri Ozarks. Some of the species occur in forests, but many occur in more sparsely wooded habitats. Our species selection is based heavily on rankings provided by NatureServe, a nonprofit conservation organization. These rankings are more fully explained at the beginning of the section on species accounts, below. Rankings are typically updated every three to five years, or whenever new information becomes available. All species covered herein were updated between 2006 and 2008. Undoubtedly some species that we do not include are more worthy of inclusion than some we do include. A lot of the information upon which our selections are based is unpublished, and not all of this originates from us. Some parts of our coverage area have been very poorly collected for moths, notably Alabama. We were not able to examine many specimens from Mississippi. Appendix 2 contains many species that appear to be rare, but for which we could provide no meaningful account.

NatureServe represents an international network of biological inventories, known as Natural Heritage Programs or Conservation Data Centers, in all 50 states, Canada, Latin America, and the Caribbean. These programs not only collect and manage detailed local information on plants, animals, and ecosystems, but also provide information summaries, data management tools, and conservation services to help meet local, national, and global conservation needs. NatureServe and state Natural Heritage Programs and Canadian Conservation Data Centers assign animals and plants both a global rank (G) and a subnational (state or province) rank (S), respectively. These rankings are an assessment of a species' status or degree of imperilment within a given geographic region, and are based on standard risk factors and criteria (NatureServe Explorer "Interpreting NatureServe Conservation Status Ranks" online at http://www.natureserve.org/explorer/ranking.htm#interpret). The criteria for assigning ranks are uniform across the United States; hence, G and S ranks (see page 77) provide a useful scale for comparing the relative security or vulnerability of a species. NatureServe has limited control over S-ranks, which are assigned by individual states and provinces. While preparing this book, we frequently found S-ranks for the states of Maine, Massachusetts, Connecticut, New York, Pennsylvania, Michigan, Missouri, Virginia, North Carolina, Florida, and others to be useful. The S-rank is useful because it facilitates cooperation with local experts, and in some cases, because it highlights the inventory work by the Natural Heritage Programs within their states.

Not all Lepidoptera have been evaluated by NatureServe. For example, most Microlepidoptera have not been assessed. However, if funding were available, many of these could be ranked based on knowledge accumulated over the last 20 years, much of it from amateur collectors. All vertebrates and known species of invertebrates in the insect orders Odonata, Trichoptera, and Ephemeroptera have been ranked. Among the Lepidoptera, full species and some subspecies of butterflies and skippers, Saturniidae, Sphingidae, Arctiinae (the Arctiidae is treated as a subfamily of the Erebidae by Lafontaine and Schmidt 2010), Notodontidae, *Catocala*, and *Papaipema* have been ranked. Many other eastern North American Macrolepidoptera on the MONA[1] checklist (Hodges *et al.* 1983) have been evaluated by Dale Schweitzer and Paul Opler and were determined to be adequately known and sufficiently common to not be of conservation concern. The NatureServe Explorer website (http://www.natureserve.org) includes information on species ranks, food plants, phenology, range, etc., pertaining to eastern Macrolepidoptera suspected or known to meet NatureServe rarity criteria as of about 2005. For most common species, little or no information will be found on the website.

In this book, we do not include common Canadian species that barely enter the United States in places like northern Maine and the extreme northern Midwest, although we do include a few with very disjunct populations farther south in the United States. Diurnal species from South Florida are included if they are established residents that are also apparently uncommon (that is, ranked G3 by NatureServe) outside of the United States, or are considered to represent endemic subspecies. We encountered two major problems with evaluating nocturnal moths from South Florida. First, collecting restrictions on most public lands since the 1990s have strongly discouraged moth collectors from doing field work there, so the limited information we do have is at least 20 years old. Secondly, many of the species also occur in other countries for which we have even less information. Given the rapid decline of several South Florida butterflies during this period, we suspect that moths from this region are under-represented in our accounts. We present full accounts for only three South Florida moths, one of which is easily observed in the daytime. We do include some nocturnal species in Appendix 2, and provide what little information we can.

[1] The *Check List of Lepidoptera America North of Mexico* is one fascicle of many in the project commonly known as the "Moths of North America," often abbreviated as "MONA."

Life history and ecology of Lepidoptera

Although details differ substantially among species, all butterflies and moths have the same basic life history consisting of four discrete life stages: Egg, larva, pupa, and adult. After mating, female moths and butterflies lay their eggs, usually one or a few at a time, on or near plants of suitable kind and quality for the caterpillars to eat. In this book, the terms "food plant" and "host plant" always refer exclusively to the larval food. The tiny caterpillar (larva) typically chews its way out of the egg after five to fifteen days, except in species that overwinter in as larvae. Most caterpillars feed on the foliage or reproductive parts of the host plant. They often hide on the leaves or stems of the host, or nearby when not feeding, but many live in silken nests or bore into stems and roots.

Caterpillars (larvae) eat voraciously. They must molt or shed their outer cuticle several times in order to grow larger. Each larval stage is called an instar. The minimum number of instars is three, but five or six is the norm. A few have more than six instars. When the larval cuticle is shed for the last time, the pupa is revealed.

Many moths and a few butterflies, such as some hairstreaks, elfins, and blues, pupate in the leaf litter or soil. Many moth caterpillars burrow down several centimeters into the ground and then form a chamber or cell in which to pupate. Other moths and most skippers pupate in a cocoon. A cocoon is a silk covering, often made by webbing together a few leaves. Cocoons may be thin and flimsy or thick and tough. They may be made entirely of silk or include larval hairs, leaves, stems, frass, or detritus.

Caterpillars of true butterflies do not pupate in cocoons. Their sometimes ornate pupae (chrysalids, or singular, chrysalis) are typically attached with tiny hooks on the tip of the abdomen to a silk pad the larva places on some solid substrate. Pieridae (sulphurs, whites etc.), swallowtails, and a few others also have a silk thread supporting the middle (see illustrations in Klots 1951, Scott 1986, and Minno *et al*. 2005). Major reorganization of the larval tissues occurs within the pupa as transformation to the adult stage ensues. If no dormancy is involved, the adult typically emerges from the pupa within 10 to 35 days. For most temperate species, winter is spent in diapause, a state of dormancy. Diapause occurs in a specific stage that is usually the same within a genus, and in some cases, within a family. Relatively few Macrolepidoptera overwinter as adults in the eastern United States. Exceptions include most Xylenine owlet moths and some brushfooted butterflies (Nymphalidae). Several tropical species in Florida pass the winter dry season as adults.

Some species diapause in the egg stage and usually do not hatch until spring, including *Satyrium* hairstreaks, *Catocala* (underwing) moths, and many moths that lay their eggs in autumn. Species that diapause in the egg stage do not hatch until spring.

Most Lepidoptera species in the eastern United States overwinter in one of the larval instars or as a pupa. Diapause may be obligate, as in the eggs of hairstreaks and underwing moths. For many other species diapause is determined by seasonal factors such as day length. For example, providing they pupate under summer conditions when days are long, most butterflies and moths that have more than one generation per year will complete metamorphosis in a few weeks. However, if pupation occurs in August or later, many will enter diapause and not transform into adults until spring.

Termination of diapause usually requires a certain amount of chilling followed by a period of warmth and/or rainfall. In some species it probably also requires lengthening daylight. Winter diapause (hibernation) is best known, although summer diapause (aestivation) is very common, and many single-brooded species do both, but not necessarily in the same stage. Many Xylenine moth larvae feed in spring, enter diapause as mature larvae by early summer, pupate and emerge as adults in the fall, then diapause again as pre-reproductive adults until spring. Mating occurs when activity resumes in late winter or early spring.

Tropical species often have no diapause, or pass the dry season as adults in reproductive diapause (i.e., they do not mate or lay eggs until the onset of the rainy season). Some temperate species can continue to feed and grow through the winter. As far north as New Jersey, larvae and pupae of the orange sulphur butterfly (*Colias eurytheme*) and larvae of the inchworm moth (*Nemoria lixaria*) continue to develop throughout the winter without diapause, but at much slower growth rates than in summer generations (Schweitzer 2006). Many noctuid caterpillars feed and grow through the winter and early spring, then enter diapause from late spring into summer, usually as pupae. The region from southern New Jersey to Tennessee and southward has enough warm days, especially as the sun climbs higher in the sky and warms the ground in February, for this to occur.

The timing and location of diapause are important considerations in the management of rare species. For example, whereas a winter prescribed burn will not kill many, if any, *Schinia* moths which pupate in the soil at that time, it could kill nearly all Karner Melissa blue butterflies or *Papaipema* moths that diapause as eggs in dry leaf litter. Food of suitable quality must be available to caterpillars after diapause ends in the spring, and regrowth may not be present when needed if the habitat is burned or mowed at the wrong time. Entire habitats should not be burned or mowed in the same season.

Identification

This book is unique in discussing and illustrating the rarest moths and butterflies in the forests of the eastern United States. It may be fairly easy to identify most species of butterflies and some distinctive moths in the field or from photographs. However, some specimens may need to be collected and closely examined in order to be identified. If significant new locality records are found, these should be vouchered with a specimen. Within a species, moths and butterflies are well known for having considerable variation among individuals, between sexes, and among populations from different broods, as well as different regions. It is best to consult several illustrated references for difficult groups, such as skippers and hairstreaks, in order to understand the variation within each species.

There are many recent illustrated guides to butterflies of the eastern United States, including Opler and Krizek (1984), Opler and Malikul (1992), Glassberg (1993, 1999), Glassberg *et al.* (2000), Brock and Kaufman (2003), and Cech and Tudor (2005). Though difficult to find, Klots (1951) is still quite useful. Examining series of specimens in a museum or personal collection and consulting local experts would be far better than consulting books alone.

Identifying moths of the eastern United States has always been challenging, because there are few illustrated guides available. It still is often not possible to identify all species found in any particular area from the available literature. The taxonomic information and keys in scientific descriptions, revisions, and monographs are difficult to find. However, most commonly encountered macromoths and some micros can be identified to species or at least to genus using Covell's field guide (1984, reprinted in 2005).[2] Still, there are many described and undescribed species that are not included, so comparing one's specimen for a best match on these plates will not always lead to a correct identification.

Forbes' publications, *The Lepidoptera of New York and Neighboring States* (1923, 1948, 1954, 1960), are still essential for anyone seriously interested in eastern United States moths. This series has a broader scope than the title suggests, and is often useful for identifying species occurring in eastern Canada southward to North Carolina and westward to Missouri. Although the entire series contains only one plate of adult specimens, this series is still very useful for three major reasons. First, most species in our coverage area are included with technical descriptions. Secondly, there are useful drawings of genitalia of many species, and finally, Forbes referenced the color plates of Holland (1903), which can serve as companion illustrations for Forbes' work.

[2] The 2005 reprint is virtually identical to the original, and is not a revised edition in the usual sense. We cite this book as Covell (1984) because that is the first publication date, and also because we in fact used that version.

More modern, illustrated books that cover a significant number of moth species include Kimball (1965), *The Geometridae of Canada* series by McGuffin (1967, 1972, 1977, 1981), Rockburne and Lafontaine (1976), Covell (1984), Rings *et al.* (1992), Hardwick (1996), Handfield (1999), Wagner *et al.* (2001 and in press), Wagner (2005), and Metzler *et al.* (2005). Unfortunately, a few of these illustrate misidentified specimens, and specimens for which identification is probably, but not certainly, correct.

In the northern states and southern Canada, the illustrations in Grehan *et al.* (1995) and Ferge and Balogh (2000) can be quite useful. None of these publications, nor the butterfly guidebooks, adequately illustrate the variation in every species they include, although Brock and Kaufman (2003) make an effort to do so.

The various fascicles of the *Moths of America North of Mexico* (MONA) series covering certain families, subfamilies, and genera are excellent, fully illustrated works with accurate identifications, and often illustrate a sufficient series to capture the variation of difficult species. However, relatively few have been completed. The MONA publications are currently sold by the Wedge Entomological Foundation and BioQuip® Products, Inc. Few other publications adequately illustrate the variation in every species they include.

Those planning to become proficient with local moths will need to collect specimens and spend some time examining well-curated collections which have good series of local species, and get expert help with difficult identification. This experience also will help with butterflies and skippers, and if properly cared for, the specimens will have lasting value.

There are also some good moth and butterfly identification sites available on the Internet, such as Butterflies and Moths of North America (http://www.butterfliesandmoths.org/). However, specimens illustrated on websites are more likely to be misidentified than are those in books. We recommend the Georgia Lepidoptera website (http://www.daltonstate.edu/galeps/) by James Adams, and The Moths of Canada website (http://www.cbif.gc.ca/spp_pages/misc_moths/phps/mothindex_e.php), because they are virtually error free. The North American Moth Photographers Group website (http://mothphotographersgroup.msstate.edu/MainMenu.shtml) has photos of living moths, as well as spread specimens, and is a useful tool, despite some misidentifications. It can be particularly useful for assessing geographical variation if one already knows the species well enough to ignore misidentifications. Misidentifications of butterflies are also common on websites, and there are a few in modern field guides. The NatureServe Explorer website (http://www.natureserve.org/explorer/) offers information about rare species and some common ones, but at the time of this writing does not include illustrations.

Features of the genitalia of moths and butterflies are often much more diagnostic and definitive for species identification than the wing patterns. If the hair-like scales at the tip of the abdomen are brushed away, the male genitalia in *Lithophane*, *Metaxaglaea*, and a few Notodontidae are relatively easy to view through a handlens. Other species and most females require dissection in order to view the diagnostic structures. However, the need for dissection of specimens of difficult-to-identify species often decreases with study, and comparison of subtle wing patterns and other differences in known specimens or published illustrations can also help. As Rings *et. al.* (1992) point out, for some genera, a series of specimens is easier to identify than a single moth. Their hints for identifying *Papaipema* and *Acronicta* species are particularly helpful. With some moth genera it is often necessary to get expert help. Even experts occasionally consult with colleagues concerning genera known to contain difficult or undescribed species.

While photos of unknown species may be determinable by a knowledgeable person, even experts (including us) are known to misidentify images of species they would not consider to be difficult from actual specimens, including *Papaipema*, *Lithophane, Pyreferra*, *Acronicta*, *Catocala*, *Zale*, several genera of skippers, and many Microlepidoptera. Images do not convey size, can distort color, tint, or contrast, or may fail to accurately show critical characteristics. Images of spread specimens taken in good light are more likely to be identifiable than field photos, especially those taken at lights at night. If taking a photograph for identification purposes, for reference it helps to include in the same image a known species of similar color and reflectance. In general, we do not recommend accepting field photographs as the basis for important records of moths, and we recommend caution in doing so with butterflies and skippers.

Until recently almost no caterpillar guides existed for our region, except for a couple of long-out-of-print books. Mitchell and Zim (1964) and Wright (1993) cover a few common or spectacular species. Klots (1951) also illustrates some representative butterfly larvae and pupae. Recent comprehensive guides to butterfly and skipper caterpillars are Allen (1997), Allen *et al.* (2005), Minno *et al.* (2005), and O'Donnell *et al.* (2007). Together, these four books illustrate the larvae of nearly all of the butterflies and skippers found in the eastern United States. Minno and Minno (1999) provide photographs, not only of the larvae, but also the chrysalids of nearly 70 species of butterflies found in Florida. O'Donnell *et al.* (2007) include photographs of larvae and chrysalids of many butterfly species found in Connecticut.

Most commonly encountered macrolepidopteran caterpillars that feed on shrubs or trees in our coverage area can be identified at least to the genus level using Wagner (2005) and the United States Forest Service Technical Manuals initiated by Richard Reardon. The first of these manuals (Wagner *et al.* 1997) shows many common forest caterpillars, especially of certain families such as prominent moths (Notodontidae) and hawkmoths (Sphingidae). Wagner *et al.* (2001) illustrate most inchworms (Geometridae) likely to be encountered in eastern forests. Maier *et al.* (2011) include photos of most conifer-feeding species, including Microlepidoptera, occurring from New Jersey northward. Although they cover the fauna of the northwestern United States and British Columbia, Canada, Miller and Hammond (2003) and Duncan (2006) are also useful in the northern parts of the eastern United States. Caterpillars of most *Schinia* species and other heliothine moths can be reliably determined to species using Hardwick (1996), at least if the food plant is known. David Wagner, Dale Schweitzer, and Bo Sullivan are finishing a guide to the noctuoid moth families (Wagner *et al.* in press) that will illustrate over 700 species of caterpillars, and in most cases, the adults.

For *Datana* species (Forbes 1948), the last instars are much easier to identify than the adults of species found north of Florida. Caterpillars of some species vary in color or other features, and the few published illustrations may not represent the total range of individual or geographic variation, making identification difficult. In some places, especially southward, one needs to be aware of the possibility of species whose caterpillars are unknown or at least are not illustrated in whatever references one is using.

Some caterpillars (e.g. many Limacodidae, Saturniidae and Notodontidae) can be identified from a good image, but field-collected larvae in many families such as Erebidae, Noctuidae, Geometridae, and most Microlepidoptera should be reared to the adult stage to verify the species. Winter (2000) and Wagner (2005) provide techniques for rearing caterpillars. When practical, and providing the species is native to the region and so poses no risk if a few escape, we recommend sleeving on growing plants outdoors.

Because some moths and nearly all butterflies tend to be very host-specific, food plant identification is important in narrowing down the possible species that an unknown caterpillar may represent. First, one needs to be sure the plant it was found on is actually a food plant. Some species commonly spend the day away from their feeding sites. Robinson *et al.* (2002) is the most up-to-date compilation of host records, but there have been others (e.g. Tietz 1972) *et al.* Although extremely useful, their information was compiled from many sources, including some that made errors when identifying the caterpillars or the host. Also, it is not always clear if the records in these compilations refer to natural observations or artificial rearings, although Robinson *et al.* try to make that distinction. Forbes (1923, 1948, 1954, 1960) and other standard references include substantial food plant information.

There are many resources available for identifying plants of the eastern region. Some good field guides with color photos or illustrations include: Chung (1989), Eastman and Hansen (1992, 1995, 2003), Elias (1980), Nelsen (1994, 1996), Niering and Olmstead (2001), and Taylor (1992). Technical manuals with keys to vascular plants of the eastern United States include: Deam (1940) for Indiana; Radford *et al.* (1968) for the Carolinas; Fernald (1950), Gleason and Cronquist (1991), and Magee and Ahles (1999) for the Northeast; Strausbaugh and Cove (1978) for West Virginia; Godfrey and Wooten (1979, 1981) for wetland plants; and Hitchcock (1951) for grasses. Kartesz (1994) gives a list of the vascular plants of the United States, Canada, and Greenland.

Useful websites featuring plants include: the United States Department of Agriculture, Natural Resources Conservation Service PLANTS database (http://plants.usda.gov); the Missouri Botanical Garden Tropicos (formerly VAST) database (http://www.tropicos.org/); the Flora of North America website (http://www.efloras.org); and the Institute of Systematic Botany's Atlas of Florida Vascular Plants website (http://www.plantatlas.usf.edu).

Roles of collecting, collections, and specimens

For most of the species in this book, more collecting and study, including rearing, are needed. Little is known about many moths, even about some common species. Most of what we do know about rare moths (and most butterflies) traces back to collectors. There are only two microlepidopterans with accounts in this guide. This is not because microlepidopterans are less rare or imperiled, but because until recently, too few collectors were interested in them. Hence, we know frustratingly little about our eastern fauna of microlepidopterans, and very few have been ranked by NatureServe. Metzler *et al.* (2005) was the first publication to address the status and habitats of a substantial number of rare Microlepidoptera in our region. It is not until one gains substantial, range-wide familiarity with a group, that it becomes possible to recognize whether a species is rare or common, imperiled or secure. Host plant and life history data are especially needed to assess a species' rarity or vulnerability. Furthermore, without years of sampling, it is usually impossible to understand population trends, identify critical habitat, or suggest best management practices. Life history studies are essential for sound management decisions, and these require collecting and vouchering. Specimens are also essential documentation for biodiversity inventories, every species reported should be vouchered with a specimen. Although it is often impractical to prepare and store specimens of all taxa, persons conducting such inventories should keep in mind that due to changes in taxonomic concepts or other reasons, unvouchered records may not be verifiable to future workers. Thus they are likely to be ignored. Inventory or research efforts, especially with moths, should be focused where collecting is permitted.

When conducting a study of possible conservation importance, one should keep a field notebook, collect voucher specimens, document findings with photographs, record natural behaviors, study life cycles, characterize habitat requirements, and make an effort to reveal other aspects of the species' life history.

Occasionally, moth larvae can be collected more reliably than their adults. Examples discussed herein are most *Papaipema* and many *Schinia* species, as well as *Acronicta dolli*, *Hadena ectypa*, and *Psectrotarsia hebardi*. Larval surveys can also greatly expand the period of time over which inventory or monitoring might take place. For example, the galleries of *Papaipema* larvae remain in place months after a caterpillar has left its host, and in some cases can be identified reliably enough for census work (although their identity should always be verified with specimens). For most Lepidoptera, the taxonomy of the immature stages is too incompletely known for occurrence records to be based solely on larval identifications, at least without examining their DNA. While some of the species mentioned above can be identified as larvae, especially if the food plant is known, we recommend collecting a sample of larvae and rearing some individuals through to adult specimens. It is important that in addition to photographing the larvae, one preserves some; at least any that die can be preserved. Both specimens and photographs are important. Details of color and pattern may be lost in fluid-preserved caterpillars, especially green ones. On the other hand, some structural details will not be visible in images. Saving specimens of parasitoids, head capsules, pupal exuviae, cocoons, and even the frass, can greatly augment the value of a study. Taking photos and making notes also provide a record of the biology and life history of the species. Above all, share what you have learned. Share surplus specimens with colleagues and with reputable public collections. If nothing else, this is a sort of insurance against the possibility that your collection may somehow be destroyed. For example, a major personal collection for Mississippi was destroyed by Hurricane Katrina, so only the shared specimens remain at this time.

We encourage responsible collecting and vouchering with specimens, especially outside of well-known, previously sampled colonies. While we encourage the use of cameras to document the occurrence of vulnerable species that can be reliably identified from images, specimen vouchers have greater scientific value and are preferred in nearly all cases. Images, especially photographs taken in the field, sometimes do not show diagnostic features clearly. This is something we have come to appreciate more with experience. Photographs commonly distort color and usually do not convey size. On the other hand, specimens can be examined morphologically and dissected, and each is a library of genes that can be sequenced. Collections allow us to understand things such as what variation is infra-subspecific, and whether observed variation is clinal or discrete. Collections help determine which populations represent significant evolutionary units, as well as previously unrecognized species. Even dried specimens in collections can be viable sources of high-copy genes. Mitochondrial DNA can sometimes be amplified and sequenced decades after a specimen has been collected. For example, Lozier and Cameron (2009) were able to document recent genetic changes by comparing DNA of 40 year old museum specimens and freshly collected specimens of two species of bumblebees.

Specimen vouchers are especially important for taxa that are known to be difficult to identify, such as members of species complexes, where species are not well-defined. For example, images will not suffice for documentation of the eastern Persius duskywing (*Erynnis persius persius*), which is of high conservation concern in most parts of its range. Not surprisingly, we often do not know which taxon will turn out to be a species complex. Twenty years ago, few lepidopterists would have guessed the familiar tiger swallowtail (*Papilio glaucus*) would actually be several species, but three (*Papilio glaucus, Papilio canadensis*, and *Papilio appalachiensis*) are currently recognized (Scriber and Ording 2005, Pelham 2008) in our coverage area. Most of our familiar azure butterflies were considered to be one transcontinental species (*Celastrina ladon*), or even a multi-continental species (*Celastrina argiolus*), as recently as Miller (1992). Pelham (2008) recognizes six species in this complex, and most counties from Maine to New Jersey have three or four of these. Other butterfly and skipper genera that might contain currently unrecognized species in our area include *Satyrium, Megisto, Phyciodes,* and *Anatrytone*. The underwing moth we grew up calling *Catocala amica* is now known to be three common biological species in the Northeast and Appalachians, with possibly more species farther south. In groups such as these, without a specimen, future workers may not be able to assign records to species. We can only guess what other species complexes will be discovered in the future.

Personal collections are critical to many taxonomists. Lepidopterists rely upon them when they do not have permanent positions at museums or universities that house major collections. It is a very good idea if even those who do have such positions maintain personal collections, because it is possible they may have to move on to another institution. Furthermore, public collections may be understaffed or over-regulated, making them less accessible to researchers than those of reputable private collectors. Many specimens illustrated in this book are from personal collections. For many researchers, travel to major collections for specimen identification is too expensive. We appreciate the many avocational collectors who contributed heavily to this book, including the leading authorities for several geographic areas.

A personal collection can be donated to a public collection when a person is no longer actively using it, ideally, prior to death. Most of the major institutional collections we consulted, as well as the published distributional information we cite, were originally derived from personal collections. This includes major institutions, such as; the American Museum of Natural History, the National Museum of Natural History (Smithsonian Institution), the Peabody Museum of Natural History at Yale University (Yale Peabody Museum), the Museum of Comparative Zoology at Harvard University, and the Florida State Collection of Arthropods. Authors publishing based upon information from personal collections include Farquhar (1934), Ferge and Balogh (2000), Rings *et al.* (1992), Covell (1999), and Kons and Borth (2006).

Lepidoptera collections, both public and personal, are essential to conservation of rare Lepidoptera and other insects. We can think of dozens of instances where specimen vouchers served as sources of occurrence data that were then used to curb development, justify a land purchase, or influence a management decision that resulted in the survival of a population. Moreover, there is an important hunting/conservation paradox that results from the relationship between the hunter and prey. As one of us points out (Wagner 2006a):

> Several of the great tiger reserves of India were established by tiger hunters. Edward James Corbett, India's greatest tiger hunter, gained deep respect for these magnificent cats--over the course of his life he worked to create the Association for the Preservation of Game in the United Provinces and to establish India's first national park in the Kumaon Hills (for tigers). Other examples of the hunting/conservation paradox are U.S. National Wildlife Refuges, which were established with revenues provided through the sale of Federal Duck Stamps, a program whose legislation was written and pushed forward by our nation's sportsmen. Since 1934 sales of Federal Duck Stamps have generated more than $700 million for wetland conservation, with most going to the acquisition of more than 5.2 million acres of habitat for NWR system. Trout Unlimited spends millions each year to protect watersheds through their clean-ups, lobbying and other legislative efforts, dam removal initiatives, outreach programs, and myriad other projects. In this country and elsewhere, it is often the collectors/hunters that end up working the hardest for the preservation and long-term survival of the creatures that have, for so long, been the object of their attentions.

Paraphrasing from the same article: The metamorphosis from hunter to steward is certainly not universal, but is common. With moths, most of these stewards or conservationists will remain collectors. Stalwarts of invertebrate conservation such as Paul Ehrlich, Thomas Eisner, Thomas Emmel, Larry Gall, Alexander Barrett Klots, Robert Pyle, and Edward O. Wilson, and many other started off as collectors, as did we. Many of them maintain personal collections or work at institutions that have extensive collections.

Taking the long view, regulators should be circumspect about discouraging collectors, including beginners. The impact of discouraging younger collectors could well be the quelling of their interest in the natural world. Youngsters are more likely to be interested in things they can catch, touch and wonder about, than things they only observe or watch on their computer or television (Louv 2008). In the late 1960s and early 1970s personnel at two state parks in southeastern Pennsylvania and at what is now a state natural area at Batsto, New Jersey helped Dale Schweitzer monitor light traps and provided gate keys. Several thousand of the specimens that were collected still exist. Historic information on the moth fauna of these three sites is thus available (see also Schweitzer 1974), and several specimens from Batsto are illustrated in Sargent's (1976) book on underwing moths. The moth *Spartiniphaga carterae,* which is rare enough to merit an account in this book, was named for the park naturalist at Batsto who helped operate the light traps in which most of the type series was collected. Unfortunately, today it is very unlikely that such an amateur as he was then would have been allowed to collect in these places at all. With the current trend among some children and adolescents toward less interest in the natural world, we fear that there will be fewer knowledgeable persons in the future who will be able to carry on the work of invertebrate conservation.

Finally, we must remind ourselves and those in charge of regulating collecting activities that nearly all of the discourse on the supposed negative impacts from insect collecting has little or no basis in fact. This destructive discourse has taken focus, effort, and in some cases money, away from efforts to stop the threats that demonstrably impact our imperiled insect fauna. Lack of collection records has diminished efforts to decrease habitat loss, manage habitat properly, control invasive species, keep deer populations in check, and so forth.

Collecting restrictions in some areas have become so burdensome that many experts, both amateurs and professionals, have stopped documenting and monitoring local lepidopteran populations. In fact, because of severe collecting restrictions over the last 20 years, we have only three accounts of South Florida moths in this book, and the status of one of these is basically unknown due to lack of collecting. Marc Minno has even had to get permits to merely photograph Lepidoptera on some public lands in Florida. Given the extreme declines of several south Florida butterflies and skippers, and two apparent extinctions (Minno 2010a), we suspect that some nocturnal moths have also declined severely or disappeared over the last 20 years. However, we have no way of knowing.

Furthermore, collecting restrictions are currently (as of 2010) hindering acquisition of much needed life history and taxonomic information for rare species such as the frosted elfin (*Callophrys irus*) in North Carolina and the moth *Heliocheilus turbatus* in Florida. The latter was thought to be extinct, since none had been collected since the 1860s (Hardwick 1996). However, this species was rediscovered at a preserve in Florida in 1999 and 2000. At this preserve, the persons who rediscovered it are no longer allowed to conduct research, including even attempting to learn what the food plant is, simply because they lack university affiliation (Kons and Borth 2006).

Traditionally, amateur collectors, who often have no university or other institutional affiliation, have been important sources of specimens and information about Lepidoptera and other insects. Many such persons are listed in our acknowledgments. People who are motivated to make a contribution to our limited knowledge should be allowed do so without being unduly hampered by collecting restrictions.

The most likely impact of regulating most insect collecting, including most collecting on public lands, will be prevention of studies or inventories that would help document the fauna. This can happen anywhere, including in places where conservation is a management objective, and where rare species are at risk of extirpation or extinction due to lack of knowledge and inappropriate management.

Kons and Borth (2006) provide substantial discussion of their experiences in obtaining, or failing to obtain, permission to collect in various places. A number of places where managers were cooperative, notably the The Nature Conservancy's Apalachicola Bluffs and Ravines Preserve, Blackwater River State Forest, and Withlacoochee State Forest in Florida are mentioned in our text as sites for several very rarely encountered species. Hundreds of species records are available for these and other important places where they were allowed to collect (Kons and Borth 2006). These records can be verified or corrected because they are backed by actual specimens which can be rechecked as necessary.

Obviously this type of verifiable information cannot be provided for places where collectors were refused permission to inventory the Lepidoptera. All three of these places have rich assemblages of species associated with dry sandhill pinelands, as well as other interesting habitats. At least two of the three now rare *Ceanothus* specialists we discuss in this book are at or near their southern limit at Blackwater River State Forest, where *Erastria coloraria* was discovered by Hugo Kons and Robert Borth. Withlacoochee State Forest is known for its rich assemblage of *Catocala* species. The Apalachicola region proved to be a stronghold for *Cyclophora culicaria*, which Kons and Borth (2006) also found in Dixie and Alachua counties, but which otherwise had not been verified anywhere in more than 150 years. Several other globally rare species, notably *Catocala grisatra* and *Hypomecis buchholzaria*, were found there. Rare species such as *Catocala grisatra* will only be considered in management activities such as prescribed burning when land managers know they are present.

Another very likely result of such regulation is discouraging a serious interest in entomology or conservation biology by young persons. We are in dire need of people who will pursue these fields either as a hobby or a profession. The greatest number of insects that are of conservation concern will be best served by embracing a large, engaged constituency, one that includes responsible and dedicated insect collectors, photographers, and watchers. Of this we can be certain: Given the magnitude of today's conservation challenges, there will never be enough scientists, conservation professionals, and land managers, to collect the data needed to protect our native invertebrate fauna.

Rarity

With diligent searching, most moths and butterflies can be found in suitable habitat and at the right time of year. Sometimes the numbers of highly specialized species may be high, even though there might not be many localities with viable populations. More often than not, it is suitable habitat, rather than the insects, that is rare. For example, *Spartiniphaga carterae* and *Agrotis buchholzi* can be among the most abundant species in light trap samples in ideal habitats during their flight seasons, but they probably only occur in substantial numbers in a few dozen places. *Agrotis buchholzi* occurs only in three counties in New Jersey. Similarly, at a few sites, adults of the endangered Karner Melissa blue butterfly (*Plebejus melissa samuelis)* recently attained some of the highest densities (over 200 per hectare per day) which we have observed or are aware of for an eastern butterfly. In contrast, eastern tiger swallowtail (*Papilio glaucus*) densities rarely seem to exceed a few dozen per hectare per day in most habitats, except occasionally in summer when adults may become highly concentrated in patches of favorite flowers. However, this species occurs in nearly every county from southern New England and southern Wisconsin south to southern Florida.

Determining the size and extent of Lepidopteran populations is a daunting task, and such information will usually not be available for assessments of conservation status. Various census methods have been used to monitor butterfly numbers (Gall 1985), from simple counts of adults seen in an area, to mark-release-recapture studies. The latter generally give the most accurate estimates of the size of localized populations, and have the advantage that they give an estimate of their reliability in the form of confidence limits. However, such studies are very time- and labor-intensive.

The abundance of moths at a site is usually much more difficult to assess, due to their largely secretive, nocturnal habits. Light trap samples do not necessarily reflect population sizes, because although some moths are highly attracted to lights, others ignore them. Similarly, not all moths feed as adults or are attracted to baits (Holland 1903, Schweitzer 1974, Sargent 1976) on a given night. Light traps are widely used in monitoring population changes among pest species, and have provided valuable information on *Catocala* (underwing) moths (Sargent 1976). However, at best, only crude assessments of population sizes can be made from light trap and bait samples, even for the many species for which one of these techniques is the best tool for documenting presence.

Furthermore, population size is difficult to extrapolate even from one-day estimates with small confidence intervals, or from count transects for diurnal species, because in most cases the flight season is longer than individual life spans. A major unknown is the proportion of the population present as adults on any particular day. That is to say, numbers observed on a given day should not be confused with actual population estimates, even when it is reasonable to conclude that most adults present that day were observed. In the end, population size data are almost never available for nocturnal moths (Young 1997), and not often for butterflies either.

For the purposes of this book, and for NatureServe ranking, rarity is usually based on:

- The known or estimated number of occurrences,
- Association with uncommon habitats.
- Evidence of decline or of persistence and stability.
- Level of threats.

Rare species are sometimes limited because their natural food plant or habitat is uncommon. Moths and butterflies that are obligately associated with uncommon plants have little or no potential to be any more common than their host. For example, species that specialize on pyxie moss (*Pyxidanthera barbulata*), sand myrtle (*Leiophyllum buxifolium*), or pine barrens reedgrass (*Calamovilfa brevipilis*) occur in limited areas in the northern half of the New Jersey Pine Barrens, but are even more localized in small remnant habitats in North Carolina where these plants also occur.

Some species that are rarely collected are, in fact, not rare, or are at least much less rare than they seem. "False rarity" always should be considered a strong possibility when an insect species is almost never collected commonly, or at least reliably. Some signs of false rarity are if the few collections seem to come from common habitats such as mixed hardwood forests, or from many different kinds of habitats, or from collectors' yards, and especially if the caterpillar is known to feed on a common tree or shrub. Also, false rarity is suspect if a species is found somewhat predictably at lights or baits, but usually in low numbers even in the right habitat, and especially if none are seen on most nights in areas where the species is known to be present. Similarly, false rarity is very likely if a species comes abundantly to bait in a few places or years, but otherwise is taken only occasionally at light, often at very ordinary places. Such observations suggest the species is hard to collect except during unusual weather or during infrequent adult food shortages (Sargent 1976).

Sthenopis auratus is a widespread, rarely collected, but spectacular moth that would occasionally turn up at a light or otherwise be encountered, generally in rather ordinary forests. Observations of McCabe and Wagner (1989) made it clear that the reason for this apparent rarity was that the adults do not come readily to light, but can be found if properly sought in fairly common habitats. A more recently documented case of false rarity involves *Lithophane joannis*, a moth that was not even formally named until 1992. Until very recently, this species was rare in collections, in large part because the adults are not attracted to lights (Wagner 2006b). Only a few collectors who baited for moths in the colder months in southern Ohio and Kentucky had found adult specimens. While the few adults in collections would suggest that *Lithophane joannis* is among the rarest of eastern North American moths, its caterpillars were found to be very common on buckeye (*Aesculus flava*) in the spring in the Great Smoky Mountains. This moth is now known to occur throughout much of the range of buckeye, and is believed to be common overall. Similarly, *Lithophane patefacta* has not been found at blacklights or other collecting lights in southern New Jersey. However, in the last 40 years, more than 2,000 adults have come to bait and a few to flowers, with over 100 on certain fall nights. James Adams has collected a few on building lights in Georgia. We suggest an element of false rarity in our account for *Lithophane lemmeri*, because this species apparently does not come reliably to bait. Only a single specimen of the locally common *Zale confusa* would be known from New Jersey based on collections at light. *Acronicta lanceolaria* and *Acronicta dolli*, are rarely collected as adults at lights or bait, but the larvae are not uncommon in suitable habitats (Farquhar 1934, Bower 1974, Dale Schweitzer and David Wagner observations, Tim McCabe personal communication with Dale Schweitzer).

Sampling adult nocturnal moths with ultraviolet lights (blacklights) of less than 20 watts generally will undersample or miss some species, especially in areas where there is appreciable light pollution. Probably the larger moths, such as large *Catocala* species, Sphingidae, and Saturniidae, are more likely to be undersampled. A 2007 sampling project in southern New Jersey used two 15-watt ultraviolet light traps and a mercury vapor light with a sheet. Over 90% of species that came to any lights came to the blacklight traps, and a large majority of species came to both. The largest species in the Geometridae, Saturniidae, and the three largest Erebidae (including Arctiinae) came only to the mercury vapor light/sheet set up. The mercury vapor light got fewer species overall, perhaps because many smaller moths left the sheet at dawn.

Other less extensive efforts gave similar results, and sometimes missed the largest Sphingidae. Figures 23–26 and Table 11 in Kons and Borth (2006) provide 57 case studies of the relative effectiveness of using mercury vapor-ultraviolet lights with a sheet, ultraviolet light traps, and bait trails (where one paints bait on trees along a trail) on individual survey nights for northern Florida. The pine devil (*Citheronia sepulcralis*), formerly a real collector's prize in southern New Jersey, shows up at the rate of perhaps one per 50 nights of collecting if 15 or 20-watt blacklights are used. The pine devil moth will turn up about half the time in good habitat with 150-watt or greater mercury vapor lights (Dale Schweitzer). Each of about a dozen virgin females of the pine devil that were tethered in New Jersey forests at various times over the years obtained a mate on the first night, indicating that this moth is more common than blacklight trap sampling suggests. Dale Schweitzer was unaware that *Sphinx drupiferarum* occurred in his home county until he tethered reared virgin females in his yard on several nights and found males attached by 11:30 p.m. in three consecutive years.

Several forest butterflies that spend most of their time in the tree canopy are likely examples of false rarity. Persistent effort will usually turn up *Parrhasius m-album* and *Satyrium favonius ontario* in southern New Jersey oak woods, yet one's chance of seeing either on a given day is rather low. Both are now thought to be canopy species. The former can sometimes be observed in the canopy before the leaves are fully expanded in April. An affinity for the tree canopy complicates assessment of other hairstreak butterflies such as *Chlorostrymon maesites*, *Callophrys hesseli,* and *Erora laeta*, which are of conservation concern. The bog elfin (*Callophrys lanoraieensis*), which comes down from the treetops mostly to nectar or sip moisture from sand or mud, is also easily overlooked.

Causes of decline and imperilment

Most of the species that we discuss herein are ranked as globally rare primarily due to human activities. This includes the intentional and/or accidental introductions of exotic species. The most important threat to moths and butterflies throughout the eastern United States is loss of habitat from urbanization, agriculture, and, in the Southeast, intensive silviculture. Habitat change due to alteration of fire regime is another threat that is especially prevalent in the South, along the coastal plain, and in the upper Midwest. In Connecticut the major threats to imperiled butterflies are habitat succession and urban development, followed by deer herbivory, invasive species, global warming, and beavers (O'Donnell *et al.* 2007, Wagner 2007).

Many forest and woodland species do not persist well in small, isolated habitat patches of a hundred hectares or less. Even much larger isolated examples of uncommon communities, such as pine barrens, usually lack some expected species. Related to habitat loss is fragmentation, which occurs when natural areas are divided into smaller blocks by roads, houses, farm fields, etc. Fragmentation creates insularized pieces of habitat that may be so separated across the landscape that moths and butterflies cannot move between them in sufficient numbers to maintain viable populations. Isolated colonies, even fairly large ones, may die out in a bad year, and if dispersing females cannot start new colonies, regional extirpation may result.

The decline of the regal fritillary (*Speyeria idalia*) in the eastern United States is generally thought to have been caused in part by the fragmentation and isolation of its grassland habitat by natural reforestation, development, and agricultural intensification (NatureServe 2008). This habitat fragmentation process in the Northeast gradually increased, and by about the 1950s, recolonization could no longer keep pace with local extirpations. By the 1980s, the few available habitats on the mainland were no longer occupied.

The abundance of moths and butterflies fluctuates from year to year (for example, see the appendices in Sargent 1976). Many species have metapopulation dynamics whereby the regional population consists of smaller subpopulations whose fates are interconnected. In unfavorable years, some individual colonies fail. However, as long as others survive and movement occurs between subpopulations, the species persists. Daily and Ehrlich (1996) report that moths are less sensitive to habitat fragmentation than are butterflies. They attribute this to their mostly nocturnal activity and dispersal. We do not know how applicable those findings are in our coverage area.

In the threats and management sections of the species accounts below, we provide guidance on common forest and woodland management practices that are likely to affect rare Lepidoptera or their habitats, such as gypsy moth control and prescribed burning. However, we stress that the impacts of management practices on many species are poorly known. Impacts from practices like clearcutting, herbiciding of understory vegetation, and perhaps most destructive of all, site preparation in southern pinelands, appears to be obvious. However, over time the effects of clearcutting are often reversed if natural regeneration follows, and many species benefit from the successional changes that take place. In the following subsections, we discuss factors that significantly affect rare species of moths and butterflies in the forests of the eastern United States.

Impacts of non-native plants

Exotic, invasive plants can render habitats unsuitable for some moths and butterflies, primarily understory species. Generally, environmentally harsh sites with poor soils are less vulnerable than others to exotic plant invasion. However, crownvetch (*Coronilla varia*) is threatening some shale barrens in the eastern United States. Some sandy, coastal plain woodlands, such as much of the New Jersey Pine Barrens, are nearly devoid of exotic plants. Yet farther south, even coastal plain forests are susceptible to invasive plants such as Chinese tallowtree (*Sapium sebiferum*), Chinese privet (*Ligustrum sinense*), and in Florida and the Gulf states, cogongrass (*Imperata cylindrica*) (Figure 4). Some invasives, such as Japanese honeysuckle (*Lonicera japonica*), occur in a wide array of habitats, but will cause major impacts in areas with more fertile soils. Among the more notable exotics on rich soils affecting eastern United States temperate forests or their edges are understory species such as garlic mustard (*Aliaria officianalis*) (Figure 5) and Japanese stilt grass (*Microstegium vimineum*). Smothering vines like Japanese honeysuckle, oriental bittersweet (*Celastrus orbiculatus*), and in wetter places, mile-a-minute weed (*Persicaria perfoliata*) also take a toll. Shrubs such as Russian olive (*Elaeagnus angustifolia*), autumn olive (*Elaeagnus umbellata*)

Figure 4. A patch of cogongrass (*Imperata cylindrica*) at the Blackwater River State Forest, Santa Rosa County, Florida (Marc Minno photo). Cogongrass burns readily and hot enough to kill pines, but its underground rhizomes are protected from fire.

Figure 5. Garlic mustard (*Aliaria officianalis*) invading rich mesic forest in Sussex County, New Jersey (Ellen Creveling photo).

(Figure 6), multiflora rose (*Rosa multiflora*), and bush honeysuckles (*Lonicera* species) are in this category. Japanese barberry (*Berberis thunbergii*) (Figure 7) is an increasingly abundant invasive shrub in forests.

To make matters worse, many invasive plants such as garlic mustard (Roberts and Anderson 2001) and Russian olive (Orr *et al.* 2005) are known to be allelopathic to native plants. Exotic strains of common reed (*Phragmites australis*) can quickly take over small vernal wetlands or boggy areas in southern New Jersey forests. In the southeastern United States, kudzu (*Pueraria montana*), Japanese climbing fern (*Lygodium japonicum*), cogongrass, Japanese honeysuckle, and Chinese privet (*Ligustrum sinense*) (Figure 8) are rapidly expanding. Florida has problems with Brazilian pepper (*Schinus terebinthifolius*) (Figure 9), Australian pine (*Casuarina* species), Old World climbing fern

Figure 6. Autumn olive (*Elaeagnus umbellata*) invading habitat for the northern metalmark at Bethel, Fairfield County, Connecticut (David Wagner photo). The butterfly was nearly lost from this site because of this non-native plant.

Figure 7. Japanese barberry (*Berberis thunbergii*) invading rich mesic forest on the Kittatinny Ridge, Warren County, New Jersey (Robert Allen photo).

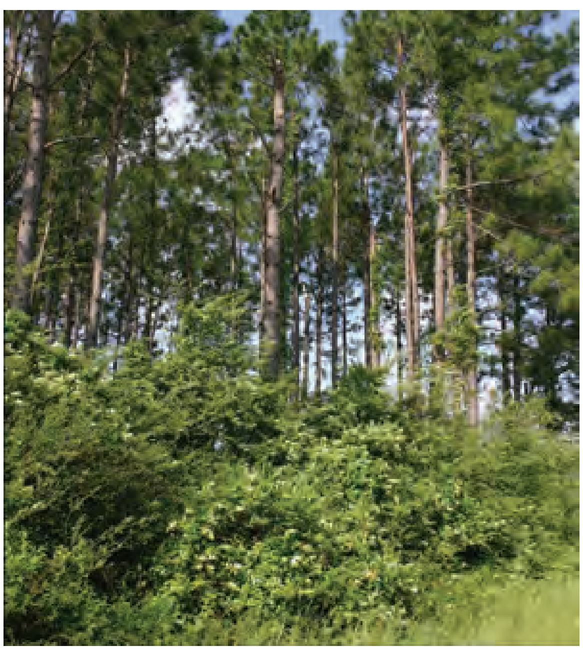

Figure 8. Chinese privet (*Ligustrum sinense*) invading pine forest in Okaloosa County, Florida (Marc Minno photo).

Figure 9. Brazilian pepper (*Schinus terebinthifolius*) overtaking pine flatwoods habitat, Palm Beach County, Florida (Marc Minno, photo).

(*Lygodium microphyllum*) (Figure 10), punktree (*Melaleuca quinquenervia*), carrotwood (*Cupaniopsis anacardiodes*), downy rose myrtle (*Rhodomyrtus tomentosa*), skunk vine (*Paederia foetida*), hydrilla (*Hydrilla verticillata*), and many others (Florida Exotic Pest Plant Council, http://www.fleppc.org).

Figure 10. Old World climbing fern (*Lygodium microphyllum*) smothering a small cypress swamp at Jonathan Dickinson State Park, Martin County, Florida (Marc Minno photo).

At least 21% of New Jersey's butterflies and skippers feed to some extent on exotic plants (Schweitzer 2006), but most of these are species found in open, disturbed, often weedy habitats. Foreign species are now important food plants for a few forest or woodland moths and butterflies, such as the moth *Coryphista meadii*, which is almost entirely dependent on Japanese barberry (*Berberis thunbergii*) in most of our region. By the 1980s, the formerly rare elfin butterfly (*Callophrys henrici*) began using exotic *Rhamnus* species as hosts near Ottawa, Canada and Boston, Massachusetts, and has since become much more common (Layberry *et al.* 1998, Dale Schweitzer). Anthony McBride has recently observed females of the northern pearly eye (*Lethe anthedon*) ovipositing on Japanese stilt grass (*Microstegium vimineum*) in northwestern New Jersey and Dale Schweitzer noticed adults associated with most patches of this grass that he observed there in July 2008. The bumblebee clearwing sphinx (*Hemaris diffinis*) was very scarce or maybe even absent in southern New Jersey before the 1980s (Dale Schweitzer, Smith 1910), but it is now common with *Lonicera japonica* as its main food plant. Forest understories are among its many habitats. Ironically, where emerald ash borer (see Impacts of Exotic Insects section) eliminates ash trees, introduced privets, especially the invasive *Ligustrum sinense*, could become important refugia for ash-feeding Sphingidae and other moths (Wagner 2007a). In the southeastern United States, *Nastra lherminer, Lerema accius, Ana-*

trytone logon, Lerodea eufala, Oligoria maculata, and *Problema byssus* were found to use highly invasive exotic cogongrass (*Imperata cylindrical*) as a food plant (Minno *et al.* 2004). The invasive exotic *Rosa multiflora* often provides new growth in late winter (end of February in southern New Jersey) or early spring, before native host plants leaf out. Thus, it is not surprising that many Noctuidae and some Geometridae will use it, given that over 200 native species are reported from various species of rose. There are very few or no polyphagous species reported to regularly use exotics in genera such as *Celastrus, Euonymus, Berberis, Ligustrum, Lonicera*, and *Ailanthus* (Wagner *et al.* 2001, Robinson *et al.* 2002), but feeding experiments conducted by Dale Schweitzer for The Nature Conservancy in New Jersey suggest some of these, especially *Ligustrum sinense*, may be more suitable hosts for generalists than the literature suggests. Still, with the possible exception of *Rosa multiflora*, none of the invasive shrubs and woody vines in the Northeast appears to support nearly as many generalists as do native genera such as *Vaccinium, Corylus,* and *Ostrya*, not to mention the specialists on these genera. Replacement of native understory and edge flora by invasive exotic species that are shunned by most polyphagous caterpillars could have major impacts on the caterpillar-prey biomass of forest understories. However, it is not a foregone conclusion that such a change will always be negative, because some of the displaced native shrubs may be less suitable to generalists than the exotics. Spicebush (*Lindera benzoin*) is a likely example of a plant avoided by most generalists. In fact, even some *Viburnum* specialists, e.g. *Zale horrida* and *Metaxaglaea inulta*, will not eat *Viburnum acerifolium*. These two shrubs are often co-dominant in understories on rich soils.

Impacts of foreign plant pathogens

Some exotic plant pathogens have caused profound changes in eastern North American forests. Although the abundance of American elm (*Ulmus americana*) has been much reduced by the Dutch elm disease fungus (*Ophiostoma ulmi*), this tree still occurs as small individuals in northern forests and thickets and is fairly common in southern woodlands. Other species of native and introduced elms were less affected, so no elm-specialist Lepidoptera appear to have been lost from our region. Although some are regionally rare, e.g., in northern New Jersey where there are now few elms, no elm feeders are now considered to be globally rare.

American chestnut (*Castanea dentata*), a formerly dominant or co-dominant tree in much of our region, was nearly eliminated by the European chestnut blight fungus (*Cryphonectria parasitica*). Opler (1978) compiled published information on the insects that had been reported from American chestnut. His list was reviewed by Schweitzer (1989) and staff of the American Chestnut Foundation (American Chestnut Foundation 1999, 2002). All Macrolepidoptera that feed on chestnut also use oaks or feed on many genera of trees. Seven species of Microlepidoptera were identified as possible specialists on chestnut. Only two of these seven microlepidopterans have been collected since Opler's publication. *Coleophora leucochrysella* was still extant in the 1990s in Connecticut (David Wagner). Forbes (1923) considered this moth to be a common species. The chestnut clearwing moth (*Synanthedon castaneae*) (Figure 11) has proven to be very resilient. It has even been found damaging chestnut restoration projects in Connecticut (Anagnostakis *et al.* 1994), turning up in five of six sites sampled in 1989 and 1993. In addition, recent specimens of the chestnut clearwing have been reported for Georgia, Alabama, North Carolina, South Carolina

Figure 11. *Synanthedon castanaeae* (chestnut cleawing moth) from York County, Pennsylvania, collected in 1918 (David Wagner photo).

(Snow and Eichlin 1986), and Florida (Eichlin and Duckworth 1988). This moth is probably using chinkapin (*Castanea pumila*) and introduced *Castanea* species and hybrids as hosts, but it does seem to be localized around chestnuts.

The other five chestnut specialist moths have not been collected in more than 50 years, and might be extinct. They are: *Ectoedemia castaneae* from Maryland and perhaps Rhode Island (Farquhar 1934); *Ectoedemia phleophaga* from Maryland; *Tischeria perplexa* from Virginia; *Swammerdamia castaneae* from Pennsylvania, Connecticut, and New Hampshire; and *Argyresthia castaneella* from New Hampshire, Vermont, and Virginia. All were undoubtedly much more widespread than indicated by the documented ranges (Forbes 1923, Opler 1978), which reflect mainly where a few people collected Microlepidoptera before 1940. It is also possible that some of these moths still persist on chinkapin in the poorly collected Southeast. There is some doubt that *Tischeria perplexa* and *Swammerdamia castaneae* are valid species, in large part because so few specimens of these genera were collected when chestnut was common.

More recently, butternut (*Juglans cinerea*) has been greatly reduced by the butternut canker fungus (*Sirococcus clavigignenti-juglandacearum*). Lepidoptera known to use butternut also eat black walnut (*Juglans nigra*), and most also feed on other genera. Therefore, they are not likely to be severely impacted in most of their ranges. Beech canker fungus (*Nectria ditissima*) is impacting American beech (*Fagus grandifolia*), but it is unlikely that beech will be eliminated from large areas because some trees seem to be at least partly resistant. The early hairstreak (*Erora laeta*), will obviously be impacted by the decline of beech trees, possibly catastrophically.

In the southeastern United States, bays (*Persea* species) and other members of the laurel family (at least sassafras) are being killed by the red bay wilt fungus (*Ophiostoma* species) which is transmitted by an exotic ambrosia beetle (*Xyleborus glabratus*) in the Scolytinae (Curculionidae). The Palamedes swallowtail (*Papilio palamedes*), one of the most common butterflies of the southern coastal plain, and the moth *Caloptilia persaea*, will be severely reduced if the fungus kills most of their larval hosts (*Persea* species), and could be threatened with extinction (Minno 2007, NatureServe 2008). The spicebush swallowtail (*Papilio troilus*) also feeds on plants in the laurel family, but has a broader host range than the Palamedes swallowtail and is less likely to become imperiled due to red bay wilt.

Sudden oak death, caused by the fungus *Phytophthora ramorum*, is killing oak trees along the west coast of the United States, and has been found in nursery stock in the eastern U.S. Given the diversity and dominance of oaks (*Quercus* species) in the eastern United States and their importance to wildlife, establishment of this pathogen could have tremendous effects on hundreds of species of animals, including mammals and birds, as well as lepidopterans and other insects, although some oak species are probably less at risk than others. In some forests loss of all oaks would essentially lead to ecosystem collapse.

Impacts of exotic insects

Foreign insect pests are also causing major changes to eastern forests. Ash trees (*Fraxinus* species) in the American Midwest are under attack by a devastating exotic beetle, the emerald ash borer (*Agrilus planipennis*) in the family Buprestidae. This beetle is expected to become established in most of our region where ash trees grow. So far it has killed virtually all ashes on which it has become established. Loss of ash trees will result in large-scale declines and at least localized extirpations of more than 20 species of Lepidoptera in our region (Wagner 2007a), including several Sphingidae that might already be declining for other reasons.

Two exotic homopteran insects are killing firs and hemlocks in our region. The balsam woolly adelgid (*Adelges piceae*) attacks balsam fir (*Abies balsamea*), Fraser fir (*Abies fraseri*), and other *Abies* species. So far, only Fraser fir appears to be in jeopardy throughout its range, and large areas in the high Appalachians have lost much of their fir forests. Most fir-feeding caterpillars also use spruce (*Picea* species), so are not likely to be eradicated in places where these are also common. The fate of Appalachian fir feeders like *Xestia perquiritata* (Noctuidae) and *Macaria* species (Geometridae) may depend upon their ability to persist on the much-less abundant spruces. More than a dozen other high elevation moths may be threatened by changes in forest structure and microclimate following the thinning of the fir forest canopy (Scholtens and Wagner 2007). It is difficult to predict how species that do not feed on firs will respond, but the spider *Microhexura monticola* was so severely affected by the loss of Fraser fir that it is now on the Federal list of endangered and threatened species. High elevation Lepidoptera that do not feed on spruce or fir but may be vulnerable include: *Gazoryctra sciophanes* (Hepialidae), *Hydriomena exculpata* (Geometridae), *Lithophane georgii* (Noctuidae), *Platarctia parthenos* (Noctuidae, Arctiinae), and an undescribed species of *Agriphila* (Crambidae).

Similarly, the hemlock woolly adelgid (*Adelges tsugae*) has severely reduced hemlock abundance in parts of the eastern United States. The release of a specialized coccinellid beetle that feeds only on hemlock woolly adelgids offers some hope. Although very few Lepidoptera depend on hemlock range-wide, several, such as *Panthea acronyctoides*, *Feralia jocosa*, and *Feralia comstocki*, that otherwise use spruces and firs, extend their ranges into warmer climates (including much of our area) on hemlocks. *Macaria fissinotata* is a hemlock obligate or very nearly so despite a report (Maier *et al*. 2004) of it eating balsam fir. When the taxonomy of the geometrid genera *Hydriomena* and *Eupithecia* are better resolved, some hemlock specialists may be recognized. The collection and rearing of these genera in places where hemlocks are still common would facilitate such taxonomic resolution.

Introduced generalist predators are also a potential risk to lepidopterans. Chinese mantids (*Tenodera ardifolia*) are voracious predators of butterflies and often wait for prey at flowers such as flowering *Buddleia* bushes. They are even known to eat the distasteful pinevine swallowtail (*Battus philenor*). Some gardeners in southern New Jersey kill Chinese mantids on sight in order to preserve the butterflies. European giant hornets (*Vespa crabro*) sometimes kill and feed butterflies to their larvae.

Potentially more important are exotic predators of caterpillars like German yellowjackets (*Vespula germanica*) and the European paper wasp (*Polistes dominula*), and parasitoids such as braconid wasps. Introduced ladybird beetles (Coccinellidae) and their larvae eat small caterpillars as well as aphids. Fire ants (*Solenopsis* species) are widely believed to be impacting immature stages of the monarch (*Danaus plexippus*) and other lepidopterans in the southeastern United States, and are suspected of harming several other species. Three species of exotic predatory ants (*Pseudomyrmex gracilis*, *Solenopsis invicta*, and *Wasmannia auropunctata*) are now common in disturbed and natural habitats in southern Florida and the Keys (Deyrup *et al.* 1988, 2000, Forys and Allen 2005). Much of the recent loss of butterflies in this area is likely due to exotic predators, such as these ants (Forys, Quistorff, and Allen 2001, Forys *et al.* 2001, Wojcik *et al.* 2001), and perhaps exotic parasitoids. In Florida, exotic species of lizards, geckos, treefrogs, and toads are capable of eating many moths, especially species that are attracted to lights at night, but we do not know if they significantly affect lepidopteran populations.

We are not sure if exotic earthworms, which now abound in rich deciduous forests, significantly affect Lepidoptera. There has been much concern of late regarding the ecological consequences of introduced earthworms on some understory wildflowers and forest floor fauna (Hale 2004, Hale *et al.* 2006). Because exotic earthworms can consume most of the previous season's leaf litter by mid-summer, they may be direct predators of eggs of at least some species of forest *Papaipema* that oviposit on stems and dead leaves on the ground in the fall. Earthworms also could be significant competitors of, or predators on, eggs and early instar larvae of Herminiinae (Erebidae) in forest litter, but so far large declines of these moths have not been reported.

Impacts of biocontrol agents

It is well known that exotic parasitoids and predators can devastate faunas, particularly on islands, such as in Hawaii (Howarth 1991). The introduced parasitoid wasp, *Cotesia glomerata*, released to control the European cabbage white (*Pieris rapae*), also attacks related native pierine butterflies. It may well be the explanation for the loss of the Checkered White (*Pontia protodice*) from about a quarter of our coverage area (NatureServe 2008, Wagner 2007). The tachinid fly (*Compsilura concinnata*) introduced in our region and elsewhere to control two introduced forest pests, gypsy moth (*Lymantria dispar*) and browntail moth (*Euproctis chrysorrhoea*), is implicated in the declines of some native moths in the northeastern United States (Boettner *et al.* 2002). This fly was originally introduced in the Boston area in 1906. The first report of a major decline of a native moth due to this fly came 11 years later (Culver 1919). Elkington *et al.* (2006) provide several lines of evidence implicating *Compsilura* in the rapid eradication of the browntail moth from more than 99.99% of its North American range starting around 1914. The decline was underway in central New Hampshire about eight years after this fly was introduced more than 100 km to the south. During gypsy moth outbreaks (Figure 12), *Compsilura* densities have reached 4,000 adult flies per acre in the Northeast (William *et al.* 1992), and occasionally much higher. Moreover, *Compsilura* has three to four generations each year, while the gypsy moth has only one. Thus, for most of the season this generalist fly is parasitizing and killing only native caterpillars. Gypsy moth outbreaks are often followed by spectacular crashes in which their larvae are virtually unavailable even to the first brood of *Compsilura* for one or more years.

Lepidopterists actively collecting in the northeastern United States from the 1950s to 1970s (Muller 1973, 1976, 1979; Hessel 1976; Morrell 1979; and Schweitzer 2004) noted drastic declines

Figure 12. Defoliation of oaks and other trees by gypsy moth caterpillars at West Rock Park, New Haven, Connecticut (David Wagner photo).

of giant silk moths (Saturniidae) and some hawkmoths (subfamily Sphinginae). Based on specimens in collections, Kimball collected at least 14 *Citheronia sepulcralis* on Cape Cod from 1950 to 1952 and continued collecting until at least 1979. However, these were the last specimens of this moth, which ranged well into Maine, from anywhere northeast of southern New Jersey until 2010. That year one was found near Plymouth, Massachusetts, according to Mike Nelson. Based on reports of other collectors and his own observations, Morrell (1979) noted that some species had not just declined, but were no longer being collected at all in New England by 1970. *Compsilura* is known to parasitize at least 200 species of Lepidoptera, about 180 of which are documented by Arnaud (1978), and his list is probably far from complete. Although not noted at the time, some medium-sized moths with summer larvae, such as *Cingilia catenaria, Acronicta hamamelis*, and *Datana* species, either became very scarce or disappeared in the Northeast in the mid-20th century. Some of these have since recovered substantially. Although *Catocala pretiosa* and *Pyreferra ceromatica* disappeared around 1900, no widespread species with spring-feeding caterpillars appear to have declined dramatically in New England from 1910 through the 1980s, and only one (*Erannis tiliaria*) has declined since the 1980s.

Even though most of the giant silk moths and all of the *Datana* species have since come back to varying degrees, *Eacles imperialis* and both *Citheronia* species are still absent in most of their historical ranges in New England. Recovery began by the 1990s in Pennsylvania and New Jersey, and has accelerated since 2000. Recoveries of Saturniidae and *Datana* species have probably not been as great in New England as in the area from New Jersey southward and westward. Recovery of hawkmoths throughout the region has been mixed. Muller's (1957) life history account is the last known report of *Sphinx franckii* east of western Pennsylvania. *Sphinx chersis* also remains very rare in the Northeast, although an adult and a larva were found in Sussex County, New Jersey in 2010 (Anthony McBride). However, *Manduca jasminearum* and *Sphinx kalmiae* are no longer rare in and southwest of northern New Jersey. Heavy hyperparasitism of *Compsilura* by wasps in the family Trigonalidae (Kellogg *et al.* 2003) is a possible explanation for the recoveries. At any rate, as the Kellogg *et al.* study clearly demonstrates, the mere presence of *Compsilura* does not necessarily preclude persistence of its hosts in an area, especially in recent decades.

In field trials, Boettner *et al.* (2000) demonstrated levels of parasitism in Promethea moth (*Callosamia promethea)* and Cecropia moth (*Hyalophora cecropia*) larvae in Massachusetts that would preclude persistence of populations. They and Selfridge *et al.* (2007) found relatively modest (0-35%) parasitism by *Compsilura* in *Hemileuca maia*, despite simultaneous high levels in Polyphemus moth (*Antheraea polyphemus*) larvae nearby (Jennifer Selfridge, email to Dale Schweitzer, September 2007). The two *Hemileuca* species and the rosy maple moth (*Dryocampa rubicunda*) were the only Saturniidae that could still be easily found in Massachusetts in the 1970s and early 1980s (Dale Schweitzer, Morrell 1979). The bear oak-feeding buck moth (*Hemileuca maia*) is imperiled because there are so few of its pine barren habitats, but since the 1970s the Spiraea-feeding *Hemileuca lucina*, has become much more common. It expanded into Connecticut about 1979 (Dale Schweitzer) and Vermont (Grehan *et al.* 1995) probably in the 1980s. Other Saturniidae and big-moth populations in general waned, if they could be found at all (Morrell 1979). For reasons that are unclear to us, *Compsilura* does not seem to have had much impact on spring caterpillars, including medium-sized to large Noctuidae, such as Xylenini, and most *Catocala* (Schweitzer 2004).

We suggest *Compsilura* as a possible factor in otherwise unexplained declines of several species that meet most or all of these criteria:

- The caterpillar completes feeding in summer (after 10 July in Massachusetts).
- Trees are among the usual food plants.
- Last collections known to us were before 1945 in Maine and New Hampshire, before 1935 in the Boston area, and before 1970 (usually in the 1950s) in western Connecticut.
- Dale Schweitzer and other then-resident collectors (such as Dave Winter and Thomas Franks) very rarely or never observed the species in the 1980s (for Winter and Franks also 1970s) in appropriate habitats in the Boston area even though there are old specimens from nearby.
- If the species could be found reliably at all in Connecticut from 1975 to 1981, the habitat was generally urban or agricultural, away from forests.
- Extensive habitat continues to be present.
- The species was widespread, but now occurs mostly on islands or sandy coastal habitats.

As far as we know, the relatively large summer-feeding caterpillars that declined in the Northeast have remained relatively stable from southwestern Chester County, Pennsylvania, southward and westward and in southern New Jersey, but we have some doubt for *Citheronia regalis, Hyalophora cecropia* and especially several arboreal Sphinginae.

The endosymbiotic bacteria, *Wolbachia* species, are being studied for biological control of mosquitoes. Naturally-occurring *Wolbachia* are known to infect many arthropod species, and are estimated to be found in more than half of all insect species. These bacteria are common parasites in Lepidoptera that can interfere with reproduction. *Wolbachia* infection has serious implications for captive breeding programs and the release and re-introduction of individuals into wild populations. It is a known problem for the Karner Melissa blue, and is being investigated in relation to management of Mitchell's satyr. Nice *et al.* (2009) conclude that:

> Conservation management plans for threatened and endangered arthropods should therefore include screening for the presence of *Wolbachia*, if not other endosymbionts. This is especially important for reintroduction and/or population augmentation programs. If *Wolbachia* is detected, further identification of strains using the multilocus sequence typing...should be pursued to assess the number and geographic distribution of infecting strains. Experimental diagnosis of the *Wolbachia*-induced phenotype will facilitate direct determination of the potential risks associated with the spread of the infection. These efforts should minimize the potentially devastating impacts of *Wolbachia* for endangered arthropods.

Impacts of white-tailed deer and other mammals

Excessive herbivory by unnaturally dense white-tailed deer (*Odocoileus virginianus*) populations is a severe and rapidly growing threat in many parts of our region (Herr 2007, Rawinski 2008) (Figure 13). Forest understories and openings are probably the most severely devastated habitats, but impacts also occur in nearby wet meadows, fens, etc. National Park Service lands in northern New Jersey (Morristown National Historical Park), eastern Pennsylvania (Valley Forge National Historical Park), western Maryland (Catoctin Mountain National Park), and Virginia (Shenandoah National Park) contain some of the most severely impacted places. In northern New Jersey, most parks and preserves where hunting is prohibited are comparably devastated. Impacts are worsening in North Carolina State Parks, and in substantial parts of Ontario, Canada that prohibit hunting. Deer have an impact on moths and butterflies in a number of ways:

- They eat and sometimes kill their food plants.
- They inadvertently consume eggs and larvae on the plants.
- They consume nectar flowers.
- They also alter forest structure by attacking and sometimes eliminating the shrubs, tree seedlings, and many native herbs.

Lepidoptera that depend on spring growth or flowers of lupine (*Lupinus perennis*), wild indigo (*Baptisia tinctoria*), or on New Jersey tea (*Ceanothus americanus*) (Figure 14) foliage in spring or summer are among the most impacted and all are discussed below. Deer are regarded as the third most serious threat to butterflies in Connecticut (O'Donnell *et al.* 2007, Wagner 2007a). In fact, deer are probably either the most serious threat, or second only to land development in northern New Jersey. It can be difficult to disentangle the relative, and sometimes synergistic (e.g., Latham *et al.* 2005) impacts of deer and exotic plants in the general reduction and local elimination of native understory flora and fauna in the Northeast. However, in the worst-impacted places both native

Figure 13. Mesic upland hardwood forest with virtually the entire understory consumed by overly abundant deer in Sussex County, New Jersey (Ellen Creveling photo). A few decades ago such forests had dense shrub and diverse herb layers. Inset: Diversity of woodland wildflowers and tree saplings, New River, Wythe County, Virginia (Gary Fleming photo).

and exotic shrubs and herbs are eliminated. To date, deer have probably had the greatest impact on forest understory Lepidoptera.

Nor are severe threats from white-tailed deer confined to the northeastern United States. Herbivory from deer observed by Dale Schweitzer in and near Pinery Provincial Park in Ontario in July 1984 was the worst he had seen anywhere to date (damage in northern New Jersey was minimal then), and damage was drastically worse by August 1993. Among Lepidoptera that disappeared from Pinery Provincial Park, there were two butterflies: The tawny crescent (*Phyciodes batesii batesii*) and the mottled duskywing (*Erynnis martialis*). The Karner Melissa blue (*Plebejus melissa samuelis*) was already extirpated from the Park by 1984. Elsewhere in Ontario, Don Lafontaine (email of 5 July 2008 to Dale Schweitzer) reports:

> Deer have become a huge pest in much of southern and central Ontario, not only through the lack of wolves but through many municipalities prohibiting hunting. Ottawa amalgamation has made a city that is 60 miles wide along the river and extending inland 25 miles and even places like Constance Bay [a well-studied jack pine barren]...is still 10 miles inside the city [=municipality where there is no

Figure 14. White-tailed deer have eaten all New Jersey tea (*Ceanothus americanus*) plants to within 8″ of the ground outside this fence in Canaan, Connecticut. Much of the seed being produced derives from the three dozen shoots protected by the fence (David Wagner photo). Inset: New Jersey tea (*Ceanothus americanus*) from Connecticut (Ken Metzler photo).

> hunting]!! Deer have been everywhere and are very common in all our *Ceanothus* areas.

The last comment does not bode well for *Erynnis martialis*, which no longer occurs at Constance Bay or Pinery Provincial Park, and is now very rare elsewhere in Ontario. Nor is it good for the two *Ceanothus*-specialized Geometridae (*Apodrepanulatrix liberaria* and *Erastria coloraria*) that may still exist in Ontario. In the Ottawa area, occasional winters with persistent and very deep snow pack cause high mortality of deer in some years (such as in 2008). This periodically allows some temporary recovery of the flora, and perhaps fauna. Although still present in 1985, by 1996–1997 *Erynnis martialis* had apparently been extirpated from its last two known colonies in the serpentine barrens of Chester County, Pennsylvania by deer. Between 1986 to 1995 there had been several years of excessive herbivory by deer. The deer herd was subsequently reduced, most *Ceanothus* recovered, and both of the associated Geometridae still occur in these barrens. A small population of *Callophrys irus* was also extirpated concurrently.

Occasionally, rabbits and other mammals impact food plants of rare moths and butterflies, especially around forest edges, but not on the same scale as deer. Beavers are increasing in numbers in some areas of the eastern United States and are causing habitat changes that affect wetland species. Beavers recently eliminated several populations of rare butterflies and skippers on protected lands in northwestern Connecticut, including the most well-known colony of *Euphyes bimacula* in that state (Wagner 2007a). However, this was a species already imperiled by other factors. The original role of beavers in our landscape was complex. Originally, beavers both created and destroyed habitats, and many species of wetland butterflies and skippers, including *Euphyes bimacula* and the Federally endangered Mitchell's satyr (*Neonympha mitchelli francisci)*, often occur in beaver-created wet meadows.

IMPACTS OF HERBICIDES AND INSECTICIDES

The use of herbicides that are carefully applied to woody plants along powerlines is an effective way to control vegetation, as well as to maintain excellent butterfly and moth habitat. Careful applications of herbicides against common reed (*Phragmites australis*) have produced spectacular and rapid results in terms of native tidal marsh restoration in Cumberland County, New Jersey. Similarly, Burch and Zedaker (2003) documented substantial recovery of native forest herbs after herbicide applications successfully eliminated *Ailanthu*s stands in Virginia. However, broadcast herbiciding of forest or woodland understories, right-of-ways, and roadsides can have devastating impacts locally. A large metapopulation of frosted elfins (*Callophrys irus*) in Cumberland County, New Jersey, was eradicated by a combination of the herbicide application and disking along several kilometers of a powerline route in 2004. For decades, this powerline route had been maintained by winter mowing and this rare butterfly thrived. A second, much smaller population on another powerline route that was not disked barely survived a herbicide treatment, but eventually did recover. The use of herbicides is cited as a threat to prairie butterflies, usually because it affects their nectar plants (Royer and Marrone 1992).

Large quantities of insecticides are applied each year in the eastern United States by homeowners, lawn care services, agriculture, industry, and government agencies. Natural lands near agricultural fields are likely to receive pesticide drift from crop duster planes and other spray applications that can impact moths and butterflies (Dover *et al.* 1990, Davis *et al.* 1991). Rare species of moths and butterflies are most likely to be killed by insecticides that are sprayed into the air and then may drift for miles from the application site (Hennessey *et al.* 1992). Most uses of pesticides have the potential to impact moth and butterfly populations in eastern United States forests and woodlands, but usually do not do so on a large scale because applications are aimed at croplands, suburban yards, etc. However, gypsy moth and spruce budworm spraying may affect substantial tracts of forest land. Mosquito control practices vary regionally, but insecticides may be sprayed into relatively natural landscapes. In some states, even parks, preserves, and wildlife refuges may be sprayed for mosquito control.

ABOUT DDT

DDT and the technology to spray from airplanes were first developed in the mid-1940s. Rachael Carson's book, *Silent Spring*, published in 1962, served as a clarion call that alerted the world to the dangers of pesticide use, and is widely credited for helping to launch the modern environmental movement in the US. It wasn't until 1972 that the use of DDT was legally banned in this country. DDT continued to be used in the US for years after 1972, but at a much reduced amount, and it is still used in numerous other countries. Many pests, including mosquitoes, had quickly developed resistance to DDT anyway, and other insecticides were developed.

IMPACTS OF MOSQUITO CONTROL

The organophosphates, malathion (the active ingredient in Fyfanon®) and naled (used in

Dibrom®), and the synthetic pyrethroids, resmethrin (Scourge®), permethrin (Biomist®, Kontrol®), and sumithrin (Anvil®), are among the insecticides used most to kill adult mosquitoes. The effects of mosquito spraying on non-target species are not well documented, but day-active adult butterflies are less likely to be affected than small nocturnal insects such as Microlepidoptera. After West Nile virus appeared in New York in 1999, intensive mosquito control efforts later that summer and fall tried but failed to contain and eradicate the disease. Although Gochfeld (2000) warned of impacts to butterflies and other non-target species from the spraying, we could not find any published follow-up studies documenting such effects. Dale Schweitzer observed many times that aerial applications of malathion to kill adult mosquitoes over his yard in New Jersey had no detectable impact on caterpillars and killed only a few adult butterflies and moths. His observations included controlled field exposure tests using luna and imperial moth caterpillars and pre- and post-spray observations of marked adult Nymphalidae, as well as many direct observations of naturally occurring caterpillars in his yard. However, malathion may have less impact than synthetic pyrethrins such as Scourge® , which are now more widely used in some states, and these observations did not involve any caterpillars smaller than second instar tawny emperors (*Asterocampa clyton*). Salvato (2001) found LD50 doses of malathion to be about 48 times greater than those for naled and permethrin.

Impacts of gypsy moth control

The insecticides used to control the gypsy moth are selected for their lethal impacts to caterpillars. Dimilin®, or formerly dichlorodiphenyltrichloroethane (DDT), persist on foliage for months. As would be expected, spraying with these types of chemicals has impacted rare moths and butterflies (Schweitzer 2004). In the past, gypsy moth control practices, including spraying with DDT, Sevin®, or Dimilin®, were a major reason for the decline of the Appalachian grizzled skipper (*Pyrgus wyandot*). This butterfly declined substantially or disappeared very soon after large-scale applications of insecticides to control gypsy moth were made in New Jersey in the late 1950s and 1960s (Gochfeld and Burger 1997). About 20 years later in Maryland and West Virginia, declines of the Appalachian grizzled skipper also occurred in sprayed areas. Pesticides for gypsy moth control had a role in localized crashes of many moths (Muller 1973, 1976, 1979; Hessel 1976, Schweitzer 2004), including a few that no longer occur in New Jersey. Current suppression programs are more tightly focused, smaller in scale, and often avoid places with rare Lepidoptera. The U.S. Forest Service minimized impacts in the recent Asian gypsy moth eradication project in eastern North Carolina (Hall *et al.* 1999) with a carefully planned combination of methods and non-target species monitoring. Populations of several very rare moth species survived, and the Asian gypsy moth was eradicated.

Control of gypsy moths using Gypchek, a viral preparation, has little (possibly no) impact on native species (Schweitzer 2004). The fungus *Entomophaga maimaiga*, which can bring about the collapse of impending gypsy moth outbreaks, caused trivial to low mortality to native moth caterpillars of several families in field situations (Hajek *et al.* 1995, 1996, 2000, 2003). Although Gypchek and *Entomophaga maimaiga* pose little risk to non-target moth and butterfly populations, neither is available commercially. To prevent eradication of rare moth and butterfly populations due to gypsy moth spraying, Natural Heritage Programs (which review spray proposals in many

About mosquito control

Thermal fogging has been used to apply mosquito adulticides in many areas of the eastern US. With this method, the insecticide is diluted in an oil, such as #2 diesel fuel, vaporized by heating to high temperature, and blown through a nozzle (Florida Coordinating Council on Mosquito Control 1998). Upon contact with the cooler outside air, the vapor condenses into a fog of tiny droplets ranging from 0.5 to 1.5 microns in size. Recently, mosquito control agencies began using ultra low volume (ULV) technology in which aerosol generators blow small amounts of undiluted and unheated insecticide into a ULV fog of droplets ranging from 5 to 15 microns in size (Florida Coordinating Council on Mosquito Control 1998). The advantage of ULV application is that much less insecticide is needed (rarely more than 1 ounce per acre) for mosquito control. The droplets drift in the air for hours and are able to penetrate relatively dense foliage where adult mosquitoes like to hide. Aircraft applying mosquito adulticides may be guided by computer devices that measure wind speed and direction, altitude, and other variables and then calculate the best spray release path to hit the target of interest. As well, the computers can be programmed to avoid specific areas. For example during the 2006 Eastern Equine Encephalitis outbreak in Massachusetts, the Natural Heritage Program worked in cooperation with the Department of Public Health to avoid aerial application of Anvil® over GIS-mapped habitats of state-listed insects active at that time of year. Those habitats were mostly in uninhabited wildlife refuges and other conservation lands. The insecticides currently used to kill adult mosquitoes are usually applied at dusk or night, and most break down quickly upon exposure to sunlight and moisture.

States bordering the Gulf of Mexico, Atlantic Ocean, and Great Lakes have large amounts of wetlands and habitats favorable to mosquito breeding. Mosquito control agencies use an integrated approach that targets larvae and breeding sites as well as adults. Spraying adulticides is typically based on bite counts, complaints, or disease prevention. Some Florida counties apply more insecticides to kill adult mosquitoes than do most states. In 2006, Florida mosquito control districts reported applying nearly 32,700 gallons of adulticides from aircraft to 8,620,887 acres of land and another 70,160 gallons of adulticides from trucks to 15,692,334 acres (Florida Division of Agricultural and Environmental Services 2007). On a less regular basis, large swaths of Florida have also been sprayed with insecticides to eradicate Mediterranean fruit fly infestations and after hurricanes to prevent outbreaks of mosquito transmitted diseases.

Mosquito spraying in the Florida Keys has been a controversial issue due to worries about harming rare butterflies, tree snails, and other non-target animals. Laboratory tests have shown that mosquito adulticides applied in the Keys are moderately to extremely toxic to the giant swallowtail (*Papilio cresphontes*), gulf fritillary (*Agraulis vanillae*), zebra heliconian (*Heliconius charitonia*), and painted lady (*Vanessa cardui*) butterflies (Emmel and Tucker 1991, Eliazar 1992, and Emmel and Eliazar 2002), but data linking declines of butterflies in the wild to mosquito spraying (Hennessey and Habeck 1991, Hennessey *et al*. 1992, Salvato 1999, 2001) were confounded by uncontrolled factors and are difficult to interpret. In contrast to the laboratory investigations, the giant swallowtail, gulf fritillary, and zebra heliconian are among the most common and widely distributed butterflies in the Keys and are especially abundant in urban areas. There has been a significant decline and loss of butterflies in the Keys in recent times (Minno and Minno 2009), but urban development, habitat change, establishment of non-native predators, and climate change may be the major causes, because population declines have also happened in areas that are not sprayed, such as Biscayne National Park. Compared to the multi-year efforts of Richard Reardon and USDA Forest Service-sponsored investigations of non-target impacts of gypsy moth control, there has been remarkably little research to document non-target effects from mosquito adulticiding. But, considering the scale and frequency of mosquito spraying in Florida, we suspect there have been impacts, to moth and butterfly populations.

states) and other conservation agencies map the locations of rare species. In most cases, either these areas can be avoided, or alternative control methods can be applied.

Impacts from applications of the bacterium *Bacillus thuringiensis* var. *kurstaki* (*Btk)* and exotoxins produced by it, as well as from gypsy moth defoliation are complex issues (Sample *et al.* 1996, Wagner *et al.* 1996, Peacock *et al.* 1998, Rastall *et al.* 2003, and Schweitzer 2004). *Btk* applications in the springtime are sometimes preferable to allowing severe defoliation of the habitat by gypsy moth larvae, especially if no rare species with spring-feeding caterpillars are present. The impacts of *Btk* are virtually confined to moth and butterfly caterpillars, but sensitivity varies tremendously among species, even those in the same genus, and sometimes between instars of a species (Peacock *et al.* 1998). Based mostly on a review of the literature, Schweitzer (2004) determined that few species are sensitive to the *Btk* after about two weeks post application, and we doubt substantial mortality occurs for nearly that long in most species. All of the data we evaluated suggest little or no impact to species feeding in summer after mid-spring applications. Peacock *et al.* (1998) found that some caterpillars of most species—even a few of highly sensitive species—that ate a dose of *Btk* managed to recover and produce adult moths with more or less normal fecundity. Many native species were not significantly impacted from *Btk* in the laboratory tests, and some had no mortality in these assays. *Btk* certainly should be considered for control of gypsy moth in some situations, even where rare moths or butterflies may be present. For example, *Btk* would be preferable to chemical pesticides in preserves having rare moths with caterpillars that feed on oaks in the summer (e.g., *Aconicta albarufa* and *Heterocampa varia*). Generally, reduction of gypsy moth larvae from *Btk* is less than with Dimilin®, but mortality occurs more quickly with *Btk*. The same is probably true of most native species, given that Dimilin® kills a vast array of organisms that produce chitin at their next molt, persists for weeks to months on foliage, and is lethal at very low doses (Schweitzer 2004). *Btk* kills only caterpillars of some, but far from all, Lepidoptera species and usually remains active for only a few days. On the other hand, Dimilin® severely impacts immature insects of many foliage-eating species, including aquatic insects that eat fallen leaves, and can remain effective for months.

Forest defoliation by gypsy moth caterpillars can lead to starvation of native species (Gall 1991b, Schweitzer 2004). Crowding, altered food plant chemistry (Sample *et al.* 1996), and other factors may lead to reduced fecundity of the adults. However, sublethal impacts probably do not seriously affect populations of rare species unless impacts occur over several consecutive seasons. Most caterpillars of spring-feeding lepidopterans mature before severe defoliation by gypsy moths becomes widespread, including most underwing moths (*Catocala*), Xylenini, Bistonini, some Orthosiini, hairstreaks, and elfins. However, ridgetops may be defoliated earlier than other habitats, and large-scale starvation can occur in these areas. This puts species found primarily in such places, such as S*atyrium edwardsii*, at risk.

Caterpillars that feed in the summer may be more vulnerable to impacts from severe defoliation of forest trees than most spring-feeders. Defoliation usually peaks around the time oak leaves harden in late May or early to mid-June. Because refoliation takes several weeks, suitable oviposition substrates for summer moths may be unavailable through much of June. Some summer-feeding caterpillars, such as many Notodontidae, cannot develop normally on young leaves (Ferguson 1963, Dale Schweitzer). Food for these species could be unavailable well into July. Often some Notodontidae are undersized the summer following an outbreak, but this has not been quantified and is very unlikely to have any long-term impact.

One example of this was observed by Dale Schweitzer with Polyphemus moth (*Antheraea polyphemus*) caterpillars. The larvae were sleeved (enclosed on the branch in a net bag) in early September on a small oak. This same oak had been defoliated earlier in May by sleeved *Hemileuca maia* larvae. The Polyphemus caterpillars molted into the last instar in mid-October, whereas their siblings on normal oaks that had not been defoliated were already spinning their cocoons by that time. The laggards failed to complete development before leaf fall. If this situation simulates field conditions, then gypsy moth defoliation could impact a lot of summer-feeding species. Controlled experiments are needed to evaluate this anecdotal observation. Non-target species also are obviously impacted if tree mortality occurs.

It is difficult to generalize which has the worst impact on most non-target Lepidoptera: *Btk* or defoliation. Either could severely impact some species, but it is probable that they impact different, rather than the same, species. Creating a mosaic of *Btk* treated and untreated patches may be the ideal solution. Populations impacted by *Btk* are likely to recover in a few years if there are unsprayed refugia nearby, and in many cases even if there are not. Based on their lab assays, Peacock *et al.* (1998) conclude that most forest species are very likely to have at least a few survivors, especially if some larvae have reached the third instar by the time application occurs. In the threats and management sections below, we discuss the potential risk for species found in places where *Btk* and gypsy moth defoliation are likely to be issues. Because sensitivity is so variable between species and instars, for most species all we can do is indicate whether exposure is likely, and approximately which instars might be affected. In doing so, we assume a lethal residue would not last more than two weeks.

The impacts of defoliators on other Lepidoptera and their habitats may not be entirely negative. For example, frequent outbreaks of the native pine looper (*Lambdina pellucidaria*) in southeastern Massachusetts may be among the natural processes that limit the growth of pitch pines on harsh sites, which in turn helps to maintain open barrens, which support rare moth species such as *Acronicta albarufa* and *Catocala herodias gerhardi*. Mike Nelson suggests that defoliation by the native forest tent caterpillar (*Malacosoma disstria*) and the introduced gypsy moth and winter moth (*Opherophtera brumata*) may help maintain some of the open oak woodlands and scrub oak barrens in that region. This could be especially important where fires, another natural process, have been virtually eliminated.

Impacts of fire

Fire is an important natural process in many habitats. Fire is also important as a management tool, because many natural communities, especially prairies, oak savannas, and pinelands, must burn in order to maintain the habitat (Figures 15, 16, and 17). Yet prescribed burning has been a controversial issue in Lepidoptera conservation. Even though most species recover quickly after fire (Panzer 1998; Swengel 1994, 1995, 1996a, 1998, 2001; Swengel and Swengel 1996a, 1996b, 2001, 2006; and U.S. Fish and Wildlife Service 2003), rare, highly localized species can be eliminated by it. Metzler *et al.* (2005) and Swengel and Swengel (2006) provide literature reviews. Most habitats supporting the rarest Lepidoptera in the New Jersey Pine Barrens are now being lost to shrub or tree encroachment resulting from decades of fire suppression, among other causes. Farther south, both too little fire and extremely frequent fire (e.g. one or two year rotations) are of concern. In

Figure 15. A longleaf pine (*Pinus palustris*) forest at the Blackwater River State Forest, Okaloosa County, Florida a few days after a prescribed burn (Marc Minno photo).

Figure 16. Pine flatwoods shortly after a prescribed fire at Ocala National Forest, Putnam County, Florida (Marc Minno photo).

Figure 17. Dwarf pitch pine (*Pinus rigida*) and blackjack oak (*Quercus marilandica*) scrub following a June wildfire in the New Jersey Pine Barrens, Ocean County (Marc Minno photo).

extensive wooded habitats there may be no practical alternatives to fire, and in any habitat, managers must take precautions to make sure that prescribed fires do not cause extirpations of rare species.

Most of the research on the effects of fire on rare butterflies has been conducted on Midwestern prairie species, but the general principles are applicable in coastal pine barrens, savannas, and other fire-maintained habitats. Although many of our rarest moths and butterflies are characteristic of fire-maintained habitats, refugia are needed during fires, and extreme fire frequencies can be detrimental. Hall and Sullivan (2004) regard extremely frequent fires (every year or two) on some public lands in North Carolina as a severe threat to *Hemipachnobia subporphyrea*, one of the rarest moths in the eastern United States. Steve Hall (personal communication with Dale Schweitzer) reports that only a single larva of the very rare moth (*Papaipema eryngii*) (see Appendix 2), was found the year after its only known North Carolina location in a pine savanna was burned. In a season when all Arogos habitat was burned, a colony of the eastern Arogos skipper (*Atrytone arogos arogos*) was extirpated by prescribed burning of Red-cockaded Woodpecker (*Picoides borealis*) habitat (Minno and Minno 1996) on a site in the Ocala National Forest, Florida. Logic and available data support a growing consensus that cautious use of prescribed burning is an appropriate management tool for many woodland and savanna habitats that harbor rare moths and butterflies. However, it is essential that adequate unburned refugia are provided, and sufficient time is allowed between burns for recolonization to take place. The imperiled eastern Arogos skipper originally occurred almost entirely in fire-maintained habitats, and it occurs in savannas that burn a few times per decade. Yet, extreme fire frequencies (one or more per year to about one every three years) appear to exclude it from many reedgrass (*Calamovilfa brevipilis*) savannas on the Fort Dix military reservation in New Jersey. For this species, the following factors are critical:

- Dozens of hectares of its favored habitat are available to it.
- Fires are not prescribed, but are relatively random accidental results of military training activities.
- Fires do not burn all habitats in a single year.
- There are skips (areas that do not burn--for example, in wet spots).

Swengel and Swengel (2006) recommend permanent unburned refugia in prairie habitats, but this may not be practical or even desirable in most large barrens or pineland tracts. The habitat of the permanent refugia could become overgrown with hardwood trees and shrubs in the absence of fire. Should that occur, the rare species could be lost due to succession. Finally, alternative management practices such as mowing or grazing may not be practical.

Prescribed burning is a threat to populations of Lepidoptera primarily when an entire habitat is burned in the same season or two. Many moths, skippers, and almost all butterflies that occupy fire-dependent habitats lack any means to avoid the lethal heat from fires. In general, mortality is very high to any immature stages that are above ground during a fire. Such species can only recolonize from nearby unburned areas or rebuild their numbers from a few survivors in unburned patches. Lepidopteran populations are sometimes concentrated in a particular area in a given year, or consistently in most years, so direct mortality may be particularly high if that unit is burned. Exceptions undoubtedly occur, but if there are unburned refugia and recolonization occurs quickly, Lepidoptera populations usually recover to at least pre-burn levels in one or two generations (Panzer 1998).

A critical point is that many insects that occur in or depend upon fire-prone habitats persist primarily by their ability to recolonize. There must be sufficient time between burns not only for recolonization, but also to allow the resultant population to increase and become an effective exporter of immigrants to other burned sites. Most studies show that such recovery takes only a few years. Therefore, we suggest a five-year interval between fires on a given burn unit. This should be sufficient for most species, providing the food plant is not a woody plant that requires more than one full growing season to recover to a usable condition. A lot probably depends on scale. For example, unburned northeastern barrens dominated by pitch pine, bear oak, or heaths are often floristically simple, uniform communities covering hundreds or thousands of hectares. In real-world contexts, lack of fire is likely to be a greater threat than suboptimal prescribed burns. While the ideal might be something like burning a quarter of the habitat (25%) every four or five years, an occasional burn consuming a much larger proportion, but not all (100%) of such a barren would probably not put species with caterpillars that feed on oak or heaths at risk. However, risks may increase in small habitats or where there are small or uncommon microhabitats, such as grassy openings within pine barrens. In this book, we provide information on the vulnerability of each species to fire. Documentation that a prescribed burning rotation is increasing or maintaining stable populations of rare or specialized fire-sensitive insects would be evidence that managers are approximating a natural fire regime for the habitat, even if the "natural" fire regime is unknown.

Right-of-way management

In areas where wild fires have been suppressed, formerly open woodlands have grown into dense forests. As shrubs and trees increase in size and abundance, grasses and forbs decrease or disappear, along with any specialized moths and butterflies that use such plants as larval hosts. However, mown powerline right-of-ways provide open grassy or shrubby habitat through dense forests, and therefore are refugia for rare species. Habitats of native flora that are maintained by mowing are very important for many species of rare moths and butterflies, especially some that originally occurred mostly in fire-maintained habitats. This includes powerlines, approach zones around airports, and other right-of-ways. Almost all Pine Barrens specialists that feed on low shrubs, grasses, forbs, and even summer (but not spring) bear oak leaves (*Quercus ilificolia*) do very well on winter-mowed right-of-ways in New Jersey. Mowing of roadsides at the wrong time could be detrimental to some rare species that depend on ephemeral flowers (Figure 18).

Most Arogos skipper (*Atrytone arogos arogos*) colonies are found on powerline right-of-ways in Mississippi, one of the few states where this skipper still occurs. This is the case as well for the Arogos skipper in northern New Jersey. Similarly, most colonies of frosted elfins in New Jersey (Dale Schweitzer), and many in Connecticut (O'Donnell *et al.* 2007) and elsewhere depend upon powerline right-of-ways. We have observed that management techniques that include winter mowing at intervals of one to five years perpetuate rich assemblages of moths, butterflies, and wild flowers in several states. Careful use of herbicides aimed at tall or dense woody vegetation can also do this. Unfortunately, power companies in some states such as Georgia and a few counties in Pennsylvania have plowed under the native flora and planted exotic grasses, such as Bahiagrass, on many of their powerlines.

Browsing deer impact flora and fauna along powerline right-of-ways in some states.

IMPACTS OF COLLECTING

We have already discussed the need to collect specimens for proper vouchering and reliable identification. For some very rare species (such as the Miami blue in Florida), collecting could occasionally pose a potential threat. However, even for the most localized species, a few voucher specimens will not impact an otherwise viable population, and it is always valuable to document where species occur. While there has been much discussion of the alleged but unsubstantiated and unlikely threats of collecting, we are unaware of any peer-reviewed literature documenting measurable collecting impacts to butterflies and moths in eastern North America. It's worthwhile to note that although the Miami blue colony on Bahia Honda Key in Florida was in a highly visible and well known area within a state park, it was not collecting, but poor management, that allowed feral iguanas to defoliate the larval host plants, ultimately leading to the demise of this critical population.

Figure 18. A colony of frosted elfins (*Callophrys irus*) at the Blackwater River State Forest, Okaloosa County, Florida, somehow survived prescribed fire in the longleaf pine forest and roadside mowing during the adult flight season (Marc Minno photo).

We believe that undercollecting poses a greater threat to a larger fraction of the species discussed in this work. For example, a conspicuous diurnal moth, *Pseudocharis minima*, has become quite rare, and several butterflies and skippers from South Florida are endangered, threatened, or already extirpated/extinct. One would expect some of the more numerous nocturnal moth species in southern Florida to be of conservation concern, including some threatened by land management, or lack of it, in their habitats. However, collecting restrictions on public lands since about 1990 have greatly hampered evaluation of the populations of such moth species. We include a few nocturnal South Florida moths in Appendix 2. Due in large part to lack of recent collecting and rearing, we can provide accounts for only two, *Synchlora cupendaria* and *Madoryx pseudothyreus*. The current status of the former is unknown, and we suspect the latter is not rare.

Our discussion is based upon our shared belief that a species' long-term survival has primacy in guiding actions, and our years of experience as lepidopterists and conservation biologists. The purpose of collecting should be to sample, not to deplete or harvest the population. The long-term survival of a colony must be held as being of primary importance. The population demographics of most insects are such that adults are being culled daily by ants, spiders, robber flies, birds, bats, and other natural enemies. Thus, the removal of a small number of adults by a collector is likely to be of little genetic or demographic consequence.

The majority of the species in this guide, especially the moths, are so infrequently encountered and difficult to collect, that under normal circumstances there would be little chance of a responsible collector impacting a colony as a result of one or two visits in a season. To a large measure this is because staggered emergence ensures that only a fraction of a population is on the wing on any given day during the flight season. Furthermore, males are more common than females in most collections because they are usually easier to find. Because the total population size will generally not be apparent, and even the total for that day might not be, we can suggest only general guidelines for collecting Lepidoptera beyond merely a voucher specimen or two. These are:

- With diurnal species, collect only a few (never more than half) of the males actually seen.
- Collect substantially fewer (or none, if scarce) of the fresh females during the peak of the flight season.
- If additional collections are planned, or it is likely that others will be sampling the same colony, then the number of specimens taken should be proportionately reduced.
- Do not operate powerful light traps on successive nights for an extended period, or too frequently, in areas of unusual habitats of only a few acres.

Overzealous collecting and commercial exploitation pose a threat to rare species. Species occurring in small, localized populations would be most vulnerable. Sedentary taxa that stay close to their preferred habitats, larval hosts, or nectar sources are particularly at risk, such as the *Calephelis* metalmarks. Other species that may be susceptible to overcollecting include those occurring in small habitat patches that can easily be drawn to baits and pheromones (including calling females) in large numbers.

Powerful light traps in spatially-restricted habitats probably have the potential to impact some moths. However, the data in Väaisäien and Hublin (1983) suggests that they possibly do not. We note that light traps have proven very valuable for surveying agricultural pests, for biodiversity studies, and for general collecting, but they have not proven to be effective for controlling pests. For most species, attraction to light may be an idiosyncrasy of an individual's physiological state. Data in Väaisäien and Hublin (1983) suggest that only a small portion of individuals come to light on a given night, even in tiny habitats. In our experience, lights only sample a small fraction of the moths flying in the vicinity of a sheet or trap; many more of the same species can often be seen at bait or flowers nearby. Light traps have not to our knowledge been implicated in the decline of rare moths. Nevertheless, and to perhaps err on the side of caution, we discourage the frequent deployment of unmonitored kill traps in habitat patches less than a few hectares in extent. We doubt that occasional use of 15- or 20-watt blacklight traps has potential to harm otherwise viable populations.

Late instar caterpillars, if easily located, such as those of flower-feeding lycaenids, might be vulnerable to over collection. However, over collecting would be unlikely with first instars, because most of these would otherwise be killed by a variety of natural causes. One could imagine instances where a misguided individual could locate every last instar or pupa of a *Papaipema* species in a small host population. Species that have a long pre-reproductive diapause, such as *Speyeria*, xylenine Noctuidae that overwinter as pre-reproductive adults, and some large southern *Catocala*, also would seem to be at a disadvantage if collecting pressures are chronic and populations are small or localized. However at least for the moths, we cannot cite any examples of such populations being harmed.

We urge collectors to be mindful and adhere to the collecting guidelines laid out in the Lepidopterists' Society Statement on Collecting, the guidelines for which can be found online at http://www.lepsoc.org/statement_on_collecting.php. Collecting should only sample a population. Particularly when it comes to rare species, single ill-considered actions could lead to population declines. Err on the side of caution. Your reputation, and that of any institutions, organizations, or societies to which you belong, and most importantly, the insect's long-term survival, may depend on it. Use cameras rather than nets and traps when truly prudent to do so, but be mindful that specimens are better vouchers than images, especially for important new locality records. In terms of potential impacts, it makes no difference if collection is recreational, falls under the aegis of scientific research, or is accidental, such as a result of a photographer or butterfly watcher crushing a larvae or pupa underfoot. All sources of potential impact should be considered.

Collectors must be sure they do not violate any laws while taking specimens. They should obtain permission from landowners or land management agencies before collecting Lepidoptera outside of their own property. Some of the species treated in this guide are in some way protected, and collecting them is regulated. A few are rare enough that such restrictions are prudent due to small population sizes. Two examples are Schaus' swallowtail, which is protected under the U.S. Endangered Species Act, and Bartram's scrub-hairstreak. These species may be scarce enough that collecting could have an impact on populations. We recommend that *Atrytonopsis loammi* generally should not be collected, except for a male to verify new occurrences.

Impacts of artificial lights

Artificial lights pose a threat to moths, but the magnitude of the impact depends on many factors. Millions of moths are drawn to lights every warm night. On every such night, many are eaten by bats, lizards, toads, spiders, or other predators that hunt around lights. Many others simply settle and remain there until they die a few days later. It should be noted though, that a large majority of these are males. Eisenbeis (2006) estimates that about one-third of insects that fly to street lights in Germany die from predation. Lights can also alter and disrupt many behaviors such as feeding, flight, and reproduction (Muirhead-Thomson 1991, Eisenbeis 2006, and Frank 2006). Väaisäien and Hublin (1983) tested the impact of lights on one of the few remaining populations of *Hydraecia petastites* in Finland. Over a 48 night study, about half of the males and a third of the females were trapped at least once. This means most individuals probably were not trapped, even though the total area for both habitat patches was less than a hectare. This suggests to us that these traps would have had little impact on a population on any single night despite the miniscule habitat. Since some Noctuidae that fly to lights do not end up in a trap (Muirhead-Thomson 1991), these are probably underestimates.

Anthony McBride is studying the effectiveness of light traps for the related genus *Papaipema* in New Jersey. Based on his preliminary data, he suggests slightly over half of individuals that fly to a light and remain near it will end up in a bucket trap, and lights operated with sheets are slightly more effective than bucket traps. However, anybody who has collected more than occasionally with lights and sheets is presumably aware that many moths arrive, fly around for a few minutes or less, and leave. While many moths may be found around an isolated rural light or a blacklight trap in a dark forest, far fewer will be seen around a similar light in a more illuminated place. Frank (2006) lists and reviews other factors, including learning by the moths, which tend to reduce response of moths to lights. We also suspect that by now, since lights have been killing moths for more than a century (Holland 1903), natural selection might have favored reduced attractiveness of some species to urban lights. This would be an interesting area for research, and we suggest Saturniidae (Attacinae), Sphingidae, and *Catocala* species as potential subjects.

Mercury vapor lights have been blamed for the demise of Saturniidae and Sphingidae in New England and New Jersey, but no supporting evidence has been published. Parasitism by *Compsilura concinnata* is now considered the more likely cause. Several species have or had refugia in cities, and they continue to occur abundantly in parts of New Jersey where there is obvious light pollution. The evidence is unequivocal that populations of many species of moths can persist near artificial lights. Frank (2006) concludes that it is unlikely that artificial lights could eliminate large populations of moths, even isolated ones, but that they probably can impact small populations that are already at risk. He reviewed many studies and did not find any examples of moth species that could not persist near lights. He reports that 305 species of moths in England are now considered to inhabit exclusively or predominantly suburban or urban habitats where artificial lights are prevalent. Some 362 species of moths were found in the gardens at Buckingham Palace in London. Cities such as New Haven, Connecticut, and Cambridge, Massachusetts, were refugia for the Cecropia moth (*Hyalophora cecropia*) during its decline (presumably from *Compsilura*) in southern New England in the 1970s and 1980s, and to some extent probably still are.

North America has a richer moth fauna than England, and Hugo Kons reports 479 species of nocturnal Macrolepidoptera in a suburban yard in Appleton, Wisconsin where there is extensive light pollution. Dale Schweitzer found 31 species of *Catocala* and over 80% of Xylenini that occur in that county at bait in a similar setting in Hamden, Connecticut from 1976 to 1982, and several of these also as larvae. *Catocala minuta* maintained populations in nearby New Haven and in downtown Boston in the 1980s, and probably still does, by using non-native honey locust (*Gleditsia tricanthos*) trees planted in landscapes. Several other *Catocala* species, especially *Catocala amatrix* and the uncommon *Catocala meskei,* use poplars (*Populus* spp. and cultivars) planted in urban areas. If their food plants are present, many *Catocala* species, Noctuidae, Sphingidae, and some Saturniidae seem to do well in cities. While light traps can be rendered less effective by urban light pollution, they may produce hundreds of species over time. Catches are less affected by light pollution on clear nights than under cloudy or overcast conditions. Baiting can often be very productive in cities if one avoids areas of direct illumination by street lights.

Eisenbeis (2006) and Frank (2006) suggest that the most important effect of lights on moth populations is probably disruption of dispersal between habitat patches, thereby increasing the impacts of fragmentation. Impacts of lights on moths and other fauna can be reduced simply by turning them off when not needed, and by using lamps that emit light toward the yellow and red end of the spectrum. Most insects do not see red or yellow light well. However, high pressure sodium lamps, which emit yellowish light, are still disruptive because they are so intensely bright. Still, they are less so than mercury vapor lamps, which are even brighter and use a wider spectrum. The only lights that have virtually no effect on flying insects are low pressure sodium lamps (Frank 2006). Therefore, to the extent possible, low pressure sodium lights should be considered where illumination is necessary between or in small habitat patches containing rare species. Mercury vapor and other lights that emit near the ultraviolet range of the spectrum should be avoided or equipped with filters that block ultraviolet light.

Contrary to advertisements, electric insect traps, commonly called "bug zappers," do little to control mosquitoes. They also do nothing to control gypsy moths, because female gypsy moths do not fly. However, they do kill many moths and beneficial insects (Frick and Tallamy 1996). Their use should be banned in parks that preserve natural areas, and discouraged in other areas.

On nights with a full moon shining, light trapping results tend to be poor. Results can also be poor near cities where there is a considerable amount of artificial background illumination. In many cases, the same moth species that are rare or absent at collecting lights are very easily found by other methods, such as baiting or searching for caterpillars or cocoons. In an area of extreme light pollution near Atlantic City, Dale Schweitzer has found that imperial moths (*Eacles imperialis*) were scarce at blacklights (none in most summer samples) but were often found entangled in mist nets used by bat researchers. Furthermore, both larvae and resting adults were found in the woods during the daytime.

Other factors affecting rare Lepidoptera

Both legal and illegal harvesting of wild plants important to rare moths and butterflies poses a threat to some species. For example, nearly 160 tons of roots of black cohosh (*Actaea racemosa*), a medicinal plant and the only known food plant for *Celastrina negelctamajor* and *Eupithecia cimicifugata*, were harvested in 2003 alone, "mostly from the Appalachian wilderness" (Harder 2006). Illegal poaching of Venus flytraps is among the causes of the decline of the Venus flytrap cutworm (*Hemipachnobia subporphyrea*) in North Carolina (Steve Hall personal communication with Dale Schweitzer).

It is too soon to predict the threat to moths and butterflies posed by global warming in our region, but populations on the southern edges of current ranges may be in jeopardy, and it is likely that some states will lose northern species. Climate change, which is already underway, is expected to alter the distributions of many common eastern United States trees, with some southern species expanding, and the ranges of some northern species shrinking (Iverson *et al.* 1999). Predictions indicate that global climate change will most likely affect arctic and high altitude species first, such as *Gazoryctra sciophanes* in the southern Appalachians. Presumably in response to global warming, a number of common moths have been expanding northward, especially since about 1989.

Examples in southern New Jersey include now fairly common to abundant species such as *Megalopyge opercularis, Nemoria lixaria, Nemoria saturiba, Idaea obfusaria, Glena plumosaria, Lacinipolia explicata, Schinia nubila,* and *Ablablemma brimleyana*. Only *Idaea obfusaria*, which presently occurs as far north as Connecticut (David Wagner), was collected regularly in New Jersey before 1989. Five of the other seven moths were first collected in the state from 1989 to 2007, and there was only one prior specimen of *Glena plumosaria*. Other southern moths such as *Arugisa lutea* (which is the *Arugisa latiorella* of authors) and *Agnorisma bolli* are still scarce there, but turn up occasionally and probably are established. The latter is now locally common in nearby northern Delaware. While one might expect northern species to start disappearing in southern New Jersey, so far we know of no examples.

Coastal areas will continue to change due to accelerating sea level rise and increasingly severe winter storms and hurricanes. Rising sea level, a natural process that is accelerated by global warming, has already eliminated hundreds of hectares of habitat for *Catocala pretiosa*, *Callophrys hesseli*, and *Lithophane lemmeri* along Delaware Bay and in the Mullica River basin in New Jersey (Dale Schweitzer observation), and more will be lost this decade. The affected forests and thickets have been converted mostly to stands of dead trees over primarily invasive, non-native *Phragmites* with a few persisting shrubs. Eventually native salt marsh flora may move in as these areas become more saline.

Special habitats

The focus of this book is on wooded habitats, and there are many different types. Forests are broadly defined as places with dense trees that are typically at least 10 meters tall and that shade more than 60% of the ground. Woodlands have fewer trees (25% to 60% cover), often with discrete openings, and therefore, often have a greater diversity of understory plants. Savannas are places with sparse trees (only 5% to 25% cover) that often have a flora and fauna similar to prairies. Descriptions and information about the natural communities of the eastern United States can be found at the various Natural Heritage Program websites. Kons and Borth (2006) provide preliminary lists of Macrolepidoptera species hypothesized to be dependent on special habitats in northern Florida. Long leaf pine savannas and various kinds of scrub are among those that harbor many rare species. Ferge and Balogh (2000) discuss the fauna of special habitats in Wisconsin. Florida has a number of special habitats, which are discussed in Myers and Ewel (1988), Florida Natural Areas Inventory *et al.* (2010), and Whitney *et al.* (2002). Rare species of moths and butterflies are often associated with particular plants in uncommon habitats. In the following sections we discuss some special wooded habitats in greater detail.

Figure 19. Deciduous forest, Black Rock Mountain State Park, Rabun County, Georgia (Marc Minno photo).

Deciduous forests

The larvae of most species of Lepidoptera that occur in deciduous forests feed primarily on the foliage of canopy-level trees. Almost all of these moths and butterflies are widespread. Their populations seem secure, unless they are heavily dependent on ash trees which are at risk from emerald ash borer. However, there are some specialists that use understory plants. Some types of deciduous forests (Figure 19) support diverse understory floras of spring and summer wildflowers, ferns, and grasses in the Northeast, Midwest, Piedmont, Inner coastal plain, and Appalachians. However, until relatively recently, deciduous forests have not been a priority for Lepidoptera inventory either by collectors or Natural Heritage Programs. Understory herbs are currently being severely reduced or virtually eliminated by deer herbivory and crowded out by invasive plants, especially in the Northeast including northern Virginia. In the most severely impacted forests, even shrubs such as spicebush (*Lindera benzoin*), viburnums (*Viburnum* species), native honeysuckles (*Lonicera* species), hazels (*Corylus* species), chokeberry (*Aronia* species), and highbush blueberry (*Vaccinium coymbosum*), all of which support specialized Lepidoptera, have been almost completely consumed by deer. Furthermore, almost no tree seedlings survive to reach 30 cm (about a foot) in height. A single incident of severe herbivory by deer has the potential to wipe out all localized Lepidoptera on a site, even if the plants later recover. Such extirpation can be permanent if there are no other populations nearby.

Figure 20. Silvery checkerspot (*Chlosyne nycteis*) from Perry County, Indiana (Jeffrey E. Belth photo).

The fauna associated with the herbaceous plants of the forest understory is of increasingly significant conservation concern. Appendix 1 provides a list of 65 species of Lepidoptera associated with understory herbs and their known food plants, including common as well as rare species. This list is hampered, because we could not reach a fully satisfactory functional definition of forest edge or opening versus understory, and the habitat associations of many species vary regionally.

Figure 21. West Virginia white (*Pieris virginiensis*) from Brown County, Indiana (Jeffrey E. Belth photo).

Early indications that forest understory species were in trouble in the Northeast involved declines in butterfly populations. For example, the silvery checkerspot (*Chlosyne nycteis*) (Figure 20), a species of the forest understory, abruptly disappeared from Connecticut forests in 1986 (O'Donnell *et al.* 2007). There were also reports of the West Virginia white (*Pieris virginiensis*) (Figures 21) declining (Shapiro 1974). The common roadside-skipper (*Amblyscirtes vialis*) (Figure 22), which was regularly encountered in forest understories a few years earlier (Shapiro 1966) became quite rare in New Jersey (Gochfeld and Burger 1996), eastern Pennsylvania (Dale Schweitzer observation, David Wright personal communication with Dale Schweitzer), and Connecticut (O'Donnell *et al.* 2007) by the 1980s.

Figure 22. Common roadside-skipper (*Amblyscirtes vialis*) from Perry County, Indiana (Jeffrey E. Belth photo).

In northwestern New Jersey, Joseph Garris and Anthony McBride collected extensively at lights almost nightly from 2005 to 2010, and

Dale Schweitzer and other Nature Conservancy staff used light traps occasionally in 2009 and 2010. They also searched for diurnal species and for larvae of forb specialists. About 95% of the tree-feeding Macrolepidoptera, excluding Xylenini, that are historic for northwestern New Jersey were documented.

All expected Ericaceae specialists were found, in large part because lowbush blueberries (*Vaccinium pallidum* and *V. angustifolium*) usually remain abundant in heavily browsed forests on acid soils. Ferns also remain abundant, or often increase in places with severe browsing by deer, since these animals generally avoid ferns (Rawinski 2008). At least eight fern specialists were found, and no others are historic in the area.

On the other hand, deer have a significant impact on many other shrubs and forbs, and almost half of the specialists on non-ericaceous shrubs and forest understory forbs were not found. Three that were not found are *Ceanothus* specialists that have accounts in this book. Several forbs specialists that were not found, and three that were (*Calephelis borealis, Papaiepema astuta,* and *Psectrotarsia hebardi*), are also rare enough to have accounts in this book. Less extensive sampling by Dale Schweitzer with the Delaware Natural Heritage Program produced similar results for forb feeders.

NatureServe's combination ranks for many understory species (for example, G3G4 or even G2G4), reflect uncertainty about the severity of the decline elsewhere, especially in the southern Appalachians. In particular, one can still readily observe native understory flora and fauna in Great Smoky Mountains National Park and in some parts of Virginia, which is in sharp contrast to many conservation lands in Connecticut, southeastern New York, southeastern Pennsylvania, northern New Jersey, Maryland, and northern Virginia. There are still pockets of productive understory habitat on state wildlife management areas in northwestern New Jersey, central Pennsylvania, and presumably elsewhere, where deer hunting is popular. However, in the not too distant future, if their forest understory habitat continues to deteriorate, several understory and opening species are likely to become quite rare or disappear entirely in our region (see Appendix 1).

While most forest understory species tend to exist in localized colonies, some nettle feeders, such as the red admiral (*Vanessa atalanta*) and eastern comma (*Polygonia comma*) butterflies, and the moth *Hypena humuli* are migratory and seem quite at home in any habitat where their food plants occur. The latter two overwinter routinely as adults in or near Dale Schweitzer's yard, although they are not present in summer most years.

In Appendix 1, we include only those species that use herbaceous plants strongly associated with forest understories. Cane feeders are not included in Appendix 1 even though several occur in deciduous woods. They are discussed separately (see our account for the Apameini in the family Noctuidae). Some species of *Apamea*, *Oligia,* and *Neoligia* are most commonly collected in wooded areas, but they were not included because the specific grasses or sedges used by these Noctuidae are poorly known (e.g. Mikkola *et al.* 2009) and forests may not be their breeding habitat. Many of the species in Appendix 1 are still common, others may be declining in some areas but are not yet in trouble range-wide, and some are probably of concern, range-wide. A few appear to be naturally uncommon, but they are not obviously declining where forest understories persist. Whether migratory or not, most species feeding on species of *Urtica*, *Laportea*, *Boehmeria,* and *Pilea* in the nettle family seem to be rather common in large parts of their ranges, none seem to be declining seriously, and some have benefited by feeding on exotic strains of *Urtica dioica*. Populations of fern feeders also seem to be stable, which would be expected because most ferns are shunned by deer (Horsley *et al.* 2003, Rawinski 2008) and often remain abundant where almost all other understory vegetation, including shrubs, has been consumed. The only fern feeder in Appendix 1 ranked other than G4 or G5 is the ostrich fern borer moth (an undescribed *Papaipema* species) because of its limited range.

Rock outcrops

Outcrops and ridges where shallow soils overlay certain kinds of rock often harbor distinctive plant communities (Brooks 1987, Anderson *et al.* 1999) as well as specialized Lepidoptera, some of which are now very rare. Rock outcrops themselves are localized and very patchily distributed. They usually have very well drained, nutrient-poor soils, patches of bare rock, and few trees, although red cedar (*Juniperus virginiana*) or pines are often present. Some types of outcrops, such as alvars on limestone, may be seasonally wet. Alvars tend to be dominated by grasses, forbs, and mosses (Catling and Brownell 1999). Outcrops with patches of bare rock, such as many shale barrens (Figure 23) and trap rock (basalt) glades, are significantly hotter and drier than surrounding areas (Vanderhorst 2005). Scrubby oak or oak-pine woodlands often occur around the edges of outcrops, with post oak (*Quercus stellata*) being especially characteristic from coastal Connecticut

Figure 23. Shale barren at Green Ridge State Forest, Allegany County, Maryland (Marc Minno photo).

and southern Pennsylvania southward, and bear (or scrub) oak (*Quercus ilicifolia*), found northward and in the mountains south to the Virginias. Most kinds of outcrops that occur from southern Pennsylvania southward have endemic plants.

Where serpentine rock (Figure 24) outcrops, soils have low levels of calcium and relatively high levels of magnesium and metals, rendering such places toxic to most plants (Brooks 1987, Tyndall and Hull 1999). Serpentine barrens are concentrated near the Mason-Dixon Line in Pennsylvania and Maryland, but some occur southward in North Carolina (Gatrelle 2001c), as well as northward in the mountains. A serpentine outcrop on Staten Island, New York, was investigated for butterflies by Shapiro and Shapiro (1973). Shale barren soils (Braunschweig *et al.* 1999) also have unusual mineral content and are found in Pennsylvania, Maryland, West Virginia, and Virginia. Trap rock (basalt) woodlands and glades have acidic soils and are especially characteristic of south-central New England and the Palisades area of New York and New Jersey, just west of New York City. Granite outcrops (Shure 1999) and associated acid soils are prevalent in Alabama, Georgia, the Carolinas, and the Virginias. Similar natural communities also occur on granite farther north, especially on the hills around Boston, Massachusetts, which are mentioned frequently in our species accounts. Granite outcrops and balds sometimes occur near the tops of high mountains and tend to be dominated by grasses or heaths (Wiser and White 1999). Limestone and dolomite outcrops have higher pH soils and support red cedar barrens or glades communities (Baskin and Baskin 1999). Limestone and dolomite outcrops are best developed in Tennessee, but also occur in Kentucky, Alabama, and Virginia (Heikens 1999, Ludwig 1999), and northward to Connecticut. Limestone barrens or alvars are found mostly in the Great Lakes region, and are dominated by grasses, herbs, and mosses (Catling and Brownell 1999).

Figure 24. Goat Hill Serpentine Barren, Chester County, Pennsylvania (Betsy Leppo photo).

We know of no species of Lepidoptera found only in one type of outcrop. Although most Appalachian populations of Olympia marble (*Euchloe olympia*) are confined to shale ridges, some in Virginia occur on limestone (Steve Roble personal communication with Dale Schweitzer). Most outcrop species also occur in similar open habitats, such as powerline right-of-ways through forests on these rocks. Among the rarest outcrop species are the Appalachian grizzled skipper (*Pyrgus wyandot*) (Figure 25), and the northern metalmark (*Calephelis borealis*) (Figure 26). New Jersey tea (*Ceanothus americanus*) was originally a common shrub on most of these rock types, especially trap rock, limestone, and serpentine. It also occurs in sandy places inland. However, it has been drastically reduced in abundance by deer and habitat changes in most of our coverage area, especially from Pennsylvania to New England. In fact, the name "deer bush" is used for shrubs in this genus in the western United States. All three known macrolepidopteran specialists on this once common shrub, *Erynnis martialis*, *Erastria coloraria,* and *Apodrepanulatrix liberaria,* are imperiled or extirpated in much of our area. In the late 1700s their food plant was so abundant it was even commercially harvested as New Jersey tea. The Lepidoptera were still widespread in New Jersey

Figure 25. Appalachian grizzled skipper (*Pyrgus wyandot*) from Brattons Run Shale Barrens, Rockbridge County, Virginia (Rick Cech photo).

Figure 26. Northern metalmark (*Calephelis borealis*) from Litchfield County, Connecticut (Michael C. Thomas photo).

over a century later. New Jersey tea is seldom seen in that state now, and all three of the Lepidoptera are considered to be historic there. The geometrid moth (*Metarranthis apiciaria*) may have been an outcrop specialist in some places, and the now essentially extinct *Phyciodes batesii batesii* (in the strict sense) sometimes occurred on outcrops. Acidic rocks such as granite can support pine barrens fauna, including a few specialized species such as *Speranza exonorata*, *Catocala herodias gerhardi*, and *Psectraglaea carnosa*.

Savannas

Pine savannas

Historically, savannas with sparse pines (usually longleaf pine, *Pinus palustris*) and grassy understories (Figure 27) were among the major natural communities along the Gulf Coastal Plain throughout most of Florida, and occurred northward along the Atlantic coastal plain to New Jersey. However, they are now rare. Some pine savannas, especially in Florida, have less than 5% tree cover and are essentially prairies. Although some occur on rather dry sandy soils, many pine savannas are often quite wet, especially in the summer rainy season in Florida. Some pine savannas are interspersed with pitcherplant (*Sarracenia* species) wetlands and shallow marshes. A few savannas in the New Jersey Pine Barrens are permanently wet. Unlike northern bogs that have peaty soils, southern pitcher-plant wetlands occur mostly in pine savannas on acid mineral soils, typically clays or mucky sands. The diversity of wildflowers, grasses, and sedges is relatively high in southeastern savannas, and the flora and fauna are similar to those found in prairie habitats (Platt 1999).

On the other hand, New Jersey pitch pine (*Pinus rigida*)-reed grass (*Calamovilfa brevipilis*) savannas have low plant diversity. Lepidoptera diversity is not high either, but light trap samples are occasionally composed mostly of species with accounts in this book, such as *Agrotis buchholzi, Dichagyris reliqua*, or *Spartiniphaga carterae*. *Atrytone arogos* is the most frequently observed skipper in the pine savannas in which it occurs in New Jersey. The apparently endemic *Crambus daeckellus* is often numerous around the edges. Kons and Borth (2006) note some similarities in the specialized Lepidoptera fauna of the north Florida turkey oak/longleaf pine sandhill savannas relative to Wisconsin dry prairie and barrens. The greatest diversity of pitcherplants and butterworts (*Pinguicula* species) occurs along the Gulf Coast from eastern Louisiana to the western Florida Panhandle.

Figure 27. Longleaf pine (*Pinus palustris*) savanna at the Disney Wilderness Preserve, Osceola County, Florida (Marc Minno photo).

However, only one of the three species of *Exyra*, which are pitcherplant specialists, is known from west of Florida (Lafontaine and Poole 1991).

In contrast to most pitcher-plant bogs in the north, fire is an important factor in maintaining the open structure and biodiversity of these southern systems. Absent fire, these bogs convert to forests of pines and bays. Some rare butterflies and moths (Figure 28) found in pine savannas are the dotted skipper (*Hesperia attalus*), Arogos skipper (*Atrytone arogos*) (Figure 29), Loammi skipper (*Atrytonopsis loammi*) (Figure 30), dusky roadside-skipper (*Amblyscirtes alternata*), and the moths *Cyclophora* species near *culicaria*, *Pygarctia abdominalis*, *Agrotis buchholzi*, *Agrotis carolina*, *Dichagyris reliqua*, *Hemipachnobia subporphyrea*, and several *Schinia* species.

Figure 28. *Exyra semicrocea* from Fulton County, Georgia (Henning von Schmeling photo).

Scopula purata occurs in many wet savannas from New Jersey to the Gulf States. This species seems to be rarely encountered, except in New Jersey where it also occurs in bogs. *Gabera diastema* appears to be characteristic of southern pine savannas, and two species of *Gabara* occur in New Jersey savannas. Dry pine savannas in Louisiana appear to be among the most

Figure 29. Eastern Arogos skipper (*Atrytone arogos arogos*) from Blackwater River State Forest, Okaloosa County, Florida (Mary Ann Friedman photo).

Figure 30. Loammi skipper (*Atrytonopsis loammi*) from Okaloosa County, Florida (Mary Ann Friedman photo).

depauperate habitats for moths in the eastern United States based on light-trap data in Landau and Prowell (1999), although we hesitate to generalize from this one study.

Oak savannas

This type of savanna formed the transition from eastern hardwood forests to the prairie lands farther west. Oak savannas once extended over a broad area of the American Midwest, from eastern Texas to the Great Lakes (Anderson and Bowles 1999, Fralish *et al.* 1999, Heikens 1999), with a few localized examples east to Massachusetts. However, only about 1% currently remain. Most Midwestern oak savannas (Figure 31) occur on well drained sandy soils, but some occur on richer and wetter soils (Henderson and Epstein 1995, Will-Wolf and Stearns 1999). Those on richer soils were mostly converted to agriculture. The Oak Openings of Ohio (Rings *et al.* 1992) were a patchwork of woodland and savanna habitats. Similarly, the Cross Timbers area was an oak savanna dominated by post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*) in the southern Great Plains of eastern Kansas, Oklahoma, and northern Texas (Hoagland *et al.* 1999). Several uncommon or rare oak-feeding underwing moths such as *Catocala herodias herodias, Catocala delilah*, and *Catocala jair*, occur in that region and are characteristic of such savannas. Oak savannas or openings in oak woodland often harbor prairie species (Henderson and Epstein 1995, Swengel and Swengel 1996b, Ferge and Balogh 2000, Metzler *et al.* 2005). Historically they were an important habitat for a few butterflies, such as the lupine-feeding strain of the frosted elfin (*Callophrys irus*), the Federally Endangered Karner Melissa blue (*Plebejus melissa samuelis),* mottled duskywing (*Erynnis martialis*), and the Persius duskywing (*Erynnis persius persius*), and moths, such as *Erastria*

Figure 31. Midwestern oak savanna at Ober Sand Savanna, Starke County, Indiana (John Shuey photo).

coloraria, *Apodrepanulatrix liberaria*, and *Metarranthis apiciaria*. Most of these Lepidoptera also occur in barrens habitats. The main threats to the remaining oak savannas are:

- Succession, usually due to lack of fire.
- Conversion to urban uses.
- Invasion by exotic plants.

In some places in Wisconsin, according to Hugo Kons, loss of intermediate successional stages due to excessive cutting and burning is a threat to some Lepidoptera.

Pine barrens

The term "pine barrens" is used in many parts of the eastern United States and elsewhere for places where dry sandy or rocky soils favor pine-dominated communities. "Barrens" refers to areas that are unsuitable for most forms of agriculture. The pine barrens community is dominated by pines and scrub oaks, typically with an understory primarily of various low heaths like blueberries (*Vaccinium* species). The oaks tend to drop out in the far north.

Great Lakes pine barrens

Pine barrens in the Great Lakes region occur on sandy soils and are dominated by jack pine (*Pinus banksiana*) (Pregitzer and Saunders 1999) or mixed jack pine and red pine (*Pinus resinosa*). Pine barrens also occur with oak savannas in Kentucky and Tennessee (Baskin *et al.* 1999), often with several species of pines present. Great Lakes pine barrens share many plants with oak savannas, such as sundial lupine. Three of their specialized Lepidoptera, the Karner Melissa blue, frosted elfin, and Persius duskywing (U.S. Fish and Wildlife Service 2003) feed on the sundial lupine. The rare phlox moth (*Schinia indiana*) (Swengel and Swengel 1999a, Ferge and Balogh 2000, Metzler *et al.* 2005) is also found in this habitat. Other species that are characteristic of sandy pine barrens in Wisconsin include *Hemaris gracilis*, *Apodrepanulatrix liberaria, Erastria coloraria, Schizura apicalis*, and *Psectraglaea carnosa* (Ferge and Balogh 2000), and we would add *Brachionycha borealis*.

Northeastern inland sandplain pine barrens

Pine barrens in parts of New York, Massachusetts, Maine, New Hampshire, and Connecticut are dominated by pitch pine (*Pinus rigida*) (Figure 32) and scrub oaks (primarily *Quercus ilicifolia*), with an understory largely consisting of ericaceous shrubs such as blueberries (*Vaccinium pallidum*, *Vaccinium angustifolium*). Grassy openings occurred naturally in these habitats historically, but are now mostly on powerline right-of-ways.

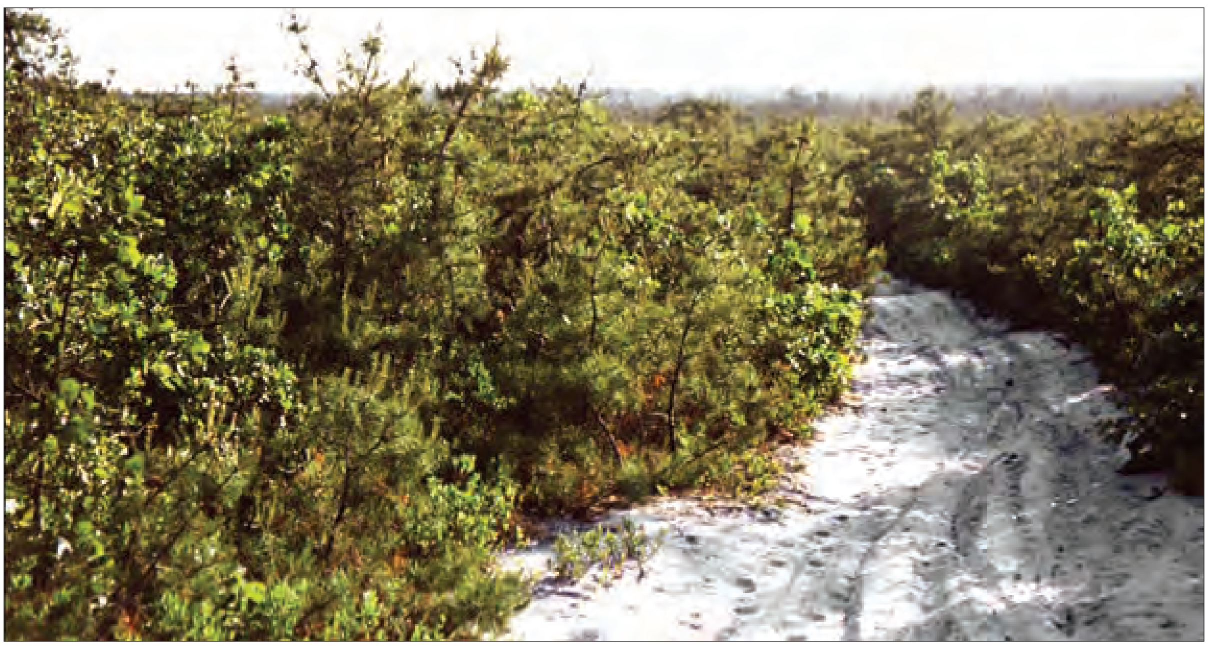

Figure 32. Dwarf pitch pine (*Pinus rigida*) and blackjack oak (*Quercus marilandica*) scrub in the New Jersey Pine Barrens, Ocean County (Marc Minno photo).

Some of these barrens have small remnants of what may have been black oak savannas (a habitat of the Midwest) around the edges. One of the most studied pine barrens is the Albany Pine Bush in New York. At least 31 species of Lepidoptera have disappeared from this site during the 20th century. Other species, such as the Karner Melissa blue, have declined in abundance (Tim McCabe 1995).

Except for the surviving examples in Maine and near Ossipee, New Hampshire, the sandplain pine barrens, which are inland northeastern pitch-pine barrens, shared a number of important food plants with similar habitats around the Great Lakes. Most notably, they had substantial populations of *Lupinus perennis* and *Ceanothus americanus*. While they are now rare or extirpated from the region, the lupine-feeding butterflies (the Karner Melissa blue, frosted elfin, and Persius duskywing), as well as the *Ceanothus*-feeding specialists (mottled duskywing, *Erastria coloraria,* and *Apodrepanulatrix liberaria*), once occurred in sandplain pine barrens in New York, the Merrimack Valley of New Hampshire, and adjacent Massachusetts.

Another rare species, *Metarranthis apiciaria,* formerly occurred in most of the larger examples of these barrens, according to pre-1920 specimens in museums. *Phyciodes batesii* was documented from the vicinity of Albany, New York, so it may have occurred in this habitat, too. The only New England specimen of this butterfly was from a long-gone pine barren near Norway, Maine, that had red pine (formerly sometimes known as Norway pine) (*Pinus resinosa*) as well as pitch pine. *Phyciodes batesii* is still found in pine barrens and oak savannas in Michigan and Wisconsin, and is more common in western Canada. The frosted elfin, Karner Melissa blue, and pine devil moth (*Citheronia sepulcralis*) once occurred in the Norway barrens too, but all apparently disappeared from Maine before 1905. The frosted elfin and *Apodrepanulatrix liberaria* continue to persist at a few localities in New England. The Albany Pine Bush still has small populations of all of the *Ceanothus* specialists.

Disjunct populations of the boreal and western *Lycia rachelae* (Handfield 1999) discussed in our species accounts, occur in most sandplain pine barrens in northeastern Massachusetts, New Hampshire, and Maine. This moth was formerly more widespread in the Boston area (Farquhar 1934), when perhaps it was not as strongly associated with barrens.

Northeastern coastal pine barrens

These pine barrens are found on sandy soils in eastern Massachusetts, Rhode Island, and on Long Island, New York. Like other barrens in the northeast, pitch pine, bear oak, and heaths are the dominant trees and shrubs. For the most part, these barrens are densely vegetated today, but in the past, coastal pine barrens probably had more grasses and important forbs, including *Baptisia tinctoria*, which now occurs mostly on powerline right-of-ways and other disturbed areas. Colonies of the frosted elfin occur mostly on powerline right-of-ways in many areas, but some still occur on well-managed, more natural *Baptisia*-containing habitats in southeastern Massachusetts. One such site also contains Persius duskywing. Coastal pine-bear oak barrens are most notable for rare moths that feed on oaks such as *Speranza exonerata*, *Acronicta albarufa, Heterocampa varia*, *Catocala herodias gerhardi*, and, on Long Island only, *Catocala jair*. Some globally secure moths that occur in a wider array of habitats farther south, reach the northeastern limits of their ranges in these coastal barrens, including *Cicinnus melscheimeri*

Figure 33. *Cicinnus melscheimeri* (Lacosomidae) is a southern moth that extends its range northward in the coastal pine barrens. From Massachusetts (Michael W. Nelson photo).

Figure 34. Buckmoth (*Hemileuca maia*, Saturniidae), from Massachusetts (Michael W. Nelson photo).

(Figure 33), *Catocala umbrosa*, *Morrisonia mucens*, *Lycia ipsilon*, and true *Sphinx gordius*. The buckmoth (*Hemileuca maia*) (Figure 34) may be the best known southern forest and woodland moth to extend its range northward in pine barrens.

NEW JERSEY PINE BARRENS

Much has been written about the New Jersey Pine Barrens (Harshberger 1916, McPhee 1967, McCormick 1970, Boyd 1991, Gibson *et al.* 1999). These scrubby woodlands comprise tens of thousands of hectares on sandy soils in central and southern parts of the state. Pitch pine, heaths, and bear oak, blackjack oak, and post oaks are the dominant plants. A major difference between these and more northern pine barrens is the widespread occurrence of mesic to wet pitch pine lowlands and localized patches of moist to boggy pine savannas, which are comparable to habitats found in pinelands much farther south. At least 39 species of Lepidoptera and numerous plants reach their northern limits in the New Jersey Pine Barrens. Accordingly, about 32 northern peripheral or disjunct moths and butterflies, mostly heath feeders, also occur there.

Quite a few of these southern moths and plants are more widespread and numerous in the New Jersey Pine Barrens than in their core ranges, for example, the plants *Leiophyllum buxifolium*, *Pyxidanthera barbulata*, *Calamovilfa brevipilis* and *Gentiana aumtumnalis,* and the moths that feed on the first three plants. The New Jersey Pine Barrens and similar areas in eastern North Carolina are centers of endemism that contain unique species as well as a few shared ones (Schweitzer and McCabe 2004). *Spartiniphaga carterae* and *Cyclophora* species near *culicaria* occur in both areas, but are not known from anywhere else. Species that appear to be endemic to the New Jersey Pine Barrens include the moths *Agrotis buchholzi, Crambus daeckellus*, and apparently two unnamed *Crambidia* species (Forbes 1960), in addition to what we consider to be an ecologically distinctive subspecies of *Dichagyris reliqua* (see the original description in Lafontaine 2004). *Agrotis carolina* is endemic to pinelands in eastern North Carolina, and *Hemipachnobia subporphyrea* is apparently nearly endemic. Twenty other rare species with accounts in this book are or were found in the pinelands of these states.

Several specialists on scrubby oaks or heaths appear to be more widespread in the New Jersey Pine Barrens than elsewhere, including *Catocala herodias gerhardi*, *Heterocampa varia*, *Psectraglaea carnosa*, *Speranza exonerata*, and *Hypomecis buchholzaria*. *Heterocampa varia* is rather common there, but in recent decades has been collected in only a handful of other places (such as the North Carolina Fall Line Sand Hills and a few places in Florida). Species that feed on taller shrubs, scrubby oaks, and pines are mostly doing well in the Pine Barrens, or at least not declining seriously. However, between 1950 and 1960, *Dasychira leucophaea*, a coastal plain oak feeder[3] disappeared mysteriously. Grasses and forbs have declined noticeably since the 1960s (Windisch 1999, Dale Schweitzer). Considering McCormick (1970) rarely mentions them, they were probably already in decline before that. In New Jersey, common and rare species of moths and butterflies dependent on herbs and grasses are now largely confined to powerline, airport, and other right-of-ways. These include *Digrammia eremiata* and frosted elfin (*Callophrys irus*), and several skippers, most notably *Hespeia me-*

[3] The food plant of *Dasychira leucophaea*, shown in Abbot's ancient figure reproduced by Calhoun (2006), is terminal growth of *Quercus phellos* (willow oak), and not a willow (*Salix* species) as has sometimes been reported.

tea and *Atrytonopsis hianna*. Two species found in grassy pineland habitats, *Pygarctia abdominalis* and possibly *Ptichodis bistrigata*, have disappeared. *Atrytone arogos* and *Dichagyris reliqua* are now critically imperiled. *Grammia placentia* has also become very rare in New Jersey.

Fire is a major contributor to changes in New Jersey. There has been a major shift from frequent, probably relatively light, fires to infrequent, much hotter burns. Over 100,000 hectares of the New Jersey Pine Barrens are now designated conservation lands, and most of the region is a national reserve. Some parcels of conservation land exceed 20,000 contiguous hectares, so development is not generally the main threat to the Pine Barrens. Rather, lack of fire or inappropriate prescribed fire are major issues. Most pine barrens communities in New Jersey require frequent to occasional fires to persist. Harshberger (1916) describes a very different, but not necessarily more natural, landscape than the one that exists today at a time when the now very rare Arogos skipper and extirpated moth *Pygarctia abdominalis* were notably less rare.

OTHER PINE BARRENS

Pitch pine/bear oak/heath barrens also occur on glacial tills in northeastern Pennsylvania and on rocky ridges in northern New Jersey, southeastern New York, New England, and the Virginia mountains. Most New England ridgetop barrens are small in size and do not seem to harbor many unusual Lepidoptera, but a few of the larger, more western sites do have rare species, such as *Catocala herodias gerhardi* (not known in Pennsylvania), *Psectraglaea carnosa,* and *Speranza exonerata*. *Lycia rachelae* occurs disjunctly in the pitch pine and bear oak barrens of northeastern Pennsylvania, as well as in a limited portion of New England. A few pine-feeding southern moths, such as *Zale squamularis* and populations very close to *Panthea furcilla australis* (both of which also reach Long Island), occur in the Pocono barrens. The pitch pine/bear oak communities in the mountains south of Pennsylvania have not been well explored for moths and butterflies, and may have other rare species besides *Catocala herodias gerhardi* and *Speranza exonerata*, which are known to occur in Virginia.

FLORIDA SCRUBS

Forests dominated by sand pine and scrub oaks, especially myrtle oak (*Quercus myrtifolia*) and Chapman's oak (*Quercus chapmanii*), occur on ancient dune ridges and other excessively drained, sandy soils in Florida (Myers 1990, Menges 1999, Whitney *et al*. 2004) (Figure 35).

Figure 35. Sand pine (*Pinus clausa*) scrub, Ocala National Forest, Marion County, Florida (Marc Minno photo).

The sand is typically white at the surface. Florida scrub is usually densely vegetated and difficult to walk through. This community occurs along the Gulf and Atlantic coasts as well as inland in central and northern Florida. Ocala National Forest has the most sand pine scrub in the world. Many unusual, rare, or endemic plants and animals occur in this community. Fire, a rare event in scrubs, kills sand pines and some other plants, which must regrow from seeds. Oaks and ericaceous shrubs typically re-sprout. Kons and Borth (2006) provide comparative information for Florida sand hills and scrubs which harbor many of the same specialized Lepidoptera. *Itame inextricata* and *Hypomecis luridula* are perhaps the most restricted to scrubs according to Kons. The only locality in Florida for *Phoberia ingenua* listed by Lafontaine *et al.* (2008) is a sand pine scrub, but this moth occurs in a variety of other xeric scrubby oak habitats over a very large range farther north.

SANDHILLS

In this book we treat "Sand Hills" as a proper noun when referring specifically to the Fall-Line Sand Hills of the Carolinas and Georgia, because it refers to a specific place. However, the term "sandhills" is also widely used, especially in Florida, to describe xeric long leaf pine (*Pinus palustris*) and turkey oak (*Quercus laevis*) habitats. When referring to xeric long leaf pine and turkey oak sandhills, we do not capitalize the term. Generally, the term is not used in New Jersey.

Sandhills, sometimes called high pine, are widely distributed in hilly terrain in the southeastern United States. However, most of the remaining patches are in poor condition due to logging and fire suppression. Kons and Borth (2006) provide a lot of information and moth records for sandhill habitats and scrubs. They found that there appears to be considerable variation in the diversity and composition of Lepidoptera faunas between different scrubs (including sandhill as a type of scrub), and that some of the scrub species appear to be more localized than others, although more data are needed.

Figure 36. Longleaf pine (*Pinus palustris*) sandhills at Ocala National Forest, Putnam County, Florida (Marc Minno photo).

Sandhills are typically dominated by longleaf pine (*Pinus palustris*) (Figure 36) and wiregrass, and are home to many imperiled species of wildlife, such as the red-cockaded woodpecker, Sherman's fox squirrel, and the gopher tortoise (Myers 1990, Whitney *et al.* 2004). In peninsular Florida, sandhills occur on well-drained brown or yellow sandy soils; elsewhere in the Southeast they also are found on reddish sandy clays. Often there are pitcher-plant seeps and canebrakes on the lower sides of the hills.

In contrast to scrubs, this community is open and park-like and burns on a regular basis.

Oak barrens, often dominated by turkey oak (*Quercus laevis*), develop in sandhill areas where the pines are harvested and fire is suppressed. The oaks shade out the understory grasses and herbs, resulting in a floristically depauperate habitat. However, the oaks themselves host a number of specialized moths, including *Catocala jair*, *Catocala delilah, Heterocampa varia*, *Hyparpax perophoroides*, and *Hypomecis buchholzaria*. Rare butterflies such as *Satyrium kingi* (Figure 37) occur in xeric hammocks where there are lots of oaks.

Figure 37. King's hairstreak (*Satyrium kingi*) from Wakulla Springs State Park, Wakulla County, Florida (Mary Ann Friedman photo).

Specialized oak feeders in the Sand Hills of North Carolina include *Hypomecis buchholzaria, Acronicta albarufa*, *Heterocampa varia*, *Catocala jair, Dasychira leucophaea,* and *Phoberia ingenua*. These oak feeders, except for *Hyparpax perophoroides* and *Catocala delilah*, also occur in the New Jersey Pine Barrens, although *Dasychira leucophaea* has not been collected there in over 50 years.

Moths included in the species accounts below that are found in sandhills, and whose larvae do not feed on oaks, include *Fernaldella georgiana*, *Pygarctia abdominalis*, *Idia gopheri,* and *Schinia petulans*. A spectacular tiger moth (*Grammia placentia*) is also a species of dry, grassy sandhills. Although it has become very scarce in New Jersey, it is still found in dry grassy long leaf pine habitats in the Carolinas, Georgia and Florida. *Catocala grisatra* and *Catocala consors* sometimes occur around the edges of savannas and in adjacent, more wooded, habitats.

Rare skippers that occur in grassy habitats within sandhills include *Hesperia attalus* and *Hesperia meskei*. Among the true butterflies the typical silvery blue (*Glaucopsyche lygdamus lygdamus*) may be (or may have been) restricted to the Georgia and South Carolina sandhills. The Florida striped hairstreak (*Satyrium liparops floridensis*) occurs in xeric hammocks and shrubby sandhills as well as in more mesic habitats nearby.

Kons and Borth (2006, Table 6) provide an extensive list of localized species that occur in Florida sandhill habitats, many of which have accounts in this book or at least are noted in Appendix 2. Some like *Pyrrhia aurantiago, Catocala jair,* and *Erastria coloraria* also occur in specialized xeric habitats much farther north. A few others are rather common in the New Jersey Pine Barrens such as the oak-feeding *Trichosilia manifesta, Heterocampa varia,* and *Nemoria bifilata*. Many have limited ranges outside of Florida, including *Ptichodis pacalis, Schinia scissoides, Schinia fulleri, Schinia arefacta,* and *Trichoclea vindemialis.*

Pine flatwoods

Pine flatwoods is a broad category of pine-dominated woodlands found throughout the southeastern United States. As the name suggests, this community type occurs in landscapes with little topographic relief. The lowlands of pine flatwoods are typically moist to seasonally wet. This community is often interspersed with swamps, wet prairies, ponds, and blackwater streams. The most common tree is usually slash pine (*Pinus elliottii*), but some flatwoods are dominated by longleaf pine (*Pinus palustris*), pond pine (*Pinus serotina*) (Figure 38), loblolly pine (*Pinus taeda*) or mixtures of these species (Abrahamson and Hartnett 1990).

Typical flatwoods soils are spodosols which have a relatively impermeable, darkly-colored spodic horizon. The spodic horizon consists of fine sand cemented with organic material, iron, and aluminum that forms near the level of the average water table. Water becomes perched upon the spodic horizon during the summer rainy season, but spodosols often become droughty during the dry season. Thus, plants that grow in flatwoods must be able to tolerate both very wet and very dry conditions.

Figure 38. Pond pine (*Pinus serotina*) flatwoods at Ocala National Forest, Putnam County, Florida (Marc Minno photo).

Flatwoods vegetation varies considerably, from low wet types found near the coast, to the scrubby flatwoods found in central Florida that contain many species more typically found in drier forests. Flatwoods in central and southern Florida tend to be more like savanna or prairie habitat, and are most often used as rangeland for cattle. More northern or xeric flatwoods have dense thickets of saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), and other shrubs in the understory. Flatwoods in northern Florida, Georgia, the Gulf states, and other parts of the Southeast are biologically depauperate, as they have mostly been converted into managed plantations of slash or loblolly pine for pulp and timber production. Under natural conditions, flatwoods burn on a regular basis; if fire is suppressed, they become overgrown by oaks, red maple, other hardwoods, and shrubs.

Some of the rarest species found in pine flatwoods are grass-feeding skippers, notably *Hesperia attalus, Hesperia meskei, Atrytonopsis loammi*, and *Amblyscirtes alternata*. North Carolina flatwoods share rare specialists with New Jersey savannas and pitch pine lowlands, including the Arogos skipper, an undescribed *Cyclophora* species, and *Spartiniphaga carterae*.

TROPICAL PINELANDS (PINE ROCKLANDS)

Tropical pinelands or pine rocklands (Figure 39) occur in small areas of southeastern Florida, especially in eastern Everglades National Park, southern Miami-Dade County, Big Pine Key, Little Pine Key, Cudjoe Key, and Sugarloaf Key. Rocklands are outcrops of highly weathered limestone

Figure 39. Pine rockland at the National Key Deer Refuge, Big Pine Key, Monroe County, Florida (Maria Minno photo).

or dolomite. The terrain is pockmarked with solution holes and depressions, which makes walking on it difficult. The dominant plants are south Florida slash pine (*Pinus elliottii* var. *densa*), palms, and tropical hardwoods such as poisonwood (*Metopium toxiferum*) and locustberry (*Byrsonima lucida*) (Snyder *et al.* 1990). Some of the rarest butterflies in the United States are found in pine rocklands, including the Keys form of the Pilatka skipper (*Euphyes pilatka klotsi*) (Figure 40), Florida duskywing (*Ephyriades brunnea floridensis)* (Figure 41), Bartram's scrub-hairstreak (*Strymon acis bartrami*) (Figure 42), and the Florida leafwing (*Anaea troglodyta floridalis*) (Figure 43). The latter butterflies

Figure 40. Palatka skipper (*Euphyes pilatka klotsi*) from the National Key Deer Refuge, Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 41. A female Florida duskwing (*Ephyriades brunnea floridensis*) from the National Key Deer Refuge, Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 42. Bartram's scrub-hairstreak (*Strymon acis bartrami*) from Everglades National Park, Long Pine Key, Miami-Dade County, Florida (Marc Minno photo).

Figure 43. Florida leafwing (*Anaea troglodyta floridalis*) from Everglades National Park, Long Pine Key, Miami-Dade County, Florida (Marc Minno photo).

are both candidates for federal listing. The now-extinct rockland Meske's skipper (*Hesperia meskei pinocayo*) (Figure 2) also occurred in this habitat.

Figure 44. West Indian hardwood hammock on Key Largo, Monroe County, Florida (Marc Minno photo).

The nocturnal moth fauna of pine rocklands is very poorly documented. Without fire, pine rocklands quickly become overgrown by hardwoods and gradually change to hardwood hammocks. Even so, rare Lepidoptera in remnant patches of rockland could easily be eliminated if too much of the habitat is burned at one time.

West Indian hardwood hammocks

Tropical hardwood forests (Figure 44) or hammocks contain a great diversity of trees and shrubs from the Caribbean region, such as wild tamarind (*Lysiloma latisiliquum*), gumbo limbo (*Bursera simaruba*), pigeon plum (*Coccoloba diversifolia*), mahogany (*Swietenia mahagoni*), poisonwood (*Metopium toxiferum*), crabwood (*Gymnanthes lucida*), and many other species (Snyder *et al.* 1990). Tropical hardwood hammocks are found in coastal uplands of Florida from Tampa Bay and Merritt Island southward into the

Keys. These forests are sometimes affected by winter freezes, but are also shaped by hurricanes and tropical storms. The Federally listed Schaus' swallowtail (*Papilio aristodemus* ponceanus) and many other butterflies and moths of West Indian affinity occur in the tropical hardwood hammocks of the Florida Keys. A number of other butterflies occur mostly in tropical hammocks, such as the Bahamian swallowtail (*Papilio andraemon bonhotei*), Miami blue (*Cyclargus thomasi bethunebakeri*), amethyst hairstreak (*Chlorostrymon maesites*), Florida white (*Glutophrissa drusilla neumoegenii*), Florida purplewing (*Eunica tatila tatilista*), and dingy purplewing (*Eunica monima*).

Three notodontid moths (Appendix 2) might occur mostly in these habitats. We have very little information on the moth fauna of this habitat type. Florida's coastal areas and islands in the Keys, where these forests occur, are also highly favored by people, and much of the tropical hardwood hammock vegetation has been scraped away and converted to urban landscapes.

Swamps

Swamps are forested wetlands. Various types of swamps, dominated either by conifers or hardwoods, occur in the eastern states.

Atlantic white cedar swamps

Atlantic white cedar (*Chamaecyparis thyoides*) (Figure 45) swamps are patchily distributed, often along blackwater streams from Mississippi to northern Florida and northward along the Atlantic coast and Fall Line to Maine. White cedar is a favored timber tree, and most stands have been cut over, often several times, since Colonial times. Today, Atlantic white cedar is most common in New Jersey and southeastern New England. This conifer has specific environmental requirements, such as peaty soils with relatively consistent flow of acidic, low-nutrient water. Laderman (1987, 1989) and Ward and Clewell (1989) discuss the ecology of white cedar swamps. Atlantic white cedar stands cannot regenerate after fires or logging where deer are excessively abundant, because the seedlings are a favored winter food for deer. In such situations, hardwoods will replace the cedars. Hessel's hairstreak (*Callophrys hesseli*) (Figure 46) feeds only on Atlantic white cedar, and *Lithophane lemmeri* (Figure 47) is found in cedar swamps of New Jersey and Florida and probably a few other places. *Lithophane lemmeri*

Figure 45. Atlantic white cedar (*Chamaecyparis thyoides*) swamp along Panther Creek, Blackwater River State Forest, Okaloosa County, Florida (Marc Minno photo).

Figure 46. Hessel's hairstreak (*Callophrys hesseli*) from Blackwater River State Forest, Okaloosa County, Florida (Mary Ann Friedman photo).

Figure 47. *Lithophane lemmeri* from Atlantic County, New Jersey (Damon Noe photo).

and *Glena plumosaria* (at least in New Jersey) seem to be more or less specialists on Atlantic white cedar in areas where it is abundant, but they use red cedar elsewhere. Prior to 1989, only one specimen of the southern *Glena plumosaria* (Geometridae) had ever been collected in New Jersey, but Dale Schweitzer found this moth again in that state in 1989 and 1994. By 1999, *Glena plumosaria* was abundant in several Atlantic white cedar swamps (including the 1994 collection site), often with 20 or more adults appearing at a blacklight. *Hypagyrtis brendae* seems characteristic of white cedar swamps from North Carolina to Florida, but also presumably uses red cedars elsewhere.

Cypress swamps

Swamps dominated by bald cypress (*Taxodium distichum*) (Figure 48) occur along the margins of rivers, streams, and lakes, or in strands and sloughs along the Atlantic coastal plain from Delaware to southern Florida, westward to south-central Texas, and northward in the Mississippi River system to southern Illinois and Indiana. Bald cypress occurs in pure stands or mixed with hardwoods such as tupelos (*Nyssa* species), ash, and other trees (Ewel 1990, Rose 2000). Pond cypress (*Taxodium ascendens*) lacks the feathery leaves of bald cypress and occurs mostly in small isolated depressions in the flatwoods in the southeastern United States.

Five moths that specialize on cypress follow bald cypress to the northern end of its range in southern Delaware and/or adjacent Maryland: *Isoparce cupressi*, *Anacamptodes pergracilis*, *Cutina albopunctella*, *Cutina distincta*, and *Lithophane abita* (species number 2258,1 in Kimball 1965). Hugo

Kons found *Macaria aequiferaria, Anacamptodes pergracilis, Isoparce cupressi, Cutina distincta, Cutina aluticolor, Cutina arcuata,* and *Cutina albopunctilla* complex near the northern limit for cypress in Posey County, Indiana. All four species of the genus *Cutina* appear to be cypress specialists, and all occur in Virginia as well, and range south to Texas (Pogue and Ferguson 1998; Virginia Natural Heritage Program). No cypress specialists are currently thought to be globally rare. Four other rare moths associated with cypress swamps are *Anacamptodes cypressaria, Zale perculta*, *Acronicta perblanda,* and *Acronicta sinescripta,* although at least two of these do not feed on cypress and the food plant of the first is unknown.

Figure 48. Bald cypress (*Taxodium distichum*) swamp in Lake County, Florida (Marc Minno photo).

Arborvitae (*Thuja occidentalis*) is a conifer that occurs in swamps, and in many northern habitats besides swamps, in the Great Lakes region and New England. *Lithophane thujae* larvae feed on arborvitae (Webster and Thomas 1999). This moth is known in the United States only from northern parts of Wisconsin and Michigan, but probably is not as rare in Canada. Black spruce (*Picea mariana*) swamps and more open bogs occur in the northernmost parts of our area, and the uncommon bog elfin (*Callophrys lanoraieensis*) occurs in some of these swamps, especially in Maine.

HARDWOOD SWAMPS

Southeastern hardwood swamps occur from Florida and the Gulf states northward to North Carolina, particularly in bottomlands along streams and rivers and in depressions. A variety of trees such as ash (*Fraxinus* species), swamp cottonwood (*Populus heterophylla*), willow (*Salix caroliniana*, *Salix nigra*, etc.), tupelo (*Nyssa aquatica* and *Nyssa sylvatica*, the latter of which is also called black gum), bottomland oak (*Quercus* species), maple (mostly *Acer rubrum*), holly (*Ilex* species), hawthorn (*Crataegus marshallii, Crataegus aestivalis,* etc.), and many others occur in these swamps. Bay swamps and pocosins dominated by evergreen or semi-evergreen broad-leaved trees including sweetbay magnolia (*Magnolia virginiana*), loblolly bay (*Gordonia lasianthus*), and swamp bay (*Persea palustris*), are often found on the lower slopes of hills and other seepage areas in coastal areas of the Southeast and Florida.

Rare or at least specialized Lepidoptera in southeastern hardwood swamps include Dukes' skipper (*Euphyes dukesi*) (Figure 49), Delmarva mulberry wing (*Poanes massasoit chermocki*), Seminole Texan crescent (*Anthanassa texana seminole*) and the underwing moths *Catocala atocala* and *Catocala marmorata*. While red maple (*Acer rubrum*), sweetbay, and blackgum are common in swamps south to Florida, they become increasingly dominant as the more southern bays and hawthorns decline or drop out north of southern Virginia. Pitch pines (*Pinus rigida*) usually occur in small numbers in hardwood swamps in New Jersey, and other pines sometimes occur southward. In New Jersey, *Catocala pretiosa* and, to a lesser extent, an undescribed *Metarranthis* species are characteristic of hardwood swamps. Sweetbay is the food plant of a somewhat uncommon saturniid moth, *Callosamia securifera*, in the Southeast. No rare lepidopterans are known to occur regularly in hardwood swamps north of southern New Jersey.

Figure 49. Dukes' skipper (*Euphyes dukesi calhouni*) from Seminole Ranch Conservation Area, Orange County, Florida (Mary Ann Friedman Friedman).

Mangrove swamps

These wetlands (Figure 50) occur in salt and brackish water in coastal areas of central and southern Florida. Red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*) are typically the only trees that grow in these saline wetlands (Odum and McIvor 1990). They may occur in relatively pure or mixed stands. Red mangrove, with unusual arching prop roots, is the most tolerant of flooding, waves, and tidal fluctuations. Mangrove swamps are habitat for a few specialized insects that occur nowhere else in the United States, including the mangrove skipper (*Phocides pigmalion*) whose larvae eat red mangrove, and the mangrove buckeye (*Junonia evarete*) and false-windowed sphinx (*Madoryx pseudothyreus*), whose larvae eat only black mangrove.

Figure 50. Mangrove swamp at Saddlebunch Keys, Monroe County, Florida (Marc Minno photo).

Canebrakes

Species of cane are bamboos (Figure 51), which are very large grasses sometimes several meters tall. They grow in a variety of mesic to wet wooded habitats including savannas, wet flatwoods, the edges of cypress or hardwood swamps, along streams and ditches, and on hillside seeps north to the southern Ohio Valley and lower Delmarva region. Dense stands of cane, which spreads by rhizomes, are called canebrakes. They are often found along streams and riv-

Figure 51. A mature, unburned, canebrake on St. Catherines Island, Liberty County, Georgia (Erik Neff and Eric L. Quinter photo).

Figure 52. Switch cane (*Arundinaria gigantea*) at Blackwater River State Forest, Okaloosa County, Florida (Marc Minno photo).

ers in hardwood communities, especially inland. Moist, coastal plain pinelands and swamps are also typical places to find cane, sometimes in disturbed settings like ditches. In recent decades, all cane in the United States had generally been treated as a single variable species, *Arundinaria gigantea* (Figure 52), although some botanists recognized the smaller *Arundinaria tecta* as a separate species. *Arundinaria tecta* is restricted to the coastal plain (Clark and Triplett 2007), where it occurs in moist pinelands and other wet wooded habitats, often where fires are frequent. Recently, Triplett *et al.* (2007) revised the taxonomy and named a third species of cane, *Arundinaria appalachiana*.

About 20 species of moths feed only on cane, and the ranges of several of these seem to coincide only with that of *Arundinaria gigantea*, but it is not clear whether any are restricted to only one of the three species of cane. Most of the cane-feeding moths are little known except to Eric Quinter, who has studied canebrake fauna extensively and described or co-described four Noctuidae associated with cane in Mikkola *et al.* (2009). Besides Quinter's multi-state efforts, Bo Sullivan and Steve Hall in North Carolina, Steve Roble in Virginia, Hugo Kons and Robert Borth in Florida and Texas have made important collections from canebrakes.

Quinter kindly provided us with substantial information which we summarize in our discussion of the Apameini (Noctuidae). Over a dozen species of Apameini are cane specialists, most of them as borers. A few others are closely associated with canebrakes, but they have not been documented as feeding on cane. Two other Noctuidae, *Argillophora furcilla* and *Leucania calidior*, are thought to feed on the foliage. There are also some Pyraloidea that use cane, such as *Crocidophora pustuliferalis* (Covell 1984).

Figure 53. Southern pearly-eye (*Enodia portlandia*) from the Great Dismal Swamp National Wildlife Refuge, Nasemond County, Virginia (Rick Cech photo).

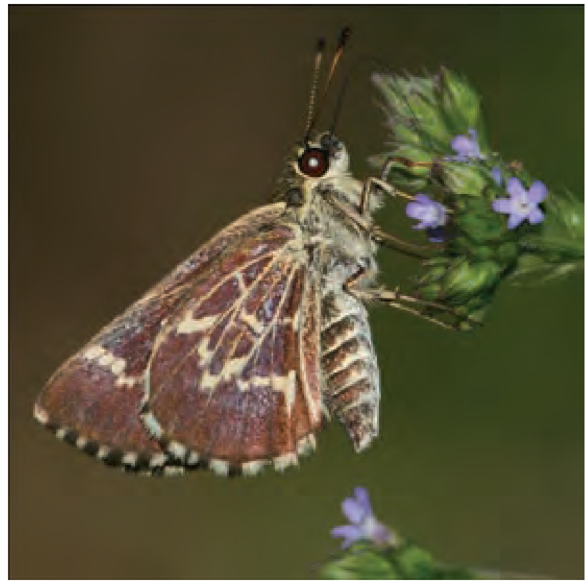

Figure 54. Lace-winged roadside-skipper (*Amblyscirtes aesculapius*) from the Choctawhatchee River Wildlife Management Area, Holmes County, Florida (Mary Ann Friedman photo).

Figure 55. Reversed roadside-skipper (*Amblyscirtes reversa*) from Walton County, Florida (Mary Ann Friedman photo).

Larvae of two butterflies, the southern pearly-eye (*Lethe portlandia*) (Figure 53) and the Creole pearly-eye (*Lethe creola*), and three species of skippers, *Amblyscirtes aesculapius* (Figure 54), *Amblyscirtes carolina*, and *Amblyscirtes reversa* (Figure 55), feed on cane, probably exclusively. *Amblyscirtes carolina, Amblyscirtes reversa*, and most of the cane-feeding Apameini have much more limited ranges than does cane. Most of them are absent from the Florida peninsula, although *Leucania calidor, Argillophora furcilla, Amblyscirtes aesculapius,* and *Enodia portlandia* do occur there (Kons and Borth 2006).

Canebrakes are fire tolerant, and fire is a potential issue for cane-associated Lepidoptera. By summer, some of the borers are in the base or roots where they would be protected from some fires, and they pupate underground. But there is no "safe" season for burning canebrakes that protects all of these species. For example, *Protapamea* spend most of the year as eggs in the dead axillary shoots (Quinter in Mikkola *et al.* 2009). The unnamed species we illustrate (page 348) spends most of the year as an egg in the sheaths, low on first year shoots (Dale Schweitzer). *Papaipema* species overwinter as eggs in the litter or on the cane. The butterflies and skippers have no underground stages. Unburned refugia should always be left during prescribed burns. Some of the species seem to need impenetrable thickets of dense, large cane, and do not turn up even where cane is abundant in areas that are burned regularly, according to Quinter (personal communication with Dale Schweitzer). When unburned refugia are provided, the skippers and butterflies with two or more broods should recover from fire faster than the single-brooded apameine borers.

Sources of information

Specimens preserved in collections provide historical information, and most of the information in this book came directly or indirectly from collectors and collections. A thorough examination of all collections was not practical for this project, but over the years we have visited many of the major eastern research institutions and private collections. Institutional collections we have visited include:

- National Museum of Natural History (NMNH)
- American Museum of Natural History (AMNH)
- Museum of Comparative Zoology (MCZ, Harvard University)
- New York State Museum
- Peabody Museum of Natural History (Yale University)
- North Carolina State University
- Florida Department of Agriculture and Consumer Services, Division of Plant Industry (DPI)
- University of Vermont
- University of New Hampshire
- University of Delaware
- Rutgers University

Private collections are often the best sources of current information, and there is the added advantage that the collector can provide additional information such as habitat, numbers seen, etc. We have been in frequent contact with collectors, ecological consultants, preserve managers, Natural Heritage Programs, and others involved in biological surveys and inventories across the eastern United States and Canada. Collectors have provided access to their collections and shared their extensive information (see the Acknowledgements section). All three of the authors have been involved in the formulation and review of state lists of rare and endangered Lepidoptera.

Regarding published information on the Lepidoptera of the eastern United States and Canada, we routinely consulted regional works. For general ranges of moths, we consulted Forbes (1948, 1954, 1960) and Covell (1984); Jones (1928-32) for Delaware; Farquhar (1934) for New England, especially Massachusetts; Crumb (1956), Kons and Borth (2006) for northern Florida, Kimball (1965) or Heppner (2003) for southern Florida; Brower (1974) for Maine; Rings *et al.* (1992) for Ohio; Grehan *et al.* for Vermont; Covell (1999) for Kentucky; Handfield (1999) for Quebec; and Ferge and Balogh (2000) for Wisconsin. Kons and Borth (2006) have distributional, habitat, and phenology data for north Florida Macrolepidoptera, including specific locality data. Ferge and Balogh (2000) provide summaries of species that they consider to be characteristic of specialized habitats in Wisconsin. We do not necessarily cite these standard works in every range account. We also consulted the series, "*Moths of America North of Mexico*," specifically Ferguson (1978, 2008), Lafontaine (1987, 1998, 2004), and Lafontaine and Poole (1991).

Similarly, butterfly information is available from many guides. We relied mostly on Glassberg (1999) and Brock and Kaufman (2003) for butterflies and skippers, because these works have detailed range maps that show discontinuous ranges accurately.

We often consulted Layberry *et al.* (1998) for Canadian ranges. Metzler *et al.* (2005) also provide a significant amount of distributional information for prairie and savanna species.

The Brower, Heppner, and Kimball references contain errors of identification for some of the species included in this book. However, a large portion of the records in the last two are based on specimens in the Florida Department of Plant Industry collections in Gainesville, which we have examined in the 1990s and since. Upon visiting this collection, we found that many specimens were misidentified, and we base records from that source on our own identifications. Farquhar (1934) is remarkably reliable for New England, and Dale Schweitzer has seen some of his specimens.

Our coverage is admittedly weaker from Missouri to Texas, which is beyond the primary coverage area of this book. Some Natural Heritage Programs are also valuable sources of faunal information for Lepidoptera, and their records are generally verifiable from specimens, or at least photographs. The Natural Heritage Programs of North Carolina, Virginia, and Massachusetts were especially valuable sources of information for this book. Edward Knudson and Hugo Kons Jr., helped us with distributions in Texas. Bordelon and Knudson (1999) contains information on moths of eastern Texas, which has a fauna similar to that of the Gulf Coastal Plain and northern Florida.

Species accounts

Our species selection is based heavily on rankings provided by NatureServe, a non-profit conservation organization. Ranks and their definitions are as follows:

G1 – Critically imperiled: Species are at very high risk of extinction due to extreme rarity (often 5 or fewer populations[4]), very steep declines, or other factors.

G2 – Imperiled: At risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

G3 – Vulnerable: Globally uncommon to rare, but not immediately imperiled these species are vulnerable due to a restricted range, relatively few populations (often 80 or fewer), declining or rare habitats, recent and widespread declines, or other factors.

G4 – Apparently secure: Uncommon but not rare, these species are considered secure for now, but there may be some cause for long-term concern due to declines or other factors. These species may be imperiled in some parts of their range.

G5 – Secure: Common, widespread, and abundant species.

GU – Global status unknown: The ranking of these taxa cannot be determined due to lack of critical information, or in some cases due to rapidly changing status.

GNR – Unranked: This rank is used if the species has not been evaluated.

GH – Globally historic: These species have no verified occurrences within at least the last 20 years, or the species is thought to be extirpated at all documented occurrences, including recent occurrences. There is still some possibility these species will be rediscovered.

GX – Extinct.

Combination ranks are commonly used when there is uncertainty about the current status of a species. For example, G3G4 means G1, G2, and G5 can be eliminated, but it is not clear whether G3 or G4 should apply. In other words, the species is uncommon and perhaps rare, but not now either imperiled or obviously secure.

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[4] Population refers to metapopulations or population clusters, wherever possible. We generally avoid using the term metapopulation in this book.

The term globally rare (or uncommon to rare), if based on NatureServe ranks, refers to species ranked G1 to G3, usually including G3G4.

S-ranks (subnational) are used by states, Canadian provinces, and elsewhere. For example, in Massachusetts the buckmoth (*Hemileuca maia*) is G5S2, meaning it is common and widespread elsewhere (for example in southern New Jersey), but is imperiled in Massachusetts.

T-ranks refer to the status of subspecies. The Federally endangered Karner Melissa blue butterfly (*Plebejus melissa samuelis*) is ranked G5T2 and SX (extirpated) in Ontario, Pennsylvania, and Massachusetts. As currently defined, the species *Plebejus melissa* is common and widespread in western North America, but the Karner Melissa blue occurs in relatively few places.

Species ranked by NatureServe as G1 to G3 are included in the accounts below, providing they are primarily forest, woodland, or savanna species and we know enough about their biology and status to write a meaningful account. Others that are less well known are listed in Appendix 2. We were selective about species ranked G3G4, since not enough is known about some of them to write a useful account. With more collecting in proper habitats and seasons, many probably will be found to be more common. Currently G3G4 is applied to numerous species found in dry scrub habitats in Florida and neighboring states. Some of these have full accounts in this book, and others are noted in Appendix 2. Given the rapidity of loss of such habitats and the paucity of moth collectors, we often do not know which of these scrub inhabiting species are now rare. Hugo Kons reports (personal communication with Dale Schweitzer) that collecting restrictions on some public properties have hampered his efforts to survey north Florida scrubs. We include a few species that have declined over a large part of the eastern United States, notably *Catocala consors* and *Autochton cellus*, but which are ranked G4 because they occur more commonly farther west. We include two northern moths, *Lycia rachelae* and *Brachionycha borealis*, that have widely disjunct and limited ranges in our coverage area, but are more common much farther north and west. Populations of *Lycia rachelae* in New England and Pennsylvania and Appalachian populations of *Brachionycha borealis* are probably as evolutionarily significant as most butterfly subspecies.

NatureServe does not necessarily track all subspecies. It is unlikely to track a subspecies if both the subspecies and full species are globally common, or a subspecies appears to represent non-disjunct ends of clinal variation. While even slightly divergent populations of butterflies and skippers usually have been given subspecies names, very few moth populations have been distinguished in this way. Disjunct New Jersey populations of *Dichagyris reliqua* probably warrant subspecies status, as was noted in the original description. Gall and Hawks (2010) sank (synonymized) a number of other subspecies, but recognize two subspecies of *Catocala pretiosa*. Among skippers, three examples of rare subspecies of G4 or G5 species are included, one from Florida. Among butterflies, there are eight examples, including three from Florida and two subspecies of *Phyciodes batesii*.

Phyciodes batesii batesii illustrates a problem with subspecies. The two most recent revisers of this group differed substantially in their circumscriptions of subspecies. Scott (1994) described *Phyciodes batesii lakota*. Yet Gatrelle (1998b) does not consider it to be distinctive enough to merit recognition. Apparently disjunct high elevation southern Appalachian populations are much more distinctive in appearance and habitat, and are now generally recognized as *Phyciodes batesii maconensis* (described by Gatrelle), but Scott includes them in *Phyciodes batesii batesii*. By Scott's application of the name, other than what is now *Phyciodes batesii maconensis*, pure *Phyciodes batesii batesii* is extinct, although a few intermediate populations may still exist in Ontario. However, according to Gatrelle's definition, which includes *Phyciodes batesii lakota*, it still occurs in Wisconsin, Michigan, and widely in western Canada, and would be ranked as apparently globally secure (G4T4).

The U.S. Fish and Wildlife Service lists species and subspecies that are threatened or endangered, providing them legal protection under the Endangered Species Act (ESA) of 1973. This agency also maintains lists of candidate species of plants and animals for formal listing. Species on the Category 1 (C1) list are considered by the U.S. Fish and Wildlife Service to be threatened or endangered, but await the formal legal process to propose rules to list them as such. The much larger Category 2 (C2) list included species that may have been threatened or endangered, but required further study and evaluation. The C2 list was officially eliminated on 19 July 1995 by the U.S. Fish and Wildlife Service, but many of these species are still tracked.

Below we identify species that are currently listed as threatened or endangered as well as those that were on the C2 list at the time it was eliminated. Funding for listing has been very limited in recent years. This has lead to a backlog of species awaiting action. We point out several taxa for which we think there is sufficient information for listing. Some of these are much rarer than many species currently listed by U.S. Fish and Wildlife Service. In addition to U.S. Fish and Wildlife status and NatureServe rank, we include the Xerces Society rank for butterflies and skippers as they appear in Appendix H-1 of the National Research Council (2007) book on the status of pollinators.

In the accounts below, an adult is illustrated for each species, and for some, a last instar caterpillar. Sometimes we reference illustrations in other publications, especially for butterflies. We also attempt to point out published misidentifications that may cause confusion. Based on wingspan or expanse, five common class sizes are:

- Very small (1/4 inch or less [<6 mm])
- Small (greater than ¼ " to 1" [6-25 mm])
- Medium (greater than 1" to 2 ½" [25-63 mm])
- Large (2 ½" to 4" [63-100 mm])
- Very large (greater than 4" [>100 mm])

Wingspan refers to the distance from wingtip to wingtip of spread specimens, and thus varies somewhat according to how the wings were positioned. Females are typically larger than males. Most of the measurements cited below were originally published in Opler and Krizek (1984) for butterflies and Forbes (1923, 1948, 1954), Sargent (1976), or other taxonomic literature for moths. We also provide a life history account and food plants for each taxon. At the end of each account, we summarize references for the species, attempting to include all citations from that account and occasionally others. We intentionally omit citations that do not really pertain to the species, for example, if the information is incorrect or incidental (e.g. mention of a saturniid in a noctuid species account).

One of the main purposes of this book is to provide information useful in protecting and managing rare species. To that end, we discuss threats and management issues. For most species, we include a brief discussion of potential impacts related to gypsy moths, including *Btk* applications and defoliation, or briefly state why gypsy moth-related issues probably do not apply. We discussed impacts from Dimilin® applications against gypsy moths earlier, so we do not usually discuss them in the species accounts below. If the caterpillar feeds on foliage or forest litter present at the time of Dimilin® application, high mortality would be expected for the rest of the season. However, for *Btk,* usually all we can do is indicate whether the caterpillars would be exposed to applications aimed at gypsy moth larvae. Sensitivity to *Btk* varies greatly among caterpillar species and even among instars of the same species. Therefore, exposure of larvae to *Btk*, especially after the second instar, merely indicates that there is potential for adverse impacts. For a few species with summer-feeding caterpillars, use of *Btk* to suppress gypsy moth larvae may possibly be beneficial.

For species that occur in fire-prone habitats, we indicate when they would, or would not, be exposed to potentially high mortality during fires. In addition, we cite lack of fires as a potential threat for species found in fire-adapted habitats.

Overly abundant deer are among the most commonly mentioned threats, and the main threat for many understory Lepidoptera species in the Northeast. Encouraging deer hunting, including the hunting of does, is a greatly-needed management strategy for rare Lepidoptera in many areas. This is especially true where deer densities are much above 20 individuals per square mile. Other management issues or threats are included, where appropriate.

Nomenclature follows Pelham (2008) for the butterflies and skippers. Classification above the species level within the Noctuoidea follows Lafontaine and Schmidt (2010). It proved impractical to follow a few of their generic changes, as it would have required moving many accounts and illustrations, although we do note such changes. Major changes include splitting Erebidae and some other traditional Noctuidae off as families, and placing the former Arctiidae and Lymantriidae as subfamilies at the beginning of the Erebidae. Most moth names in other families follow the Hodges *et al.* (1983) MONA checklist. For undescribed species, we follow NatureServe (2008) for those covered on their website, except that in their database "species" is usually abbreviated as "sp."

While both are given at the beginning of each species account, scientific names are preferred over common names in the text for moths. Very few moths have common names that are widely used. Sometimes we use a common name to denote a species that has not been given a Latin name. Even if we use common names in the text for a full species, we usually use scientific names when referring to one of its subspecies. Usually we use only the scientific name when referring to other moth species for which we do not provide an account. However, we often use both names for butterflies and skippers.

Common names are not in general use for most groups of moths, except for agricultural pests. English names that one might find in Covell (1984) or Holland (1903) are not known to, or useful for communicating with, most moth specialists. While the familiar and appropriate terms underwings or underwing moths are commonly used for the genus *Catocala* (Noctuidae), almost all underwing enthusiasts use the Latin name to refer to the species. Readers who are already somewhat familiar with moths (other than Saturniidae), are far more likely to know them by scientific names. To those who are just learning moths, we strongly recommend using the scientific names, because you will need them to communicate with experts. If pronunciation is a stumbling block, remember there is such a variety of pronunciations in use that there is no "right" way. A useful tip is that there are no silent letters in Latin names.

There are no "official" common names for most insects, but for butterfly and skipper species we follow recent guides, such as Glassberg (1993, 1999), Glassberg *et al.* (2001), and Brock and Kaufman (2003). Miller (1992) is the most thorough review of common names of butterflies. Alternate common names in various popular guides such as Klots (1951) or Allen (1997) or those in Miller's (1992) review of the topic are equally correct. However, the common names listed by the North American Butterfly Association (NABA) are most widely used. For moths, we either used a common name that we found in the literature (such as in Holland 1903, Covell 1984; Wagner *et al.* 2001, Wagner 2005), or we invented something that seems appropriate.

Butterflies

Family Hesperiidae (skippers)

Subfamily Eudaminae (broad-winged skippers)

Golden banded-skipper (eastern population)

Autochton cellus (Boisduval and Le Conte)

Identification

This relatively large (40 to 50 mm) skipper is dark brown with a diagnostic wide golden band across each forewing (Figures 56 and 57). The underside of the hindwing has an iridescent purple sheen. Several other similar skippers have golden spots across the forewings, but not a smooth-edged band. The common silver-spotted skipper (*Epargyreus clarus*) has a large white patch on the underside of the hindwings. The larva is green with yellow stripes and a dark reddish-brown head that has two yellow eyespots (Figure 58).

Figure 56. Golden banded-skipper (*Autochton cellus*) upperside male from Alachua County, Florida (Marc Minno photo).

Figure 57. Golden banded-skipper (*Autochton cellus*) underside male from Alachua County, Florida (Marc Minno photo).

Taxonomic notes

In the United States, this butterfly has a disjunct distribution. Although widely separated, eastern and southwestern populations have not been given subspecies status because the adults are not phenotypically distinctive, despite biological differences (Burns 1984).

Figure 58. Golden banded-skipper (*Autochton cellus*) larva from Alachua County, Florida (Marc Minno photo).

Range

The western populations occur in a small area in western Texas, then more widely west to southeastern Arizona and adjacent New Mexico, and southward into southern Mexico. The historical range in the eastern United States was from southwestern New Jersey across Delaware to northern Virginia, southwest through parts of West Virginia and the Ohio Valley to Missouri, Arkansas, adjacent Oklahoma. It also ranged southward through the mountains and Piedmont to northern Georgia, with outlying populations in northern Florida and central Texas. The eastern range includes most of Tennessee and Kentucky. This impressive skipper was briefly present in Lancaster County, Pennsylvania, in the early 1980s. The food plant is common much farther north. There were two population centers in Florida. The golden banded-skipper used to occur in mesic woods in Gainesville, Alachua County, but has not been seen there since the late 1990s. It also occurs disjunctly in the eastern Florida Panhandle.

Rarity

NatureServe global rank: G4 (the eastern version would probably rank G4T3). This species is probably secure throughout its range, because it is fairly common in parts of Arizona and Mexico. However, it is very rare and declining in the eastern United States. It is probably extirpated at least from New Jersey, Delaware, Pennsylvania, Maryland, and northern Virginia. The last known New Jersey and Delaware specimens were collected before 1965. In our region this species is typically seen in low numbers, most often as single individuals. It may be that colonies consist of few individuals and therefore die out frequently and isolated populations are unlikely to persist. However, it is also possible that some of these observations were made away from the primary habitat. In North Carolina this species has been reported 23 times in the last 15 years with no more than four (once) on a single day, and apparently 20 of these records were single individuals. LeGrand and Howard (Butterflies of North Carolina website) regard the species as very rare in the mountains and extremely rare farther east. This species was occasionally seen in larger numbers in the mountains. The golden banded-skipper has recently become abundant at Elinor-Klapp-Phipps Park in Tallahassee where dozens of adults were observed in July 2010 (Jue *et al.* 2011).

Life history

In most of the East, the main flight is in May or June, persisting into July northward. There is a partial second brood in most areas around late July or early August. Adults feed on nectar from a variety of woodland and field flowers (Iftner *et al.* 1992) and sip water from moist soil. Adults often perch on the undersides of leaves. The eggs are laid singly or in small groups or strings on the leaves of the host. Like most skippers, the larvae live in a shelter of leaves or leaf sections folded over and tied with silk.

This species overwinters in the pupal stage (Scott 1986, Allen 1997).

Host plants

In the East, the caterpillars feed on hog peanut (*Amphicarpaea bracteata*), a sprawling herbaceous vine in the pea family (Fabaceae). Larvae have occasionally been found on the invasive pest vine kudzu (*Pueraria montana*) in Gainesville, Florida (Marc Minno observation). In 2010 Marc Minno and Mary Ann Friedman found larvae of the golden banded-skipper on a new host plant, *Phaseolus polystachios* (thicket bean) at Florida Caverns State Park near Marianna.

Habitat

In the core of its eastern range, any wooded area with abundant food plant seems to be potential habitat, but there could be unknown habitat requirements. Colonies are generally found in mesic, predominantly deciduous forests, and are often associated with streams, paths, or small forest openings, but are also found on drier oak-dominated ridges. It is uncertain whether nectar is a limiting habitat feature, but this species is commonly absent from areas with substantial patches of larval food plant. Adults are seen in openings and along roads, and, at least in North Carolina, in relatively pristine forests (LeGrand and Howard Butterflies of North Carolina website). The native food plant can be abundant in forest understories that are not heavily invaded by exotics.

Threats & management issues

Threats to the golden banded-skipper include fragmentation and loss of habitat, floods, non-native weeds, excessive deer herbivory, and possibly gypsy moth spraying. This species should be collected very sparingly or not at all. Good photographs should suffice for identification. Populations tend to be small and probably unstable, so maintaining a cluster of populations close together may be important for their persistence. Mowing nearby roadside nectar plants during the flight season should be avoided.

Fire is not likely to be an issue in most mesic forests where this skipper occurs, but no life stage would likely survive a fire. Jue *et al.* (2011) describe how the use of prescribed fire at Elinor Klapp-Phipps Park in Tallahassee, nearly extirpated one of the last remaining colonies of the golden banded-skipper in Florida. However, by working with the park land management staff and advisory committee, they were able set aside a refugium for the butterfly in subsequent prescribed fires. The host plant has since spread into new areas of the park that were burned. The golden banded-skipper has recovered at Phipps Park beyond any other known colony in the eastern United States. On July 24, 2010 a team of five observers tallied 83 adults at the park (Jue *et al.* 2011).

The possibility of integrating management of this species into timber-harvest plans should be evaluated. It seems quite possible that selective cutting could open up and temporarily improve habitat if the understory was not severely disrupted.

Gypsy moth control could be a problem in some habitats. Spraying with Dimilin® would pose a serious threat if the larvae feed on foliage present at application time; there should be little risk from *Btk,* because larvae would usually appear several weeks after application.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Burns (1984), Cech and Tudor (2005), Clark (1936), Covell (1999), Gerberg and Arnett (1989), Glassberg (1993, 1999), Glassberg *et al.* (2000), Hernández (2004), Holland (1898), Howe (1975), Iftner *et al.* (1992), Irwin and Downey (1973), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Scott (1986), Shapiro (1974), Tietz (1952).

Subfamily Pyrginae (spread-winged skippers)

Florida duskywing

Ephyriades brunnea floridensis Bell and W. P. Comstock

Identification

This medium-sized skipper ranges from 32 to 42 mm. Males are black with a few apical white spots near the tips of the forewings (Figure 59). Females are brown with darker markings and a purplish iridescent sheen (Figure 60 and 61). Both males and females hold the wings open while perching. The zarucco duskywing (*Erynnis zarucco*) and Horace's duskywing (*Erynnis horatius*) are similar to the Florida duskywing, but have additional white spots on the forewings. The caterpillar is pale green with a narrow yellow line above the spiracles and a dark brown head with orange patches (Figure 62).

Figure 59. Florida duskywing (*Ephyriades brunnea floridensis*) upperside male from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 60. Florida duskywing (*Ephyriades brunnea floridensis*) upperside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Taxonomic notes

This is the only subspecies of *Ephyriades brunnea* found in the United States, but other populations in the Caribbean have been named. *Ephyriades brunnea floridensis* is not very different in color pattern or other features from the other named subspecies.

Figure 61. Florida duskywing (*Ephyriades brunnea floridensis*) underside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 62. Florida duskywing (*Ephyriades brunnea floridensis*) larva from Stock Island, Monroe County, Florida (Marc Minno photo).

Range

Ephyriades brunnea floridensis has a disjunct distribution, occurring in parts of the southeastern Florida mainland, including Long Pine Key within Everglades National Park, and a few natural areas south of Miami. It also occurs on a few of the larger islands with pine rockland habitat in the lower Florida Keys, such as Stock Island, Sugarloaf Key, Cudjoe Key, No Name Key, and Big Pine Key.

Rarity

NatureServe global rank: G5T2. This subspecies rank was revised by the Florida Natural Areas Inventory Program in September 2006. This skipper is locally common in parts of the lower Florida Keys and Miami-Dade County, Florida, but its habitat is declining due to urban development. Although currently protected in some parks, we expect this species to diminish over the next few decades because its habitat is in high demand for development, and exotic, predatory ants are now common in southern Florida. This species varies in abundance, from just a few adults to a few dozen observed per day on Big Pine Key (Marc Minno observation). It is much less numerous on the mainland.

Life history

Adults of this tropical species occur every month of the year and visit flowers such as Spanish needles (*Bidens alba*), pineland croton (*Croton linearis*), narrowleaf yellowtops (*Flaveria linearis*), cheese shrub (*Morinda royoc*), and Florida Keys blackbead (*Pithecellobium keyense*) (Minno and Emmel 1994). Females lay eggs singly on the new growth of the host shrubs.

Larvae live in leaf shelters on the food plant.

Host plants

This tropical butterfly is closely associated with Long Key locustberry (*Byrsonima lucida*), a shrub or small tree in the *Malpighia* family (Malpighiaceae). It also uses the non-native Barbados cherry (*Malpighia emarginata*), a shrub in the same family, sometimes grown in gardens for its tart, edible fruit.

Habitat

This skipper occurs in pine rocklands and at the edges of tropical hardwood hammocks containing locustberry. It is sometimes found in gardens containing Barbados cherry or locustberry.

Threats & management issues

The known threats to the Florida duskywing include the conversion of its habitat to urban land uses, habitat fragmentation, lack of appropriate land management, exotic predatory ants, hurricanes/tropical storms, and sea-level rise. The pine rockland habitat of this skipper is apparently fire-maintained. Applying too much prescribed fire to its habitat is likely to be detrimental; conversely, the lack of prescribed fire allows hardwoods and palms to dominate. The host plant is tolerant of shaded conditions, but the butterfly prefers open rocklands or hammock edges. Related to habitat change, fragmentation of rocklands into small isolated parcels has made prescribed-fire management difficult, if not impossible, especially where houses have been built nearby.

The lower Florida Keys were affected by several hurricanes and tropical storms in recent years. Hundreds of mature pines were killed by the winds and saltwater storm surge of Hurricane Wilma in October 2005. Many of these pine areas are changing to hardwoods and palms. Furthermore, global climate models predict rising sea level in this century. This change in hydrology will likely eliminate most of the remaining pine rockland habitat in the Florida Keys.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Hernández (2004), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Lenczewski (1980), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Scott (1986), Smith *et al.* (1994), Tamburo and Butcher (1955).

Mottled duskywing

Erynnis martialis (Scudder)

Identification

This is a small (25 to 33 mm) duskywing with a highly mottled wing pattern (Figures 63 and 64). The hindwings have well-defined bands of dark spots, which are present but less distinct on other duskywing species. The forewings have more than the usual amount of gray, and fresh individuals have a purplish sheen to the wings. Small females of Juvenal's duskywing (*Erynnis juvenalis)* or Horace's duskywing (*Erynnis horatius*) can easily be mistaken for mottled duskywings. Hugo Kons points out to us that some females of this and *Erynnis persius* cannot be easily separated without dissection of the genitalia. If the underside of the hindwing can be seen, nearly all northern Juvenal's duskywings can be recognized by the two pale spots near the apex. The larva is pale green with a black head having a few small patches of orange (Figure 65).

Figure 63. Mottled duskywing (*Erynnis martialis*) upperside from Orangeburg, South Carolina (Marc Minno photo).

Figure 64. Mottled duskywing *(Erynnis martialis*) underside from Orangeburg, South Carolina (Marc Minno photo).

Figure 65. Mottled duskywing (*Erynnis martialis*) larva from Jasper-Pulaski Fish & Wildlife Area, Jasper County, Indiana (Marc Minno photo).

Duskywing skippers are a particularly challenging group to correctly identify, and the mottled duskywing has sometimes been misidentified in the literature. We are not sure if all of the records for *Erynnis martialis* in Shapiro (1966) are correct based on habitat. Most of his voucher specimens are probably no longer extant (Arthur Shapiro personal communication with Marc Minno May 2011). Also, Shapiro's comment about adults being high-fliers probably refers to Horace's duskywing (*Erynnis horatius*), which is often seen in the oak canopy in spring (Dale Schweitzer observation). Runty female Horace's duskywings are easily mistaken for mottled duskywings unless collected or well photographed, and such runts are not uncommon after gypsy moth outbreaks. Sight records should not be accepted as the basis for documenting new occurrences of this species, and occasionally even photographs may not be identifiable. However, most of the species in this genus, including this one, can be reliably identified by genitalia characters (Scott 1986, Forbes 1960). Where it is present in low numbers, we suggest specimen vouchers be limited to one or two males. In practice, larvae can be identified by their food plant, which is not shared by any other skipper in our region.

Range

The mottled duskywing occurs from near Albany, New York, and formerly also southern New England, westward across southern Ontario and the Great Lakes states to Minnesota and western Iowa, then southward into Georgia and the Florida Panhandle, the Gulf states, and central Texas (Opler and Krizek 1984; Brock and Kaufman 2003). In North Carolina, the species has recently been found very rarely in the Sand Hills, Piedmont, and mountains. It also occurs in western Nebraska, eastern Kansas, and the Ozarks. It is also found as disjunct isolated populations in the eastern foothills of the Rocky Mountains in central Colorado, and in the Black Hills (Stanford 1981, Opler and Krizek 1984, Opler 1994, Brock and Kaufman 2003).

Rarity

NatureServe global rank: G3. This species is now rare, declining, historical, or known to be extirpated in most of its eastern range and is not common anywhere.

The mottled duskywing is very rarely encountered and may be extirpated in Quebec, Ontario, and the northeastern United States. It is rarely found and then generally very scarce in North Carolina, and is uncommon to rare elsewhere in the Southeast. It seems to be more stable westward, and it has been found abundantly (>100 in a day) in Burnett County, Wisconsin at least into the 1990s (Hugo Kons personal communication with Dale Schweitzer). There seems to have been a general pattern of disappearance from the Northeast, proceeding south and west. The last known collections in Massachusetts and Connecticut were in the 1880s and 1930s, respectively. The last specimens for New Jersey were collected in the 1970s, and for southeastern Pennsylvania in 1985. Because butterflies have traditionally been more popular than moths with collectors, the demise of the mottled duskywing is better documented than the other two very rare *Ceanothus* specialists in our region. In New England, New Jersey, and Pennsylvania, the mottled duskywing seems to have disappeared several decades before the other two *Ceanothus* specialists (*Apodrepanulatrix liberaria* and *Erastria coloraria*), which are partially diurnal moths in the family Geometridae.

In Ontario, adults were common in July 1984 at the Port Franks Estates site (Dale Schweitzer observation), which has since been mostly developed (Packer 1994). In the Ottawa area, Don Lafontaine (email to Dale Schweitzer 4 July 2008) states that only one of five recent sites has produced adults in the last ten years, and that is a large alvar (a natural limestone pavement barren) about 20 miles west of the city where only three were seen in 2007 and two in 2008.

Of the 29 counties for which Shapiro (1974) found records, only two or three still have the species. The mottled duskywing is, or at least was recently, less scarce in the Albany, New York Pine Bush, but its status there has not been evaluated. As of 2006–2007, the species was still extant in the Albany, New York pine barrens (Tim McCabe) and a few other widely separated places in New York (New York Natural Heritage Program) including the Clintonville barrens.

Voucher specimens exist for nine counties in New Jersey, with reports for four others (Iftner and Wright 1996), and its range closely approximated that of its food plant (Hupf 1983). Similarly, the Pennsylvania range had dwindled from at least 13 counties (Wright 1995 and personal communication with Dale Schweitzer in 2003 and 2010) to two small colonies about 2 km apart in Chester County in 1985, and by 1996 not one was found. In West Virginia, it appears to be restricted to some of the shale barrens. It is believed to be extirpated in Ohio. Threats to the remaining colonies, at least from deer, are likely to increase. There may be unknown factors involved in its decline.

The mottled duskywing is extant in North Carolina (LeGrand and Howard Butterflies of North Carolina website) and in northern Georgia (James Adams). Dean and Sally Jue also recently found a colony in southern Georgia near Thomasville (Dean and Sally Jue personal communication with Marc Minno in 2009). A few adults were observed in late June in 2004 and 2005 in the Blackwater River State Forest in the Florida Panhandle, but have not been seen there since (Mary Ann Friedman, photographs verified by Marc Minno). Besides occurring in few places, this species also usually occurs in low numbers. Most of a dozen or so recent observations in North Carolina have been of one or two individuals (LeGrand and Howard Butterflies of North Carolina website), and the maximum daily total observed is only five. The status in Georgia appears to be similar (James Adams).

Life history

This duskywing is double-brooded in all but possibly the northern edge of the range. It appears later in spring than most other species of duskywings. The first brood is mostly in May into June from Pennsylvania northward. Unlike several other duskywings, there are no March records for North Carolina where the first brood persists into June even on the Piedmont. The second brood starts in late June and is found mostly in July. Each brood lasts about one month (Glassberg 1999, LeGrand and Howard Butterflies of North Carolina website, Dale Schweitzer observation). The histogram in LeGrand and Howard (Butterflies of North Carolina website) suggests the broods might overlap in North Carolina, although in any given year they probably do not.

The larvae live in folded leaf nests on the host plant and feed on adjacent leaves. When mature, the larva spins a cocoon in the leaf litter where it either pupates and emerges in a few weeks or overwinters until spring. Dale Schweitzer has observed that two other species of this genus (*Erynnis brizo, Erynnis horatius*), leave the hibernation cocoon on warm days in February (in New Jersey), wander about, and spin another cocoon before pupating.

Adults take nectar from a variety of flowers, especially the food plant in the summer brood, and males sip water from moist soil.

Host plants

Throughout the eastern United States, this skipper feeds on the leaves of New Jersey tea (*Ceanothus americanus*), a small shrub in the buckthorn family (Rhamnaceae). This plant has also been called redroot, but another unrelated plant (*Lachnanthes caroliana*) that is not eaten by the mottled duskywing has also been given that common name. Other species of *Ceanothus* are used in the western portion of its range (Scott 1986).

HABITAT

The habitats of the mottled duskywing range from sandhills in the Southeast to glades, outcrops, and dry prairies, as well as openings in oak woodlands or savannas, pine barrens, and savannas in the Northeast and Midwest. In New York and Canada it occurs in alvar grasslands. Canopy cover, if any, is generally some mixture of scrubby oaks and pines. This skipper probably never was as widespread and common as the food plant eastward, and has been incorrectly reported in the past. Substrates can be granite, serpentine, shale, and probably other rocks eastward. In New York, Ontario, and the Upper Midwest, sandy soils seem to have been most typical. A key feature of the habitat may be the occurrence of multiple patches of the food plant, as well as scattered individual plants between these, over an area of generally at least one hundred hectares. In the northern areas of its range, this butterfly rarely occurs in isolated patches of the food plant or where the plants are sparsely distributed in forests.

THREATS & MANAGEMENT ISSUES

The early decline of the mottled duskywing is probably due to factors such as fire suppression, succession, reforestation, and urbanization (especially in sandy areas). Habitat changes associated with reforestation and fire suppression contributed to the decline of the food plant, and therefore, the mottled duskywing.

The mottled duskywing's host plant, *Ceanothus americanus*, was originally so abundant that it was commercially harvested as New Jersey tea around the time of the American Revolution, and remained common for at least another 130 years. The host plant had declined somewhat in New Jersey between 1930 and 1980, but it was still frequent in its core range in the northern counties (Hupf 1983). New Jersey tea is now rarely seen in abundance in most of the Northeast.

The major decline of New Jersey tea since 1980 is probably attributable mostly to deer. In fact, deer are apparently the main threat to the mottled duskywing in much of the eastern United States and Canada. As deer numbers increased rapidly in the northeastern United States, New Jersey tea, being one of their favorite browse plants, disappeared. Deer alone probably account for recent disappearances from the Pennsylvania serpentine barrens. The deer herd has since been reduced in these areas. By 1997 both *Ceanothus*-obligate geometrid moths were found on both barrens. However, for unknown reasons, the mottled duskywing did not recover.

Gypsy moth spraying is another issue affecting the mottled duskywing. Extensive DDT applications occurred during the late 1950s and 1960s. Today, the risk to mottled duskywing larvae from *Btk* applications to kill gypsy moth caterpillars would vary with application dates. Typical applications would probably be made before most female mottled duskywings emerge, and the residue would largely be gone before their larvae appear. However, applications made when young larvae of the butterfly are present, about mid-or late May in the northern areas of the range, would probably kill them.

Fire is another significant factor in the decline of the mottled duskywing. Excessive prescribed burning is probably more of a threat than lack of fire in the upper Midwest in states such as in Iowa and Wisconsin. All stages of this skipper are vulnerable to fire, so refugia are needed in prescribed burns. In the Great Lakes region and other areas where the mottled duskywing still sometimes occurs in substantial numbers, the suitability of fire regimes should be evaluated.

The mottled duskywing sometimes occurs with the endangered Karner Melissa blue butterfly, and where both are numerous, the management needs of these two species probably are similar. Indeed, it would be very useful if researchers monitoring the Karner Melissa blue would also monitor associated rare species such as the mottled duskywing, Persius duskywing, and the frosted elfin. Occurrences should initially be verified with a few specimens. Although duskywings can be challenging to identify, an experienced observer should be able to correctly determine most mottled duskywings in the field, and photographs would generally suffice for monitoring.

REFERENCES

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Burns (1964), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1993, 1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Iftner and Wright (1996), Irwin and Downey (1973), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Metzler *et al.* (2005), Minno *et al.* (2005), Opler (1993, 1994), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986), Shapiro (1966, 1974), Shuteye (1996a), Stanford (1981), Swengel (1998), Wright (1995).

PERSIUS DUSKYWING (EASTERN POPULATION)

Erynnis persius persius (SCUDDER)

IDENTIFICATION

This is a small (28 to 35 mm), dark or grayish duskywing (Figures 66 and 67). The Persius duskywing is commonly confused with the nearly identical wild indigo duskywing (*Erynnis baptisiae*) that is often present in the same habitats. It may also be confused with the columbine duskywing (*Erynnis lucilius*) which can occur with it, especially in Wisconsin. Persius duskywing adults occur only in late spring, whereas wild indigo and columbine duskywings fly in spring and again in the summer. The larva is green with a brown head having paler blotches (Figure 68).

Figure 66. Persius duskywing (*Erynnis persius persius*) upperside male from New London County, Connecticut, verified by genitalia (David Wagner photo).

Figure 67. Persius duskywing (*Erynnis persius*) underside female from Grant County, Wisconsin (Marc Minno photo).

Figure 68. Persius duskywing (*Erynnis persius*) larva from Teller County, Colorado (Marc Minno photo).

At least in our region, the only known reliable way to identify the Persius duskywing is to examine the male genitalia (Forbes 1960) or forewing scales with a microscope. We strongly recommend the former. Sometimes the valves can be seen adequately by merely removing some scales from the tip of the abdomen.

Male Persius duskywings have an abundance of white, raised, curved, hair-like scales on the forewings. This characteristic can be difficult to interpret, because the male wild indigo duskywing also have a few hair-like scales on the forewing. However, the hair like scales in the wild indigo duskywing are flat against the wing. In the field, Persius duskywing males are smallish and uniformly dark or sometimes frosty looking, not strongly brownish. The apical spots on the forewing of this species tend to be more linearly arranged than on other species, but all three species are variable. Most wild indigo duskywings have a somewhat contrasting brownish patch in the distal area of the forewing that is not present on the Persius duskywing.

Active Persius duskywings usually perch on bare soil or dead leaves. Male wild indigo duskywings perch conspicuously from projecting twigs or old stems and often return to the same area when disturbed. In the Northeast, a good rule of thumb for field identifications is, if it looks like wild indigo duskywing then it is that species, and if it looks like Persius duskywing, it is probably also a wild indigo duskywing.

Positive identification from photographs is not usually possible, although in many cases photos can be used to verify that an individual is not a Persius duskywing. Klots (1951) shows an especially distinctive specimen of *Erynnis persius persius* compared to the example in Layberry *et al.* (1998), which is more typical. The photo of a Persius duskywing in Glassberg (1999) from eastern Connecticut is probably correct, based on specimens from the same colony collected by David Wagner. A male, photographed at a well-known site in Plymouth, Massachusetts, shown in O'Donnell *et al.* (2007), is also probably correctly identified.

The larva of the Persius duskywing has a brown head with a darker brown patch on the face, whereas the head of a wild indigo duskywing larva is black (Allen *et al.* 2005).

Taxonomic notes

Erynnis persius fredericki H. A. Freeman is widely distributed in the western United States. *Erynnis persius avinoffi* (Holland) was described from Alaskan specimens. Although the eastern and western populations are disjunct, the wing patterns are very similar, and Scott (1986) did not recognize any subspecies of this skipper. *Erynnis persius persius* has often been erroneously reported due to misidentifications with similar duskywings. Published records, except from Burns (1964), Iftner *et al.* (1992), Iftner and Wright (1996), and Layberry *et al.* (1998), should be regarded as suspect unless it is specifically stated that male genitalia or male wing scales were examined. As Shapiro (1974) pointed out, some of his New York records were unverified.

Range

The disjunct eastern population, *Erynnis persius persius*, occurred historically in a narrow band from Wisconsin to New Hampshire (and probably Maine), then extended south through New Jersey and into northern Virginia, and possibly farther south in the mountains. Hugo Kons dissected voucher specimens confirming sites in Portage (2 sites), Menominee, Adams, Jackson, and Burnett counties in Wisconsin during the 1980s and 1990s. It is still extant in Massachusetts, Connecticut, Pennsylvania, northern Ohio (probably), Michigan, and Wisconsin. The Persius duskywing is apparently extirpated from New Hampshire, Rhode Island, New York, New Jersey, Virginia, Maryland, and extreme southern Ontario, as well as Maine, if it actually ever occurred in Maine. Handfield (1999) was unable to verify the species for Quebec. This skipper probably occurred in the major barrens and savanna regions occupied by the Karner Melissa blue, but also extended a bit farther south.

Rarity

NatureServe global rank: G5T1T3. Xerces Society rank: Imperiled. As far as we know, the western subspecies are not rare, but the eastern Persius duskywing has declined in, or is extirpated from, most states in its historical eastern range. Its current stronghold is probably still the sandy pine barren areas of Wisconsin where it occurred widely in the 1990s. However, this has not been confirmed by properly verified recent specimens. Some of these places may no longer be suitable habitats due to intensive prescribed burning and other management practices. Hugo Kons' site in Adams County was lost to succession by the late 1990s. *Erynnis persius persius* is listed as threatened in Michigan, which may also be a stronghold. Fewer than 20 extant populations are known east of Michigan, although most large potential habitats have been checked. Nevertheless, it has been found at some atypical sites in Pennsylvania, Virginia, and Connecticut, so it could turn up unexpectedly in other states. The Connecticut Butterfly Atlas Project (O'Donnell *et al.* 2007) did produce a few verified specimens from that state. Extensive efforts by Dale Schweitzer and others, including the Massachusetts Butterfly Atlas Project, failed to find any colonies in Massachusetts other than those already known near Plymouth in the 1980s, nor have any others been found since then.

The Persius duskywing is likely to have declined due to habitat changes, the decline of lupine, and, especially in New England, large scale aerial spraying for gypsy moth in the mid-20th century. Competition from the increasingly abundant wild indigo duskywing may also have contributed to the decline. Based on museum specimens, the Persius duskywing and the spring brood of wild indigo duskywing were comparably frequent in Rhode Island and southeastern Massachusetts in and before the 1950s (see also Forbes 1960 and Burns 1964). However, only a single metapopulation of Persius duskywing was known to be extant in Plymouth County, Massachusetts near the northern edge of this area in the 1970s and 1980s, although this species has since been found in Connecticut. In the interim, much of the habitat south of Plymouth County was sprayed at least once with DDT and/or carbaryl, and the localized, single-brooded Persius duskywing might not have been as capable of recovering as was its bivoltine relative. There were no collections in New Jersey after the widespread pesticide applications (DDT and carbaryl) of the late 1950s and 1960s. The wild indigo duskywing became much more common in the Northeast starting in about the mid-1960s, after it adapted to a new host plant, the introduced crownvetch (*Coronilla varia*) (Wheeler 1974, Shapiro 1979, Dale Schweitzer observation). The appearance around 1990 of the wild indigo duskywing at least roughly coincided with the disappearance of the Persius duskywing near Concord, New Hampshire, but these events also coincided with increasing crownvetch abundance along the highways, large-scale destruction and urbanization of the pine barrens habitat, and at least moderate impact to lupine by deer. The last native Karner Melissa blue population in New England, which used the same lupine patches, died out at about the same time.

We note, too, the absence of wild indigo duskywing at a presently reliable Persius site in Connecticut. While both the Karner Melissa blue and the lupine-feeding frosted elfin still occur at the Albany, New York, pine barrens, the Persius duskywing disappeared from this site in the 1960s, based on specimens known to Dale Schweitzer and Tim McCabe. The disappearance of the Persius duskywing in the Boston area well before 1950 was probably mostly a matter of urbanization.

Life history

The Persius duskywing has one brood that flies for about three weeks between late April and mid-June, depending on the year and location. The Persius duskywing usually flies earlier than the Karner Melissa blue where they occur together. First brood adults of *Erynnis baptisiae* and *Erynnis lucilius* are concurrent with *Erynnis persius*, but those species have another brood around July, and sometimes a third flight in late summer.

Larvae of the Persius duskywing live in a leaf nest on the food plant. At maturity, in summer, they spin a nest in the leaf litter, and hibernate through fall and winter, then pupate in spring without further feeding.

Host plants

The only food plants verified recently for *Erynnis persius persius* are sundial lupine (*Lupinus perennis*) and wild indigo (*Baptisia tinctoria*), both in the pea family (Fabaceae). Opler and Krizek (1984) noted that lupine had been reported as a host plant in two states, but willow and poplar (Salicaceae) were thought to be the food plants for eastern populations of the species. *Thermopsis* species, *Astragulus* species, lupine, and other legumes are used by the western subspecies (Scott 1986). The wild indigo duskywing also lays eggs on *Lupinus, Baptisia,* and other genera (Scott 1986), so, being common, it is likely to occur with the Persius duskywing. Old reports of willow and aspen as host plants (Scudder 1881, 1889 and repeated by Klots, 1951; Shapiro, 1966, 1974; and others, may actually refer to the dreamy duskywing *(Erynnis icelus*). However, larvae of the legume-feeding *Erynnis zarucco* from Florida readily ate the leaves of Carolina willow (*Salix caroliniana*) in captivity (Marc Minno observation), and *Erynnis icelus* feeds on locust tree (*Robinia pseudoaccacia*, Fabaceae) as well as willow and aspen (Salicaceae) (e.g. O'Donnell *et al.* 2007), so the possibility of the Persius duskywing using willow or aspen cannot be excluded.

Habitat

The Persius duskywing is most often found in openings or right-of-ways within pitch pine or jack pine/oak barrens and oak savannas and woodlands. In Pennsylvania, it is found in open hilltop scrub and powerline right-of-ways. An abundance of one of the food plants in a dry, generally oak-wooded or barrens area, seems to be a key habitat requirement. The soils where this species occurs are usually sandy, but can also be thin and acidic on rock outcrops. Eastern habitats frequently have bear oak, and small oaks, often sprouts, are typical of more western habitats as well. Hugo Kons reports that he has found several adults resting on small oak twigs in cloudy weather in Wisconsin. Resting adults of this genus wrap their wings around twigs with the upperside and body exposed. Occasional individuals have been collected in atypical habitats.

Threats & management issues

The main threats to *Erynnis p. persius* include:

- Loss of habitat
- habitat fragmentation
- Deteriorating habitat often due to fire suppression
- Range-wide decline of its preferred food plant (*Lupinus perennis*)
- Gypsy moth spraying
- Deer herbivory
- Poorly implemented prescribed burning

Some populations occur along powerlines where vegetation management has kept the habitat open. However, dependence on right-of-ways leaves these populations vulnerable to abrupt changes in management practices. Winter mowing and accurately applied spot herbiciding of individual shrubs are compatible management techniques on right-of-ways.

The current rarity of the Persius duskywing relative to the wild indigo duskywing suggests Persius may have habitat needs other than sufficient food plant. Yet, in much of our region both the rarity of the Persius duskywing and the abundance of the wild indigo duskwing are apparently recent phenomena. It is possible that the wild indigo duskywing has displaced the Persius duskywing to some extent.

No life stage of the Persius duskywing is safe from fire during prescribed burns. Refugia are needed, or this skipper will be eliminated. Large-scale spraying to control gypsy moths is implicated in the decline of *Erynnis persius persius* during and after the 1950s. The risk of harm from *Btk* in more modern gypsy moth suppression efforts will vary with application date. If the application is before females appear in the spring, exposure of hatchling larvae to residue should be low. If the application is during or shortly after the peak of the flight season, mortality to hatchlings could be very high. Gypsy moth larvae do not defoliate the food plant of the Persius duskywing during outbreaks. It is very unlikely that *Compsilura* would have had much impact on a species that lives in a shelter on herbaceous legumes. However, both food plant species are strongly favored early in the season by deer, a concern in Connecticut, particularly.

It's likely that management aimed at Karner Melissa blue recovery would suffice for *Erynnis persius*. However, research into management and habitat requirements of *Erynnis persius* is needed. Both the Persius and the Karner Melissa blue must have unburned refugia where prescribed burning is used. However, the Karner Melissa blue probably recolonizes and recovers faster after fires, since it tends to be more numerous and has two generations annually. *Erynnis persius* is usually seen in lower numbers than first brood Karner Melissa blues (e.g. in New Hampshire in the 1980s and Wisconsin), and is absent from some Karner Melissa blue habitats. Persius duskywing is probably more confined to wooded or brushy habitats, typically with small oaks. It would be very useful if land managers focused on the Karner Melissa blue would pay more attention to the less numerous *Erynnis persius* and the frosted elfin (*Callophrys irus*) that are using the same food plants and whose habitat needs are not nearly as well understood.

In Wisconsin and probably elsewhere, listing the Persius duskywing as state endangered or threatened has meant that very few persons can legally voucher the species, which largely precludes verification of new sites and accurate monitoring due to confusion with other species.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Brower (1974), Burns (1964), Cech and Tudor (2005), Forbes (1936, 1960), Glassberg (1993, 1999), Handfield (1999), Holland (1898), Howe (1975), Iftner *et al.* (1992), Iftner and Wright (1996), Klots (1951), Layberry *et al.* (1998) O'Donnell *et al.* (2007), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Scudder (1881, 1889), Shapiro (1974), Tietz (1952).

APPALACHIAN GRIZZLED SKIPPER

Pyrgus wyandot (W. H. EDWARDS)

IDENTIFICATION

This is a small (20 to 28 mm), blackish skipper with white spots (Figures 69 and 70). The only remotely similar species in its range is the common checkered skipper (*Pyrgus communis*). The common checkered skipper has much more extensive white spotting, especially on the forewing, and rarely flies as early as *Pyrgus wyandot*. The larva is whitish green with a black head (Figure 71 and Allen 1997).

Figure 69. Appalachian grizzled skipper (*Pyrgus wyandot*) upperside male from Montgomery County, Virginia (Marc Minno photo).

Figure 70. Appalachian grizzled skipper (*Pyrgus wyandot*) underside male from Montgomery County, Virginia (Marc Minno photo).

TAXONOMIC NOTES

Most authors have treated *Pyrgus wyandot* as a subspecies of the circumboreal *Pyrgus centaureae*, despite differences in the shape of the genitalia (Klots 1951, Forbes 1960, Shapiro 1974), adult color pattern, larval color (Allen 1997), and habitat. Other than the original description, Shapiro (1974) was the first to treat *Pyrgus wyandot* as a separate species.

Figure 71. Appalachian grizzled skipper (*Pyrgus wyandot*) larva from Greenbrier County, West Virginia (David Wagner photo).

Allen (1997) noted that Michigan populations differ from typical *Pyrgus wyandot* in food plant, habitat, adult appearance, and larval color (they are pinkish brown, not green). While there is obviously uncertainty regarding the taxonomy, we treat *Pyrgus wyandot* as a full species due primarily to genitalia differences. These differences exist at least between the Appalachian populations and *Pyrgus centaureae freija*. The habitat differences are suggestive as well. *Pyrgus centaureae* is a circumboreal species of boreal, subarctic, and alpine habitats, while *Pyrgus wyandot* can occur in some of the hottest microclimates in our region (Vanderhorst 2005), and often at low elevations. Shuey (1994) discusses the habitats in Michigan. He points out that these are rather variable, and some are on exposed limestone bedrock communities which are structurally similar to Appalachian shale habitats.

We agree that the food plant difference between the Michigan and other populations is not taxonomically significant.

Range

All United States records for *Pyrgus centaureae* from Ohio south and east refer to *Pyrgus wyandot*. However, popular guides tend to overstate the original range, which was in several disjunct areas. We follow Shuey (1994) in retaining northern Michigan populations within this taxon. Minnesota and Ontario populations are *Pyrgus centaureae freija*. *Pyrgus wyandot* is found mostly at low to moderate elevations in the Appalachians or their foothills. The core of the range is the shale region from about Huntington County, Pennsylvania, southwest through western Maryland, much of West Virginia (Allen 1997) and adjacent Virginia, with a few isolated collections in North Carolina. In the 1950s, populations occurred east (not exclusively on shale) to Lancaster and Dauphin counties, Pennsylvania (Shapiro 1966, George Ehle letter to Dale Schweitzer). Clark and Clark (1951) had records from nearby Fairfax County, Virginia, adjacent to Washington, D.C., where the species was first described (one from Rock Creek Park in the Academy of Natural Sciences).

In its historical occurrence, there are no gaps more than two counties wide from Dauphin County, Pennsylvania and Washington, D.C. to southwestern Virginia (Parshall 2002), and immediately adjacent North Carolina (LeGrand and Howard Butterflies of North Carolina website). A few seemingly isolated colonies were also found in the early 1970s in central New York (Shapiro 1974), but these populations could have been an extension of the main range via intervening shale ridges. As recently as 1960 there were disjunct, well-known populations in the trap rock glades region and to the west in northern New Jersey (specimens from seven counties are recorded by Iftner and Wright 1996) and immediately adjacent New York. There are several disjunct populations in southern Ohio (Iftner *et al.* 1992, Shuey 1994).

A pre-1863 Long Island record was probably in error for a nearby part of New Jersey or New York, because no likely edaphic formations occur on Long Island. The Cook County, Illinois, location shown by Parshall (2002) is very dubious, and we consider the Kentucky record to be an error. We do not know the validity of the three reports along Lake Erie in New York and Ohio (Parshall 2002, Shapiro 1974), but occurrences there seem plausible considering that populations occur near the Great Lakes in Michigan.

Aside from omitting the seven New Jersey counties, the map in Parshall (2002) seems to be a very complete compilation as of that time. This species is still extant at a few places in Virginia (Chazal *et al.* 2004), West Virginia, Ohio, Maryland, Pennsylvania, Michigan, and North Carolina.

Rarity

NatureServe global rank: G1G2Q. The "Q" of this rank indicates uncertainty that the Appalachian grizzled skipper is a full species rather than a subspecies of *Pyrgus centaureae*. If *Pyrgus wyandot* is treated as a subspecies, the rank would be G5T1T2.

While this was a common "generally distributed" skipper occurring in "all suitable localities" in the Virginia mountains (Clark and Clark 1951), fewer than 20 extant populations of the Appalachian grizzled skipper were found by Parshall (2002), and few new ones have been found in the past decade. Very few occurrences that were documented in or before the mid-1980s remain extant.

It would be difficult to imagine any species as being more potentially vulnerable to gypsy moth spraying. Larvae occur almost entirely in the most open, exposed microhabitats, within forest types that are highly vulnerable to gypsy moth outbreaks, with 100% of the population in the larval stage at or within a few days after typical pesticide application dates. The Appalachian grizzled skipper disappeared during a brief period of widespread gypsy moth spraying in the late 1950s and 1960s in New Jersey (Gochfeld and Burger 1997), with one record as late as 1960 (specimen in the American Museum of National History), and essentially did the same in West Virginia after extensive applications of Dimilin® and *Btk* in the late 1980s and early 1990s, although we know of at least one extant population there now.

The obvious conclusion, that pesticide spraying for the gypsy moth (with DDT, carbaryl, Dimilin®, and *Btk*) was a factor in the widespread collapse of this species in places where it was formerly common, is now widely accepted. However, there are other factors, including succession. Gypsy moth spraying is not a plausible explanation for the rarity of this skipper in North Carolina, but there is no evidence of it having previously been more common there.

Another likely contributing factor is climate. Drought in peripheral parts of Pennsylvania, such as Lancaster County, where the species was present in the 1950s (Shapiro 1966; George Ehle personal communication with Dale Schweitzer), and habitat changes at the central New York sites (Shapiro 1974), were temporarily occupied for a few years in the early 1970s (but apparently not much earlier or later). Habitat succession is regarded as a current threat in Virginia (Chazal *et al.* 2004).

This taxon is considered historic, extirpated, imperiled or critically imperiled range-wide and appears to be much rarer than some federally endangered species. As of August 2010, all state ranks are SH, S1, or S1S2. The once rather common Appalachian grizzled skipper (Clark and Clark 1951) is officially listed as endangered in Maryland, Ohio, and New York, and as threatened in Virginia.

Gypsy moth spraying threatens the Appalachian grizzled skipper in Michigan where the rank is S1S2, but habitat changes may be more of a threat there, at least where populations occur in sandy barrens or disturbed places within them.

Life history

The Appalachian grizzled skipper has one brood, which occurs during April in most places, rarely as early as the end of March or as late as mid-May. Other spring butterflies found flying with it include the Olympia marble (*Euchloe olympia*), the falcate orangetip (*Anthocharis midea*), and the silvery blue (*Glaucopsyche lygdamus nittanyensis*). Adults of the Michigan and New York populations of the Appalachian grizzled skipper fly in May.

The life history was summarized by Allen (1997). The larvae feed from May through much of August, and the species hibernates as a pupa.

HOST PLANTS

Members of this taxonomic complex feed on herbs and small shrubs of three closely related genera of the rose family (Rosaceae). The only documented host for the Appalachian populations is five fingers or dwarf cinquefoil (*Potentilla canadensis*), a remarkably common, weedy, plant. The host in Michigan is wild strawberry (*Fragaria virginiana*), also a common plant. West Virginia larvae accept wild strawberry as a food plant in captivity (Allen 1997). In Canada, *Pyrgus centaureae* generally eats cloudberry (*Rubus chamaemorus*), which is structurally similar to both *Pyrgus wyandot* food plants. Populations in the Rocky Mountains also feed on *Potentilla* species (Layberry *et. al.* 1998).

HABITAT

Typical *Pyrgus wyandot* habitat is trap rock (a form of basalt) glades, shale barrens, and forest openings on other types of rock outcrops. This includes limestone in New Jersey and Michigan. Other important habitats are pastures, relatively open oak woods, powerlines on south to west-facing shale slopes, and disturbances along a Forest Service road in Ohio (Shuey 1994). *Pyrgus wyandot* habitat always features much bare rock or soil (Schweitzer 1989, Allen 1997). In Michigan, the best-known habitats consist of natural or anthropogenic openings within sandy jack pine or pine-oak barrens or woodlands. In addition, Shuey (1994) reports that there are populations in the limestone barrens along the northeastern coast of Michigan's Lower Peninsula. These habitats structurally resemble those farther south. This species was characteristic of, but not restricted to, shale ridges and especially shale barrens. Colonies occasionally occurred as high as about 760 m in West Virginia, and the current North Carolina populations (LeGrand and Howard Butterflies of North Carolina website) occur over 900 m, but most colonies are found at lower elevations, often below 100 meters, northward.

In most of its range this skipper occurs in disturbed as well as natural habitats. Two of the five current Virginia occurrences are in recently logged areas. Disturbed or successional habitats may be more important than has been generally appreciated in that state and elsewhere (Chazal *et al.* 2004). Where the original colonizers of the Ithaca area populations came from is an interesting question. The exact nature of the habitats near Ithaca, New York is not certain, but it appears they were successional stages of reforestation (Robert Dirig email to Dale Schweitzer on 15 February 2005 and site visits by Dale Schweitzer in the 1980s). The geological and butterfly distribution maps of Shapiro (1974) show that the area has much shale. Furthermore, *Glaucopsyche lygdamus nittanyensis*, another characteristic Appalachian shale inhabitant, also occurred in central New York (Dirig 1986).

In a 1986–1987 survey, Schweitzer (1989) reported that the Appalachian grizzled skipper was found at 11 of 12 unsprayed sites, but at none (0) of 4 sprayed sites. This was a statistically significant difference.[5] They looked in Pennsylvania and West Virginia shale regions with this combination of features:

- South- or west-facing slopes with an abundance of bare soil or rock (used by adults for thermoregulation)
- Clumps of grasses such as *Andropogon virginicus*

[5] Fisher's exact p= 0.00275.

- Abundant food plant on otherwise bare ground
- Abundant low nectar flowers such as springbeauty (*Claytonia caroliniana*), birdfoot violet (*Viola pedata*), pussy-toes (*Antennaria* species), or moss pink (*Phlox subulata*)
- A source of moisture
- Woods within 30 meters on at least two sides

Adults have sometimes been seen in forest areas adjacent to more typical habitat, and may spend the night and periods of inclement weather there. Oaks and hickories in such xeric habitats leaf out later in the year, so the canopy is open for much of the flight season.

Threats & management issues

The most immediate management issue is maintaining the few habitats that still support this species and protecting them from gypsy moth spraying and succession. It is not known if *Btk* poses less risk than chemical pesticides, but circumstantial evidence suggests little difference with this species. It may benefit some populations if the cinquefoil host plants were augmented during droughts.

A longer-term goal is restoring metapopulation dynamics that almost certainly existed until the late 1980s. In the past, colonies were clustered closely enough together that females could easily colonize new or vacant habitats as old colonies were lost to succession or other causes. Other possible improvements might come from controlling herbivory of the food or nectar plants by deer, and eliminating invasive exotic weeds like crownvetch that compete with the host plant. Deer herbivory may be more of a potential threat in Michigan, because wild strawberry grows slightly taller and may be more conspicuous to deer than the prostrate cinquefoils used elsewhere by the grizzled skipper.

Colonies on right-of-ways may be impacted by broadcast herbiciding. Dormant season mowing or careful selective ground applications of herbicides aimed at sprouts or shrubs would be preferable. A few historical sites were pastures, so grazing might be a potential management tool. At a few sites in Virginia, and perhaps elsewhere, forest succession may be an issue (Chazal *et al.* 2004). It's possible that logging might be used beneficially as a management tool. The U.S. Forest Service and Virginia Natural Heritage Program are monitoring and attempting to restore populations in Virginia, so we hope that their successes and failures will increase our understanding of this species. Gypsy moth spraying is also a critical issue for the Michigan populations. Habitat management needs for populations in limestone barrens may be similar to those in other bedrock communities elsewhere. Management may be rather different where habitats are openings or disturbances as opposed to barrens, such as openings in pine, oak, or mixed barrens or woodlands. These openings were probably originally maintained by occasional fires. Because there is so much less suitable habitat for this species now, survival within a burned area would be unlikely unless there were a lot of skips. Some amount of prescribed burning combined with a high amount of unburned refugia would be beneficial to the species.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Clark and Clark (1951), Cech and Tudor (2005), Chazal *et al.* (2004), Forbes (1960), Glassberg (1993, 1999), Gochfeld and Burger (1997), Holland (1898), Howe (1975), Iftner and Wright (1996), Iftner *et al.* (1992), Irwin and Downey (1973), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Nielsen (1985), Opler and Krizek (1984), Opler and Malikul (1992), Pague and Schweitzer (1991), Parshall (2002), Schweitzer (1989), Shuey (1994), Scott (1986), Shapiro (1974), Tietz (1952).

Subfamily Hesperiinae (grass skippers)

Lace-winged roadside-skipper

Amblyscirtes aesculapius (Fabricius)

Identification

This small (25 to 35 mm), dark skipper (Figure 72) is relatively easy to identify by the unique, white, cobweb-like pattern on the underside of its hindwings (Figure 73). The upperside pattern is black with white spots on the forewings, similar to several other species of *Amblyscirtes*. The antennae are relatively long, and the fringes of the wings are checkered. The caterpillars are greenish, except the head is light brown with black stripes (Figure 74, Allen *et al.* 2005, Minno *et al.* 2005).

Figure 72. Lace-winged roadside-skipper (*Amblyscirtes aesculapius*) upperside female from Liberty County, Florida (Marc Minno photo).

Figure 73. Lace-winged roadside-skipper (*Amblyscirtes aesculapius*) underside female from Liberty County, Florida (Marc Minno photo).

Range

This is the most widespread of the southeastern cane-feeding *Amblyscirtes* species. The lace-winged roadside skipper inhabits most of the range of the host plants, including both coastal plain and interior portions, from southeastern Virginia to southern Illinois and Missouri, south to eastern Texas and northern Florida. There are records in over 60% of the counties in the Carolinas, although these may not represent extant populations. In Kentucky, there are records (not all recent) from 21 counties (Covell 1999).

Figure 74. Lace-winged roadside-skipper (*Amblyscirtes aesculapius*) larva from Alachua County, Florida (Marc Minno photo).

RARITY

NatureServe Global Rank: G3G4. This species is included primarily because we give accounts for the other cane feeders in this genus, so it seems useful to include all three of them. We suspect that better information on this species would support a change in its rank to G4, apparently secure. On the other hand, it is possible that the entire genus could be declining in the east. The common roadside-skipper (*Amblyscirtes vialis*) is no longer common in most of the Northeast. The lace-winged roadside-skipper is the most secure of the three cane-feeding *Amblyscirtes* species, but its occurrences and population viability are still not well known.

LIFE HISTORY

In North Carolina (Glassberg 1999) and probably in most of its range, there are two broods. Adults are present mostly in late May through June and late July through August. In northern Florida Kons and Borth (2006) report seeing it flying from late April through early May, and early September through early October.

The greenish eggs are laid singly on the leaves of the host. The caterpillars feed on the leaves and hide in shelters formed by folding over part of a leaf and tying the flap with silk. The mature larva clips the shelter from the leaf, closes the openings with silk, and pupates within this cocoon on the ground.

The adults visit flowers, and species of *Bidens* are favorites. Hugo Kons reports that they are most likely to be seen early in the morning or in the late afternoon or early evening.

Males perch on the leaves of shrubs or cane in forest openings to await receptive females.

HOST PLANTS

The larvae have been reported to feed on two species of canes (*Arundinaria gigantea* and *Arundinaria tecta*), which are the two most widespread of the native bamboos in the United States.

HABITAT

This species apparently has the greatest range of habitats of the three cane feeders in its genus, and occurs in deciduous or mixed hardwood and pine forest with cane. The lace-winged roadside-skipper can usually be found on the lower slopes of longleaf pine sandhills and at the edges of blackwater streams, pitcherplant bogs, and swamps. Adults are most likely to be seen in small sunlit openings in the woods. In the core parts of the range it is likely that almost any wooded cane patch is potential habitat. The host plant spreads by rhizomes, and forms patches called canebrakes (see Special Habitats section). The southern pearly-eye (*Lethe portlandia*), Creole pearly-eye (*Lethe creola*), and over a dozen species of Apameini (Noctuidae), among other moths, are also associated with this habitat. The species comes readily to flowers. At other times it can easily be located where sunlight penetrates dense coastal plain woodlands.

Threats & management issues

All life stages are above ground, so prescribed fire could eliminate this and other rare species if all of the habitat in an area were to be burned at once. Because *Amblyscirtes aesculapius* and other cane-feeding skippers have two or more broods each year, recovery from unburned refugia should occur quickly. However, several years should elapse before a site is burned again. Gypsy moths are now present in some parts of the range of this species, and could become a problem in most of the rest. The gypsy moth, though, is unlikely to be abundant in most habitats of this skipper, unless they contain substantial oaks and sweetgum (Schweitzer 2004). We cannot predict what the impacts from *Btk* spraying would be for mid-instar caterpillars of a species that has not been assayed (Peacock *et al.* 1998). Feeding by gypsy moth caterpillars is unlikely to have any significant impact on the host plant of this species. Clearcutting would probably eliminate a population for many years, but selective harvest might be beneficial if it stimulates cane growth.

References

Allen *et al.* (2005), Bordelon and Knudson (1999), Brock and Kaufman (2003), Cech and Tudor (2005), Covell (1999), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Howe (1975), Irwin and Downey (1973), Kimball (1965), Klots (1951), Kons and Borth (2006), LeGrand and Howard (Butterflies of North Carolina website), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986).

Dusky roadside-skipper

Amblyscirtes alternata (Grote and Robinson)

Identification

This small (18 to 25 mm), dark skipper is very obscurely marked (Figures 75-78). The spots on the wings typical of other roadside-skippers (*Amblyscirtes* species) are very faint or absent on the

Figure 75. Dusky roadside-skipper (*Amblyscirtes alternata*) upperside male from Columbus County, North Carolina (Marc Minno Photo).

Figure 76. Dusky roadside-skipper (*Amblyscirtes alternata*) underside male from Columbus County, North Carolina (Marc Minno photo).

Figure 77. Dusky roadside-skipper (*Amblyscirtes alternata*) upperside female from St. Johns County, Florida (Marc Minno photo).

Figure 78. Dusky roadside-skipper (*Amblyscirtes alternata*) underside female from St. Johns County, Florida (Marc Minno photo).

dusky roadside-skipper, especially the apical spots on the forewings. The undersides of the wings have some bluish-gray frosting and faint spots, but otherwise lack any pattern. The fringes of the wings are checkered. The antennal clubs are blunt, without the tapered extensions of other skipper genera, helping to differentiate this species. The head of the caterpillar is brown with reddish-brown stripes, and the body is frosted with white wax (Figure 79, Minno *et al.* 2005).

Figure 79. Dusky roadside-skipper (*Amblyscirtes alternata*) larva from Ocala National Forest, Marion County, Florida, found by Marc Minno (Jerry F. Butler photo).

Range

The dusky roadside-skipper is found on the coastal plain and in the Sand Hills from southeastern Virginia, southward into southern Florida, and then westward to eastern Texas and Oklahoma.

Rarity

NatureServe Global Rank: G2G4. This is an uncommon to rare skipper with a moderately restricted range that is closely associated with longleaf pine. Although once a dominant tree of the southeastern United States, only a small percentage of the original longleaf pine habitat remains, much of which has been severely degraded and fragmented. This fast-flying and small skipper is easily overlooked, but can be found at flowers. Georgia and Alabama have ranks of S2S4. Mississippi and Louisiana have SU ranks. All of these ranks reflect considerable uncertainty regarding status. Arkansas and Florida ranks are S1 and North Carolina's is S2. Steve Roble informs us that there are no known extant populations in Virginia. LeGrand and Howard (Butterflies of North Carolina website) report it from eleven counties in North Carolina and six in South Carolina, not all of which necessarily have viable populations now. They consider the species rare in longleaf pine regions of the coastal plain and Sand Hills, and very rare elsewhere in the Carolinas. This is one of the few skippers Kons and Borth (2006) do not report at all. Bordelon and Knudson (1999) report it from only two localities in southeast Texas.

Life history

The life history is similar to other *Amblyscirtes* species. Records in Glassberg (1999) indicate three broods in much of the range, and two broods in North Carolina, with adults flying from late April into June, and again in August.

Eggs are laid singly on the leaves of the host plant. The caterpillars fold over part of the host leaf or tie a few leaves together to make a shelter. Mature caterpillars clip the shelter from the host and form a simple cocoon in which to overwinter on the ground.

Host plants

Marc Minno and Jeff Slotten found larvae of dusky roadside-skipper on bearded skeletongrass (*Gymnopogon ambiguous*) in Ocala National Forest, Florida in May 2004. Marc Minno has also found larvae on this grass in southern Alabama and Georgia. Literature reports of bluestems (*Andropogon* species) as the host plant are based on laboratory rearings; these grasses do not seem to be used in the wild.

Habitat

The dusky roadside-skipper occurs in grassy pine flatwoods, savannas, and sandhills. It can be found under longleaf pines with a grassy understory, usually on slightly elevated sites.

Threats & management issues

Habitats of the dusky roadside-skipper are subject to periodic wildfires that reduce hardwoods and shrubs and favor the growth of pines and grasses. This species should be given particular attention in planning and implementing prescribed burns. All life stages are above ground and are vulnerable to prescribed fires that consume or scorch the standing dry grass and litter. Because there are two or three broods, recovery from unburned refugia should occur quickly, but a given food plant patch should not be burned every year or two. Gypsy moths are now present in some parts of the range, and the sensitivity of the dusky roadside-skipper to *Btk* is unknown. Selective harvest of trees would probably not harm this species.

References

Allen *et al.* (2005), Bordelon and Knudson (1999), Brock and Kaufman (2003), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Lenczewski (1980), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Pague and Schweitzer (1991), Roble *et al.* (2000), Scott (1986).

Bell's roadside-skipper

Amblyscirtes belli H. A. Freeman

Identification

This relatively large (25 to 32 mm) roadside-skipper has a weak and somewhat fragmented spot band (Figure 80) and a light scattering of paler scales on the underside of the hindwings (Figure 81). It lacks the blue-gray shading on the underside of the hindwings found in *Amblyscirtes vialis*. The upperside forewing inner median spot is often V- or U-shaped. However, if this spot is rounded, it may not be possible to separate this species from the closely similar *Amblyscirtes celia* using wing characters alone, in which case the genitalia should be examined. Brightly patterned specimens of *Amblyscirtes alternata* are similar, but smaller. The antennae of Bell's roadside-skipper are relatively long, and the fringes of the wings are checkered. The larva is green with brownish stripes on the head (Figure 82, and Allen *et al.* 2005).

Figure 80. Bell's roadside-skipper (*Amblyscirtes belli*) upperside male from Dallas County, Texas (Marc Minno photo).

Figure 81. Bell's roadside-skipper (*Amblyscirtes belli*) underside male from Dallas County, Texas (Marc Minno photo).

Range

This skipper has a limited and discontinuous range from the mountains and upper Piedmont of Georgia and South Carolina to the Ohio Valley and westward to Kansas and Texas, but it is largely absent from the immediate Mississippi Valley (Opler and Malikul 1992). Isolated colonies have been found in southern Indiana (Shull 1987, Marc Minno collection). Bell's roadside-skipper is locally common in the Ozarks (Heitzman and Heitzman 1987).

Figure 82. Bell's roadside-skipper (*Amblyscirtes belli*) larva from Pickens County, South Carolina (Tom Allen photo).

Rarity

NatureServe Global Rank: G3G4. This species is uncommon to rare in most or all parts of its range, but less so westward. While it is not imminently imperiled, there seems to be inadequate evidence to conclude that it is apparently secure. It is possibly secure in the Ozarks or Texas.

LIFE HISTORY

The life history of Bell's roadside-skipper is similar to other *Amblyscirtes* species. There are two broods, with adults present from late April into June and again in August. Adults appear earlier in the spring, and probably have a third brood farther south.

The eggs are laid singly on the leaves of the host plant. The caterpillars fold over part of the host leaf or tie a few leaves together to make a shelter. The mature caterpillar clips the shelter from the host and forms it into a simple cocoon in which to overwinter on the ground.

HOST PLANTS

The primary food plant of this species is Indian woodoats (*Chasmanthium latifolium*), a grass that is sometimes used as an ornamental plant in landscaping. Glassberg (1999) also observed numerous ovipositions on Johnsongrass (*Sorghum halepense*) in Texas. Johnsongrass is an exotic, noxious weed, and its significance as a food plant for Bell's roadside-skipper is uncertain.

HABITAT

The habitat of Bell's roadside-skipper is hardwood forests bordering rivers and streams. The host plant, Indian woodoats, grows along the banks of streams and rivers. Bell's roadside-skipper sometimes occurs in grassy areas in and around woodlands, and has occasionally been seen visiting city gardens, but it is usually found along creeks (Scott 1986, Opler 1992) and in bottomland forests.

THREATS & MANAGEMENT ISSUES

Fire probably is not an issue in the mesic to wet habitats of this species, but channelization of streams and rivers could impact its habitat.

Gypsy moth control is likely to become an issue in the range of this species, but not necessarily in its habitat. Gypsy moth is now present in some parts of the range, but the sensitivity of Bell's roadside-skipper to *Btk* is unknown. Whether its habitats are vulnerable to severe defoliation depends mostly on the prevalence of oaks and other trees gypsy moth larvae prefer to eat.

Clearcutting would likely destroy the habitat for several decades at least, and permanently if native understory plants were to be replaced by invasive exotics or planted pines. It is unclear what impact selective harvest might have.

Deer and invasive plants are likely to become problems for this species.

REFERENCES

Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1999), Heitzman (1965), Heitzman and Heitzman (1987), Howe (1975), Irwin and Downey (1973), Kimball (1965), Klots (1951), Minno and Emmel (1994), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Shull (1987).

Carolina roadside-skipper

Amblyscirtes carolina (Skinner)

Identification

This smallish (21 to 28 mm) skipper (Figure 83) may be identified by the pattern of pale spots on a yellowish ground on the underside of the hindwings (Figure 84), and the relatively long antennae. The spots on the upperside of the forewings are yellowish and prominent, especially the two in the cell. The fringes of the wings are checkered. The Carolina roadside-skipper is most similar to females of the fiery skipper (*Hylephila phyleus*), which differ in that they have short antennae and orangish spots on the forewings. The larva of the Carolina roadside-skipper is green with stripes on the head (Figure 85 and Allen *et al.* 2005).

Figure 83. Carolina roadside-skipper (*Amblyscirtes carolina*) upperside male from Nansemond County, Virginia (Marc Minno photo).

Figure 84. Carolina roadside-skipper (*Amblyscirtes carolina*) underside male from Nansemond County, Virginia (Marc Minno photo).

Range

The range of this species is much smaller than that of its host plant. The Carolina roadside-skipper occurs in southeastern Virginia, and is widespread on the North Carolina coastal plain and immediately adjacent Piedmont. There is a report of an isolated disjunction substantially to the south in Berkeley County, South Carolina (LeGrand and Howard Butterflies of North Carolina website). Otherwise, it seems to be much more sporadic on the Piedmont of western North Carolina and extreme northwestern South Carolina, westward across the northern halves of Georgia, Alabama, and Mississippi. There are a few additional disjunctions, most notably in southern Illinois and extreme southeastern Missouri (Scott 1986, Heitzman and Heitzman 1987, Opler and Malikul 1992, Glassberg 1999, Brock and Kaufman 2003). This species is not found

Figure 85. Carolina roadside-skipper (*Amblyscirtes carolina*) larva from Suffolk County, Virginia (Tom Allen photo).

along the Gulf coast and does not reach Florida. A Delaware record is based on mislabeled Virginia specimens (Chris Heckscher personal communication with Dale Schweitzer on 27 December 2000). The host plant has not been recorded from Delaware.

Rarity

NatureServe Global Rank: G3G4. The Carolina roadside-skipper is uncommon and local in a moderate-sized range. The number of colonies and their long-term viability is not known. This species is apparently rather rare except in the northeastern corner of its range.

Life history

The life history is similar to that of other *Amblyscirtes* species. There appear to be three broods in much of North Carolina from early April through September (LeGrand and Howard Butterflies of North Carolina website). Adults appear earlier in spring than other cane-feeding skippers.

The eggs are laid singly on the leaves of the host plant. The caterpillars fold over part of the host leaf to make a shelter. The mature caterpillar clips the shelter from the host and forms it into a simple cocoon in which it pupates on the ground. Individuals from the final brood of the year overwinter in cocoons.

Host plants

Like the reversed roadside-skipper and lace-winged roadside-skipper, the caterpillars of the Carolina roadside-skipper feed on the leaves of *Arundinaria* species, native bamboos in the grass family (Poaceae). It appears that they use switch cane (*Arundinaria tecta*) usually or exclusively.

Habitat

The Carolina roadside-skipper is found in close association with switchcane in grassy pine flatwoods, savannas, and at the edges of bay swamps and pocosins. In North Carolina it is usually found in edges and openings of hardwood forests, and not in pine woods according to LeGrand and Howard (Butterflies of North Carolina website). However, Bo Sullivan notes that they are almost always in mixed or pure pinewoods on the coastal plain. Steve Hall also observed them in old beaver ponds in pine dominated landscapes, and points out that hardwood habitats that may be used are often imbedded in relatively open fire-maintained pine woodlands.

Threats & management issues

All life stages of this species are above ground, so prescribed fire could eliminate this and other rare cane feeders if the canes are dry enough to burn. Therefore, not all of the habitat in an area should be burned at one time with prescribed fire. Because this species and other cane-feeding skippers have two or more broods each year, dispersal from an unburned refugia should allow recovery to occur quickly, but good management would allow several years to elapse before a site is burned again. Gypsy moth feeding and control measures are not likely to affect this species, except perhaps in North Carolina hardwood habitats. Selective harvest of trees might be beneficial if it stimulated switchcane growth, but roller chopping for site preparation would be very harmful to this butterfly. Clearcutting could be harmful if native understory plants were replaced by invasive exotics or planted pines.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Heitzman and Heitzman (1987), Cech and Tudor (2005), Glassberg (1999), Holland (1898), Howe (1975), Irwin and Downey (1973), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Mather (1975), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986).

Linda's roadside-skipper

Amblyscirtes linda H. A. Freeman

Identification

This small (25 to 28 mm) dark skipper is similar to *Amblyscirtes belli,* which occurs within its range, and *Amblyscirtes celia,* which does not. The wings are mostly unmarked above, with a few faint apical spots on the forewings (Figure 86). The underside of the hindwings has a curved row of pale spots and a moderate-to-heavy scattering of paler scales (Figure 87). The antennae are relatively long. The fringes of the wings are checkered. Identifications should be confirmed by examining the genitalia. The last stage larva has black stripes on the head and a bluish white body (Heitzman and Heitzman 1969).

Figure 86. Linda's roadside-skipper (*Amblyscirtes linda*) upperside male from Faulkner County, Arkansas (Marc Minno photo).

Figure 87. Linda's roadside-skipper (*Amblyscirtes linda*) underside male from Faulkner County, Arkansas (Marc Minno photo).

Range

This species is endemic to a small area of the lower Midwest centered in and near the Ozarks. It occurs in southern Missouri, northern Arkansas, and the immediately adjacent parts of Illinois, Kentucky, Tennessee, Nebraska, and Oklahoma (Brock and Kaufman 2003).

Rarity

NatureServe Global Rank: G2G3. Very little is known of this species, but it has a very limited range and is rare. The Missouri Natural Heritage Program ranks this species as S2? (meaning it is not certain that it is imperiled). Missouri contains so much of the total range that it is very probable that the global rank should match that state rank. Tennessee and Arkansas also rank it

S2 and S1S3, respectively, and no other state has a rank other than "status unknown." Heitzman and Heitzman (1987) describe its status in Missouri as "Rare breeding resident...extremely local...found only in undisturbed forest localities in the Ozarks."

Life history

Heitzman and Heitzman (1969) studied the life history of this species in Missouri. There are three broods from mid-April to early September (Heitzman and Heitzman 1987).

The eggs are laid singly on the undersides of the host leaves. The newly emerged larva eats the egg shell, then crawls along the leaf margin. To form a shelter in which to hide, the larva cuts two notches, folds over a resulting flap, and ties it down with silk. There are five larval instars. The last instar ties the edges of a single leaf together to form a shelter.

Unlike with other *Amblyscirtes* species, the pupal shelter is attached with silk to the host stem (Heitzman and Heitzman 1969).

Host plants

The caterpillars eat the leaves of Indian woodoats (*Chasmanthium latifolium*), a perennial, clumping grass that grows along streams and rivers.

Habitat

This skipper lives in mesic hardwood forests with an abundance of the host plant along or near small streams (Heitzman and Heitzman 1969, 1987).

Threats & management issues

Probably the same as related species, but we know very little about this skipper.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Glassberg (1999), Heitzman and Heitzman (1969, 1987), Howe (1975), Irwin and Downey (1973), Klots (1951), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986).

Reversed roadside-skipper

Amblyscirtes reversa Jones

Identification

This smallish (21 to 28 mm) skipper is very similar to *Amblyscirtes carolina* (Figure 83 and 84), which also uses the same host plant. However, in the reversed roadside-skipper, the ground color on the underside of the hindwings is not as yellow and the pale spots are reduced in size. Also, the spots on the upperside of the forewings are paler yellow (Figure 88 and 89), and the two spots in the cell are not as prominent as those on the Carolina roadside-skipper. The eyes are dark reddish in life. The antennae are relatively long and the fringes of the wings are checkered. The relatively bright chestnut brown background with a yellowish pattern could cause inexperienced observers to fail to recognize this species as a roadside-skipper (*Amblyscirtes* species). The mature larva is whitish. The head is pale brown with a triangular black patch on the face and a thick black line around the margin (Figure 90 and Minno *et al.* 2005).

Figure 88. Reversed roadside-skipper (*Amblyscirtes reversa*) upperside female from Pickens County, South Carolina (Marc Minno photo).

Figure 89. Reversed roadside-skipper (*Amblyscirtes reversa*) underside female from Pickens County, South Carolina (Marc Minno photo).

Range

The range of *Amblyscirtes reversa* is much more restricted than that of its host plant, and is similar to that of *Amblyscirtes carolina* eastward, but with fewer county records in North Carolina and a few more in South Carolina (LeGrand and Howard Butterflies of North Carolina website). Popular guides overstate the known South Carolina distribution of both *Amblyscirtes carolina and Amblyscirtes reversa*. *Amblyscirtes reversa* occurs in small local colonies from southeasternVirginia and eastern North Carolina into eastern South Carolina, then west in the Piedmont of western North Carolina and extreme northern South Carolina (LeGrand and Howard Butter-

Figure 90. Reversed roadside-skipper (*Amblyscirtes reversa*) larva from Baldwin County, Alabama (Marc Minno photo).

flies of North Carolina website). The range also extends into northern Georgia (Opler 1992, Glassberg 1999, and Brock and Kaufman 2003), and the skipper is found along the Gulf coast from western Florida to Mississippi.

Marc Minno discovered a few colonies of *Amblyscirtes reversa* in southeastern Alabama (Baldwin County) in 2001, and in the western Florida Panhandle (Blackwater River State Forest, Okaloosa County) in June 2003. Mary Ann Friedman has since found it at Eglin Air Force Base in Walton County, Florida. Disjunct occurrences have been reported from southern Illinois and Arkansas, but are not shown on recent range maps.

Rarity

NatureServe global rank: G3G4.

The reversed roadside-skipper is uncommon to rare and local, but is probably less rare in the northeastern part of its range. This is the most rarely encountered of the cane-feeding skippers. Marc Minno has found the larvae in southeastern Alabama and the western Florida Panhandle (both state records), but has seen the adults only rarely. The global rank is strongly influenced by the S3 ranks (as of 2006) from both Virginia and North Carolina, which is the core of the range. We have no information on its status in South Carolina where there are few records.

Life history

The life history is similar to other *Amblyscirtes* species. There are three broods in most of the range in late April–May, late June–July, and August through early September (Glassberg 1999).

The eggs are laid singly on the leaves of the host plant. The caterpillars fold over part of the host leaf to make a shelter. The mature caterpillar clips the shelter from the host and forms it into a simple cocoon in which to overwinter on the ground.

Host plants

Like Carolina and lace-winged roadside-skippers, the caterpillars of this species feed on the leaves of switchcane (*Arundinaria gigantea*), and perhaps other species of cane.

Habitat

The reversed roadside-skipper occurs in close association with canebrakes on the wet lower slopes of sandhills and at the edges of blackwater streams and rivers. LeGrand and Howard (Butterflies of North Carolina website) indicate that this species prefers open wet pinelands and edges of pocosins, which are generally sunnier places than Carolina roadside-skipper habitats. Such pinelands are fire dependent. More information on the larval habitats for both species would be useful.

Threats & management issues

In general, management issues should be similar to those for other cane-feeding skippers. Given its rarity, this species should be given particular attention in planning and implementing prescribed burns. It is impossible to be sure what impacts *Btk* spraying would cause to this skipper, although its habitats should probably not often be subject to gypsy moth control. Gypsy moth feeding is not likely to affect this species. Selective harvest of trees might be beneficial by stimulating growth of switchcane, but roller chopping for site preparation would be very harmful to cane, and therefore to this skipper. Clearcutting could be harmful if native understory plants were replaced by invasive exotics or planted pines.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Glassberg (1999), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Mather (1975), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986).

Eastern Arogos skipper

Atrytone arogos arogos (Boisduval and Le Conte)

Identification

Atrytone arogos arogos is a medium-sized (27 to 32 mm) skipper. The undersides of the hindwings are golden yellow in fresh individuals, but often become brownish with age. Some females in the New Jersey Pine Barrens are rather dusky even when fresh. Males are golden yellow above with wide dark borders (Figures 91 and 92). Females are blackish brown with a scattering of golden yellow scales in the center of the forewings (Figure 93). The amount of yellow on the uppersides of the forewings of females varies greatly between individuals and populations. Some females from along the Gulf coast resemble those of Midwestern populations. The common Delaware skipper (*Anatrytone logan*) is similar, but larger, and the head and eyes are relatively large compared to the size of the thorax; in the Arogos skipper, the head and eyes are relatively small with respect to the thorax. In northern New Jersey these two species occur together, but in the Pine Barrens, populations of Arogos skippers fly later, and the two barely overlap. Worn individuals could be confused in the field with the tawny-edged skipper (*Polites themistocles*), but that species has apical spots on the forewings. From the underside very worn dark females of Arogos skipper could be mistaken for the swarthy skipper (*Nastra lherminier*). The caterpillar is

Figure 91. Arogos skipper (*Atrytone arogos arogos*) upperside male from Duval County, Florida (Marc Minno photo).

Figure 92. Arogos skipper (*Atrytone arogos arogos*) underside male from Duval County, Florida (Marc Minno photo).

Figure 93. Arogos skipper (*Atrytone arogos arogos*) upperside female from Duval County, Florida (Marc Minno photo).

Figure 94. Arogos skipper (*Atrytone arogos arogos*) larva from Okaloosa County, Florida (Marc Minno photo).

pale bluish white. The head is light brown with reddish-brown stripes (Figure 94). It is similar to the larvae of *Nastra* species, but the anterior margin of the prothoracic shield behind the head is black on the caterpillars of the Arogos skipper.

Taxonomic notes

This skipper was first described from Georgia, probably Screven County, where the species was still extant in 1946 (Harris 1972). Populations found along the Gulf and Atlantic coastal plains are now considered to be the typical subspecies, *Atrytone arogos arogos*, which has wide black borders above. Males have a short dark bar at the end of the cell, and females are mostly dark above. Within *Atrytone arogos arogos* there are several different variants or ecotypes (Hall *et al.* 1999, Minno and Minno 2006, Dale Schweitzer observation). There may be phenotypic differences between the two ecotypes that occur allopatrically in New Jersey (Anthony McBride, Dale Schweitzer), as well as the others (Marc Minno observation). Midwestern prairie populations from Texas northward to Colorado and North Dakota are *Atrytone arogos iowa* Scudder, which has narrower dark borders and more extensive golden yellow above, especially in the females, and is paler. Males of *Atrytone arogos iowa* lack the dark bar at the end of the cell. *Atrytone arogos iowa* is not as rare as *Atrytone arogos arogos*, but has lost over 95% of its prairie habitat and is also in need of conservation efforts.

Range

A few specimens from central Mississippi have been identified as *Atrytone arogos iowa* (Mather and Mather 1958), but more specimens are needed for study. Marc Minno has not been able to relocate any Arogos skipper colonies in central Mississippi. The typical eastern Arogos skipper once occurred from southern Florida near Miami to southern South Carolina. A variant is known from eastern Louisiana, southern Mississippi, southern Alabama, and the western Florida Panhandle. Another variant occurs in coastal North Carolina and the core of the New Jersey Pine Barrens. Another version occurs in northern New Jersey, formerly extending into New York (Staten Island and Long Island) and Bucks County, Pennsylvania. Shapiro (1966) reported *Atrytone arogos*s from Salem, Pitman, and Williamstown in southwestern New Jersey but no populations have been found in that part of the state in more recent times (Iftner and

Wright 1996, Wright personal communication with Dale Schweitzer, and Dale Schweitzer field work). Voucher specimens from these New Jersey locations are probably no longer extant (Arthur Shapiro personal communication with Marc Minno May 2011).

We question the reliability of the old records in the mountains at Blacksburg, Virginia, and Tryon, North Carolina, reported by Clark and Clark (1951), and no specimens from anywhere in or near the mountains have been found (Hall *et al.* 1999).

Rarity

NatureServe global rank: G3T1T2; Xerces Society rank: Vulnerable for the entire species.

This subspecies was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995. *Atrytone arogos iowa* can be locally numerous in southern parts of its range. The Arogos skipper has declined greatly throughout its eastern range, and most colonies may not be viable over the long term. As of 2010, the Arogos skipper is believed to be extirpated from Georgia, North Carolina, South Carolina, New York, Pennsylvania, and Virginia. This skipper is at serious risk of extirpation in most of its eastern range within the next 10–20 years. The Gulf Coast ecotype recently had the most occurrences (one in Louisiana, 12–15 in Mississippi, 1 in Alabama, and 3 at Eglin Air Force Base, Florida, Marc Minno observations), but Hurricane Katrina devastated its Gulf coast habitat in August 2005 during the latter part of the flight season. There have not been any surveys since the storm to assess status there. The typical ecotype appears to be extirpated in South Carolina and Georgia, but still occurs at a few sites in Florida. It is most abundant at a few large wildlife management areas in Osceola County in Central Florida.

As of early 2009, the Arogos skipper was known from one site at Croatan National Forest, in North Carolina. However, the Croatan population may not have survived a fire in 2009, as no adults were reportedly seen during either the second flight period that year or in 2010.

The Arogos skipper is also known from a few sites at Fort Dix and elsewhere in the New Jersey Pine Barrens. The Pine Barrens populations declined abruptly in 2005, although there was recovery at Fort Dix by 2008. The Arogos skipper is listed as an Endangered Species by New Jersey, where the distinctive northern ecotype is obviously endangered and the Pine Barrens ecotype is seriously threatened or endangered. In northern New Jersey, Pennsylvania, and New York, colonies may have been mostly ephemeral. Most potential habitats have been obliterated by development, but the Arogos skipper disappeared from Staten Island by the late 1980s or early 1990s even though the habitat was still intact. Fires in the 1980s might have been a factor.

The situation in the New Jersey Pine Barrens is more complex. Compared to other skippers, the New Jersey records in Smith (1910) do not suggest an especially rare species. Smith's records all appear to be *bona fide*. Furthermore, there are specimens in various collections from Lakewood and Lakehurst south to the Chatsworth - Pine Plains area. Dale Schweitzer saw one at Batsto slightly farther south. The species was once more widespread in the core of the Pine Barrens (Burlington and Ocean counties) than it is now, especially if Shapiro's (1966) Atco record is correct, as seems quite likely. Much habitat was lost to fire suppression after the 1940s. On the other hand, a number of historical sites (at least Plains Highway, presumably current Route 72, and Mt. Misery) were within the path of a 31,000-hectare wild fire. The fire was the largest of several totaling nearly 38,000 hectares that started on 20-21 April 1963. A crown fire of that severity would have killed virtually all larvae in its path, but also opened up much new habitat. Several colonies were just south of this fire, so recolonization should have occurred, and this event probably benefited the species in the long run.

This species is prone to large fluctuations in numbers in the Midwest (Heitzman 1966) and elsewhere. In the 1990s to 2005 this species was always the most numerous or only skipper present in its wet pinelands habitats in New Jersey. Colonies there have changed from locally abundant to extirpated in one season, and small colonies can suddenly appear or "wink out" for no apparent reason (Dale Schweitzer observation). Except on Fort Dix, in those places checked in 2005–2008, numbers observed were zero to only 15% of previous numbers earlier that decade. Regularly burned and recently unburned habitats alike were affected. One of the two metapopulations at Fort Dix recovered, and both persist as of 2008 However the other two major recent population clusters in Pine Barrens may not have fared so well. The West Plains population cluster is probably extirpated. No adults were found from 2005 to 2009. Only one adult was seen in another previously reliably productive cluster of swales a few kilometers to the west in 2005, and none in 2006, 2007, or 2008. However, not all habitats in the western cluster were visited, nor were some isolated colonies. For the northern New Jersey ecotype, numbers were much lower in 2002 than in 2001 and most other recent years. However, we have no information from there in 2005 through 2008 other than reports (from Anthony McBride) that some were seen by reliable observers. Apparently this species had a period of exceptional abundance during the 1960s and early 1970s in northern (but not southern) New Jersey, and briefly extended its range into adjacent parts of Pennsylvania and New York (Shapiro 1966, 1974, Christian Adams personal communication to Dale Schweitzer).

Life history

In New Jersey and adjacent states there is one brood. Old records are from 29 June to 23 July except Smith (1910) reported one on 30 August. All recent observations and collections of adults have been from 21 July to 10 August at Pine Barrens sites, except slightly earlier at the northernmost colony. The difference in old versus modern flight dates is real and probably reflects increased restriction to boggy pine savannas and swales, which are very cold on clear spring nights. In North Carolina there are or were generally two broods, mostly between mid-May and mid-June and again in August to mid-September. In Florida and along the Gulf Coast there are three broods with adults flying from mid-April into May, June through July, and August into September or October (Minno and Minno 2006); however, the timing in any one year can vary considerably. The most reliable time to find adults in the South is mid-August to mid-September.

Females lay eggs singly on the leaves of specific grasses, which vary regionally. Larvae emerge from the eggs in about a week, make a shelter, and begin to feed. Young larvae make a shelter by folding over a piece of leaf near the tip of the blade. Older caterpillars tie the margins of a single leaf together to make a tube, or tie two overlapping leaves together. The larvae overwinter. Heitzman (1966) observed that fourth instar *Atrytone arogos iowa* overwintered in Kansas. In the spring, the larvae resume feeding and complete development in late spring or very early summer.

The pupal stage is reported to last twelve days in Kansas (Heitzman 1966).

The flight is rapid and erratic near the ground. Both sexes readily visit flowers for nectar, but only while the sun is shining. Some of the New Jersey Pine Barrens habitats have no nectar at all in dry summers and very little in the best years. For a few years after fires, nectar becomes scarce for the first brood in North Carolina (Steve Hall). Northern New Jersey colonies depend on weedy native and exotic species like knapweeds (*Centaurea* species), common milkweed (*Asclepias syriaca*), and several others. Purple-flowered milkworts (*Polygala* species) are the most frequently available nectar sources in southern New Jersey, especially after fires, but Carolina redroot (*Lachnanthes caroliana*) is preferred where it is present on disturbed soils. In the South, Carolina redroot, thistles (*Cirsium* species), blazing star (*Liatris* species), *Lobelia* species, and milkworts (*Polygala* species) are commonly visited. *Liatris* spp. are favored nectar plants for Arogos skippers in the Southeast, but in New Jersey the native species blooms about a month after the flight season ends. Potted blooming *Liatris* plants are useful in attracting Arogos and other skippers during surveys of habitats with little or no available nectar in New Jersey. Steve Hall reports that the Venus flytrap (*Dionaea muscipula*) and sand bog deathcamas (*Zigadenus glaberrimus*) are used in North Carolina; as in New Jersey, nectar may not be reliably available. While feeding, Arogos skippers are extremely docile to the point that they may be touched without flying away.

In New Jersey, males and fresh females are most active very late in the day. Neither sex is active in the heat of the day or above 32–33°C except rarely for flower visits. They may even become torpid and remain on blossoms for several hours after feeding during hot weather. Most take shelter in dense grass or shrubs. Males begin perching soon after 3:00 pm on cooler days (below 30°C), but usually around 4:30 to 5:30 on hot days, and are active until about an hour before sunset. Females arriving during this period are quickly found by the males, and there are few, if any, skippers in which mating is easier to observe and photograph. Dale Schweitzer has seen one case where the female approached the male. Courtship behavior is minimal. Pairs separate before dark. Perches are usually in sunny reedgrass patches in shrubby habitats, but in more extensive grass stands males may select small depressions dominated by low shrubs. Exposure to late day sun is a critical habitat feature, and orientation probably explains why some otherwise suitable linear swales are unoccupied.

Oviposition has been observed in late morning and in the afternoon. It is possible that mating activity occurs early in the morning, but occasional adults observed on perches then are probably thermoregulating. In September 2007, Mary Ann Friedman (personal communication with Marc Minno) encountered the same late afternoon activity by Arogos skippers at Eglin Air Force Base, Florida. Males were actively flying and looking for mates until after sunset, while females were laying eggs.

Host plants

The food plants of the Arogos skipper are grasses, but the species vary regionally (Hall *et al.* 1999, Minno and Minno 2006, Dale Schweitzer observation). Little bluestem (*Schizachyrium scoparium* -- formerly known as *Andropogon scoparium*) is the food plant in northern New Jersey and at the former Staten Island colony (Shapiro and Shapiro 1973). The Atlantic coast ecotype in North Carolina and the New Jersey Pine Barrens feeds on pine barrens reedgrass (*Calamovilfa brevipilis*). The host from southern South Carolina and Georgia to southern Florida is, or was, lopsided Indiangrass (*Sorghastrum secundum*).

The Gulf Coast ecotype feeds on toothachegrass (*Ctenium aromaticum*). At Eglin Air Force Base, Mary Ann Friedman and Marc Minno also observed females laying eggs on broomsedge bluestem (*Andropogon virginicus*) late in the evening in late summer. They also found a larva on *Sorghastrum secundum* in the spring the following year. It is not yet known if the colonies in pitcherplant seeps at Eglin Air Force Base are feeding on *Ctenium aromaticum*. If they are, this would be the only population of Arogos skipper known to use such distantly related species of grass at a single locality.

It is possible that historical populations farther inland in Mississippi were using bluestems. Colonies of *Arogos arogos iowa* in the Midwest feed on big bluestem (*Andropogon gerardii*) (Heitzman 1966) and possibly little bluestem (*Schizachyrium scoparium*) which used to be classified as an *Andropogon*. The northern New Jersey-New York-Pennsylvania ecotype is most similar to the Midwestern subspecies in habitat and food plant. John Abbott (in Boisduval and Le Conte 1834) illustrated the larva on barnyard grass (*Echinochloa crus-galli*), but we agree with Calhoun (2006) that this introduced weed was probably a rearing plant, not a natural food plant. The identity of "buffalo grass," which Abbott also gives as a food plant (Harris 1972), cannot be determined, but is likely to be lopsided Indiangrass (Marc Minno observation).

HABITAT

In northern New Jersey, the Arogos skipper is sometimes associated with remnant tracts of former xeric sandy morainal habitats such as the Succasunna Plain. All recent habitats there are artificial, such as right-of-ways, old fields, abandoned pastures, and roadsides, and are dominated by little bluestem. The original habitats there are unclear, but most likely were xeric oak savanna or even more prairie-like vegetation. The habitat was similar on a nearby Staten Island, New York, serpentine outcrop (Shapiro and Shapiro 1973, Shapiro 1974, Dale Schweitzer observation). The Shapiros' report on this one site (possibly briefly two sites) lead to the misconception that this skipper occurred on serpentine barrens. However, the Arogos skipper has not been found on well-known serpentine barrens in Pennsylvania, Maryland, or anywhere else. The dry "*Andropogon*" meadows used in Pennsylvania (Shapiro 1966) were probably *Schizachyrium scoparium* or *Andropogon virginicus* dominated old fields. There were no known natural grasslands within several dozen kilometers of this area. While this area is now quite nondescript, the known range of the globally historical (GH) moth *Holomelina nigricans* is similar to this northeastern ecotype of *Atrytone arogos*. The late Joseph Muller collected both on his property in Hunterdon County. This suggests that originally there was some sort of unusual grassland or savanna community in this region.

In the rest of its range, the eastern Arogos skipper is essentially a species of open pinelands and sometimes powerline right-of-ways within them. The habitat in the New Jersey Pine Barrens is mesic to wet pitch pine-reedgrass savannas, wet burn scars and swales in pitch pine lowlands, sometimes with a saturated sphagnum moss substrate, but more often moist sand or peat. While more observations are needed, it appears that this species is usually most abundant a few years after fires. Observations at Fort Dix suggest females commonly move into recently burned areas by the end of their flight season, in one case becoming nearly absent in nearby unburned areas where they were numerous a week or two earlier. The Arogos skipper is excluded from most of the largest known potential habitat (on Fort Dix) in most years by extremely frequent fires. These areas burn once or twice in most years, but occasional small colonies of the

Arogos skipper populate wet patches that do not burn for a year or two. Eventually, even the wet sites burn and these colonies are eliminated. More stable colonies occupy similar adjacent savannas that burn less often. These are nested within or outside of this excessively burned savanna, and in some cases are sufficiently wet to allow some larvae to survive fires. Adults will move at least 100 meters out of preferred habitat to find nectar in New Jersey, but many probably never locate nectar. Adults there eclose with very large fatty abdomens.

Colonies of eastern Arogos skippers in the New Jersey Pine Barrens were clustered and (as of 2004) probably functioned as several metapopulations, two in well separated parts of the Fort Dix Military Reservation, another in the West Pine Plains, and another a few kilometers to the west. There were also at least three more isolated colonies, although two of these were within four kilometers of at least one cluster. Both local temporary extirpations and recolonizations were observed within three of these clusters from 1995 to 2004, usually, but not always, involving fires. Most habitats outside of Fort Dix have shrunk due to lack of fires for several decades, and perhaps also changes in the water table. Some of the wettest habitats in the New Jersey Pine Barrens were occupied at least 65 years after the last fire. However, most Arogos sites burn at least rarely, and without fire, the habitat becomes overgrown by shrubs and sometimes by dense regeneration of pitch pine, about 10–15 years after hot crown fires open them up.

In the South, the eastern Arogos skipper occurs in pine savannas and dry prairies. Pitcherplants are almost always present, except in peninsular Florida. In South Carolina and northern Florida, some colonies were also in dry longleaf pine sandhills. Southern habitats also depend on fires, generally at intervals of about five to perhaps ten years, to keep shrubs and hardwoods from becoming too dense. The very rare Loammi skipper (*Atrytonopsis loammi*) and Arogos skipper share the same host plant and often occur together in peninsular Florida. New Jersey Pine Barrens habitats harbor numerous moths rare enough to merit accounts in this book, such as *Spartiniphaga carterae, Dichagyris reliqua, Agrotis buchholzi,* and others. In North Carolina, *Hemipachnobia subporphyrea*, one of the rarest moths in the eastern United States, and *Agrotis carolina* occurred at the site of the last known Arogos population.

Threats & management issues

The primary cause of the decline of this skipper in most of its range has been loss and fragmentation of habitat, due to development, silviculture, agriculture, and altered fire regimens. In the South, predation by fire ants (*Solenopsis invicta*) might be a threat. Fire ants have not yet established in New Jersey.

Longleaf pine savannas once were a dominant habitat in the southeastern United States from Virginia to eastern Texas, and the Arogos skipper likely was locally common through much of this range. About half of the colonies near the Gulf Coast and some in northern New Jersey are on powerlines, where the habitat has been kept open and grassy by periodic mowing. The continued existence of populations in these areas will depend on benign management of these powerlines.

Otherwise, almost all known populations are or were in fire-prone pinelands. Arogos skipper immatures have no means of surviving fires, except when substrates are too boggy to burn. Although fires may burn the shrubs in these wet places, the grasses and litter may be unaffected and adults may appear in numbers the next summer (one observation in New Jersey); however, such habitats do burn in drought conditions, and unburned refugia are needed for this skipper's survival. Swengel (1996a) found this species to be slower than most to recover after prescribed prairie burns, but in New Jersey adults often move into and reproduce in burned areas by the end of the next flight season, and are well established by the following season. In peninsular Florida, lopsided Indiangrass stands can be maintained with burn intervals of 2–4 years (Penfield 2006). Management with two burn units with one off year between fires seems minimal, and three or more off years would be much safer. This may be difficult where the habitat patch is very small, such as at the recent site in North Carolina.

Prescribed burning eliminated a well-known colony at Ocala National Forest (Minno and Minno 1996). None was seen for several generations after a fire at Eglin Air Force Base (Mary Ann Friedman) in Florida, and for a least two generations after a fire in North Carolina in the 1990s (Steve Hall and Bo Sullivan personal communications with Dale Schweitzer). In both cases the species did reappear, but it may have recolonized from other sites. The North Carolina colony may not have recovered after a 2009 wild fire.

On the other hand, long term lack of fires is probably a major cause for the decline of this skipper in the New Jersey Pine Barrens and other areas. Another factor there may be a lowering of the water table in the Pine Barrens due to increased human use. As a result, succession is allowed to proceed in habitats formerly kept open by the hydrology. The continued existence of the species in rapidly urbanizing northern New Jersey, where it is not using fire-prone habitats, is likely to depend mostly on benign right-of-way management, since the best known site is, or was, a vacant lot on a major road. Disking, mowing during the growing season, and broadcast herbiciding must be avoided, although precise herbicide applications aimed at dense shrubs and invasive non-native weeds might be beneficial. The possibility of increasing habitat in these right-of-ways needs to be explored. If fire regimens do not change greatly, the metapopulations on Fort Dix will probably persist. If fire frequency decreased slightly at the more eastern site, the Arogos skipper would almost certainly immediately expand into vacant habitats which are immediately proximate to occupied areas (but another very rare moth that sometimes occurs in the same locations, *Dichagyris reliqua,* seems to prefer an even higher frequency of fire). The other sites are mostly owned by the State or private conservation groups, and currently have no fire management, so most of them are at risk from succession. Suitable management strategies are under consideration in these areas and might be implemented in time to maintain these metapopulations; however, current regulations and practices make implementing appropriate fire regimens very difficult in New Jersey.

REFERENCES

Allen *et al.* (2005), Boisduval and Le Conte (1834), Brock and Kaufman (2003), Calhoun (2006), Cech and Tudor (2005), Clark and Clark (1951), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (1993, 2000), Hall *et al.* (1999a), Harris (1972), Heitzman (1966), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Mather and Mather (1958), Metzler *et al.* (2005), Minno and Emmel (1994), Minno and Minno (1996, 2006), Minno *et al.* (1997), Minno *et al.* (2005), Opler (1985), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986), Shapiro (1966, 1974), Shapiro and Shapiro (1973), Smith (1910), Swengel (1996a).

Loammi skipper

Atrytonopsis loammi (Whitney)

Identification

This is a fairly large (30 to 35 mm) dark skipper with long antennae and relatively long pointed forewings. The upperside of the forewings and underside of the hindwings are dark brown with white spots (Figures 95-97). The more common dusted skipper (*Atrytonopsis hianna*) is similar, but smaller, darker, and the white spots on the underside of the hindwing are largely absent. The dusted skipper has only a single spring brood, while *Atrytonopsis loammi* has two broods per year, one in spring and another during late summer and fall. The larva is pinkish with relatively long wispy setae, a brown head, and a narrow black prothoracic shield (Figure 98). The caterpillar of the twin-spot skipper (*Oligoria maculata*) is similar, but has a broader black prothoracic shield. Identification should rarely be a problem, except in North Carolina, where two other similar *Atrytonopsis* taxa occur (Cech and Tudor 2005).

Figure 95. Loammi skipper (*Atrytonopsis loammi*) upperside male from Pasco County, Florida (Marc Minno photo).

Figure 96. Loammi skipper (*Atrytonopsis loammi*) upperside female from Duval County, Florida (Marc Minno photo).

Figure 97. Loammi skipper (*Atrytonopsis loammi*) underside female from Duval County, Florida (Marc Minno photo).

Figure 98. Loammi skipper (*Atrytonopsis loammi*) larva from Duval County, Florida (Marc Minno photo).

Atrytonopsis hianna and *Atrytonopsis loammi* are illustrated in several recent books. We caution readers that Glassberg *et al.* (2000, Plate 37, Figure 2) illustrate a female cobweb skipper (*Hesperia metea*) labeled as a dusted skipper.

Taxonomic notes

Although Klots (1951) appreciated the distinctness of this species, *Atrytonopsis loammi* was subsequently often considered to be a southern subspecies of *Atrytonopsis hianna*, based on literature citations of both having white spots on the underside of the hindwings in North Carolina where the general ranges of the two taxa overlap. However, these butterflies look quite different in eastern North Carolina and elsewhere, and they differ in biology as well as wing pattern. Their food plants differ, and we note that *Atrytonopsis loammi* is bivoltine everywhere including its northernmost populations. On the other hand, *Atrytonopsis hianna* is univoltine over the more than four degrees of latitude where their ranges overlap. There is no evidence that they hybridize, although they were nearly sympatric on the North Carolina coastal plain (Hall 2004). We follow Pelham (2008) in treating them as separate species. However, a new twist in the taxonomic debate occurred with the discovery in 2000 by Eric Quinter of a third form on islands off the North Carolina coast in Onslow and Carteret counties. This island form is heavily spotted with white below like *Atrytonopsis loammi*, but the pattern is somewhat different. John Burns studied adults and larvae of this form and thought it might represent an undescribed species (Hall 2004, Cech and Tudor 2005). For now we consider the island form to be a variant of *Atrytonopsis loammi*. It is found in dunes and other open sandy places.

Range

The Loammi skipper formerly occurred in scattered locations along the Atlantic coastal plain from southeastern North Carolina to southern Florida and westward along the Gulf Coast to eastern Louisiana.

Rarity

NatureServe global rank: G1. This rank does not include the North Carolina island populations. The Loammi skipper has declined dramatically in recent years. It appears to be extirpated from mainland North Carolina, South Carolina, and Georgia. We know of ten or fewer colonies in Florida and only one in Mississippi. Its numbers are apparently critically low at all known colonies. This species is likely to become extirpated from most or all of its range in 10–20 years, and is at serious risk of extinction. Also, the North Carolina island form is losing habitat due to coastal land development, but according to Bo Sullivan, the largest population is in a state park. Both *Atrytonopsis loammi* and the North Carolina island form, whether as subspecies or full species, appear to merit listing under the U.S. Endangered Species Act.

Life history

There are two broods in April–May and July-August.

The eggs are laid singly on the leaves of the host grass. The larvae hide in shelters made by tying leaves near the base of a grass clump together with silk. This species apparently overwinters as a last instar larva, possibly pre-pupal.

Males have a rapid flight, typically low to the ground. They perch on low vegetation to await females. Both sexes readily visit flowers for nectar such as yellow thistle (*Cirsium horridulum*) in the spring, and other purple or pink skipper flowers in the fall.

Host plants

The only known host is lopsided Indiangrass (*Sorghastrum secundum*) in Florida. In the western and northern parts of the Loammi skipper's range, this grass either does not occur or is extremely rare, so other grasses must be used. *Sorghastrum elliottii* and *Sorghastrum nutans* are widely distributed in the southeastern United States. *Atrytonopsis hianna* and the North Carolina island form feed on species of *Andropogon* and *Schizachyrium*, so these might be used by *Atrytonopsis loammi* in some places.

Habitat

Atrytonopsis loammi occurs in open pine savannas, sandhills, and dry prairies where there is an abundance of the host plant. In Florida the habitat is often a mosaic of palmettos and patches of grasses. The pine savanna where *Atrytonopsis loammi* persisted in North Carolina into the 1990s is beyond the range of lopsided Indiangrass, but contains several species of *Andropogon* grasses (Steve Hall). The North Carolina island form is found in coastal flats and dunes with nearly pure stands of its food plant, *Schizachyrium littorale*. The Loammi skipper and almost equally rare eastern Arogos skipper share the same host plant (lopsided Indiangrass), and sometimes occur together in peninsular Florida.

Threats & management issues

One of the most important management issues for this butterfly is prescribed fire, which has the potential to eradicate some colonies. Penfield (2006) found that lopsided Indiangrass flowered less in areas that were frequently burned. He also noted that burning from March to mid-June resulted in greater biomass of lopsided Indiangrass than did burning at other times of the year. Adequate refugia are essential, and the entire habitat should not be burned in a one- or two-year period. Otherwise, management involves perpetuating substantial native savanna habitat. Fire is necessary to maintain most habitats of this skipper, but it must be conservatively applied with a large portion of any occupied habitats left unburned. Fire ants might be a potential threat, and this interaction should be evaluated for skippers in general.

References

Brock and Kaufman (2003), Calhoun (1988), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg *et al.* (2000), Hall (2000, 2004), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Legrand and Howard (Butterflies of North Carolina website), Lenczewski (1980), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Penfield (2006), Scott (1986).

DUKES' SKIPPER

Euphyes dukesi (LINDSEY)

IDENTIFICATION

This is a fairly large (31 to 41 mm) dark skipper with somewhat rounded forewings. The uppersides are dark with a few white spots on the forewing of females, similar to females of the Dion skipper (*Euphyes dion*), and none on the males. Males have a dark, linear stigma in the middle of the forewings on the upperside (Figure 99). The underside of the hindwing is reddish with a yellow streak through the middle (Figure 100). The Dion skipper is similar and may occur in the same habitats, but has orange patches on the upperside of the wings. The caterpillar of Dukes' skipper is mostly green (Figure 101). The head has a dark spot on the upper face and dark lines, similar to other *Euphyes* species.

Figure 99. Dukes' skipper (*Euphyes dukesi calhouni*) upperside male from Pasco County, Florida (Marc Minno photo).

Figure 100. Dukes' skipper (*Euphyes dukesi calhouni*) underside male from Pasco County, Florida (Marc Minno photo).

TAXONOMIC NOTES

Two subspecies of Dukes' skipper have been recognized: *Euphyes dukesi dukesi* and *Euphyes dukesi calhouni*. *Euphyes dukesi dukesi* is smaller and sometimes has a hint of orange above. Females have a few pale spots on the upperside of the forewing. *Euphyes dukesi calhouni* is larger than the typical subspecies without any spots or orange above (Shuey 1996). *Euphyes dukesi calhouni* occurs only in Florida.

Figure 101. Dukes' skipper (*Euphyes dukesi calhouni*) larva from Pasco County, Florida (Marc Minno photo).

RANGE

Populations are found along the Louisiana coast extending up the Sabine River to Arkansas and Texas and northward in the Mississippi basin to southern Illinois and Missouri continuing up the Ohio River into Indiana. It also occurs in the Lake Erie lowlands of southeastern Michigan, northeastern Indiana, northwest Ohio, and a tiny piece of Ontario. There are some very disjunct populations on the Atlantic coastal plain from southeastern Virginia to Georgia. *Euphyes dukesi calhouni* occurs in northern and central Florida. There are few records from the Gulf coast, but much of this area is unexplored for this secretive species. Dean and Sally Jue found a colony at Big Bend Wildlife Management Area (Taylor County), in the eastern Florida Panhandle region in April 2008. Although the food plants and habitat are frequent in much of New Jersey, Dukes' skipper has never been found in or near that state.

Rarity

NatureServe: G3; Xerces Society: Vulnerable. This species is difficult to assess because it lives in swamps, where travel is hazardous. Both subspecies are very local and uncommonly encountered in most of the range. Duke's skipper is rarely found in the eastern part of the range. For example, there are records from only nine counties in the Carolinas, although it is sometimes seen in large numbers, up to 50 in a day there. On the other hand, it is known from 24 counties in northern Ohio, and these Lake-Erie lowlands may be a major stronghold. In many parts of the range its wetland habitat was logged, drained, or converted to agricultural and other uses. Dukes' skipper seems to be stable in some parts of its range, such as Ohio and Ontario. All state ranks are ranked from S1 to S3.

Life history

In the northern portion of its range, Dukes' skipper has only one brood, mostly in July. Throughout most of its range, however, there are two broods, mostly in June and late July into September. In Florida, adults have been found from April to early June and August into October. In Texas they have been reported in May, July, and September (Bordelon and Knudson 1999). Glassberg (1999) indicated a more continuous season, May through October, in Louisiana, but the broods are well separated elsewhere. The adults have a slow, fluttering flight pattern near the ground in shady wetland forests. Both sexes readily visit flowers, such as pickerelweed (*Pontederia cordata*), for nectar. Like other wetland skippers, adults will leave the breeding habitats to find nectar. For example, Bill Berthet recently photographed a Dukes' skipper visiting lantana (*Lantana camara*) in his garden in Jacksonville, Florida.

The eggs are laid singly on the leaves of the host plant. The caterpillars make shelters by cutting and folding over pieces of leaf, or by tying the edges of a single leaf or several leaves together. Before pupation, the mature larva plugs the entrance of its shelter with flakes of wax produced by glands on the underside of the posterior part of the body (Marc Minno observation).

Males perch on low vegetation and flutter over and through stands of the host sedges to find females. Marc Minno and Jeff Slotten found several mature larvae and pupae parasitized by tachinid flies at the Big Bend Wildlife Management Area in Taylor County, Florida on 17 October 2010.

Host plants

Caterpillars of Dukes' skipper eat sedges (Cyperaceae). In Michigan they feed on hairy sedge (*Carex lacustris*). In the Mississippi River basin, Virginia (Steve Roble), and probably North Carolina (Steve Hall), Duke's skipper caterpillars feed on shoreline sedge (*Carex hyalinolepis)*. In the Southeast the species feed on false hop sedge (*Carex lupuliformis*) and Walter's sedge (*Carex* *striata*, formerly *Carex walteriana*), and in Florida, narrowfruit horned beaksedge (*Rhynchospora inundata*), and millet beaksedge (*Rhynchospora miliacea*).

Habitat

In most of its range, this species is found in sedge-dominated areas in hardwood and cypress swamps in the dappled light of the forest or at the edges of the swamps. While many of its habitats have been hydrologically altered, such as the Miami Canal in Ohio, a shaded aspect is essential. This skipper is often found along old railroad beds in Ohio swamps. In North Carolina, where most seemingly suitable habitats lack this skipper, it has been found where slightly brackish to freshwater tidal marshes meet wet woods (LeGrand and Howard Butterflies of North Carolina website, Steve Hall).

Threats & management issues

The main threats to Dukes' skipper has been habitat destruction and alteration. Draining wetlands probably impacted this species. Current federal and state laws generally protect much of its wetland habitat from development. In Florida, habitat destruction due to development threatens this species, but the law often requires developers to mitigate destruction to wetlands. However, mitigation to replace wetland habitat destroyed by development is unlikely to help this species, because Dukes' skipper is not known to colonize created wetlands (Marc Minno).

Clearcutting or logging most of the trees in a swamp will also cause harm, because this species is intolerant of open, sunny wetlands. Cattle grazing in Florida swamps could severely reduce stands of its food plant. Mosquito adulticiding in swamps could cause mortality, and spraying should be avoided near known colonies.

The gypsy moth is already present in the northern parts of the range of this butterfly and will probably eventually occupy most of the range north of Florida. It is not known if late instar larvae are sensitive to *Btk* applications aimed at gypsy moth suppression. Known colonies should be excluded from spray blocks, especially since its wetland habitat is not particularly vulnerable to defoliation by gypsy moth larvae. In New Jersey, places similar to what LeGrand and Howard (Butterflies of North Carolina website) describe as habitat in North Carolina are extremely vulnerable to exotic strains of common reed (*Phragmites*) which invades as sea level rise or storm surges kill the trees. This threat is very likely to increase in North Carolina as well.

References

Allen *et al.* (2005), Bordelon and Knudson (1999), Brock and Kaufman (2003), Calhoun (1995a), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Irwin (1969, 1972), Howe (1975), Irwin and Downey (1973), Klots (1951), Kons and Borth (2006), LeGrand and Howard (Butterflies of North Carolina website), Mather (1963), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Pague and Schweitzer (1991), Roble *et al.* (2000), Scott (1986), Shuey (1985, 1993, 1996).

Palatka skipper (Florida Keys population)

Euphyes pilatka klotsi Miller, Harvey, and Miller

Identification

This is one of the larger (37 to 44 mm) skippers in the eastern United States. The underside of the hindwing is a uniform chocolate brown, and the uppersides are golden yellow with dark borders (Figures 102-104). Males have a conspicuous dark stigma in the middle of the forewings on the upperside. The monk skipper (*Asbolis capucinus*) is similar, but is paler brown beneath and slightly larger. The uppersides of the wings of the monk are black with traces of brown. The larva of the Palatka skipper is bluish-green with a frosting of white (Figure 105). The upper face has three black lines separated by white, rather than the single dark spot of other *Euphyes* species (Allen *et al.* 2005, Minno *et al.* 2005).

Figure 102. Palatka skipper (*Euphyes pilatka klotsi*) upperside male from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 103. Palatka skipper (*Euphyes pilatka klotsi*) underside male from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 104. Palatka skipper (*Euphyes pilatka klotsi*) upperside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 105. Palatka skipper (*Euphyes pilatka klotsi*) larva from the National Key Deer Refuge, Big Pine Key, Monroe County, Florida (Marc Minno photo).

Taxonomic notes

Two subspecies of the Palatka skipper have been described: *Euphyes pilatka pilatka* and *Euphyes pilatka klotsi*. *Euphyes pilatka klotsi* is darker brown below, and the females are much darker above than the typical subspecies.

Range

The typical subspecies is found throughout peninsular Florida northward along the Atlantic coast to extreme southeastern Virginia, and westward along the Gulf Coast into Louisiana (Glassberg 1999, Brock and Kaufman 2003). *Euphyes pilatka klotsi* has been found only in the lower Florida Keys on Big Pine, Big Torch, Cudjoe, No Name, Sugarloaf, and Stock Island (Miller *et al.* 1985). Its host plant no longer occurs on Stock Island (Marc Minno observation). This skipper is currently known to occur only on Big Pine Key.

Rarity

NatureServe global rank: G3G4T1. In addition, *Euphyes pilatka klotsi* has declined greatly from its limited historical range, and is currently known only from Big Pine Key. This skipper appears to merit listing under the U.S. Endangered Species Act, and seems to be close to extinction.

Life history

Adults of *Euphyes pilatka klotsi* have been found every month of the year, but are most common in February to April and November to December.

The eggs are laid singly on the leaves of the host plant. Caterpillars make shelters by tying overlapping leaves or the edges of several leaves together. Prior to pupation, the mature larva plugs the entrance of the shelter with flakes of wax produced by glands on the underside of the posterior part of the body (Marc Minno observation). Tachinid flies often attack the larvae.

Males perch in or near stands of the host plant to await females. Both sexes readily visit flowers, such as thistles and blazingstar for nectar.

Host plants

The caterpillars eat Jamaica swamp sawgrass (*Cladium jamaicense*) in the sedge family (Cyperaceae). This tough, spiny sedge grows from two to five feet tall in the Keys, but can be over six feet tall on the mainland. The coarse, tough leaves of sawgrass are edged by small spines.

Habitat

The typical subspecies is locally common near patches of sawgrass in freshwater and brackish marshes and wet pine flatwoods. Marc Minno has found *Euphyes pilatka klotsi* mostly in small sawgrass-dominated depressions in pine rockland habitat, as well as in sawgrass patches in the transition area between the uplands and buttonwood wetlands.

Threats & management issues

Euphyes pilatka klotsi occurs mostly on land managed by the Key Deer National Wildlife Refuge. Prescribed fire in areas where this skipper occurs should be used with extreme caution. Fire will kill all life stages of the skipper, and sawgrass burns readily. Known colonies should not be burned.

Wetlands that support this skipper probably also breed mosquitoes. Adulticides should not be used near existing colonies, but mosquitofish or carefully applied larvicides would not harm the butterfly.

With such small numbers of adults present, collecting could significantly affect this butterfly. Fire ants and other non-native predators or parasitoids may be harming this skipper.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Miller *et al.* (1985), Minno and Emmel (1993, 1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Shuey (1993).

Dotted skipper

Hesperia attalus (W. H. Edwards)

Identification

This is a medium-sized (30 to 40 mm) skipper (Figures 106-109). Almost all females and most males can be distinguished by the spots on the underside of the hindwing, which are often small, but are sharply defined and not blurred or elongated. These spots are sometimes poorly developed or occasionally completely lacking on some individuals, especially males. A few other hesperiine skippers are similar. In southern New Jersey, Texas and Oklahoma, where no other species of *Hesperia* flies with *Hesperia attalus,* the upper side pattern on males, combined with time of year, are diagnostic. On females, the upper side spot band on the hindwing, if visible, will easily rule out the cross-line skipper (*Polites origenes*), which is the only similar species likely to occur with the dotted skipper in the northern part of its range. From the underside, identification of individuals that completely lack the hindwing spot band can be difficult, but the subapical spots on the forewing are usually visible and are diagnostic for *Hesperia*. Some orange along the

Figure 106. Dotted skipper (*Hesperia attalus slossonae*) upperside male from Ocala National Forest, Putnam County, Florida (Marc Minno photo).

Figure 107. Dotted skipper (*Hesperia attalus slossonae*) underside male from Ocala National Forest, Putnam County, Florida (Marc Minno photo).

Figure 108. Dotted skipper (*Hesperia attalus slossonae*) upperside female from Martin County, Florida (Marc Minno photo).

Figure 109. Dotted skipper (*Hesperia attalus slossonae*) underside female from Martin County, Florida (Marc Minno photo).

forewing costa is usually visible on the underside of *Polites origenes*. In the South, the female fiery skipper (*Hylephila phyleus*) is similar when seen from the upper side, but has shorter antennae and a very different hindwing pattern on the underside. The sachem (*Atalopedes campestris*) is similar from a distance and occurs with the dotted skipper at one New Jersey site. However, males of the sachem have a large, black, rounded stigma, and females have a squarish, translucent spot on the uppersides of the forewings. Southward, the dotted skipper often occurs with Meske's skipper (*Hesperia meskei*), but the latter is more golden and usually flies slightly later in the season. For positive identification, we suggest a specimen voucher for all newly discovered sites. Glassberg (1999) and other regional field guides illustrate the adult and similar species. The larva is dark green with a black head (Figure 110, Allen *et al.* 2005, Minno *et al.* 2005).

Figure 110. Dotted skipper (*Hesperia attalus slossonae*) larva from Putnam County, Florida (Marc Minno photo).

Taxonomic notes

Three subspecies of the dotted skipper have been described: *Hesperia attalus attalus*, *Hesperia attalus slossonae* (Skinner), and *Hesperia attalus nigrescens* Gatrelle.

Range

Hesperia a. attalus occurs on the southern plains, mostly in Oklahoma and Texas, and is disjunct from *Hesperia attalus slossonae*, which is found in the New Jersey Pine Barrens, eastern North Carolina now perhaps only in the southern Sand Hills region), and northern and central Florida (Glassberg *et al.* 2000, Brock and Kaufman 2003, LeGrand and Howard Butterflies of North Carolina website). *Hesperia attalus nigrescens* inhabits coastal dunes in Horry County, South Carolina. *Hesperia attalus slossonae* probably was resident historically in southern Georgia, Alabama, and perhaps Mississippi and Louisiana. Scattered collections from Virginia, Pennsylvania, New

York, Maryland, and Massachusetts were mostly single specimens and none are known from these states in the last 35 years. However, an individual photographed at Ft. Jackson near Columbia, South Carolina in the early 1990s by Steve Hall could indicate a resident population there. The Massachusetts specimen was collected in September, which suggests it was a stray from a southern bivoltine population. Both Glassberg (1999) and Brock and Kaufman (2003) give accurate depictions of the small current range.

Rarity

NatureServe global rank: G3G4. The uncertainty in this ranking arises from subspecies *Hesperia attalus attalus*. The two eastern subspecies pooled would rank G3. *Hesperia attalus slossonae* (T3) is local and uncommon to rare, but probably is not immediately imperiled in the North Carolina Sand Hills, the New Jersey Pine Barrens, and Florida. It may no longer occur on the North Carolina outer coastal plain. In New Jersey, populations can be dense in a few open habitats of a few hundred hectares (or even less), or very sparsely distributed over 5,000 hectares or more. The New Jersey Pine Barrens region is much less grassy now than it was originally, a change that has probably fragmented habitat there. Most of its habitat southward has been destroyed. Due to its reduced and fragmented range, *Hesperia attalus slossonae* cannot be regarded as secure, but it is probably the least rare of the dotted skipper subspecies. *Hesperia attalus nigrescens* is probably only a single metapopulation, and therefore is particularly vulnerable. We do not know the current status of *Hesperia attalus attalus*.

Life history

In New Jersey, the dotted skipper usually has one brood, but sometimes a partial second generation occurs in advanced seasons at the less xeric northernmost sites. The phenology varies among New Jersey populations. Adults in the most northwestern colonies in Burlington County start emerging in very late May (Anthony McBride) to mid June. The southernmost New Jersey colonies in Cumberland County, inhabit a substantially warmer and drier region. This disjunct metapopulation has the latest flight season in New Jersey, with adults very rarely appearing before early July. Elsewhere in its range, there are usually two broods, approximately late May through June and August through September. In Florida, adults occur from March to May and July to November, which is probably more than two broods. Mark-release-recapture studies in New Jersey indicate that a few adults live at least 18 days, and that many adults apparently leave their initial habitats for several days at a time, but eventually return. Adults are mostly inactive after 1:00 p.m. on very hot days. At the best-studied New Jersey site in Cumberland County, adults appear in favored basking areas at the tops of piles of bare white sand around 10 to 11 a.m. and occasionally earlier, and some mating occurs then, but later in the day more were seen on lower spots in patches of bare sand, along or in dirt roads, and especially on old concrete. Territorial males usually perch on the sand if it is not too hot, but switch to pebbles or grass leaves in hotter conditions. Adults visit flowers for nectar from about 10 a.m. to 3 p.m., but mostly before 1:30.

The eggs are laid singly on grasses, often on isolated plants growing on open, sparsely vegetated white sand, and sometimes on very small plants on which larvae could not possibly mature. Such isolated plants might be especially likely to be unburned in fires.

The larvae overwinter, probably in the middle instars. The larvae live and pupate in a tube of silk and detritus at the soil surface and base of the bunchgrass host. They mature mostly in mid- or late June in single-brooded populations, and earlier where double-brooded.

Ovipositions have been observed around noon and in mid-afternoon. Some breeding habitats do not have flowers with nectar, and New Jersey adults will move into wetlands or weedy fields to find flowers. Movements of 1–2 kilometers are common. In the New Jersey Pine Barrens, native wetland flowers like Carolina redroot (*Lachnanthes caroliana*) and coastal sweet pepperbush (*Clethra alnifolia*) are often visited. The native sandwort, *Minuartia caroliniana*, is visited for nectar in the breeding habitat at some colonies in New Jersey (Anthony McBride), but exotic thistles, knapweed, and adventive milkweeds are the major nectar flowers today. Nectar appears to be a seriously limiting factor in parts of the Pine Barrens. The virtual absence of nectar probably accounts for the near absence of this skipper in and near the pine plains areas. The Cumberland County, New Jersey, population is entirely dependent on exotic weeds for nectar (100% of over 400 observations), with spotted knapweed (*Centaurea maculosa*) by far the most often used; sandwort and redroot are absent. Southward, native pineland flowers are usually available, at least in the second brood. *Liatris* spp. are favorites. In Florida, the adults also visit yellow thistle (*Cirsium horridulum*), honeycombhead (*Balduina angustifolia*), rosinweed (*Silphium compositum*), and other wildflowers. Colic root (*Aletris farinosa*) is used in the North Carolina Sand Hills (Steve Hall).

Host plants

In New Jersey, little bluestem (*Schizachyrium scoparium*) is the main host, but eggs are also laid on a species of *Dichanthelium* and on an unidentified grass. The exotic weeping lovegrass (*Eragrostis curvula*) is a suspected, but unconfirmed, host in New Jersey. Adults are commonly associated with stands of stunted switchgrass (*Panicum virgatum*), but this does not appear to be a food plant. In Florida, wiregrass (*Aristidia stricta* var. *beyrichiana*) has been reported as a host based on oviposition observations, but bluestems (*Andropogon* and *Schizachyrium* species), or lopsided Indiangrass (*Sorghastrum secundum*) may be the main hosts. Steve Hall reports that populations are usually found with wiregrass in North Carolina.

Habitat

The dotted skipper occurs in a variety of dry, sandy habitats, mainly in open grassy places. In New Jersey and probably North Carolina, sparsely vegetated, nutrient-poor, white sand is a consistent feature. The general terrain is more or less wooded, usually mostly with pines and small oaks. Adults will often appear on potted *Liatris* flowers placed in dry woodlands, but it is unclear if such adults fly in or above the woods. Actual breeding habitats in New Jersey are mostly anthropogenic, such as abandoned sand mines, weapons ranges and other military-use areas, airport approach zones, railroad beds, dry old fields, and grassy margins of sand roads. Adults occupy and mate in adjacent, more natural reedgrass savannas, and the drier ones may be breeding habitats. It is possible that the original populations in New Jersey were associated with coastal dunes like the habitats for *Hesperia attalus nigrescens* in South Carolina. However, it is well known that the Pine Barrens were much grassier before the late 20th century, and this species probably occurred sparsely over large areas, and formed denser colonies after fires. South of New Jersey, its habitats are usually less disturbed and include xeric pine-oak savannas and sandhills.

Threats & management issues

The threats to this skipper vary depending on whether the species is using native pineland communities, as it seems to do southward, or more-disturbed artificial habitats, as in New Jersey. No life stage is known to be protected underground, and in most cases survival in fires would probably be low at any season. Refugia are needed in prescribed burns.

Nectar can be limiting, is a critical resource, and could be a management concern. Nectar plants vary regionally. Most New Jersey habitats have no native potential nectar plants during the flight season; therefore, access to either weedy exotics or adventives like knapweed, thistles, common milkweed or native wetland flowers is important. Mowing could be an issue at some New Jersey sites which are in airport right-of-ways. Observed ovipositions have been within a few centimeters of the sand, and larvae probably are near the base of the grasses even in the early instars. Probably if the mower blade is set relatively high and the area impacted by wheels is minimized, mortality will be low.

Maintaining a sparse aspect with much bare sand is probably important for this species, as it seems to be for most *Hesperia*, so invasive cool season grasses could degrade habitat even if the food plants are not reduced, but generally the sites are too harsh for these to thrive.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Gatrelle (1999c) Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Kons and Borth (2006), LeGrand and Howard (Butterflies of North Carolina website), Metzler *et al.* (2005), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Shapiro (1974).

MESKE'S SKIPPER

Hesperia meskei (W. H. EDWARDS)

IDENTIFICATION

This is a medium-sized (27 to 35 mm) skipper (Figure 111-113). The undersides of the wings are golden-yellow with a row of paler spots. The spots are larger and more vaguely defined in males. Males are darker above than on the undersides, with a black stigma in the center of the forewings. Females are mostly blackish with yellow spots. The longer antennae distinguish it from the fiery skipper (*Hylephila phyleus*). The sachem (*Atalopedes campestris*) is also similar, but males have a large oval-shaped stigma, and females have a squarish, translucent spot on the forewings. The larva of Meske's skipper is similar to other *Hesperia* species in that it has a black head with two pale lines on the upper face, and a greenish to brownish body (Figure 114).

Figure 111. Meske's skipper (*Hesperia meskei straton*) upperside male from Putnam County, Florida (Marc Minno photo).

Figure 112. Meske's skipper (*Hesperia meskei straton*) upperside female from Martin County, Florida (Marc Minno photo).

Figure 113. Meske's skipper (*Hesperia meskei straton*) underside female from Martin County, Florida (Marc Minno).

Figure 114. Meske's skipper (*Hesperia meskei straton*) larva from Putnam County, Florida (Marc Minno photo).

TAXONOMIC NOTES

Besides the nominate one, two other subspecies have been named. *Hesperia meskei meskei* is found in Texas, and *Hesperia meskei straton* is found in peninsular Florida. Populations in the

Florida Panhandle, Georgia, South Carolina, and North Carolina are more similar to *Hesperia meskei straton* than to *Hesperia meskei meskei*. The far eastern populations seem to form a cline from North Carolina to southern Florida, with the spots on the forewings of the females becoming more orange, and the color of the underside of the hindwings becoming more greenish in peninsular Florida. An isolated population cluster that is similar to *Hesperia meskei meskei* occurs in central Arkansas. *Hesperia meskei pinocayo* occurred on Big Pine Key and near Florida City, southern Miami-Dade County, Florida, but is now presumed to be extinct.

Range

This species has a disjunct range, from eastern North Carolina west to Arkansas and Texas, and south (historically) to the Florida Keys. Meske's skipper is unknown from much of Georgia and possibly all of Louisiana, Mississippi and Alabama. Brock and Kaufman (2003) and Glassberg (1999) provide range maps for the skipper, but some gaps could be artifacts of insufficient collecting.

Rarity

NatureServe global rank: G3G4. This species is local and uncommon and has declined in Florida and the Southeast. *Hesperia meskei meskei* is not ranked separately from the disjunct portion of the population of *Hesperia meskei* in Arkansas. On the other hand, *Hesperia meskei straton* is ranked separately as T3. The state rankings of Meske's skipper are S3 in North Carolina, and S1S2 in Arkansas. *Hesperia meskei pinocayo* has not been seen since the late 1990s and is thought to be extinct (Marc Minno observation).

Life history

Little is known of the biology of this species. There are two broods in North Carolina, mostly in June through early July and September through October. Adults of the first generation are usually scarce.

The eggs are laid singly on grasses. In Florida and North Carolina, Meske's skipper tends to emerge later in the year than the dotted skipper (*Hesperia attalus slossonae*), which often occurs in the same places. Adults of *Hesperia meskei pinocayo* were found every month of the year, but were especially numerous in March and November.

Adults visit flowers, especially pink or purple flowers in the family Asteraceae, such as *Liatris* and *Carphephorus* species.

Host plants

The larvae feed on grasses, but the specific species are not well known. McGuire (1982) listed *Aristida purpurascens* as a host of *Hesperia meskei pinocayo* based on an oviposition, but females of *Hesperia* species sometimes lay eggs on grasses other than the food plant, and on other substrates (McNeil 1964). As with many *Hesperia* species in North America, this one oviposits on little bluestem (*Schizachyrium scoparium*) in North Carolina (LeGrand and Howard Butterflies of North Carolina website).

HABITAT

Meske's skipper occurs in dry, grassy sandhills and savannas, typically within longleaf pine communities in North Carolina and Florida. Hugo Kons and Robert Borth also found *Hesperia meskei meskei* commonly in Angelina County, Texas in longleaf pine savanna habitat. Populations also occur in other dry, grassy, partly wooded habitats westward. Like *Hesperia attalus, Hesperia meskei* is associated with wiregrass in North Carolina, although other grasses are present. According to Steve Hall, *Schizachyrium scoparium* is much less common in those habitats than are species of *Andropogon*, such as *Andropogon ternarius*. The habitat of *Hesperia meskei pinocayo* was pine rockland.

THREATS & MANAGEMENT ISSUES

Meske's skipper has lost habitat due to development, agriculture, pine plantations, and fire suppression. However, it is unlikely that any life stages could survive fires; therefore, not all of the habitat at known colonies should be burned in one year. Fire ants are established through most of the range of this skipper, and these might be a threat, especially because the larvae live near the ground.

It is not known whether mosquito spraying contributed to the apparent extinction of *Hesperia meskei pinocayo,* but if so, it is unlikely to have been the only cause.

REFERENCES

Allen *et al.* (2005), Bell (1924), Brock and Kaufman (2003), Cech and Tudor (2005), Gatrelle and Minno (2003), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), McNeil (1964), Minno (1992a), Minno and Emmel (1993, 1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986).

Mulberry wing (Delmarva population)

Poanes massasoit chermocki Anderson and Simmons

Identification

This small to medium-sized (22 to 28 mm) skipper typically has a distinctive yellow patch on the underside of the hindwings (Figure 115-117); however, compared to other populations of this species, the Delmarva population is much darker below and has a reduced yellow patch. Some individuals have the patch suffused with reddish brown. The larva is pinkish brown with some darker lines on the sides and a brown head (Figure 118).

Figure 115. Mulberry wing (*Poanes massasoit chermocki*) upperside male from Dorchester County, Maryland (Marc Minno photo).

Figure 116. Mulberry wing (*Poanes massasoit chermocki*) underside male from Dorchester County, Maryland (Marc Minno photo).

Figure 117. Mulberry wing (*Poanes massasoit chermocki*) upperside female from Dorchester County, Maryland (Marc Minno photo).

Figure 118. Mulberry wing (*Poanes massasoit massasoit*) larva from Montgomery County, Pennsylvania (Tom Allen photo).

Taxonomic notes

Two subspecies of the mulberry wing have been described in addition to the typical one. *Poanes massasoit chermocki* occurs only in southern Delaware and adjacent Maryland. Typical *Poanes massasoit massasoit* was described from Carver, Massachusetts near the northeastern end of the range of the species, while *Poanes massasoit hughi* was described from Beltsville, Maryland. The species is widespread between these localities, and authors as far back as Klots (1951) have questioned this subpecific distinction. *Poanes massasoit chermocki* is an isolated population cluster with an atypical color pattern in which the normal pattern is reduced. A few specimens approaching the *Poanes massasoit chermocki* phenotype have been found elsewhere in Maryland, which suggests past interbreeding, but these subspecies are disjunct from each other now. Populations on the New Jersey coastal plain to the east have a high incidence of the reddish "*suffusa*" form, as does subspecies *Poanes massasoit chermocki*, but they do not have a reduced pattern.

Range

Poanes massasoit chermocki is found in the Chicamacomico and Nantickoe drainages on the Delmarva peninsula. Jones (1928-1932) reported the mulberry wing from slightly to the east at Harbeson, Delaware, but no specimen has been found by us. This subspecies occurs about 130 kilometers south of other populations of the mulberry wing, and represents an outlier. The species as a whole is found mostly in two separate areas, within about 200 km of the coast from southern New England to Maryland, and from southern Ontario west through southern Minnesota, south into Iowa, Indiana, and Ohio (Glassberg 1999). Isolated populations of*Poanes massasoit* also occur in central New York.

Rarity

NatureServe global rank: G4T1. The current range of *Poanes massasoit chermocki* appears to consist of two clusters of small colonies. Although it is a wetland butterfly, there is little protection for this subspecies, which is thought to have declined. There is no population estimate, but it is very unlikely that this subspecies produces more than a few hundred adults per year, and possibly fewer.

Life history

As with other populations of this species, there is only one brood. Adults are found from mid-June into July.

The larvae tie the leaves of the host plant together into a tube and hide in this shelter when not feeding. Most of the year is spent as a larva.

The adults have a slow, fluttering flight pattern, and usually stay within the leaves of the host.

Host plants

Poanes massasoit chermocki is associated with tussock sedge (*Carex stricta*), which is also the food plant for the species elsewhere.

Habitat

The typical subspecies occurs in marshes having abundant tussock sedge, but *Poanes massasoit chermocki* occurs along streams in more or less wooded terrain.

Threats & management issues

Threats have not been assessed in detail. However, given the location, and based on information from the Delaware Natural Heritage Program, threats probably include mosquito spraying (depending on the type and quantity of chemical used), invasion by common reed (*Phragmites australis*) and mile-a-minute (*Persicaria perfoliata*), succession, and possibly herbivory by deer. Deer probably would not seriously damage the food plant, but they could eliminate nectar sources. While gypsy moth spraying would probably not be an issue in Delmarva swamps, the entire population would be present as larvae, probably mostly penultimate instars, and it is not known if *Btk* would kill the larvae. Proximity of estuaries to the east and west probably would preclude use of Dimilin® under current guidelines.

References

Allen *et al.* (2005), Anderson and Simmons (1976), Brock and Kaufman (2003), Cech and Tudor (2005), Glassberg (1999), Holland (1898), Howe (1975), Irwin and Downey (1973), Jones (1928-1932), Klots (1951), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Shapiro (1974), Tietz (1952).

Family Papilionidae (swallowtails)

Schaus' swallowtail

Papilio aristodemus ponceanus Schaus

Identification

This is a large (87 to 112 mm), dark-brown butterfly above with bands of yellow spots (Figure 119-120). The giant swallowtail (*Papilio cresphontes*) and Bahamian swallowtail (*Papilio andraemon bonhotei*) are similar, but they have a yellow spot in the center of each tail. In contrast, the tails of the Schaus' swallowtail are outlined with yellow. The tips of the antennae are yellow in the males.

Figure 119. Schaus' swallowtail (*Papilio aristodemus ponceanus*) upperside female from Biscayne National Park, Elliott Key, Florida (Marc Minno photo).

Figure 120. Schaus' swallowtail (*Papilio aristodemus ponceanus*) underside female from Biscayne National Park, Elliott Key, Florida (Marc Minno photo).

The beautiful caterpillar is brown with white patches on the sides and rows of blue spots (Figure 121, Minno and Emmel 1993, Minno *et al.* 2005).

Figure 121. Schaus' swallowtail (*Heraclides aristodemus ponceanus*) larva from a captive colony at University of Florida (Jerry F. Butler photo).

Taxonomic notes

Five subspecies of this Caribbean island butterfly have been described. Regardless of the validity of these subspecies, *Papilio aristodemus* is endangered in the United States and may be of conservation concern elsewhere. *Papilio aristodemus aristodemus* occurs on Hispaniola, Mona Island, and Puerto Rico. *Papilio aristodemus bjorndalae* is found in the southern Bahamas (Great Inagua and Mayaguana islands) and Turks and Caicos *Papilio aristodemus majasi* also occurs in the southern Bahamas on Crooked and Acklins Islands. *Papilio aristodemus temens* is known from Cuba, Isle of Pines, and Little Cayman Islands. Simon and Miller (1986) could find no consistent differences between *Papilio aristodemus driophilus* from the northern Bahamas and the Floridian *Papilio aristodemus ponceanus* Schaus. The Schaus' swallowtail has been placed in the genus *Heraclides* by some authors (Miller and Brown 1981).

Range

Papilio aristodemus ponceanus occurs in the Florida Keys and on North Andros Island, South Andros Island, and Cat Island, Bahamas. In Florida, the Schaus' swallowtail has a much more limited range than that of its host plants. It has been found on the islands of the upper Florida Keys, including; Sands Key, Elliott Key, Adams Key, Totten Key, and Old Rhodes Key in Biscayne National Park, as well as on northern Key Largo. Grimshawe (1940) claimed that it was once mostly found in the Matecumbe Keys, but Gillmore (2005) believed that she deliberately mis-reported its distribution in order to protect her business of selling specimens. A stray was seen by Alície Warren-Bradley and others on 31 May 2006, at the Deering Estate south of Miami Beach. This is the first mainland record of the Schaus' swallowtail since the types were collected in Coconut Grove. The main host plant is very rare on the mainland, but is locally common throughout the Keys.

Rarity

NatureServe global rank: G3G4T1; Xerces Society rank: Critically imperiled.

The Schaus' swallowtail was listed by the U.S. Fish and Wildlife Service as threatened on 28 April 1976. This listing was revised on 31 August 1984 to endangered. From 1985 to 1997, population estimates were made for the Florida Keys, mostly from mark-recapture studies. Populations generally ranged from about 500 to 1,000 adults per year, although the estimate for 1995 was only 350 (U.S. Fish and Wildlife Service 2008). Population estimates declined dramatically to between 300 to 400 adults in 1998 and 1999, and about 100 to 250 adults per year from 2000 to 2003 (U.S. Fish and Wildlife Service 2008). Counts of adult Schaus' swallowtails have been made on Elliott Key by North American Butterfly Association volunteers in early to mid-May since 2003, with lows of two in 2005 and four in 2008, and totals of 22 to 28 in the other four years. Marc Minno observed 29 adults on Elliott Key on 26 May 2007 (5.5 hour survey). This was seven more than the count total earlier that month. Perhaps in this season and some others, counts did not occur in the period of maximum abundance. Regardless of timing, counts reflect only the number of adults seen, and are not comparable to mark-release-recapture estimates of the number present (Gall 1985). They may, however, provide a useful index of annual fluctuations. On northern Key Largo, NABA volunteers found eight adults in 2004, three in 2006, and two in 2007. Dr. Thomas C. Emmel and his support staff successfully bred this species during the 1990's at the University of Florida in Gainesville using wild lime as a host. From 1995 to 1997 they released captive bred adults and pupae at historical locations at the Charles Deering Estate on the mainland, at six sites on Key Largo, and at one site on Lower Matecumbe Key, but none of the releases resulted in viable colonies.

Life history

Papilio aristodemus usually has only one brood each year, with adults present from late April to late June. Peak abundance occurs from mid-May to mid-June. A partial second brood has rarely been observed in Florida during early September (Brown 1976). All of the other subspecies have two broods.

The eggs may be green or yellow (Daniels *et al.* 1993) and are laid singly on the new growth of the food plant.

The larvae eat only the young leaves when small, but can feed on older foliage when mature.

Most of the year is spent as a pupa, and some pupae may remain dormant for two seasons (Klots 1951), perhaps longer.

Adults visit the flowers of blue porterweed (*Stachytarpheta jamaicensis*), scorpion's tail (*Heliotropium angiospermum*), buttonsage (*Lantana involucrata*), snow squarestem (*Melanthera nivea*), cheese shrub (*Morinda royoc*), and other nectar plants (Minno and Emmel 1993).

Host plants

Sea torchwood (*Amyris elemifera*) in the citrus family (Rutaceae) is the main food plant, but balsam torchwood (*Amyris balsamifera*), which is rare in Florida, is also used. *Amyris elemifera* is very rare and patchy along the Atlantic Coast from Miami to Merritt Island, but is found more commonly in the Keys from the islands of Biscayne National Park to Key West. The larvae will eat the leaves of wild lime (*Zanthoxylum fagara*) and *Citrus* species in captivity.

Habitat

This butterfly occurs within and at the edges of tropical hardwood hammocks. Marc Minno and Thomas Emmel once observed one flying over the ocean between islands in Biscayne National Park.

Threats & management issues

Most of the remaining habitat of the Schaus' swallowtail is located in Biscayne National Park, the Crocodile National Wildlife Refuge, Key Largo Hammocks State Botanic Site, and other public lands. Much of the upland forests on islands connected by roads have been destroyed and fragmented by urban development. This butterfly is vulnerable to hurricanes and tropical storms, but may be relatively safe from harm, because these storms occur in late summer and fall when the population is usually aestivating as pupae. Mosquito adulticides should not be sprayed near existing colonies, especially from the end of April to the end of July when the adults and larvae are active, but mosquito fish or larvicides would not harm the butterfly. The causes of the recent decline are unknown, but impacts from exotic species such as ants and lizards seem likely. Marc Minno has observed non-native ants of the genus *Pseudomyrmex* carrying off Schaus' swallowtail eggs and young larvae.

References

Allen *et al.* (2005), Baggett (1982), Brock and Kaufman (2003), C. H. Brown (1976), L. N. Brown (1973b, 1974), Cech and Tudor (2005), Covell (1978), Covell and Rawson (1973), Daniels and Emmel (2005), Daniels *et al.* (1993), Emmel (1994, 1996, 1997), Emmel and Daniels (1997), Emmel and Minno (1988), Forys *et al.* (2001), Gerberg and Arnett (1989), Gillmore (2005), Glassberg (1999), Glassberg *et al.* (2000), Grimshawe (1940), Henderson (1945a, 1945b, 1946), Hernández (2004), Howe (1975), Kimball (1965), Klots (1951), Minno (2010b), Minno and Emmel (1992a, 1992b, 1993, 1994), Minno *et al.* (1996, 2005, 2010), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Rutkowski (1971a), Scott (1986), Smith *et al.* (1994), Swengel (2004), Tyler *et al.* (1994) U.S. Fish and Wildlife Service (2008).

Ozark swallowtail

Papilio joanae Heitzman

Identification

This is a large (68 to 98 mm), black butterfly with yellow spots on the wings and body (Figure 122 and 123). The adults are very difficult to separate from the common black swallowtail (*Papilio polyxenes asterias*), but the yellow spots on the uppersides of the wings are smaller on the Ozark swallowtail, and those at the end of the forewing cell and near the costal margin are often absent. The spots on the underside of the hindwings are mostly orange, and unlike on the black

Figure 122. Ozark swallowtail (*Papilio joanae*) upperside male from Benton County, Missouri (Marc Minno photo).

Figure 123. Ozark swallowtail (*Papilio joanae*) upperside female from Benton County, Missouri (Marc Minno photo).

swallowtail, the black pupil in the orange spot of the hindwings often touches the wing margin. Habitat often provides the best clue for recognition in the field, but should not be considered reliable. The Ozark swallowtail is a butterfly of woodlands, glades and forest openings. Although the common black swallowtail can be seen in hilltop openings in forests in spring, it is normally found in open areas such as old fields, marshes, parks and gardens.

The caterpillars of the Ozark swallowtail are light green or bluish with dark bands containing yellow spots (Heitzman and Heitzman 1987). According to these authors, the caterpillars are similar to the larvae of the black swallowtail, but the dark bands are often incomplete on the sides, the spots are paler yellow, and the abdominal area is noticeably paler.

Range

This swallowtail is essentially confined to the Ozarks of Missouri and northern Arkansas. There is one specimen from western Kentucky collected in 1979 (Covell 1999), but no population has been located there. This butterfly may eventually be found in Tennessee as well.

Rarity

NatureServe global rank: G3; Xerces Society rank: Vulnerable. The ranks primarily reflect the very limited range. This butterfly is local, but is not considered to be especially rare in its range.

Life history

There are three broods, with adults flying from about April to September. The eggs probably hatch in about a week.

The larvae feed on the leaves, flowers, and developing seeds of the host plants. They probably mature in about three or four weeks in summer.

The pupae overwinter.

Adults visit a variety of woodland flowers.

Host plants

The caterpillars have been found feeding on yellow pimpernel (*Taenidia integerrima*), hairyjoint meadowparsnip (*Thaspium barbinode*), and golden Alexanders (*Zizia aurea*), all herbs in the carrot family (Apiaceae).

Habitat

This swallowtail is found in cedar glades and dry to mesic woodlands, and David Wagner has found it in bottomland forests.

Threats & management issues

Habitat loss and fragmentation have likely impacted this butterfly. Excessive herbivory by white-tailed deer could easily wipe out populations if local deer populations reach densities now seen in much of the Northeast.

While the gypsy moth is not yet a widespread problem in the Ozarks, there is no reasonable doubt that it will become established, and the vast oak forests there should be among the most suitable habitats for this pest in North America. Ozark swallowtail larvae have not been assayed for *Btk* sensitivity. Gypsy moth larvae do not eat plants in the Apiaceae as far as we know.

Oak mortality caused by gypsy moth might benefit Ozark swallowtails by opening up the habitat. At least some habitats of this butterfly are maintained by fire. Fire could destroy small colonies, but fire suppression may lead to forests too dense to support the food plants and butterfly.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Covell (1999), Glassberg (1999), Heitzman (1973), Heitzman and Heitzman (1987), Opler and Krizek (1984), Opler and Malikul (1992), Rudolf *et al.* (2006), Scott (1986), Tyler *et al.* (1994).

Family Pieridae (whites, sulphurs, etc.)

Subfamily Pierinae (whites)

West Virginia white

Pieris virginiensis Edwards

Identification

This is a medium-sized (35 to 41 mm) white forest butterfly. The wings are delicate looking, somewhat translucent, and rounded (Figure 124 and 125). The upperside may have virtually no pattern, but there are often some dark scales at the apex, and occasionally there are faint dark spots on the forewings. The wing veins on the underside of the hindwings are outlined with dark scales of varying intensity. Where their ranges overlap, from Massachusetts to Ontario and Wisconsin, the West Virginia white can co-occur with the mustard white (*Pieris oleracea*). Spring-brood individuals of the mustard white have the veins more sharply outlined with black, but some individuals will be difficult to separate (see Brock and Kaufman 2003, Glassberg 1999, Allen 1997, Iftner *et al.* 1992 and others). Cech and Tudor (2005) show the variation in both species on facing pages. The caterpillar is green (Figure 126).

Figure 124. West Virginia White (*Pieris virginiensis*) upperside male from Walker County, Georgia (Marc Minno photo).

Figure 125. West Virginia White (*Pieris virginiensis*) underside male from Walker County, Georgia (Marc Minno photo).

Figure 126. West Virginia White (*Pieris virginiensis*) larva from northwestern Ohio reared by Judy Semroc on *Cardamine diphylla* (David Wagner photo).

One cannot assume that a white (*Pieris* species) flying in a forest in spring is either *Pieris oleracea* or *Pieris virginiensis*. Cabbage whites (*Pieris rapae*) may enter forests before the trees leaf out in spring, and commonly fly in glades and forest openings. Cabbage whites have a prominent black patch at the wing tips and one or two black spots on the forewing above. The veins are never outlined with dark scales beneath, and it flies faster. The taxonomy of the West Virginia white is not in dispute, and, although there is geographical variation, no subspecies have been suggested.

Range

The West Virginia white ranges from southern and western Vermont to south central Connecticut, west through northern Pennsylvania and New York (but with a gap between northern and southern populations), to northern Ohio, along the Ohio River to Kentucky and northern Indiana, across southern Ontario to Michigan and northern Wisconsin, and down the Appalachians from Pennsylvania to northern Georgia.

Rarity

NatureServe rank G3? No rank really fits the current situation.

The West Virginia white was not a rare butterfly in the 1980s. Even into the 1990s, it was not rare in some places where it no longer occurs. It is still not rare in the northern, western, or extreme southwestern parts of its range.

In upstate New York, Robert Dirig reports four known extant populations in Tompkins County and one each in Broome and Delaware counties as of 2010. Other populations occur in Broome, Cattaraugus, and Lewis counties at least as recently as 2005. One of these sites is a wildflower garden on the Cornell Campus, which was colonized around 1990. Steve Johnson found a population in 2011 in Tioga County, Pennsylvania, which borders New York.

As far as we know, the West Virginia white is still stable in Ontario and the northern Midwest. John Shuey (personal communication with Dale Schweitzer in September 2010) reports no obvious decline in southern Indiana as of 2010. As of 2002 through 2011, the West Virginia white is still being found in its historical range in Vermont (Michael Sabourin personal communication with Dale Schweitzer in May 2011, Kent Marfarland personal communication with Dale Schweitzer in September 2010).

Photographs of West Virginia whites taken in 2007 in four different towns appear on the Massachusetts Butterfly Club website (http://www.naba.org/chapters/nabambc/) as of September 2010. The Connecticut Butterfly Atlas (O'Donnell *et al.* 2007) did not detect much difference between its historic range and its range between 1995 and 1999 there, but they noted some colonies extant then may no longer exist.

Similarly the species is still found in the mountains of southwestern (but not northern) North Carolina and eastern Tennessee (LeGrand and Howard Butterflies of North Carolina website), including Great Smoky Mountains National Park.

However, in its core range, widespread recent decline or extirpation is reported. The West Virginia white is probably extirpated in southwestern Connecticut and southeastern New York (Cech and Tudor 2005), New Jersey (Gochfeld and Burger 1997), and possibly from eastern Pennsylvania (David Wright personal communication with Dale Schweitzer). Farther south, LeGrand and Howard (Butterflies of North Carolina website) report a recent "alarming decline," in the northern and central Appalachians possibly as far south as northern North Carolina, where its original status is uncertain. Information from the 1990s such as Stanton (2001) and O'Donnell *et al.* (2007) should be regarded as historic and not reflecting current status. The West Virginia white also has had a history of being overlooked, especially prior to the 1990s, such as in Ontario (Stanton 2001, Layberry *et al.* 1998) and Indiana where Shull (1987) failed to find it. However, there are more people looking now, and this butterfly's habits and habitat are better known.

Life history

This butterfly has one generation per year, with peak adult numbers present for less than a month before and while the canopy closes. The flight season is mainly in April or May depending on local climate and weather.

Eggs are laid singly on the underside of the foliage of the food plant, and larvae eat the leaves. The duration of the egg stage is 3 to 8 days, and the larval stage is 15 to 20 days, depending on weather (O'Donnell *et al.* 2007). The food plants senesce in late spring or early summer, so larvae from late eggs are in a race to complete feeding in time in dry spring seasons.

The summer, fall, and winter are spent as pupae, and it is suspected, but not documented, that some overwinter more than once.

Very rarely a few adults eclose in early summer, but it is unlikely they can successfully reproduce due to lack of suitable food plant foliage. The adults sip nectar from a variety of spring wildflowers, including flowers of the larval food plants and the exotic garlic mustard. Males also mud puddle (visiting wet patches of ground where they sip minerals dissolved in the water). Unless they are disturbed, adults fly slowly within a few feet of the forest floor. They often bask in sunlit spots with the wings partially open.

Host plants

The larvae feed on small forest plants in the mustard family (Brassicaceae). By far the most commonly reported food plants are toothworts (formerly *Dentaria*, now placed in *Cardamine*). Two-leaved toothwort (*Cardamine diphylla*) is the most commonly reported food plant, but cut-leaved toothwort *Cardamine concatenata* (formerly known as *Dentaria laciniata*) is often reported. In Ohio, narrow-leaved toothwort (*Cardamine multifida*) is also used, and rock cress (*Arabis laevigata*) is the primary food plant for a few populations there (Iftner *et al.* 1992). Allen (1997) reported oviposition on other species of these genera in West Virginia, but some of these may not be successfully used by larvae, and we note that he also reported garlic mustard, which is known to be lethal to the larvae.

Habitat

This is an early spring butterfly inhabiting low- to mid-elevation deciduous forests with spring wild flowers. It occurs in a relatively open understory, such that the forest floor receives substantial sunlight in early spring. Sugar maple is often among the more numerous trees. Even near the southern end of the range in North Carolina, populations sometimes occur in cove forests below 2000 feet (650 meters) and do not generally occur above 4000 feet. In New England, New York, and the Ohio Valley, many colonies are below 500 feet (~150 meters). In Vermont this butterfly is found mostly in the lowlands and Champlain Islands west of, not in, the mountains. In some areas the food plants, and thus the West Virginia white, tend to be concentrated along streams. Nearly every observer and author notes that the adults are very reluctant to leave their forest habitats, as was documented by Cappucino and Kreiva (1985). Therefore isolated patches of forest with the food plant often lack colonies of this butterfly, and recolonization in such places is unlikely. However, in areas of contiguous forest, colonies do occur in relatively isolated patches of toothwort.

Threats & management issues

The West Virginia white is sensitive to forest fragmentation. Because adults seldom fly into open areas, the species seldom colonizes new sites, although Stanton (2001) and Robert Dirig report one case each where it did in New York. Roads wide enough to create gaps in canopy cover effectively fragment the habitat. Nevertheless, the species was fairly widespread and not rare in second-growth forests into the 1980s or 1990s, and in some places still is.

Overly abundant deer are probably a threat, and in many northeastern United States forests virtually no native spring ephemeral wildflowers still occur, although the alien garlic mustard may remain or become, numerous.

Gypsy moth spraying is potentially more of a threat to West Virginia white than to most Lepidoptera, due to typical low densities, and more apparently, poor colonizing ability. Pesticides may have contributed to the early disappearance of this butterfly in New Jersey. The larvae are probably sensitive to *Btk*, which is used to control its congener, the cabbage butterfly. However there are no data for the West Virginia white, and species in the same genus can differ greatly in sensitivity (Peacock *et al.* 1998). Climate change is likely to impact this species, as it occurs in a much more limited range of climates than some of its food plants. Warming temperature will probably eliminate some populations. Still, there may be some potential for the species to expand into higher elevations in some places or to extend its range northward in others. Increasingly variable precipitation is a potential threat if short-term droughts become more common. In dry spring seasons the food plants senesce early, and most larvae may starve (Cappucino and Kreiva 1985).

The most serious threat to the West Virginia white appears to be from the highly invasive alien garlic mustard (*Alliaria petiolata*) which is lethal to the larvae, yet females readily oviposit on it (Chew 1982, Courant *et al.* 1994, Cech and Tudor 2005, LeGrand and Howard Butterflies of North Carolina website). The decline of the butterfly appears to have begun in the New York

City area where garlic mustard was first introduced. The disappearance of the West Virginia white coincided closely with increasing invasion of forest understories by garlic mustard. This began sometime between 1985 to 1990 in Fairfield County, Connecticut (Victor DeMasi personal communication with Dale Schweitzer), adjacent southeastern New York (Cech and Tudor 2005 and Victor DeMasi observation), and at Slingerlands, Albany County, New York (Robert Dirig observation). Widespread decline of the West Virginia white in the Appalachians (LeGrand and Howard Butterflies of North Carolina website) has also coincided with invasion of garlic mustard into the forest understory. Garlic mustard is also a plausible factor in the recent decline of this butterfly in eastern Pennsylvania. However, garlic mustard invasion is probably not the cause of decline in New Jersey, where the most recent known specimen (in the American Museum of Natural History) is from 1935.

West Virginia whites decline when garlic mustard becomes abundant in their core breeding habitats, but several observers report persistence where garlic mustard is common along roadsides and edges but not yet abundant in forest interiors. This occurs in Massachusetts, Vermont, southern Indiana, and in the mountains from southern North Carolina south and westward. The concern is to what extent garlic mustard is likely to spread into forest interiors in these regions.

While information is not complete or current for some parts of the range, unless the West Virginia white can adapt to garlic mustard, the outlook for this butterfly appears bleak in much of the range. Adaptation could involve evolution of either an ability of the larvae to develop successfully on garlic mustard, or of avoidance of it by ovipositing females. Stanton (2001) suggested that the West Virginia white might adapt to garlic mustard. However, nearly a decade later it remains doubtful that this is happening. Porter (1994) was able to rear a few to the second instar on garlic mustard in Indiana, but we know of none reared to maturity on this weed. Courant *et al.* (1994) were able to rear adults of the closely related *Pieris oleracea* from eggs on garlic mustard in New England. Reports of persistence of West Virginia whites in southern Indiana and some parts of New England where garlic mustard has been common for about 20 years warrant careful investigation.

Even if the West Virginia white does adapt to garlic mustard in some regions, this is unlikely to happen quickly enough to salvage small colonies (Porter 1994), and West Virginia white populations in the mountains from Pennsylvania to northern North Carolina appear to be in jeopardy now. Garlic mustard removal programs are in place in some parks and preserves, including a West Virginia white site on the campus of Cornell University (Robert Dirig personal communication with Dale Schweitzer).

For now, all we can suggest as good management is the following:

- Avoid gypsy moth spraying where colonies still occur.
- Keep deer numbers low enough that spring ephemeral wild flowers such as toothworts can thrive.
- Most importantly, make diligent efforts to prevent garlic mustard from taking over forest understories, especially in places where it is already common along forest roads, but has not yet seriously invaded into the woods.

- Finally, better documentation of the extent of garlic mustard invasion where this butterfly is persisting, and where it has not, would be very useful.

References

Brock and Kaufman (2003), Cappucino and Kreiva (1985), Cech and Tudor (2005), Courant *et al.* (1994), Chew (1982), Glassberg (1993, 1999), Gochfeld and Burger (2007), Iftner *et al.* (1992), LeGrand and Howard (Butterflies of North Carolina website), Ogard and Bright (2010), Porter *et al.* (1994), Stanton (2001), Shapiro (1974).

Family Lycaenidae (harvesters, hairstreaks, and blues)

Subfamily Theclinae (hairstreaks and elfins)

Sweadner's juniper hairstreak

Callophrys gryneus sweadneri F. H. Chermock

Identification

This is a small (22 to 28 mm), greenish butterfly with bold white markings on the undersides of the hindwings (Figures 127 and 128). The hindwings also have relatively long, thread-like tails. Worn specimens are often bronze colored below. Sweadner's juniper hairstreak is found on or near red cedar.

This is a subspecies of the juniper or olive hairstreak (*Callophrys gryneus*), and is similar to Hessel's hairstreak (*Callophrys hesseli*). However, Hessel's hairstreak inhabits Atlantic white cedar swamps, and is absent from most of the range of Sweadner's hairstreak. Hessel's hairstreak is a different shade of green (more bluish; compare our illustrations of both). The first spot on

Figure 127. Sweadner's juniper hairstreak (*Callophrys grynea sweadneri*) upperside male from Dixie County, Florida (Marc Minno photo).

Figure 128. Sweadner's juniper hairstreak (*Callophrys grynea sweadneri*) underside male from Dixie County, Florida (Marc Minno photo).

the forewing of Hessel's hairstreak is offset outwardly, compared to Sweadner's juniper hairstreak.

The caterpillar of Sweadner's hairstreak is green with white chevrons, and closely resembles the foliage of its host plant, juniper (Figure 129, Allen *et al.* 2005, Minno *et al.* 2005).

Figure 129. Sweadner's juniper hairstreak (*Callophrys grynea sweadneri*) larva from Alachua County, Florida (Marc Minno photo).

Taxonomic notes

Callophrys gryneus sweadneri is one of numerous examples of moths and butterflies that have more or less distinctive phenotypes in Florida. Other examples include *Catocala jair, Catocala similis, Erynnis brizo, Callophrys henrici, Satyrium liparops, Asterocampa spp.,* and *Limenitis archippus.* In some of these Lepidoptera, the range of the distinctive phenotype extends into southeastern Georgia, but often not into the Florida Panhandle. These differences may be just minor local variations in wing characteristics, or they may indicate evolutionarily significant populations that differentiated thousands of years ago when much of what is now peninsular Florida was an island. Many of these have been named as subspecies. A multi-species study of the distinctness and origins of these populations, named or not, would be an interesting research project with potential conservation implications.

Callophrys gryneus gryneus is widespread in the eastern United States, and other subspecies occur in the West. *Callophrys gryneus gryneus* is smaller than *Callophrys gryneus sweadneri*, with shorter tails and a more jagged white line on the underside of the hindwing. This white line on *Callophrys gryneus sweadneri* is relatively straight near the costal margin of the hindwing. The juniper hairstreak has been placed in the genus *Mitoura* by some authors (Miller and Brown 1981), but we follow Pelham (2008) who considers *Mitoura* to be a subgenus of the genus *Callophrys*.

Range

Sweadner's juniper hairstreak is found mostly east of the Apalachicola River in northern and central Florida into southeastern Georgia, and perhaps northward along the coast. *Callophrys gryneus gryneus*, on the other hand, is found in the central and western Florida Panhandle northward into Illinois, Indiana, Ohio, and New Hampshire, and westward into Texas, Kansas, and Minnesota.

Rarity

NatureServe global rank: G5T2. This subspecies was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995. Sweadner's juniper hairstreak is very local, but widespread in Florida. Adults are only present for a few weeks per brood and are easily overlooked. They are difficult to find, as they usually perch at the tops of red cedar trees. Locating colonies of this butterfly can be challenging, too, because the emergence of the spring brood can vary by several weeks from year to year depending on temperature differences.

Life history

There are three broods of Sweadner's juniper hairstreak per year, with adults occurring in March and April, June and July, and August to October.

The greenish eggs are laid singly on the foliage of red cedar.

The larvae emerge in about a week and begin feeding on the leaves of the host tree.

When mature, in two to three weeks, the larvae disperse down into the duff under the host tree and pupate (Pence 2005). Akers Pence found that the butterfly prefers the younger, conical-shaped trees that have branches near the ground. These low branches help survivorship of the pupae by increasing humidity and moderating temperature of the soil. The pupae overwinter.

Adults are at times attracted to flowers, such as Spanish needles (*Bidens alba*), especially in the late afternoon. Males perch near the tops of red cedars. Females tend to perch lower in the trees.

Host plants

The host plant is red cedar (*Juniperus virginiana*), family Cupressaceae. The form of red cedar in Florida and coastal areas of the Southeast is sometimes separated as southern red cedar (*Juniperus silicicola*). *Juniperus silicicola*, which is considered to be a synonym of *Juniperus virginiana* by Wunderlin and Hansen (2003), has non-spiny mature foliage. Typical red cedar (*Juniperus virginiana*) is native in the Panhandle, but has been widely planted throughout the state for landscaping, wind breaks, hedges, and screens.

Habitat

This butterfly occurs in coastal hammocks, mesic hammocks, wet flatwoods, old fields, and disturbed areas, as well as untended landscape plantings where there are at least a few host trees. It seems to prefer places where there is a mixture of young and older red cedar trees, but Marc Minno has encountered adults at single isolated trees, as has Dale Schweitzer with *Callophrys gryneus gryneus*. Such observations suggest females are good colonizers.

Threats & management issues

The main impact to Sweadner's juniper hairstreak has been development, especially in coastal areas. Thomas Emmel of the University of Florida succeeded in getting the City of St. Augustine, the type locality, to protect Sweadner's juniper hairstreak and enact an ordinance requiring that two red cedar trees be planted for every one cut down or destroyed.

It is a common practice to trim the lower branches of red cedars in yards, but shade provided by these branches may be necessary for the survival of the pupae.

At least in areas farther north, deer heavily browse the lower branches of cedars during winter. Red cedars are often destroyed when pines are harvested in commercial plantations.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Calhoun (1993, 1996), Cech and Tudor (2005), Emmel (1997), Gerberg and Arnett (1989), Gatrelle (2001b), Glassberg (1999), Glassberg *et al.* (2000), Howe (1975), Kimball (1965), Klots (1951), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Pence (2005), Scott (1986).

Hessel's hairstreak

Callophrys hesseli Rawson and Ziegler

Identification

This small (21 to 28 mm) butterfly is similar to the juniper hairstreak (*Callophrys gryneus*), but the color on the underside of the hindwing is bluish-green, and the first spot of the white line on the forewing is offset outwardly from the others (Figures 130 and 131). Also, the proportion of brown versus green scaling is greater on Hessel's hairstreak, often including substantial brown patches beyond the white line on the hindwings.

While habitat is a very useful identification clue, in New Jersey it is not unusual to find juniper hairstreaks perching on white cedars. Dale Schweitzer collected a female juniper hairstreak that was ovipositing on a white cedar and continued to do so an hour later in confinement. Dale Schweitzer also collected a female Hessel's hairstreak on a large red cedar in a lawn about a kilometer from a cedar swamp.

Sometimes the two species are found in the same grove, especially if red cedars are nearby; therefore, new occurrences of Hessel's hairstreak should be documented with specimens or good photographs.

Glassberg (1999) and Brock and Kaufman (2003) illustrate the adult. The slug-like larva is dark green with white chevrons (Figure 132, Maier *et al.* 2011, Minno *et al.* 2005, Allen *et*

Figure 130. Hessel's hairstreak (*Callophrys hesseli*) upperside male from Liberty County, Florida (Marc Minno photo).

Figure 131. Hessel's hairstreak (*Callophrys hesseli*) underside male from Liberty County, Florida (Marc Minno photo).

al. 2005), and has a white, broken, spiracular line. The details of the spots are quite different from those of *Callophrys gryneus*, which also has a more continuous spiracular line. Our illustrations and those of Maier *et al.* (2011) should suffice for identification.

Figure 132. Hessel's hairstreak (*Callophrys hesseli*) larva from Liberty County, Florida (Marc Minno photo).

Taxonomic notes

Two subspecies have been described. The northern typical subspecies is smaller and has shorter tails than the southern race (*Callophrys hesseli angulata* Gatrelle). Hessel's hairstreak has been placed in the genus *Mitoura* by some authors (Miller and Brown 1981).

Range

Hessel's hairstreak is closely associated with its host plant, which is patchily distributed overall, but common in a few states, especially coastal southern New England, New Jersey, and eastern North Carolina. The range of Hessel's hairstreak is shown on the maps in Glassberg (1999) and Brock and Kaufman (2003). Subspecies *Callophrys hesseli hesseli* occurs along the Atlantic Coast from southern Maine to North Carolina. Populations are absent from most of Connecticut and northern New Jersey. There may be only one population between New Jersey and southeastern Virginia, on the Delaware-Maryland border. The southern subspecies *Callophrys hesseli angulata* occurs more inland in South Carolina, Georgia, and in the Florida Panhandle. Hessel's hairstreak is still fairly widespread in suitable habitats in the Pine Barrens and Delaware Bayshore regions of New Jersey where the food plant is common. Populations are fairly frequently encountered from southeastern Massachusetts across southern Rhode Island to southeastern Connecticut. Southeastern North Carolina has colonies in most counties, but in other states, this butterfly occurs mostly in isolated colonies. Many seemingly suitable habitats are apparently unoccupied.

Rarity

NatureServe global rank: G3G4; Xerces Society rank: Vulnerable. While subspecies *Callophrys hesseli angulata* has not been ranked separately, all three states where it occurs rank the species as S1. The species is also ranked S1 in Maine, Connecticut, New York, Delaware, and Virginia. In Maryland and New Hampshire it is ranked as "historic." This species exists in three core areas. These are in Massachusetts and Rhode Island, where it is ranked S2S3, New Jersey, where it is ranked S3S4 (a ranking which needs to be re-evaluated), and in North Carolina, where it is ranked S3.

As is also noted by LeGrand and Howard (Butterflies of North Carolina website), this is one of the most difficult butterflies in the eastern United States to find. This is especially true for the spring brood, because the adults usually perch in the canopy of relatively tall cedars and are only present for a few weeks per brood. Even when one knows it is present and the weather is perfect, it is far from certain that any will be seen if the cedars are very tall, and even less likely that any will be collected or photographed. Populations are easier to locate in habitats where the cedars are small enough that an extension net can be used to flush perched adults.

This species is not now imperiled, but is rare in much of the range and losing habitat in some places. A best guess is that there are over 100 colonies, mostly in New Jersey. Even in New Jersey it is uncertain what percentage of the many cedar swamps are occupied. Habitat fragmentation as a result of logging and other factors has left many colonies, especially southern ones, isolated to the extent that recolonization seems unlikely if colonies become extirpated.

Apparent current absences in isolated habitats could reflect failure of the species to recolonize decades or centuries after events such as large-scale gypsy moth spraying in the 1950s and 1960s (Doane and McManus 1981) or logging before that. A cedar swamp near Manchester, New Hampshire is probably the only New England site that is documented to have had Hessel's hairstreak (Pease 1963), but apparently no longer does (Patricia Mattson surveys in 2007).

Life history

There is normally one brood in a year, with a partial second brood in some years (such as 2007) in New Jersey. Adults are present mostly from late April to mid- or late May, and a few in late July. There is also a partial second brood in Rhode Island. In the Boston area and northward the first brood is up to a month later, and no second brood has been reported. One worn straggler collected in New Jersey (22 June 1999) was too early for a second brood there. Such stragglers occur out of season in North Carolina as well. Over most of the Southeast there are generally two broods in about April–May and in mid-July through early August. In Florida, however, three generations per year have been documented.

The greenish eggs are laid singly on the tips of the host twigs and hatch in about a week. The larvae feed mostly on the new growth, at least in the spring, and mature in about a month.

Pupation probably occurs in the leaf litter, but we do not know of pupae being found in the wild. The pupae overwinter.

Adults spend most of their time in the tops of the cedars. They do descend to visit damp soil at the edges of puddles, as well as flowers. They probably also sip moist soil after eclosion before moving to the canopy.

Flower visits are often observed at mid-day in hot weather (>32°C), but otherwise are mostly in the morning or after 4:00 pm (Glassberg 1999, LeGrand and Howard Butterflies of North Carolina website). In New Jersey, sand myrtle (*Leiophyllum buxifolium*) is preferred as a nectar plant in the Pine Barrens. Red chokeberry (*Aronia arbutifolia*) (not chokecherry as stated by Glassberg 1993) is probably favored in the more southern counties where there is no sand myrtle (or chokecherry). Old reports of adults on *Amelanchier* flowers (which appear before the flight season) probably also refer to *Aronia*. Highbush blueberry (*Vaccinium corymbosum*) seems to be the major nectar flower in New England and North Carolina. Other Ericaceae are used at least occasionally in much of the range. Sweetleaf (*Symplocos tinctoria*) is also commonly visited in North Carolina. Buttonbush (*Cephalanthus occidentalis*) and Clethra (*Clethra alnifolia*) are among the summer favorites southward.

As with some of the elfins and other hairstreaks, in areas where the cedars are relatively short, observations suggest that males congregate on certain trees within the stand, while mated females are probably more dispersed.

Host plants

The caterpillars eat the foliage of Atlantic white cedar (*Chamaecyparis thyoides*). Richard Boscoe and others have reared Hessel's hairstreak in captivity on red cedar, but adults are only rarely found in association with this tree in the wild.

Habitat

Hessel's hairstreak occurs in Atlantic white cedar stands in swamps, bogs, along the floodplains of blackwater streams and rivers, and occasionally along spring runs. Generally, white cedar comprises at least two thirds of the canopy at colony sites, but any patch of the food plant is potential habitat. Colonies are especially likely to be found along stream corridors in places where cedar swamps are frequent. Hessel's hairstreak can be found in second or third growth white cedar forests, and sometimes occupies stands only four meters in height.

This species is an effective colonizer in New Jersey. It occurs in most cedar swamps in the New Jersey Pinelands region that have been checked, but many smaller swamps have not been surveyed and some outlying ones appear to be unoccupied. Although most of these forests are fairly mature, none are old-growth.

Threats & management issues

The major issue with Hessel' hairstreak is maintaining an abundance of white cedar. The ecology of this tree is fairly well understood and has a substantial literature. With proper management, Hessel's hairstreak can persist with timber harvest, as it has for about 300 years in New Jersey. Generally, silviculture practices that maintain white cedar stands should perpetuate populations as long as there are substantial reservoirs of uncut cedars. Distances between stands should be relatively small (less than 1 km, perhaps a bit more), and logging rotations should allow the cedar to regenerate and mature between cuts.

Nectar plants may also be important, particularly during the summer generation. Logging, fires, beaver dams, and changes in water level due to road construction all affect the food plant directly, but in the long term, sapling death caused by browsing deer could be a greater threat. Overly abundant deer are seriously affecting, or outright preventing, cedar regeneration in much of New Jersey. This is especially true outside of the core of the Pine Barrens, and deer densities are typically higher farther north. In New Jersey, deer fences are sometimes installed to permit regeneration of this ecologically and economically valuable tree. White cedars are killed by fire, but in the past when deer were less numerous, they usually regenerated readily from seed. Deer can virtually eliminate chokeberry, a favored nectar flower. Sand myrtle is declining in some places, due to tall shrubs shading it out and lack of fires. In addition, much white cedar has been lost along Delaware Bay due to sea level rise and the resultant salt water intrusion. This loss is expected to increase in the future due to global climate change. White cedar forests are unsuitable for gypsy moth outbreaks and are not deliberately targeted for spraying. Nevertheless, in New Jersey, smaller stands of white cedar in generally oak-dominated areas sometimes receive applications of *Btk* at times when young Hessel's hairstreak larvae would be present.

References

Allen *et al.* (2005), Anderson (1974), Beck and Garnett (1984), Brock and Kaufman (2003), Cech and Tudor (2005), Finkelstein and Towers (1980), Gatrelle (2001b), Gerberg and Arnett (1989), Glassberg (1993, 1999), Glassberg *et al.* (2000), Howe (1975), Johnson (1983), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Maier *et al.* (2011), Minno and Emmel (1994), Minno *et al.* (2005), Ogard and Bright (2010), Opler and Krizek (1984), Opler and Malikul (1992).

Frosted elfin

Callophrys irus (Godart)

Identification

Callophrys irus is a small (22 to 36 mm) butterfly with short tails (Figures 133 and 134). The undersides of the wings are grayish and the uppersides are unmarked dark gray. For an elfin, this is a relatively large species. The combination of short tails and extensive gray beneath should be diagnostic. However, in parts of Texas, some Henry's elfins (*Callophrys henrici*) are also very gray (see Brock and Kaufman 2003). The black spot near the tail is diagnostic when it is present. Eastward, Henry's elfin has more brown, the gray is restricted to a much smaller portion of the hindwing with none on the forewing, and there is greater contrast between the outer and inner portions of the wings. Male specimens can be reliably separated by the dark patch of androconial scales on the forewing above, which is always present on frosted elfins but is absent on Henry's elfin. However, because elfins do not open their wings when perched, this character cannot be seen without capturing specimens.

The hoary elfin (*Callophrys polios*) has similar gray beneath, but it lacks tails, is smaller, and is not usually found in the same habitat (although it can be in Massachusetts).

Figure 133. Frosted elfin (*Callophrys irus*) upperside male from a *Lupinus perennis*-feeding population in Nassau County, Florida (Marc Minno photo).

Figure 134. Frosted elfin (*Callophrys irus*) underside male from a *Lupinus perennis*-feeding population in Nassau County, Florida (Marc Minno photo).

The caterpillar of the lupine-feeding form of the frosted elfin is bluish-green (Minno *et al.* 2005, Allen *et al.* 2005), and resembles that of the Karner Melissa blue butterfly. Lupine-feeding larvae we have observed (n>50) are unmarked, whereas wild-ndigo feeders (Figure 135) seen in Massachusetts, southern Connecticut, Pennsylvania, and New Jersey have a prominent to weak, pale, chevron pattern. A typical wild-indigo-feeding larva is illustrated on the cover of Volume 61(2) of the *Journal of the Lepidopterists' Society*. However, David Wagner has found larvae that lack these chevrons on wild indigo in Connecticut.

Figure 135. Frosted elfin (*Callophrys irus*) larva from a *Baptisia tinctoria*-feeding population in Atlantic County, New Jersey (David W. Wright photo).

TAXONOMIC NOTES

There are unresolved taxonomic issues with this butterfly that have conservation implications. Given a lack of persuasive evidence to the contrary, we believe the frosted elfin is a single species with complex geographical variation and strong regional food plant preferences.

Some populations of frosted elfin feed only on lupine (*Lupinus)*, but others use only wild indigo (*Baptisia*). In captivity, frosted elfin larvae will usually eat and mature on both plants, sometimes after some initial reluctance to switch hosts.

Three subspecies have been described. The typical subspecies contains the lupine feeders as well as most eastern *Baptisia* feeders. It is paler than other populations, but within it there is considerable variation. As Gatrelle (1991, 1999) pointed out, adults of wild indigo-feeding populations tend to be larger and darker than lupine feeders. Some specimens can be determined by their appearance as the *Baptisia*-feeding form, such as the neotype, or as the lupine feeder such as the specimen illustrated by Klots (1951). However, we cannot reliably separate adults of the lupine and wild indigo feeders in the northeastern United States. Old specimens of *Baptisia* feeders from the coastal Carolinas are larger than *Baptisia* feeders from New Jersey and Pennsylvania. The name *Callophrys irus arsace* has been applied to such populations, and we offer no comment on the validity of that subspecies. Occurrences on the southern portion of the Carolina coast (see map in LeGrand and Howard Butterflies of North Carolina website) would be expected to match this now very rare (if extant) phenotype.

Florida populations which feed on lupine (Minno *et al.* 2005), have rather distinctive adults that do not look like *Callophrys irus arsace*. *Callophrys irus hadros* is a *Baptisia*-feeding version that is less contrastingly patterned below and is found mostly in Texas and Oklahoma. Klots (1951) and others have suggested that this taxon might be a full species. The alleged holotype of *Callophrys irus* (also designated as a neotype and illustrated by Gatrelle 1999) appears to be a wild indigo feeder from near Philadelphia, probably actually southern New Jersey. We have examined no specimens, and cannot determine from a few photographs whether or not the current frosted elfin population at Holly Shelter State Gamelands in North Carolina matches the *Callophrys irus arsace* phenotype. Bo Sullivan informs us that these are *Baptisia* feeders. The frosted elfin was placed in the genus *Incisalia* by Miller and Brown (1981) and most earlier authors. Some recent authors have placed it in *Deciduphagus*. *Deciduphagus* may be used as a subgenus.

RANGE

Lupine-feeding populations of the frosted elfin are found mostly in the Carolina Fall Line Sand Hills south to northern Florida, and in the Great Lakes region from Wisconsin to northern Ohio. Populations extend eastward in widely scattered sandy areas through New York, central Pennsylvania, and inland New England, including southern New Hampshire, western Massachusetts, western Rhode Island, Connecticut, on Long Island New York, and historically as far as Norway Maine, and into northern New Jersey. A few populations of lupine feeders occur on the Delmarva Peninsula (Delaware and Maryland), so occurrence in Virginia seems likely.

Populations that feed on *Baptisia* occur closer to the Atlantic coast from eastern Massachusetts southward through New Jersey, eastern Pennsylvania and Virginia to eastern North Carolina. There have also been a very few documented occurrences of *Baptisia* feeders in West Virginia, extreme southern Ohio, and Kentucky, northern Arkansas, and perhaps Kansas. Subspecies *Callophrys irus hadros* is found from Arkansas to Texas.

Lupine- and *Baptisia*-feeding populations occur or occurred less than about 20 kilometers apart in New Haven and Windham counties, Connecticut, and in Suffolk County on Long Island New York (Schweitzer 1992). In North Carolina, lupine and *Baptisia* feeders occur less than 60 km apart at New Bern and Holly Shelter respectively, according to Bo Sullivan.

RARITY

NatureServe Rank: G3. The frosted elfin is extremely local and usually has very small populations outside of New Jersey and Massachusetts. While it is rare or very rare in all of the states where it still exists, the frosted elfin is not imminently imperiled range-wide, and there are reasonably secure populations in a few states. In particular, there is one very large metapopulation near Atlantic City, New Jersey, although its ultimate fate is unclear, and some right-of-way populations in that state produce hundreds of adults annually (>100 observed per hour on some dates).

However, there are serious threats in much of the range. Frosted elfins are apparently extirpated in at least Maine, Illinois, and Ontario, and it is uncertain that they still occur in Delaware. This species is ranked as critically imperiled (S1) in Wisconsin, New Hampshire, Rhode Island, Maryland, Delaware, West Virginia, Ohio, and Arkansas, and probably should be in Pennsylvania. However, it is less rare in a few states such as Massachusetts and New Jersey. Not only is the frosted elfin now known from only a few places in North Carolina, but usually only one or two adults are seen when it is found (LeGrand and Howard Butterflies of North Carolina website). The frosted elfin is known from a few sites in Nassau and Clay counties in northeast Florida. In 2008 it was found by Dean and Sally Jue and others at three sites in Apalachicola National Forest south of Tallahassee (Leon, Franklin, and Liberty counties) in the eastern Panhandle. In April 2009, Marc Minno and Mary Ann Friedman found a colony of the frosted elfin at the Blackwater River State Forest in Okaloosa County, Florida.

This species is listed as "threatened" in several states, including the major strongholds of New Jersey and Michigan. It is listed as "special concern" in Massachusetts. Few other states have as many extant populations as New Jersey, Michigan and Massachusetts.

This butterfly has a large range, although it is severely fragmented, with probably dozens of viable metapopulations still extant and others that could be recovered. We would expect the Holly Shelter population discussed by LeGrand and Howard (Butterflies of North Carolina website) to be *Callophrys irus arsace,* but otherwise we cannot verify that this subspecies is still extant.

The Arkansas Natural Heritage Program considers *Callophrys irus hadros* to be highly imperiled (S1), but the bulk of its range is in Texas where its status has not been evaluated.

A major portion of the range of the Frosted elfin coincides with that of the federally endangered Karner Melissa blue.

Life history

The adults occur only in spring, starting somewhat later than the other elfins. They fly as early as about mid-March in Florida, February to April in southeast Texas (Bordelon and Knudson 1999), and mostly in the last three weeks of April in the Carolinas. The flight season occasionally exceeds seven weeks in the large Atlantic County, New Jersey site where females in fresh condition have been seen as late as the fifth week of the flight season. Extreme dates there are 9 April to 11 June. Albanese *et al.* (2006) reported an eight week flight season in a more maritime climate in Massachusetts, with adults most prevalent in May. The flight season is probably more compressed in small populations.

The duration of the egg and larval stages varies with temperature, but larvae are generally present within two weeks of the first adults. The larval stage lasts about a month. The larvae are not usually ant-tended (David Wagner observation, Dale Schweitzer observation, Dolores Savignano personal communication with Dale Schweitzer in June 2006). However, Albanese *et al.* (2007) report substantial ant-tending in southeastern Massachusetts, and Bill Berthet photographed a larva in Nassau County, Florida with an attending ant. In April 2011, Mary Ann Friedman also found ants attending frosted elfin larvae at Blackwater River State Forest in the western Florida Panhandle. Brooks Atherton identified the ants as *Dorymyrmex grandulus,* family Dolichoderidae.

Captive larvae (<10) from lupine-feeding populations in New Hampshire and New York pupated about a centimeter deep in the sand when offered both dry vegetation and sand. However, a much larger number (>50) of wild-indigo-feeding larvae from New Jersey pupated at the surface or among the dried leaves in similar setups using either peat or sand (Dale Schweitzer observation). The mature larvae can wander several meters while looking for pupation sites (Anthony McBride observation).

Most of the year is spent as a pupa.

Frosted elfins are closely associated with their host plants, and thus are usually concentrated on right-of-ways or in openings where they perch on or near the ground, often on dead grass stems. Females are very good colonizers over distances of at least 2 kilometers. If there are substantial colonies nearby, even stands of five to 20 plants may host a few larvae and produce adults some years. Albanese *et al.* (2006) noted instances of small colonies dying out, and recolonization occurred in only two years, during observations in Massachusetts. Persistent patch vacancy is rare where population clusters occur. However, these apparent metapopulations are now mostly isolated from each other, often by more than 100 kilometers. Dispersal sometimes involves females flying along roads and paths, but adults occasionally get blown over the tree tops, and so may disperse over forests.

Adults often visit flowers late in the day or in the early evening, but females sometimes do so earlier in the day. In New Jersey, a succession of heaths starting with blueberries (*Vaccinium pallidum*, *Vaccinium corymbosum*) in April, then black huckleberry (*Gaylussacia baccata*), sweetbells (*Leucothoe racemosa*), and finally staggerbush (*Lyonia mariana*), are the main nectar sources. Nectar may be absent by the end of the season. Lupine is also a nectar source, but *Baptisia tinctoria* rarely blooms until after the flight season. Adults of the lupine feeder in New York and New England visit the flowers of pin cherry (*Prunus pensylvanica*). In North Carolina, sweetleaf (*Symplocos tinctoria*) is a favorite nectar source (Steve Hall).

Host plants

The caterpillars of the frosted elfin feed on sundial lupine (*Lupinus perennis*), sky blue lupine (*Lupinus diffusus*) and wild indigos (at least *Baptisia tinctoria, Baptisia leucophaea,* and *Baptisia australis*), which are all herbs in the pea family (Fabaceae). *Baptisia* feeders eat the young leaves. We do not know if they will eat the flowers, which normally appear after most larvae have pupated. Older larvae in *Baptisia*-feeding populations often girdle the stems of the host plants near their base (Albanese *et al.* 2007), as do sleeved larvae, but we do not know the significance of this behavior.

Observations by LeGrand and Howard (Butterflies of North Carolina website), Dale Schweitzer, David Wright, and others listed on the NatureServe Explorer website indicate that females in a given population oviposit on only one food plant genus, at least in New Jersey and Massachusetts. This happens even where both plants (lupine and *Baptisia*) occur. An Atlantic County, New Jersey population cluster occupies more than 500 hectares of mowed brushland, but adults are notably not seen on the one hill where lupine is abundant and *Baptisia* nearly absent, or in smaller lupine patches. Up to 78 ovipositions have been observed per hour in this area, with several hundred in total, all on *Baptisia tinctoria*. Three females ovipositing on *Baptisia* were captured and sleeved for several days on the flowering lupine and laid no eggs. Two of these were transferred back to *Baptisia* and began ovipositing within seconds--before the sleeves could be tied shut. Their larvae were less discriminating. The last two instars could be reared on either plant. When the larvae were given lupine only, however, they wandered considerably and fed very little for the first day (Dale Schweitzer observation). David Wagner has also successfully switched food plants with reared larvae from Connecticut.

Habitat

The frosted elfin occurs in pine barrens, oak barrens, oak savannas, sandhills, dry acid oak woods, and more often, on powerlines through such places.

In Florida this butterfly is found in only a few places. These are a powerline corridor through overgrown oak and pine sandhills near Middleberg, in cutover sandhills at the Ralph E. Simmonds Memorial State Forest, and in relatively open longleaf pine/turkey oak sandhills at Jennings State Forest, and a site in Okaloosa County.

East of central Pennsylvania and Delaware this butterfly is now essentially a species of powerline corridors and sometimes airport approach zones, but not roadsides. The wild-indigo-feeding colonies sometimes were also in barrens, but most now are in at least partially disturbed habitats such as powerlines. The Nottingham, Pennsylvania colony was in a fairly natural serpentine barren in the 1970s. Some occurrences in Massachusetts (e.g. Albanese *et al.* 2006) extend somewhat into more natural pine barrens, most notably in Plymouth County. Mike Nelson informs us that several current occurrences in southeastern Massachusetts are managed by infrequent non-growing season mowing and/or controlled burning. These strategies have resulted in either a savanna-like structure, or a grassland/forest ecotone structure, with abundant *Baptisia* and *Baptisia*-feeding frosted elfins.

Correlations of adult numbers with food plant numbers is sometimes strikingly poor in New Jersey. The possibility that ants tending the larvae result in higher densities of frosted elfins in some colonies needs investigation. Pfitsch and Williams (2008) discuss habitat for a lupine-feeding population in New York. Albanese *et al.* (2006) present a detailed analysis of habitat features for wild-indigo-feeding frosted elfins in Massachusetts. Important habitat features in their study included low canopy tree cover (<29%), high density of food plant (>2.6 per m^2), low density of native shrubs (<16% cover), and lack of exotic shrubs. They also note that, as in New Jersey (Dale Schweitzer observation), high densities tend to be in areas with moderate interspersed tree cover, and not in the middle of large open areas. At one New Jersey site, populations occur over hundreds of hectares of open habitat surrounded by woods. Here, adults are strongly concentrated within 10–15 meters of tree line, but females do wander and oviposit much farther out into open areas. The Albanese *et al.* (2006) study did not indicate the importance of trees as wind-breaks, but this habitat feature may be significant in concentrating adults along the edges of large, open, right-of-ways, such as at airports, where there is a lot of fetch (i.e., the distance over which the wind blows).

Pfitsch and William (2008) found thinning of pines to be beneficial to lupines and frosted elfins. The frosted elfin is almost always found in generally wooded terrain, and in New Jersey and Pennsylvania the adults seek shade near forest edges during hot weather.

Nectar plants are not always in the primary habitat. The fact that Albanese *et al.* (2006) do not discuss the importance of nectar plants in Massachusetts could reflect lack of observations very late in the day when most flower visits occur, or perhaps nectar may not be a critical resource.

Threats & management issues

Threats to the frosted elfin vary regionally. In many areas, frosted elfins are relegated to right-of-ways where management changes can lead to loss, as happened recently in New Jersey and Virginia. Deer are now a threat in much of the range. Deer have eradicated small colonies in Pennsylvania, probably New Jersey, and temporarily in a New Hampshire metapopulation. Deer were probably also a factor in the extirpation of frosted elfins in Ontario.

Callophrys irus arsace appeared to be in serious trouble from prescribed burning in the 1990s (Jeffrey Nekkola and Ronald Gatrelle personal communication with Dale Schweitzer), as well as development and silviculture.

Northern lupine-feeding populations are best integrated into overall barrens or savanna management. Management schemes for the Karner Melissa blue seem to be suitable for the generally much scarcer frosted elfin in New York and New Hampshire, but perhaps not farther west. In Wisconsin, the frosted elfin is absent from many Karner Melissa blue sites, and is much scarcer where both occur, so management for the Karner Melissa blue there may not be adequate to provide for the frosted elfin.

Lupine-feeding frosted elfins are probably more sensitive to the impacts of browsing deer than Karner Melissa blues, because the larvae feed mainly on the flowers, which deer prefer over leaves.

Pupation in the sand by northern lupine-feeding populations allows some survival in fires. On 30 April 1981, a few weeks after a hot fire in the Albany, New York Pine Bush, frosted elfins, including freshly emerged (teneral) adults, were found literally among the ashes. No other butterflies were present. Swengel (1996a) found Midwestern lupine-feeding frosted elfins to be "fire-aversive," suggesting some unfavorable habitat change, possibly lack of flowering heaths or lack of dry bunch grasses during the first season.

Adults often perch on or hide among such grasses. It would be very useful if Karner Melissa blue managers would also monitor the generally less common frosted elfin. The fact that this species is persisting in the Holly Shelter State Gamelands in North Carolina, where many places are burned every other year (Steve Hall personal communication with Dale Schweitzer in 2007), suggests this population may pupate in the soil like northern lupine feeders, but we have little information on this population and other wild-indigo feeders that have been studied do not pupate in the soil.

Complex permitting requirements have discouraged research with this species at known sites in North Carolina, according to Bo Sullivan, and this is probably so in some other states. Lack of basic information could become a threat to some of these populations as well as a hindrance to evaluation of the global status of this species. Adequate vouchering (including DNA samples), life history studies, and information regarding the suitability of current fire regimens, are needed in North Carolina where this species now apparently occurs in only a few places. The frosted elfin may have been reduced by prescribed burning there in the past, or may be threatened by it now. North Carolina would be a good place to evaluate the degree of distinctiveness of the lupine and *Baptisia*-feeding populations.

Currently, management of most *Baptisia*-feeding populations outside of Massachusetts involves right-of-way management, as well as deer, fire, and gypsy moth-related issues. Gypsy moth spraying could be a threat to the frosted elfin, but with *Btk* it is unlikely that a single application would eradicate an otherwise viable colony, because some larvae would usually hatch afterwards and/or start on new foliage not exposed to *Btk*.

Broadcast herbiciding and disking of powerlines in 2003 destroyed a very large occurrence of the frosted elfin in Cumberland County, New Jersey. A cluster of populations covering several kilometers of powerline on a wildlife management area in two townships in Cumberland County was destroyed based on surveys through 2–3 years after the event. While late September herbicide applications did not kill many *Baptisia*, nectar plants were severely impacted for two years. Furthermore, much of the area was also disked, further damaging the food plants and presumably killing nearly all pupae. Another colony on a different powerline that was herbicided and also browsed heavily by deer, but not disked, was reduced by about 90% for two seasons. Fortunately, by 2006 the population was more than half its usual pre-2003 size. It has persisted as of 2010, and the nectar plants have recovered. Prior to the herbicide application, habitats for these long-existing powerline colonies had been mowed in winter about every five years for decades.

Deer probably contributed to the extirpation of the well-known Assunpink, New Jersey, colony (Glassberg 1993) in 2003. However, deer were probably not the sole factor, since the habitat was very small and numbers had been low for years (Anthony McBride and other observers), and population numbers were unusually low throughout southern New Jersey in 2003 (Dale Schweitzer observation). The Nottingham, Pennsylvania population was gone by 1996-1997, with deer the likely cause. The nearby Goat Hill colony lasted a few years longer, but only one or two adults were seen per day. These colonies experienced a brief period of severe deer herbivory of the host plant a few years earlier, before the herd was reduced by hunting. Deer also impacted or temporarily eliminated small subpopulations of frosted elfins and Karner Melissa blues at Albany, New York and New Hampshire, by eating all lupine flowers. Fortunately, the overall population clusters survive in both places. Generally, metapopulations, or at least clusters of populations, may be needed for long-term survival of frosted elfins. Isolated colonies reduced to a few dozen adults, or occupying less than a hectare, often do not persist.

References

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AMETHYST HAIRSTREAK

Chlorostrymon maesites (HERRICH-SCHÄFFER)

IDENTIFICATION

This is a small (20 to 23 mm), brilliantly colored tropical butterfly (Figure 136 and 137). The uppersides of the wings are metallic purplish-blue in males, and duller blue in females. The underside of the hindwing is green with a reddish patch near the tails. The silver-banded hairstreak (*Chlorostrymon simaethis*) is similar, but is slightly larger and has a silvery line on the underside of the hindwings. The flight pattern is fast and erratic.

Figure 136. Amethyst hairstreak (*Chlorostrymon maesites*) upperside male from Key West, Monroe County, Florida (Marc Minno photo).

Figure 137. Amethyst hairstreak (*Chlorostrymon maesites*) underside male from Key West, Monroe County, Florida (Marc Minno photo).

RANGE

The amethyst hairstreak is a Caribbean species known from the Bahamas, Cuba, Jamaica, Hispaniola, Puerto Rico, Dominica, and southern Florida (Johnson 1989). In Florida it has been found mostly in Miami-Dade County and the Keys.

RARITY

NatureServe global rank: G4; this ranking needs to be re-evaluated. It is ranked S1 in Florida, its entire United States range.

The amethyst hairstreak has always been an elusive species, largely due to its small size, cryptic coloring, fast flight, and secretive habits. Collectors used to stumble upon occasional adults visiting flowers on Key Largo or zipping around the tops of trees with multitudes of Cassius blues at the Key West Botanic Garden on Stock Island (Dave Baggett personal communication with Marc Minno). During the 1970s, Andy Anderson found a few from time to time on Sugarloaf Key and Stock Island.

This species has markedly declined in Florida since the 1970s. There were no reports of it at all in Florida during the 1990s, but in June 2003, David Fine and others observed one at Bahia Honda State Park in the Keys. Later that summer, several were seen at the butterfly garden at Castellow Hammock Nature Center near Homestead, and at a private garden in Fort Lauderdale. After more than 25 years of looking for butterflies in the Keys, Marc Minno has never seen this species in Florida. Currently it appears to be extirpated, or may be a temporary colonizer in the Keys. It's possible that it barely survives in Miami-Dade County. We do not know its status elsewhere in its range, but it is generally considered to be a rare species.

Life history

Richard Boscoe reared this species from eggs obtained from a captive female, but the life history is largely unknown. Females lay eggs singly on flower buds. The larvae eat flower buds and probably the young leaves and developing seeds.

The adults have been reported from every month of the year and probably spend most of their time in the forest canopy. They have been seen at flowers such as Spanish needles (*Bidens alba*) along trails, or on lantana (*Lantana camara*) in gardens. One adult was collected by Dave Baggett shortly after dark at a blacklight on northern Key Largo. Julietta Brambila collected one adult in August 2008 in southeastern Miami (Heppner 2008). The only known record from the Cayman Islands was taken in a mosquito light trap on 10 July 2003 (Askew and Stafford 2008).

Host plants

The larvae feed on the flower buds of tropical trees in the pea family (Fabaceae), probably including false tamarind (*Lysiloma latisiliquum*) and blackbeads (*Pithecellobium* species). Boscoe reared the larvae on flower buds of woman's tongue (*Albizia lebbeck*).

Habitat

This butterfly is found at the edges of tropical hardwood hammocks.

Threats & management issues

The amethyst hairstreak has been impacted by habitat loss and fragmentation and probably other factors. Most of the remaining habitat in the northern Keys is closed canopy mature forest that is too shady and densely wooded for many species. A mosaic of fields, shrublands, young forest, and mature stands promotes the greatest diversity of butterflies. Much of the upland forests in the Keys have been destroyed and fragmented by roads and urban development.

All stages would be active and vulnerable to hurricanes and tropical storms in late summer and fall.

Mosquito adulticides should not be sprayed near known colonies, but mosquito fish or larvicides would not harm the butterfly.

Exotic predatory ants and lizards may be harming this species and many other butterflies.

References

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Early hairstreak

Erora laeta (W. H. Edwards)

Identification

This small (31 to 35 mm) butterfly is pale greenish with orange-red spots on the underside (Figures 138-140). No other butterfly in our region has this pattern. Males are mostly black above. Females have extensive blue on the uppersides of the wings, but they rarely open the wings when perched. Klots (1951), Glassberg (1999), and Brock and Kaufman (2003) illustrate the adult. The larva of *Erora laeta* is slug-like and green (Figure 141, Allen 1997, Allen *et al.* 2005) like many hairstreak larvae, but with distinctive reddish brown blotches.

Figure 138. Early hairstreak (*Erora laeta*) upperside male from Harlan County, Kentucky (Marc Minno photo).

Figure 139. Early hairstreak (*Erora laeta*) upperside female from Bennington County, Vermont (Marc. Minno photo).

Figure 140. Early hairstreak (*Erora laeta*) underside female from Bennington County, Vermont (Marc Minno photo).

Figure 141. Early hairstreak (*Erora laeta*) larva feeding on a young American beech fruit from Randolph County, West Virginia (Tom Allen photo).

Range

The early hairstreak occurs from the Canadian Maritime Provinces and Maine westward across southern Quebec, New York, northwestern Massachusetts, southern Ontario, northern Michigan, into Wisconsin, and in the mountains from Pennsylvania to northern Georgia. Even within the overall range, this butterfly is absent from substantial areas such as Connecticut and most of Massachusetts. The food plants, beaked hazelnut and American beech, occur nearly throughout both states.

Rarity

NatureServe global rank: GU (although G2G4 would also be appropriate); Xerces Society rank: Vulnerable.

The severity and potential scope of threats to this butterfly are too poorly known to assign a rank. It appeared to be secure (G4) before the beech canker (*Nectria ditissima*) became a concern. Now deer also loom as an impending threat where beaked hazelnut is the food plant. The early hairstreak is easily overlooked, because adults spend most of their time in the forest canopy. Potential habitats are not uncommon. However, Maine is a significant portion of the range of this species, and the lack of any records from Maine in over 50 years (Maine Natural Heritage Program, as of early 2006) suggests a decline. There are recent records from other New England states, including at least four sites in Vermont since 2000 (Scott Griggs).

The greatest concern is rapid loss of mature beech (*Fagus grandifolia*) trees to a non-native canker disease in the northeastern United States and the Canadian Maritimes. Mortality of mature beech has been severe, although generally not 100%, in much of Vermont and parts of Canada. Larvae feed on developing beech nuts, so regenerating stands are unsuitable for many years. Older diseased trees that are not producing nuts are also unsuitable for the caterpillars. Beech nut production varies between years, which could make long-term survival of populations of early hairstreaks unlikely except where mature beeches are common over a substantial area. Increasingly widespread decline is likely in the next few decades.

The GU rank expresses uncertainty as to how severely this species is threatened by beech canker in the core of its range, and uncertainty as to how widely beaked hazelnut (*Corylus cornuta*), and possibly other food plants, are used. This butterfly might be secure where hazelnut or possibly other plants are the main hosts, especially if deer hunting remains popular. We are aware of only one recent collection in Kentucky at Big Black Mountain in 2002 (Hugo Kons), but it still turns up in North Carolina and Georgia.

Life history

There is one principal brood in Canada in late spring, usually late May to mid-June, but occasional adults have been found in July in New England. There are two broods in West Virginia, mostly from April to mid-May and July into August (Allen 1997). In North Carolina, collection dates run from 10 April to 3 August, with a peak of observations in early July, which suggests only two broods.

Allen (1997) reports that the larval stage takes about 40 days to complete.

The pupae overwinter, probably in the leaf litter.

Adults occur mostly in the canopy, but sometimes can be seen perched on lower branches at openings. Adults sip moisture from unpaved roads, and are extremely docile when doing so. This poses a potential source of mortality from vehicles. Often, most of those observed in such situations are females on hot, late-spring mornings (Bowers 1978, Dale Schweitzer observation). However, males may predominate at puddles earlier in the season in Massachusetts (Mike Nelson personal communication with Dale Schweitzer). South of Massachusetts, summer brood adults visit many kinds of flowers, and are most often seen on daisy (*Chrysanthemum majus*) and two species of fleabane (*Erigeron*) in North Carolina. Other reports from various states include springbeauty (*Claytonia caroliniana*), *Ceanothus americanus,* and orange milkweed (also known as butterfly weed) (*Asclepias tuberosa*). One observer found ten adults on wild hydrangea (*Hydrangea sp*.) in Kentucky (Covell 1999). Wild strawberry (*Fragaria virginiana*) and pin cherry (*Prunus pensylvanica*) are visited in Massachusetts (Mike Nelson personal communication with Dale Schweitzer).

Host plants

In most of the northeastern United States and Canada the caterpillars of *Erora laeta* eat the young fruit of American beech (*Fagus grandifolia*), a common and widely distributed tree in the beech family (Fagaceae). The larvae feed externally on the husk at first, and later bore into the nut. According to Reginald Webster, each caterpillar requires two or three beech nuts to reach maturity (Layberry *et al*. 1998).

Another host plant is beaked hazelnut (*Corylus cornuta*), a shrub in the birch family (Betulaceae). The caterpillars eat the young fruit of hazelnut in the Great Lakes region, West Virginia (ovipositions observed by Thomas Allen, email of 11 July 2008 to Marc Minno), and probably elsewhere. This plant was abundant at a site in Ontonagon County, Michigan, where *Erora laeta* was present, but no beech was found (Oosting 1979). Beaked hazelnut is present in other places where the early hairstreak occurs, but beeches do not. Klots and dos Passos (1981) reared larvae on beaked hazelnut in the laboratory from eggs obtained from captive females.

Other food plants have been suggested, but none have been documented. The early flight season in the southern Appalachians could facilitate use of early-flowering *Corylus* species. Thomas Allen also points out that the late summer food plant for the second brood is unknown. However, LeGrand and Howard (Butterflies of North Carolina website) consider beech the likely food plant in North Carolina, and Allen has recently told David Wagner that it probably is at most West Virginia sites.

Habitat

The early hairstreak is usually seen along roads or in outcrops in deciduous forests containing mature beech trees or abundant beaked hazelnut. LeGrand and Howard (Butterflies of North Carolina website) indicate that it is found mostly above 4,000 feet (1219 m). However, Bo Sullivan in North Carolina and James Adams in Georgia find it at much lower elevations, typically about 2700 feet (823 m) in North Carolina (Sullivan 1971), with the best Georgia locality below 2000 feet (700 m). In New England it is often found below 1,000 feet (356 m). Adults probably spend most of their time in the canopy.

Threats & management issues

The greatest concern for the early hairstreak in most of its range is the rapid loss of mature beech trees to a non-native bark canker in the northeastern United States and the Canadian Maritimes.

Deer severely browse hazelnut foliage in New Jersey, where these once-common shrubs (Hupf 1983) are no longer frequently seen except as small (<30 cm) sprouts. Although the early hairstreak is unverified from New Jersey, it is likely that deer could become a threat anywhere that beaked hazelnut is the main food plant.

In the Appalachians, gypsy moth spraying and defoliation of the host plants during outbreaks could be of concern where oaks are numerous in the habitat. Defoliated trees usually abort immature nuts. Fortunately, northern hardwood forests where beech is most abundant are among the least likely forest types to be severely defoliated by gypsy moth larvae. Both beech and beaked hazelnut are readily eaten by gypsy moth caterpillars, with beech probably not as vulnerable as hazelnut. Adults in Appalachian populations fly quite early in the spring, so their larvae could be at risk if their habitats were sprayed for gypsy moth. Even if mortality from *Btk* were high, spraying would probably be less of an impact than large-scale nut abortion caused by severe defoliation.

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King's hairstreak

Satyrium kingi (Klots and Clench)

Identification

This is a medium-sized butterfly (30 to 36 mm), but fairly large for a hairstreak. The hindwings have thread-like tails and a reddish eyespot typical of many hairstreaks (Figure 142 and 143). The anterior third of the postmedian line on the forewing is strongly angled inward. Also, there is an indentation on the hindwing just above the tail spots, at least on males, and the orange cap of the eyespot curves inwardly above the blue. The white bands on the undersides of the wings are not fragmented as on the striped hairstreak (*Satyrium liparops*).

Satyrium kingi is sometimes difficult to separate from the variable *Satyrium calanus falacer*. A specimen or two, preferably males, is strongly advised for vouchering any new occurrences. Opler and Malikul (1992), Glassberg (1999), and Glassberg *et al.* (2000) illustrate the adult. The caterpillar is similar to several other hairstreaks, green sometimes with pale yellow markings (Figure 144, Allen *et al.* 2005, Minno *et al.* 2005).

Figure 142. King's hairstreak (*Satyrium kingi*) upperside male from Liberty County, Florida (Marc Minno photo).

Figure 143. King's hairstreak (*Satyrium kingi*) underside male from Liberty County, Florida (Marc Minno photo).

Figure 144. King's hairstreak (*Satyrium kingi*) larva from Croatan National Forest, Craven County, North Carolina, found by J. B. Sullivan (David Wagner photo).

Range

This species is found mostly in the coastal plain and Piedmont, from the southern Delaware-Maryland border and coastal Virginia, then westward across southern North Carolina and the Gulf States to eastern Texas, Arkansas, and southeastern Oklahoma (Glassberg 1999).

Rarity

NatureServe global rank: G3G4. King's hairstreak is not currently imperiled, but it is local and uncommon range-wide, despite its common food plant. Information on this butterfly is sometimes conflicting. For example, LeGrand and Howard (Butterflies of North Carolina website) found records for only 15 North

Carolina counties, eleven of which have records in the last 20 years. They call it very local and rare to uncommon on the coastal plain, which is essentially its core range, and very rare elsewhere. However, Bo. Sullivan reports that he finds adults or larvae in virtually every stand of food plant in the coastal plain that he has checked. James Adams indicates that it was found at several places on the Georgia coastal plain in 2010. According to Steve Hall, in North Carolina the species also turned up in Bladen County in the coastal plain, and Watuaga County in the mountains in 2008. Hall and Sullivan recommend more effort to search for larvae.

Life history

All *Satyrium* species are single-brooded. Glassberg (1999) gives the flight season as most of June in North Carolina. Adult King's hairstreaks appear somewhat later than most other *Satyrium* species. Gatrelle (1974) reported collecting one on 2 August in Florida where there are records as early as mid-May.

Most of the year is spent in the egg stage.

The larvae emerge from the eggs in April or May and feed on the new growth of the host. The larvae are not ant-tended.

After a pupal period of about ten days (Floyd 1974), the adults eclose, usually in May or June.

The adults are closely associated with the host plant. Adults have been reported from various flowers, such as chinquapin (*Castanea pumila*) (Gifford and Opler 1983). At Eglin Air Force Base in the Florida Panhandle, adults perch on leaves along forest trails. Like several other hairstreaks, this species turns up at blacklight traps (Bo Sullivan).

Host plants

The host plant is common sweetleaf (*Symplocos tinctoria*), also called horse sugar, a shrub in the sweetleaf family (Symplocaceae). Other food plant reports appear to have been erroneous.

Habitat

This butterfly occurs in mesic upland and bottomland hardwoods, moist pinelands and pocosin ecotones, and even dry forests southward, including unburned sandhills. The Maryland-Delaware habitat is swampy with bald cypress nearby.

Gatrelle (1974) reported adults perching on sweetgum, often high above the ground. They also often perch on the food plant. Aside from a suggestion that this butterfly might be particularly associated with young food plants (Brock and Kaufman 2003), there is little information about ecological needs of this species.

King's hairstreak is probably found most reliably in moist forests that rarely burn, but the food plant and sometimes this butterfly also occur in places that are subject to prescribed burning. It would be useful to investigate the influence of fire (or lack thereof) on the likelihood that a food plant patch will be occupied. Much of Holly Shelter State Gamelands, North Carolina, is now burned on a two-year rotation, and prior to that on a three- to five-year rotation (Steve Hall personal communication with Dale Schweitzer in 2008). Sweetleaf is common there, but King's hairstreak is apparently absent (LeGrand and Howard Butterflies of North Carolina website).

Threats & management issues

Management issues for King's hairstreak include prescribed burning, clearcut logging, and gypsy moth related impacts, but little is known about how these affect the butterfly. However, no stage would likely survive a fire sufficiently hot to scorch the food plant.

Clearcutting of upland forest at Eglin Air Force Base has impacted a population of King's hairstreak near Anderson Pond in Florida. It is likely that similar forest management practices could harm the species elsewhere.

We do not know if gypsy moth larvae eat the food plant, if defoliation might occur before King's hairstreak larvae complete feeding, or if the caterpillars of this species are sensitive to *Btk*. The apparent absence of this species at some stands of the food plant cannot now be explained, but habitat fragmentation and prescribed burning are the main concerns where it does occur.

Unburned refugia are probably critical to the persistence of King's hairstreak, unless fires are so light as not to top-kill the food plant. More information is needed about the impact of fire on this butterfly.

References

Allen *et al.* (2005), Bordelon and Knudson (1999), Brock and Kaufman (2003), Cech and Tudor (2005), Floyd (1974), Gatrelle (1974), Gerberg and Arnett (1989), Gifford and Opler (1983), Glassberg (1999), Glassberg *et al.* (2000), Howe (1975), Kimball (1965), Klots and Clench (1952), Kons and Borth (2006). LeGrand and Howard (Butterflies of North Carolina website), Minno and Emmel (1994), Minno *et al.* (2005), Ogard and Bright (2010), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Scott (1986).

STRIPED HAIRSTREAK (PENINSULAR FLORIDA POPULATION)

Satyrium liparops floridensis GATRELLE

IDENTIFICATION

This is a small (20 to 29 mm), dark butterfly with thread-like tails. The underside of the hindwing has widely separated white bands and a red and blue eyespot (Figure 145 and 146). Large orange patches also occur on the upperside of the forewing in Manitoba, Canada, but rarely occur in most of the range of the species. Gatrelle (2001) illustrates the adult.

Figure 145. Striped hairstreak (*Satyrium liparops floridensis*) upperside male from Hernando County, Florida (Marc Minno photo).

Figure 146. Striped hairstreak (*Satyrium liparops floridensis*) underside male from Hernando County, Florida (Marc Minno photo).

The larva is green with pale markings (Figure 147). Larval *Satyrium liparops floridensis* is probably not separable from other subspecies.

Figure 147. Striped hairstreak (*Satyrium liparops floridensis*) larva from Hernando County, Florida (Jeff Slotten photo).

TAXONOMIC NOTES

Three alleged subspecies of the striped hairstreak have been described from the eastern United States. In addition, *Satyrium liparops fletcheri* was described from Manitoba, Canada. The northern *Satyrium liparops strigosa*, described from Massachusetts, appears to grade clinally over a broad area into *Satyrium liparops liparops* described from Georgia. Like many hairstreaks, southern adults tend to be larger and have longer tails than northern ones of the same species.

The recently described *Satyrium liparops floridensis* from central Florida is quite distinctive, but likely also grades clinally into *Satyrium liparops liparops*. It would be very interesting to do a multi-species study of the distinctness of peninsular populations of this and the many other Lepidoptera whose phenotypes differ on the Florida peninsula.

Range

Satyrium liparops floridensis was reported by Gatrelle only from Withlacoochee State Forest in Hernando and Citrus counties in Florida. Marc Minno has also seen specimens referable to this subspecies from Alachua and Clay counties. Gatrelle states that intermediate specimens occur from northeastern Florida to southeastern Georgia. Hugo Kons reports some from the Panhandle, where most specimens are of the *Satyrium liparops liparops* phenotype.

Rarity

NatureServe global rank: G5T1T2. The state rank is S2. This is a very local butterfly, and the adults are only present for a few weeks each year. It is apparently most abundant in parts of the Withlacoochee State Forest.

Life history

Most of the year is spent as an egg glued to a twig of the host plant. The eggs overwinter and hatch the following spring. The larvae feed on young buds and developing fruit, and probably young leaves and flowers. They are not known to be attended by ants.

Adults of *Satyrium liparops floridensis* probably occur from late April into early May, but Gatrelle found adults between 28 March and 22 April 2000. The adults perch on the leaves of shrubs in the forest and visit flowers such as the food plants.

Host plants

The larvae of *Satyrium liparops floridensis* feed on sparkleberry (*Vaccinium arboreum*) a shrub in the heath family (Ericaceae), as well as hawthorns (*Crataegus* species) in the rose family (Rosaceae) (Jeff Slotten). Elsewhere in Florida, *Satyrium liparops liparops* feeds on parsley hawthorn (*Crataegus marshallii*) and other upland hawthorns (Dave Baggett, Jeff Slotten, and Dale Schweitzer observations), and wild plum (*Prunus* species). Populations of this species from Massachusetts to New Jersey commonly feed on several rosaceous genera (*Malus, Prunus, Aronia, Amelanchier*) in addition to highbush blueberry (*Vaccinium corymbosum*). Much less often, larvae occur on oaks and eastern hophornbeam (*Ostrya virginiana*). Adults of *Satyrium liparops floridensis* are often found visiting the flowers of sparkleberry (*Vaccinium arboreum).*

Habitat

Satyrium liparops floridensis occurs mostly in mesic and xeric pine-oak forest or woodland where sparkleberry is common.

Threats & management issues

Forest management such as clearcutting, harvesting of "crooked wood," and fire management may impact *Satyrium liparops floridensis*. Crooked wood includes *Vaccinium arboreum*, which is both a host plant and nectar source for the striped hairstreak. In some areas, such as Ocala National Forest, crooked wood is commonly harvested for making artificial, decorative plants for homes and commercial buildings.

Prescribed fire and wildfires are the major management issues for this butterfly. Fire is an important and essential ecological process in many wooded habitats in Florida, but none of the life stages of *Satyrium liparops floridensis* are able to survive it. Even if a few eggs survived a fire, there might be no host plant available. It is not likely that food plants top-killed by winter or spring fires would produce flowers or fruit the first year, or have foliage available in time for the larvae in spring. Thus, this butterfly needs unburned refugia and several years between return fires.

Selective logging may be beneficial to this species if its host plants are not harmed, but clearcutting of its habitat would be detrimental. Some invasive plants such as air-potato (*Dioscoria bulbifera*) and climbing ferns (*Lygodium* species) may harm this species by smothering its host plants.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Brown (1976), Cech and Tudor (2005), Gatrelle (2001), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Howe (1975), Kimball (1965), Klots (1951), Minno and Emmel (1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986).

Bartram's scrub-hairstreak

Strymon acis bartrami (W. P. Comstock and Huntington)

Identification

This is a small (25 to 30 mm) gray butterfly with thread-like tails (Figure 148). The underside of the hindwing has a unique pattern of bold white lines and spots (Figure 149). Instead of an eyespot near the tail, it has a smeared patch of red. Martial's scrub-hairstreak (*Strymon martialis*)

Figure 148. Bartram's scrub-hairstreak *(Strymon acis bartrami)* upperside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 149. Bartram's scrub-hairstreak *(Strymon acis bartrami)* underside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

and the gray hairstreak (*Strymon melinus*) are similar, but these species lack the two white spots on the underside of the hindwing that is characteristic of Bartram's scrub-hairstreak. Opler and Malikul (1992), Glassberg (1999), Glassberg *et al.* (2000) and Brock and Kaufman (2003) also illustrate the adult.

The larva is grayish-green to brownish (Figure 150, Minno *et al.* 2005, Allen *et al.* 2005).

Figure 150. Bartram's scrub-hairstreak *(Strymon acis bartrami)* larva from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Taxonomic notes

Strymon acis bartrami is the only subspecies of this butterfly found in the United States. Others occur in the West Indies.

Range

This butterfly occurs on Big Pine Key in the Florida Keys, Long Pine Key in Everglades National Park, and in a few small of pine rockland preserves south of Miami, most of which are owned and managed by Miami-Dade County.

Rarity

NatureServe global rank: G4T1. *Strymon acis bartrami* is currently being evaluated by the U.S. Fish and Wildlife Service for listing. This is one of the most imperiled butterflies in the eastern United States. It probably still occurs at less than a dozen locations, and population sizes are very small. At their population peaks during 2006 and 2007, Marc Minno found fewer than 20 adults per day on Big Pine, and fewer than 10 at Everglades National Park during monthly surveys.

Life history

The adults have been recorded every month of the year (Minno and Emmel 1993, Salvato and Hennessey 2004), but are most numerous in spring and fall. Although Mark Salvato has never observed a mating pair, Marc Minno recently found one in a weedy field near pine rockland habitat about one hour before dusk, suggesting that mating may occur very late in the day.

The eggs are laid singly on the flowers of the host plant. The young caterpillars feed on the flowers of the host, but older larvae feed on the edges of mature leaves as well, which often bleed a reddish sap (Salvato 2005, Salvato and Hennessey 2004). Older larvae also skeletonize leaves. They are not tended by ants (Salvato and Hennessey 2004).

Adults perch on the larval host or nearby. They visit the flowers of the host and other plants for nectar.

Host plants

The caterpillars feed on the leaves and flower buds of pineland croton (*Croton linearis*), a small shrub in the spurge family (Euphorbiaceae).

Habitat

Bartram's scrub-hairstreak occurs in close association with the host plant in open pine rocklands and along trails and roads through pine rocklands.

Threats & management issues

Most of the habitat of this butterfly is on public land in the Key Deer National Wildlife Refuge, the Miami-Dade County park system, and Everglades National Park.

In many places that have not burned for several years, the habitat is so overgrown by shrubs and palms that the host plant is limited to trails and roadsides. Although important, prescribed fire in areas where this butterfly occurs should be used with extreme caution. Fire can kill all stages of the butterfly. Some plants are killed by fire. The host plant is usually top-killed by fire, and takes about 8 weeks to completely recover. However, it grows lushly and flowers well after fire. The host plant seeds likely lie dormant in the soil for years, and may require fire or disturbance in order to germinate. The plant is often most abundant in disturbed pine rockland areas. Known colonies of the butterfly are very local and should not be burned. However, burning overgrown brushy areas nearby could be very beneficial. Although Salvato and Hennessey (2004) did not find Bartram's scrub-hairstreaks to be using croton patches several months after fire in Everglades National Park, in 2007 Marc Minno observed numerous adults in a patch burned by arson about six months prior on Big Pine Key. At this site, however, unburned habitat with croton was very close by.

It is unknown whether mosquito adulticides would impact populations of the butterfly, but they should not be sprayed near existing colonies. Mosquito fish or carefully applied larvicides would not harm the butterfly.

With such small numbers of adults present, collecting could significantly affect this species.

Fire ants and other non-native predators may be harming Bartram's scrub-hairstreak; more observation and research is needed.

References

Allen *et al.* (2005), Baggett (1982), Brock and Kaufman (2003), Cech and Tudor (2005), Chermock and Chermock (1947), W. P. Comstock and Huntington (1943), Emmel (1997), Emmel and Minno (1993), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Hernández (2004), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Lenczewski (1980), Minno and Emmel (1993, 1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Robbins and Nicolay (2001), Salvato (2001b, 2003b,2005), Salvato and Hennessey (2004), Salvato and Salvato (2010a), Schwartz *et al.* (1995), Scott (1986), Smith *et al.* (1994), Worth *et al.* (1996).

SUBFAMILY POLYOMMATINAE (BLUES)

MIAMI BLUE

Cyclargus thomasi bethunebakeri (W. P. COMSTOCK AND HUNTINGTON)

IDENTIFICATION

This small (20 to 28 mm) butterfly is bright blue above (Figure 151 and 153). The undersides of the wings are grayish with white patches and markings (Figure 152). The outer edge of the hindwing bears two eyespots on the underside. The upper eyespot is highlighted with red on the inner side. The nickerbean blue (*Cyclargus ammon*) is similar, but smaller and has only three dark spots on the underside at the base of the hindwing. The Miami blue has four dark spots near the base of the hindwing on the underside.

The caterpillars vary in color, but are typically dark green (Figure 154), sometimes with red. Minno *et. al.* (2005) and Allen *et al.* (2005) illustrate the larva.

Figure 151. Miami blue (*Cyclargus thomasi bethunebakeri*) upperside male from Broward County, Florida (Marc Minno photo).

Figure 152. Miami blue (*Cyclargus thomasi bethunebakeri*)) upperside female from Key Largo, Monroe County, Florida (Marc Minno photo).

Figure 153. Miami blue (*Cyclargus thomasi bethunebakeri*) underside male from Broward County, Florida (Marc Minno photo).

Figure 154. Miami blue (*Cyclargus thomasi bethunebakeri*) larva from Key Largo, Monroe County, Florida (Marc Minno photo).

Taxonomic notes

This species has also been placed in the genus *Hemiargus*, but Nabokov (1945) proposed the genus *Cyclargus*. *Cyclargus thomasi bethunebakeri* is probably the only form of this butterfly found in the United States. Other subspecies that are very similar in appearance occur in the Caribbean. Based on some tentative observations of the wing pattern variation and biology, there has been confusion about whether the surviving colonies in Florida represent *Cyclargus thomasi bethunebakeri*, or perhaps another subspecies that colonized the Keys. Emily Saarinen (2009) used molecular techniques to compare all of the populations (including from Bahia Honda and islands in the Key West National Wildlife Refuge), and found very few differences. Thus, we consider populations in the Florida Keys to be *Cyclargus thomasi bethunebakeri*.

Range

Cyclargus thomasi bethunebakeri occurs in southern Florida. It is currently known only from a few tiny islands west of Key West. The well known population residing in Bahia Honda State Park died out in 2010. Recently discovered populations in Cuba are very similar, and may also be this subspecies. *Cyclargus thomasi bethunebakeri* is also reported to occur in the Bimini Islands of the western Bahamas.

Rarity

NatureServe global rank: G3G4TU; Xerces Society rank: Critically imperiled. The species is S1 in Florida, which includes its entire United States range. The TU rank reflects uncertainty as to whether the Cuban and western Bahamian populations are of this subspecies, and this could substantially affect the global rank. However, this butterfly is probably still very rare. *Cyclargus thomasi bethunebakeri* was listed as Endangered by the State of Florida, but the Florida Fish and Wildlife Conservation Commission recently did away with the Endangered category and now list it as Threatened. Although it has been aware of its rarity for at least a decade, the U.S. Fish and Wildlife Service has failed thus far to list the species.

This is one of the most imperiled butterflies in the eastern United States. Before 1980, it was found in coastal areas of the mainland from Sanibel Island on the Gulf coast and Merritt Island on the Atlantic coast southward into the Keys. By the late 1980s it had disappeared from the mainland (Leston *et al.* 1982), but was still common and widely distributed in the Keys. During the 1990s, the Miami blue disappeared from most of its former range. Jane Ruffin discovered a colony at Bahia Honda State Park on 29 November 1999 (Ruffin and Glassberg 2000). Rick Gillmore and Buck and Linda Cooper also observed a few adults on northern Key Largo in 1996 and Rick Gillmore saw one in the same area in 2001, but no colonies have been found there in recent years. In November 2006, Paula Cannon and others found Miami blues on tiny islands (Boca Grande Key and the Marquesas Keys) west of Key West (Cannon 2006, Cannon 2007, Cannon *et al.* 2010). They counted hundreds of adults at some of these sites on subsequent visits. However, these colonies have fluctuated in population numbers. From 2002 to 2005, 20 to 142 adults were observed at the Bahia Honda colony (the largest population known) on a given day (Daniels 2006), but this population is no longer extant.

Jaret Daniels and Thomas Emmel have successfully bred this butterfly in large numbers in captivity at the University of Florida in Gainesville. Thousands of captive-bred adults and larvae were released in Everglades National Park in areas where the Miami blue historically occurred, Biscayne National Park, and other sites in the Keys, but none of the reintroductions were successful (Jaret Daniels personal communication with Marc Minno in January 2008).

Life history

The adults of the Miami blue have been recorded every month of the year (Minno and Emmel 1993), but are most abundant from April to October (Daniels 2006). Females lay bluish green eggs one at a time.

The larvae feed on leaf buds, young leaves, flower buds, and developing seeds of the host. At least five species of ants have been observed tending the larvae at the Bahia Honda colony (Saarinen and Daniels 2006).

Adults visit flowers such as Spanish needles (*Bidens alba*), scorpion's tail (*Heliotropium angiospermum*), buttonsage (*Lantana involucrata*), snow squarestem (*Melanthera nivea*), and blackbead (*Pithecellobium keyense*) for nectar (Minno and Emmel 1993).

Host plants

Rutkowski (1971b) observed a female laying an egg on snowberry (*Chiococca alba*) in the madder family (Rubiaceae), but did not determine if the larva would eat this plant. During the 1980s, Miami blue larvae were commonly found in the Florida Keys feeding on green seeds in the inflated pods of balloonvine in the soapberry family (Sapindaceae). At the time, this plant was identified as *Cardiospermum halicacabum* (Wunderlin 1982) More recent taxonomic studies have determined that *Cardiospermum corindum* is the native species in Florida, whereas *Cardiospermum halicacabum* is an uncommon garden ornamental (Wunderlin and Hansen 2003). The host record of *Cardiospermum halicacabum* in Minno and Emmel (1993) actually refers to *Cardiospermum corindum*. However, because balloonvine naturally occurs only in the upper Florida Keys, the Miami blue must have been using other hosts as well.

Caterpillars of the Miami blue on Bahia Honda ate the flower buds and young leaves of gray nicker (*Caesalpinia bonduc*), a thorny, sprawling vine in the pea family (Fabaceae).

In December 2006, Michael Meisenburg photographed a female Miami blue ovipositing on Florida Keys blackbead (*Pithecellobium keyense*), a small tree in the pea family (Fabaceae), at Bahia Honda State Park. The colonies in the Key West National Wildlife Refuge west of Key West feed on blackbead. Only a few small plants of gray nicker were present (Cannon *et al.* 2010).

Habitat

The Miami blue once occurred at the edges of tropical hardwood hammocks and in pine rocklands, but is now limited to coastal hammocks near sandy beaches.

Threats & management issues

All of the known colonies are on protected public lands within the Key West National Wildlife Refuge. These colonies are located on tiny islands and could easily be destroyed by a single hurricane or tropical storm. Hurricane Wilma and three others brushed the Keys in 2005 and severely damaged the habitat at Bahia Honda (Salvato and Salvato 2007) and on the islands near

Key West (Paula Cannon), but the Miami blue somehow survived.

Mosquito adulticides should not be sprayed near existing colonies.

During the 1990s, Florida State Park staff tried to eradicate balloonvine from state lands in the Keys, based on erroneous information that it was an exotic invasive species. This may have harmed the Miami blue butterfly. Balloonvine has since regrown in most of its former range in the Keys, and has been planted in a few gardens in the lower Keys, but the butterfly has not recolonized.

Exotic predators such as red imported fire ants and *Pseudomyrmex mexicanus* might have caused the currently unexplained disappearance of this species from the mainland and larger islands, and may be preventing successful reintroductions.

In December 2008, feral green iguanas were observed to be feeding on gray nicker at the main Miami blue colony in Bahia Honda State Park, stripping the plants of leaves. Park staff began trapping these exotic lizards in February 2009. Iguana herbivory is likely to be responsible for the disappearance of the population. Unfortunately, iguanas have now colonized the known surviving colonies in the Key West National Wildlife Refuge, but they may not eat blackbead, the host plant of the Miami blue on these tiny islands.

References

Allen *et al.* (2005), Anonymous (2003), Brock and Kaufman (2003), Calhoun, *et al.* (2002), Cannon (2006, 2007), Cannon *et al.* (2010), Carroll and Loye (2006), Cech and Tudor (2005), Comstock and Huntington (1943), Daniels (2006), Gerberg and Arnett (1989), Glassberg (1999, 2003), Glassberg *et al.* (2000), Hernández (2004), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Lenczewski (1980), Leston *et al.* (1982), Minno (2010b), Minno and Emmel (1993, 1994), Minno *et al.* (2005), Nabokov (1945), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Ruffin and Glassberg (2000), Rutkowski (1971b), Saarinen and Daniels (2006, 2007), Scott (1986), Salvato and Salvato (2007), Smith *et al.* (1994).

KARNER MELISSA BLUE

Plebejus melissa samuelis (NABOKOV)

IDENTIFICATION

This small (22 to 34 mm), blue butterfly has distinctive orange spots along the margin of the hindwing and part of the forewing on the upperside of the wings (Figure 155 -156). The underside pattern is unlike that of any other blue butterfly in its range (Figure 157). Females are mostly black above with blue on the basal areas of the wings. There are vestiges of the orange spot band on the upperside of the hindwing, and rarely a trace of it on the forewing.

Males of the various subspecies of *Plebejus melissa* are similar, and can often be differentiated only by experts.

The caterpillar is slug shaped and green (Figure 158). Glassberg (1999) has good illustrations of adults of this genus. More details regarding the information in this account can be found in U.S. Fish and Wildlife Service (2003) and other references listed below.

Figure 155. Karner Melissa blue (*Plebejus melissa samuelis*) upperside male from Montcalm County, Michigan (Marc Minno photo).

Figure 156. Karner Melissa blue (*Plebejus melissa samuelis*) upperside female from Montcalm County, Michigan (Marc Minno photo).

Figure 157. Karner Melissa blue (*Plebejus melissa samuelis*) underside male from Montcalm County, Michigan (Marc Minno photo).

Figure 158. Karner Melissa blue (*Plebejus melissa samuelis*) larva from Allegan County, Michigan (Peter J. Tolson photo).

Taxonomic notes

The Karner Melissa blue may be a full species, but we follow Lane and Weller (1994) and Pelham (2008) in retaining the traditional treatment as a subspecies of *Plebejus melissa*. A number of other subspecies occur in the western United States. The species-subspecies level taxonomy of this genus is unresolved. The Karner Melissa blue has been placed in the genus *Lycaeides* by some authors (Miller and Brown 1981).

Range

The Karner Melissa blue historically occurred in disjunct clusters of colonies along the northern limit of its food plant from southern Maine, New Hampshire, and apparently Massachusetts, through New York, southern Ontario, lower Michigan, Wisconsin into eastern Minnesota, southward to the northernmost portions of Ohio, Indiana, Illinois, Pennsylvania, and probably northeastern Iowa. The Karner Melissa blue is not known from Rhode Island, Connecticut, or Vermont, and alleged New Jersey specimens may be mislabeled. There have been erroneous reports from farther south and west. The range was carefully reviewed by the U.S. Fish and Wildlife Service Recovery Team, of which the senior author was a member.

Today, the Karner Melissa blue occurs mostly in central Wisconsin, southwestern Michigan and extreme northern Indiana, but also persists in New York. It was probably extirpated from Maine and Massachusetts before 1900 and very soon after in Pennsylvania and about that time in New Jersey and Iowa (if it occurred in either). Extirpation in Ontario came in 1990 (Packer 1994). The Karner Melissa blue has been reintroduced to New Hampshire and Ohio where native populations died out in the 1990s, in large part because much of their habitat was developed.

Rarity

NatureServe global rank: G5T2; Xerces Society rank: Critically imperiled.

The Karner Melissa blue is listed by the U.S. Fish and Wildlife Service as Endangered. This is the most extensively studied butterfly covered in this book. The Karner Melissa blue occurs as large metapopulations (usually with colonies scattered over at least 1,000 hectares) in areas with sandy soils. There are several places where the species can be seen in good numbers in the upper Midwest.

Eastward, the Albany Pine Bush in New York is the best-known and most accessible place to find the Karner Melissa blue. However, the species is much less abundant at this location now than it was in the 1970s At that time, anywhere from a few to many could be seen almost anywhere over about an 800-hectare area. The Albany Pine Bush was originally ten times its current size (Givnish *et al.* 1988). Karner Melissa blues now occur there in small discrete areas where sundial lupine (*Lupinus perennis*) still grows. This decline since the 1980s seems to largely reflect a general decline in the lupine population, the causes of which were much discussed in the past (Givnish *et al.* 1988), and are still not fully understood. The role of excessive herbivory by deer in reducing lupine was under-appreciated in that study (of which Dale Schweitzer was a co-author) and accompanying public hearings, but it is still unclear how much of an impact deer had at that time. Some of the decline was due to encroachment of woody vegetation resulting from lack of fires, but lupine decline also occurred in burned areas.

The Karner Melissa blue was usually abundant where found, at least in the summer brood. Observations from the 1960s through the 1980s in Ontario, New Hampshire, and New York indicated that extirpation often occurred within a decade, once summer brood populations fell much below 1,000 adults in normal years (Packer 1994, Schweitzer 1994a).

Life history

The Karner Melissa blue has two broods. The first adults often appear by the end of May and fly well into June. Most adults live less than a week, but development is somewhat staggered so that each brood has a total flight period of several weeks. A second flight period starts around the middle to end of July and lasts for about 3–4 weeks.

Eggs laid by first-brood females hatch in a few days and the life cycle repeats. Eggs laid by second brood females overwinter on the dried remains of lupine plants or the litter under them.

Larvae hatch in April and must locate the new growth upon which they feed. Larvae are tended by ants (U.S. Fish and Wildlife Service 2003), as are some other Lycaenids. The ants feed on sugary secretions produced by the larvae and provide substantial protection from predators and parasitoids. This protection may be one reason why Karner Melissa blues sometimes occur at very high densities (sometimes over 200 adults per acre per day) in optimal habitats.

The pupal period is brief (10–20 days) depending on temperature.

Adults are generalists when it comes to nectar, and visit many genera of native and exotic flowers. Some favorite nectar flowers include New Jersey tea (*Ceanothus americanus*), orange milkweed (*Asclepias tuberosa*), spotted knapweed (*Centaurea maculosa*), flattop goldenrods (*Euthamia* species), hawkweeds (*Hieracium* species), sweet clover (*Melilotus alba*), and dogbanes (*Apocynum* species).

Host plants

The larvae feed in nature only on the foliage of sundial lupine (*Lupinus perennis*), although in captivity they will eat some other legumes.

Habitat

Typical habitats for the Karner Melissa blue are in sandy pine barrens and oak savannas, or openings and on right-of-ways in these forest types. Populations in Saratoga and Warren counties, New York, are found mostly in disturbed areas such as powerlines, airports, and old fields. Many associated wooded areas are now unsuitable habitats, including oak and mixed oak-white-pine forests. The original natural community that supported this species in this area is unclear.

Farther south around Albany the species originally inhabited pitch-pine barrens.

East of Michigan, Karner Melissa blue habitats were often associated with rivers, such as the Merrimack, Hudson, and upper Delaware.

It is believed that virtually all original habitats were fire-maintained, yet it is known that this species, like nearly all butterflies and most skippers, has very poor survival in fires. Survival of metapopulations thus depended upon unburned refugia and colonizing ability, which may explain why this butterfly was found primarily within extensive barrens or savannas.

Threats & management issues

This species is protected by United States law. No stage of the Karner Melissa blue can be legally disturbed without a permit from the U.S. Fish and Wildlife Service. New information on the ecology and management of this butterfly appears every year. Land managers of sites where this butterfly occurs should refer to the recovery plan and the U.S. Fish and Wildlife Service website. In most cases land managers already are in contact with U.S. Fish and Wildlife Service.

The decline of the Karner Melissa blue is attributed mostly to habitat change from fire suppression and ensuing succession, as well as habitat loss due to urban and suburban development, agriculture, and silviculture.

The extirpation in Ontario is the best documented loss of a population of this species (Packer 1994). Population estimates for the second brood were 840 in 1984 and 916 in 1986, but only one adult was seen there in 1990. Weather was an important factor, but perhaps not the only one. The decline started in the second brood of 1987, during a period of unusually hot, dry weather. The impact from similar weather the following season was exacerbated by the removal of an important large shade tree during the winter.

With increasing numbers, deer could become a problem in some parts of the range.

Recently, there has been concern about possible impacts from introduced predatory lady beetles (Coccinellidae) that may eat the immature stages.

Another recent concern is hybridization with the western subspecies, which has been expanding its range eastward along roads (Dana *et al.* 2005). In addition, the different subspecies of the Melissa blue carry different strains of the endosymbiotic bacteria, *Wolbachia*, which can cause various health effects including inability to reproduce (C. Nice *et al.* 2009).

Occupied habitats are protected from spraying for gypsy moths because *Btk* kills the larvae. Gypsy moth larvae do not eat lupine.

Currently, most remaining occurrences are substantially protected and adequately managed. However, the Karner Melissa blue has almost no prospects for continued survival without perpetual habitat management. Populations are prone to occasional crashes. In the Recovery Plan (U.S. Fish and Wildlife Service 2003), it is pointed out that populations that are typically below 1,000 individuals may not recover from bad years. An average July brood of about 3,000 adults is the "minimum viable population" threshold for recovery planning (U.S. Fish and Wildlife Service 2003).

Some variation in microhabits with lupine, such as differing slope, aspect, and partial shade as well as open exposure to the sun, are believed to buffer against the effects of variable weather, and may improve the chance for persistence of this species.

The spring brood is usually about a third as large as the summer one, but numbers vary substantially. With two annual generations, this species can recover relatively quickly from fires if refugia are nearby. When properly applied, prescribed burning is a practical, commonly used, and effective management tool, however, late summer through winter mowing is also effective. Although most adults stay within 100 meters of where they eclose, some individuals do wander.

Karner Melissa blues are effective colonizers over distances up to a few kilometers, depending on the landscape.

There is concern about global warming, given that the subspecies is naturally restricted to the northern edge of the range of lupine, and the plant is unlikely to move northward rapidly. Weather events such as those that contributed to its extirpation in Ontario can be expected to become more common in the future.

References

Allen *et al.* (2005), Andow *et al.* (1994a), Andow *et al.* (1994b), Bleser (1994), Baker (1994), Brock and Kaufman (2003), Brown and Boyce (1998), Cech and Tudor (2005), Dana *et al.* (2005), Dirig (1973, 1994, 1996), Glassberg (1993, 1999), Grigore and Windus (1994), Grundel *et al.* (1998a, 1998b, 2000), Kwilosz and Knutson (1999), Helmbolt and Amaral (1994), Holland (1898), Howe (1975), Irwin and Downey (1973), King (1998, 2000, 2002, 2003), Kleintjes *et al.* (2003), Klots (1951), Knutson *et al.* (1999), Kwilosz and Knutson (1999), Labus *et al.* (2002), Lane (1994), Lane and Andow (2003), Lane and Dana (1994), Lane and Weller (1994), Lawrence (1994), Martin (1994), Masters and Karpuleon (1975), Metzler *et al.* (2005), Nice and Shapiro (1999), Nice *et al.* (2005, 2009), Opler (1985), Opler and Krizek (1984), Opler and Malikul (1992), Packer (1987, 1994), Packer *et al.* (1998), Savignano (1994a, b), Schellhorn *et al.* (2005), Schweitzer (1994a, b), Scott (1986), Shapiro (1974), Shuey (1996a, 1997), Smallidge *et al.* (1996), Smith *et al.* (2002), Sommers and Nye (1994). Spoor and Nickles (1994), Swengel (1994, 1995), Swengel and Swengel (1996b, 1998, 1999b, 2002, 2005a, b), Toledo Zoo (2002), U.S. Fish and Wildlife Service (2003), Wilsmann (1994), Wisconsin Department of Natural Resources (1999, 2000).

Family Riodinidae (metalmarks)

Northern metalmark

Calephelis borealis (Grote and Robinson)

Identification

This small (25 to 32 mm) butterfly is brownish above and orange below with metallic silvery markings (Figure 159 and 160). The adults often perch on the underside of leaves with the wings held open.

It is very similar to the swamp metalmark (*Calephelis muticum*), but the northern metalmark has a dark band across both wings on the upper side and somewhat brighter silvery lines. Male swamp metalmarks have a slightly more pointed forewing. The northern metalmark is the only metalmark species in most of its range, making identification easy. Where the range overlaps that of the swamp metalmark (*Calephelis muticum*), especially in Missouri and Arkansas, we recommend that newly discovered occurrences of either be documented with at least one male specimen, and in some cases verification by examination of the genitalia would be prudent.

In New Jersey, adults of the northern metalmark commonly wander into adjacent fens from adjacent hillside habitats. Therefore, where both species could occur, habitat alone is not a sure way of separating northern metalmark adults from swamp metalmarks. We recommend taking a voucher specimen for newly found occurrences of either of these metalmarks, but both species should be collected sparingly, especially females.

Figure 159. Northern metalmark (*Calephelis borealis*) upperside male from Allegany County, Maryland (Marc Minno photo).

Figure 160. Northern metalmark (*Calephelis borealis*) underside male from Centre County, Pennsylvania (Marc Minno photo).

The caterpillars are pale green, slug-shaped, and covered with long hairs (Figure 161). They are also illustrated by Allen *et al.* (2005). No similar caterpillars are likely to be found on the food plant.

RANGE

This species occurs in three major population clusters with a few outliers:

- The limestone belt from northwestern Connecticut and adjacent New York to northwestern New Jersey.
- The mountains from central Pennsylvania through western Maryland, West Virginia and Kentucky, including a bit of Virginia, then northward in the Ohio Valley of Ohio-Indiana.
- The Ozark region mainly in Missouri.

Figure 161. Northern metalmark (*Calephelis borealis*) larva from Fairfield County, Connecticut (David Wagner photo).

Opler and Malikul (1992) show the range extending into Arkansas and Oklahoma. Published information (Iftner *et al.* 1992) suggests that Ohio may be a stronghold for the northern metalmark. However, there seems to be uncertainty now, since the current state rank (as of March 2008) is S1S3. There is a single specimen of the northern metalmark at the University of California, Davis collected by Arthur Shapiro at Lima, Delaware County, Pennsylvania, on 19 July 1965 (*fide* David Wright). Other records from nearby counties are recorded in Shapiro (1966).

RARITY

NatureServe global rank: G3G4; Xerces Society rank: Imperiled.

This butterfly often occurs in clusters of small local colonies, although movements between the small habitat patches appear to be rare. State ranks include S2S3 for New Jersey, Virginia, and Kentucky, suggesting that these states are now its strongholds.

Despite the small numbers usually seen, the well-known Springdale, New Jersey population was still extant in the 1990s after a century of visits by butterfly collectors. With much of the original habitat now converted to lawn or overgrown with saplings, this colony appears to have died out (Anthony McBride). There are unpublished population studies in New Jersey (The Nature Conservancy) and Connecticut (David Norris).

This butterfly has declined substantially in some parts of the range, such as eastern Pennsylvania. If colonies are mostly as tiny and isolated as they appear to be based on casual observation, then most of them are probably not viable.

We are not sure to what extent populations in West Virginia and Maryland recovered from large-scale Dimilin® applications in the late 1980s and 1990s.

Colonies on protected lands in New Jersey now appear to be stable, and new ones are occasionally being found (Anthony McBride personal communication with Dale Schweitzer in 2005). A population was discovered in nearby Dutchess County, New York, in 2007, over 140 years since the species was described from nearby Orange County (Utter and Wallace 2008).

Life history

There are two broods, one in late May to June, and the other in mid-August in southwestern Missouri (Scott 1986). In the rest of the range, there is just one brood, with adults appearing from late June to mid-July and are finished by the end of July.

Adults have been found from 13 June to 31 July in Ohio (Iftner *et al.* 1992) which probably includes both the earliest and latest dates for single-brooded populations. The corresponding larval stage would be from about mid-July to early June.

Utter and Wallace (2008) found adults in New York from 12-22 July. They start earlier than 12 July in most years in New Jersey.

Hibernation probably occurs in the larval stage, under the basal rosettes of the food plant, perhaps a bit into the soil. Scott (1986) indicates that, in the 5th or 6th instar larvae (out of eight or nine) hibernate. However, recent observations by David Norris in Connecticut indicate that hibernation occurs in younger larvae. Adults are often seen on flowers such as black-eyed Susans (*Rudbeckia hirta*), daisies (*Chrysanthemum majus*), and orange milkweed (also known as butterflyweed) (*Asclepias tuberosa*). Utter and Wallace (2008) also report mountain mint (*Pycnanthemum* species).

Adult northern metalmarks commonly rest with their wings open on the underside of leaves. In New Jersey, Dale Schweitzer has found them rather readily in inclement weather by jarring shrubs and small trees in the habitat and edges of adjacent fens. When disturbed, the orange and silver undersides appear to have a startling or distractive function like underwing moths (*Catocala* species). Active adults often perch on flowers.

Host plants

The larval host is roundleaf ragwort (*Pakera obovatus*, formerly *Senecio obovatus*), an herb in the aster family (Asteraceae). As far as we know, no colony has been found associated with golden ragwort (*Pakera aurea*), but Shapiro's collection on a serpentine barren at Lima, Pennsylvania suggests Small's ragwort (*Pakera anonyma*) may be a food plant.

Habitat

Northern metalmarks occur in mesic to dry open woodlands or openings within more heavily wooded areas. Openings may be natural outcrops such as shale or serpentine barrens, limestone or cedar glades, or artificial openings like powerline right-of-ways.

The Dutchess County, New York, site is described as an open glade on calcareous soil with red cedars and shrubs at the edges (Utter and Wallace 2008), similar to a few New Jersey sites. Adults sometimes disperse along powerlines and roadsides. It is suspected that they also move through forest habitats, but this is not known.

Critical resources are abundant larval food plant, afternoon sunlight, and, according to Utter and Wallace (2008), nectar plants. At least in New Jersey, habitats are often adjacent to wetlands (especially fens), which may be important nectaring areas. The food plant typically grows on limestone and shale ridges and shale barrens.

Iftner *et al.* (1992) note that northern metalmarks are usually found on southeast facing slopes in Ohio. The major serpentine barrens in southeastern Pennsylvania and adjacent Maryland were checked in the 1970s–1990s by Dale Schweitzer, David Wright, and others, but no colonies of the northern metalmark were found. The Lima record mentioned above is the only such occurrence that we can verify. At least in the Connecticut-New Jersey portion of the range, most of the seemingly suitable sites with the food plant do not have this butterfly, but we can only guess as to the reasons.

Threats & management issues

Problems for the northern metalmark include habitat change, development, encroachment by invasive exotics, isolation of small colonies, elimination of summer nectar sources by deer herbivory, spraying for gypsy moths, fire management, and possibly logging.

The Dutchess County, New York colony is threatened by change in the habitat from open meadow to forest, as well as by development. In Connecticut, colonies have declined or disappeared due to succession also, as well as limestone quarrying. Populations in Connecticut also suffer from elimination of their food plant and nectar sources by invasive shrubs and vines. In New York, the species is threatened by encroachment of invasive plants such as autumn olive (*Elaeagnus umbellata*) and tartarian honeysuckle (*Lonicera tartarica*) (Utter and Wallace 2008). In New Jersey, even on public lands and preserves, the northern metalmark is declining because its habitats are becoming smaller and more isolated. Populations do fluctuate, and small, isolated colonies are likely to eventually die out.

Deer do not seem to prefer the leaves of the food plant, but where their populations are excessive they appear to be eating many of the flowers, and thus threaten the continued existence of the food plant. In New Jersey, where deer are overly-abundant, they sometimes eliminate most of the summer nectar plants by repeated browsing.

Spraying for gypsy moths is also an issue, because the entire population would be in the larval stage at spray time. The sensitivity of larvae to *Btk* is not known, and this could vary substantially with instar.

No stage is protected from fire, and refugia would be needed. However, the somewhat succulent leaves of the food plant might sometimes provide sufficient insulation to allow some survival in very light burns.

The impacts of logging on this species would be worth studying. Selective cutting is being used in Connecticut to open up additional habitat in densely forested areas adjacent to colonies.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), dos Passos (1936), Glassberg (1993, 1999), Holland (1898), Howe (1975), Iftner *et al.* (1992), Klots (1951), McAlpine (1971), Marks (2010), Opler (1985), Opler and Krizek (1984), Opler and Malikul (1992), Randle (1953), Scott (1986), Shapiro (1974), Tietz (1952), Utter and Wallace (2008).

Family Nymphalidae (brushfooted butterflies)

Subfamily Nymphalinae (brushfoots)

Seminole Texan crescent

Anthanassa texana seminole (Skinner)

Identification

This medium (35 to 43 mm) butterfly is black with yellow spots (Figure 162 and 163). There are no similar species in the southeastern United States.

Figure 162. Seminole Texan crescent (*Anthanassa texana seminole*) upperside male from Alachua County, Florida (Marc Minno photo)

Figure 163. Seminole Texan crescent (*Anthanassa texana seminole*) underside male from Alachua County, Florida (Marc Minno photo).

The larvae are black with white along the sides and rows of branching spines (Figure 164, Allen *et al.* 2005, Minno *et al.* 2005, Ross 2005).

Figure 164. Seminole Texan crescent (*Anthanassa texana seminole*) larva from Jackson County, Florida (Marc Minno photo).

Taxonomic notes

This butterfly is currently treated as a subspecies of *Anthanassa texana*, but studies are needed to determine whether it is actually a separate species. The typical subspecies not only looks somewhat different than the Seminole Texan crescent, but it also prefers more open habitats.

Range

The Seminole Texan crescent is found from southern Louisiana eastward, and southward to east-central Florida (Daytona Beach), and northward along the Atlantic coast barely into North Carolina (LeGrand and Howard Butterflies of North Carolina website). The nominate subspecies occurs farther west.

Rarity

NatureServe global rank: G5T3T4. State ranks are S2S4 or S2S3 in the core range. This is a very locally distributed butterfly. In Florida it is widely distributed in the Panhandle, and it may be common at times where it does occur.

Life history

In northern Florida, this butterfly has three generations per year, with adults present from late April to early June, July through early August, and September through late November.

The eggs are laid in large, evenly spaced groups on the undersides of the host leaves. The larvae feed together in a web while young, but become more solitary as they mature. The adults perch on low plants and visit flowers such as Spanish needles (*Bidens alba*) for nectar.

Host plants

The larvae eat looseflower waterwillow (*Justicia ovata*), an herb in the acanthus family (Acanthaceae), and probably other *Justicia* species.

Habitat

The Seminole Texan crescent occurs at the edges of hardwood and cypress swamps and in bottomland forests along rivers, streams, and large lakes. It occasionally occurs in more open habitats.

Threats & management issues

The most significant management issue may be clearcutting of its habitat. While the larval host plant would likely grow well after clearcutting, this is a forest butterfly that apparently requires some shade.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Minno *et al.* (2005), Ogard and Bright (2010), Opler and Krizek (1984), Opler and Malikul (1992), Ross (2005), Scott (1986), Watts and Habeck (1991).

Gorgone checkerspot (Southeastern populations)

Chlosyne gorgone (Hübner)

Identification

This is a medium-sized (32 to 40 mm), orange butterfly with black markings (Figure 165-167). The underside wing pattern is diagnostic for this species. The silvery checkerspot (*Chlosyne nycteis*) is similar above only. Adults from the Georgia-South Carolina Sand Hills, as illustrated by Gatrelle (1998a), tend to be darker and more boldly marked than other populations (Klots 1951, Gatrelle 1998, 2001). They also supposedly lack a white "pupil" in the eyespot in cell M3 on the underside of the hindwing, and have the white chevrons along the margin reduced. However, in the specimen we illustrate here (Figure 167), the chevrons are strong and the white pupil is present. Some Midwestern specimens lack the pupil, as seen in the example illustrated by Glassberg (1999) from Arkansas. The caterpillars of *Chlosyne gorgone* are black with white variegation along the sides (Figure 168, Allen *et al.* 2005).

Figure 165. Gorgone checkerspot (*Chlosyne gorgone*) upperside male from Bartow County, Georgia (Marc Minno photo).

Figure 166. Gorgone checkerspot (*Chlosyne gorgone gorgone*) in the strictest sense) upperside female from Burke County, Georgia (Marc Minno photo).

Figure 167. Gorgone checkerspot (*Chlosyne gorgone gorgone*) in the strictest sense) underside female from Burke County, Georgia (Marc Minno photo).

Figure 168. Gorgone checkerspot (*Chlosyne gorgone carlota*) larva from Sheridan County, Nebraska (Tom Allen photo).

Taxonomic notes

The subspecific taxonomy of this species is confused. Klots (1951) and Gatrelle (1998, 2001a) restricted the name *Chlosyne gorgone gorgone* to populations in the Georgia and South Carolina Sand Hills region. Gatrelle identified specimens from Oconee County, South Carolina, as the western subspecies, *Chlosyne gorgone carlota*. Klots (1951) considered mountain populations in adjacent northern Georgia to be intergrades between the two subspecies. Furthermore, Gatrelle (2001c) reports newly discovered populations in the North Carolina mountains that he considered to be neither of these subspecies. Harris (1972, Plate 7) also illustrates several northern Georgia specimens.

We doubt that this western Carolina and Georgia population cluster includes three subspecies. However, southeastern populations of this butterfly may or may not prove to be taxonomically distinct from what is now called *Chlosyne gorgone carlota*, and within these there may be some clinal north to south variation. A more critical analysis of specimens from Georgia and the Carolinas would be very useful. Even if taken together, however, the entire cluster appears to be of conservation concern. Therefore, we provide this account and leave the subspecific taxonomy to others.

Some authors (Miller and Brown 1981) place this species in the genus *Charidryas*. The name *Melitaea ismeria* Boisduval and LeConte probably also applied to *Chlosyne gorgone*, but that ambiguous name was recently suppressed by the International Commission on Zoological Nomenclature.

This is one of very few cases among eastern United States butterflies where a subspecies is claimed to show substantial ecological differences. Other populations of this species have two or more broods even as far north as Wisconsin (Glassberg 1999), and there are several generations in Texas. Yet, *Chlosyne gorgone* reportedly has only one brood in the Georgia and South Carolina Sand Hills. Furthermore, we note that Gatrelle's (2001) "unique" population in western North Carolina has so far been observed only in spring (see also LeGrand and Howard Butterflies of North Carolina website). Among the Georgia records cited in Harris (1972), 21 of 24 mountain and Piedmont specimens were collected in April or May, with only three in June and July, suggesting that the entire southeastern population cluster may be essentially univoltine, not just those in the Sand Hills as suggested by Gatrelle.

Range

The known recent range of the various southeastern populations of this species extends from southwestern North Carolina and northern South Carolina southward through much of Georgia and possibly into adjacent Alabama. This species has not been found in recent inventory efforts in Great Smoky Mountains National Park. Gatrelle (1998a, 2001) would restrict the taxon *Chlosyne gorgone gorgone* to Sand Hills populations in South Carolina and Georgia. Indeed, a Sand Hills population was extant in April of 1993 and 1994 in Orangeburg County, South Carolina. There were also collections about 200 years earlier in Burke or adjacent Screven County, Georgia (Klots 1951, Harris 1972). The main permanent range of *Chlosyne gorgone,* as mapped by Glassberg (1999) and Brock and Kaufman (2003), apparently does not extend east of the Mississippi River below central Illinois, although a few specimens have been collected in most states from New York (Shapiro 1974) to Kentucky (Covell 1999).

Rarity

By Gatrelle's circumscription, *Chlosyne gorgone gorgone* might be the rarest butterfly in the eastern United States, assuming it is not extinct. By a more inclusive definition, as used above, a rank of G5T2T3Q seems appropriate for the southeastern segregate.

Life history

Midwestern populations of this species at similar latitudes have three or four broods. However, *Chlosyne gorgone gorgone,* in the strict sense of Gatrelle and Klots, has only one generation per year. Gatrelle (1998) suggested that these Sand Hill populations became univoltine due to lack of nectar in the habitat for potential later broods, especially the brood that would be expected in June through July. Mouse-ear tickseed (*Coreopsis auriculata*) is the primary nectar source in spring.

We note though that a disjunct, now possibly extinct, population cluster of *Chlosyne nycteis* from northern New Jersey, the New York City area, and Connecticut, which used the same food plant that *Chlosyne gorgone* uses in Georgia and South Carolina, was also univoltine (Smith 1910, Gochfeld and Burger 1997, O'Donnell *et al*. 2007). Populations of *Chlosyne nycteis* that use other food plants such as *Verbesina* species at similar latitudes in Ohio and westward are bivoltine (Iftner et al. 1992). So univoltinism may be an adaptation to the larval food plant.

Most observations and specimens from Georgia and the Carolinas have been in April and May. This would imply that larvae feed through much of May and usually enter diapause in late May or June, resuming feeding in about March of the following year. At least in northern Georgia, a few continue to grow and produce adults in June and July.

Eggs are laid in clusters on the leaves of the host plant. The larvae live together in a web of silk when young, but become more solitary in later instars.

Host plants

The food plant of the southernmost populations is woodland sunflower (*Helianthus divaricatus*) (Gatrelle 1998), an herb in the aster family (Asteraceae). Other *Helianthus* species may be used in the Carolinas and Georgia as well. More western populations will use sunflowers and various species of closely-related genera.

Habitat

Sand Hill populations occur in longleaf pine-turkey oak woodland. In Georgia and the Carolinas, additional observations of the species occurred in various openings and edges, along wooded roadsides, and in powerline right-of-ways up to 3,600 feet (1097 m) elevation (Harris 1972, LeGrand and Howard Butterflies of North Carolina website).

Threats & management issues

The greatest threat to the gorgone checkerspot is from habitat destruction for agriculture, forestry, and second homes. Threats appear to be exceptionally high and likely to increase in the Sand Hills.

Some habitats are fire-dependent, and too much or too little prescribed fire could eliminate this butterfly.

Gypsy moth spraying is probably a threat, because pesticide applications would be likely to occur before overwintered larvae complete feeding. It is unknown how lethal *Btk* would be to late instars.

We do not know if deer are presently a threat, but they readily eat the food plant, *Helianthus divaricatus*. Deer are suspected as a factor in the demise of *Chlosyne nycteis* populations that fed on *Helianthus divaricatus* and *Helianthus strumosus* in New Jersey. In addition to severely browsing the food plant, deer could also eliminate critical nectar flowers.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Covell (1999), Glassberg (1999), Holland (1898), Howe (1975), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Metzler *et al.* (2005), Ogard and Bright (2010), Opler and Krizek (1984), Opler and Malikul (1992), Scott (1986), Shapiro (1974).

Tawny crescent (Northeastern and Appalachian populations)

Phyciodes batesii batesii (Reakirt)

Phyciodes batesii maconensis Gatrelle

Identification

This medium-sized (33 to 40 mm) butterfly is similar to the pearl crescent (*Phyciodes tharos*) and the northern pearl crescent (*Phyciodes coctya*). However, the antennal tips are usually black and white rather than orange, and the markings on the underside of the hindwings are usually reduced (Figure 169-171). Interestingly, the illustrations of *Phyciodes batesii* in Glassberg (1993) appear to show orange antennal tips on otherwise normal-looking individuals stated to be from a classic *Phyciodes batesii* locality. On the underside of the forewings the black patch on the inner margin (often not visible in the field) is larger than the subapical patch on the costa. The underside of the hindwing of males and many females is rather plain yellowish tan with little pat-

Figure 169. Tawny crescent (*Phyciodes batesii maconensis*) upperside male from Macon County, North Carolina (Marc Minno photo).

Figure 170. Tawny crescent (*Phyciodes batesii maconensis*) underside male from Macon County, North Carolina (Marc Minno photo).

Figure 171. Tawny crescent (*Phyciodes batesii maconensis*) upperside female from Clay County, North Carolina (Marc Minno photo).

Figure 172. Tawny crescent (*Phyciodes batesii)* larva from North Carolina (Tom Allen photo).

tern at the margin, but usually with a weak crescent spot and a small accompanying dark patch. Such specimens should not pose identification problems in our area. Some females have more brown on the underside of the hindwing, and are nearly identical to the northern pearl crescent It is likely that these can be separated from that species only if their antennal clubs clearly lack orange. Males of *Phyciodes batesii* can be reliably identified by genitalia (Scott 1986, 1994). We recommend that occurrences be vouchered with one or more male specimens, or in exceptional circumstances, good images of the undersides of the wings.

Gatrelle (1998b and 2004) illustrates a number of adults showing some of the variation. Opler and Malikul (1992) show a male with unusually reduced maculation on the hindwing beneath. Other adult illustrations are found in Klots (1951), Glassberg (1993, 1999), and most other eastern butterfly guides. Allen (1997) illustrates the larva. In at least New York and New England some mid and late 20th century collectors recognized local populations of *Phyciodes cocyta* as different from the more common *Phyciodes tharos* and assumed they were *Phyciodes batesii*, since no other species had been recognized.

Subspecies *Phyciodes batesii maconensis* (Gatrelle 1998) is larger and has reduced black markings on the underside of the forewing. All known male specimens lack any brown patch or crescent spot on the hindwing, leaving the underside of the hindwing nearly plain yellowish tan with a faint row of postmedian dots. The crescent spot is faint to absent on females. Unlike northern *Phyciodes batesii* populations, any individual of *Phyciodes batesii maconensis* can probably be identified to species from a good image that shows the underside. *Phyciodes batesii* from further north are more variable, and some specimens, such as that shown by Opler and Malikul (1992) from Quebec, resemble the less variable *Phyciodes batesii maconensis* more than others.

The caterpillar is brown and with branching spines (Figure 172).

Taxonomic notes

Five subspecies of *Phyciodes batesii* have been described in addition to the typical one (Pelham 2008). Populations from the northeastern United States, Quebec, and a few from eastern Ontario were *Phyciodes batesii batesii*. There is confusion about whether Winchester, Virginia (Scott

1994) or Gloucester, New Jersey (Klots 1951) is the type locality, but the identity of *Phyciodes batesii batesii* is the same for either location.

Phyciodes batesii lakota (Scott 1994) is the widespread Canadian and upper Midwest subspecies which Gatrelle (1998b, 2005) included within *Phyciodes batesii batesii*. While it is useful to discuss them separately here, we do not necessarily consider *Phyciodes batesii batesii* and *Phyciodes batesii lakota* to be distinct. *Phyciodes batesii maconensis* Gatrelle (1998) is a more distinctive, larger, and apparently disjunct high-elevation southern subspecies. Even the females are easily identified to species by the greatly reduced pattern on the ventral hindwing. Gatrelle (2000) treated *Phyciodes batesii maconensis* as a full species based on mitochondrial DNA, but subsequently reverted back to the original subspecies status (Gatrelle 2004). The number of species in this genus in the East is still uncertain and might be as many as four. We agree with Pelham's (2008) treatment of *Phyciodes incognitus* as a subspecies of *Phyciodes cocyta*.

RANGE

Phyciodes batesii lakota is widespread in western Canada and survives (although it may be somewhat uncommon), as far southeast as Michigan (Gatrelle 1998, 2005). A few populations near Ottawa, Ontario appear to be intermediate between this subspecies and the more eastern *Phyciodes batesii batesii*. In our coverage area, *Phyciodes batesii lakota* occurs in Wisconsin and Michigan.

Phyciodes batesii batesii was collected at Norway, Maine (a 19th century specimen in the Yale Peabody Museum), but nowhere else in New England. It also occurred in extreme southern Quebec (Handfield 1999) and adjacent eastern Ontario (west at least to Lambton County), much of New York (Shapiro 1974), southward through central and eastern Pennsylvania to Winchester, Virginia and Coalburgh, and West Virginia (Gatrelle 2004). One of the syntypes was collected in southern New Jersey. Both Gatrelle (1998) and David Wright (personal communication with Dale Schweitzer) have verified a specimen at the University of California, Davis, collected by Arthur Shapiro on 23 June 1965, at Wissahickon, in Philadelphia, Pennsylvania. Wissahickon is near the Fall Line, about 25 km west of Gloucester City where a syntype was collected about 100 years earlier. Based on examination of more than 35 collections, this appears to be the only verifiable record for southeastern Pennsylvania (David Wright personal communication with Dale Schweitzer). Yet, Glassberg (1993) claimed that this species persisted elsewhere in Philadelphia until at least 1980. There are no other known specimens from New Jersey aside from the syntype (Iftner and Wright 1996). However, Smith (1910) and Shapiro (1966) reported *Phyciodes batesii* in that state.

In addition, we tentatively place specimens of *Phyciodes batesii* from Giles and Bedford counties, Virginia (Clark and Clark 1951) (both now at the National Museum of Natural History), into subspecies *batesii*. In addition, we presume that one we have not seen from nearby Kentucky (Covell 1999), is also *Phyciodes batesii batesii*. On the two Virginia specimens, the hindwings are rather striate beneath. Also, the black markings on the ventral forewing of the female illustrated by Clark and Clark (1951, Plate 11) from Bedford County, Virginia are not reduced like most *Phyciodes batesii maconensis*. The Giles County specimen is relatively large, but we did not measure it.

Phyciodes batesii maconensis Gatrelle (1998b and 2004) is found mostly above 4,000 feet (1,212 m), in Macon, Swain, Clay, and Buncombe counties in western North Carolina, in adjacent Tennessee (Great Smoky Mountains National Park), and in Rabun County, Georgia. There are also reports of this butterfly from Graham, Haywood, and Jackson counties, North Carolina. If our placement of all Virginia and Kentucky specimens as *Phyciodes batesii batesii* is correct, there is no evidence that the ranges of *Phyciodes batesii batesii* and *Phyciodes batesii maconensis* were ever contiguous, but the decline of *Phyciodes batesii batesii* was underway before 1900, so a past cline cannot be ruled out.

Rarity

NatureServe global rank: G4T1 for *Phyciodes batesii batesii*, G4T2T3 for *Phyciodes batesii maconensis*, and G4T4 for *Phyciodes batesii lakota*. The rarity rank for *Phyciodes batesii batesii* is based upon Scott's circumscription of *Phyciodes batesii lakota*. The T1 refers to the Ottawa area blend zone populations. In the strict sense, *Phyciodes batesii batesii* may be extinct (which would be designated as TX). *Phyciodes batesii batesii* was always rare in the northeastern United States, except perhaps in New York, based on the rarity of specimens in collections. Furthermore, some records were incorrect, in part due to confusion with *Phyciodes cocyta*, which has only recently been recognized as a species. The last collections in Maine, New Jersey, and West Virginia were from before 1900. The only known 20th century Virginia specimens were collected in 1938 and 1940, whereas the only Kentucky specimen was collected in 1977. There have been no verifiable reports in the United States since the 1970s or in Canada since the 1990s, except for blend zone populations near Ottawa, Ontario. Substantial efforts were made by the Natural Heritage Program staff and others to check New York alvars in the 1990s, but no colonies were found, and the classic Jamestown colony is extirpated.

Regardless of subspecies issues, the species *Phyciodes batesii* in our coverage area is known extant in the mountains of southwestern North Carolina, Georgia, and Tennessee, at a few sites in Michigan, and more widely in northern and central Wisconsin.

The reasons for the decline of eastern populations of this species are poorly understood. Habitat loss and fragmentation seem unlikely as a full explanation. Given that the last collections in New England, New Jersey and West Virginia were in the 1860s to 1880s, it appears the decline was already underway in the 19th century. The possibility that the decline of *Phyciodes batesii* coincided with an increase of *Phyciodes tharos* in Ontario (and perhaps more generally) should be evaluated based on specimens of *Phyciodes tharos* and *Phyciodes cocyta* in collections. It may be possible to reconstruct the ranges of *Phyciodes tharos* and *Phyciodes cocyta* in upstate New York when *Phyciodes batesii* was still found there, as indicated by extant specimens, and compare these ranges to the present ones.

Overly abundant deer were a factor in the final extirpation of this butterfly in Lambton County, Ontario. This was especially evident at Pinery Provincial Park, one of the last places *Phyciodes batesii batesii* was collected (Allen 1997, Plate 15 and Dale Schweitzer observation). The Park habitats were eliminated by 1993 due to extreme herbivory. However, deer could not be the explanation for most of the earlier declines in the United States. It appears that the butterfly had disappeared long before gypsy moths arrived in its range and while deer were very scarce. The food plant remains common.

Phyciodes batesii maconensis is known from fewer than ten counties in North Carolina and Georgia. This subspecies seems to be local, but can be rather numerous where it occurs. However, considering the unexplained extinction of other eastern populations and threats from gypsy moth spraying, we do not consider this subspecies to be secure. As Gatrelle (1998) pointed out, there is considerable unexplored habitat, but it is unknown how much is occupied. So far there are fewer than two dozen documented localities.

Life history

Adults of *Phyciodes batesii batesii* occurred mostly in June. The larvae usually diapaused in the third instar (Allen 1997) until spring, when development was completed. Adults sometimes occurred in late July in Michigan and Lambton County, Ontario (two collected by Dale Schweitzer in 1984). Allen (1997) illustrates adults from the latter population.

Phyciodes batesii maconensis has one brood with collection dates ranging from 10 May to 28 June (Gatrelle 1998, 2001). The actual flight season is not likely to last a month in any given year. LeGrand and Howard (Butterflies of North Carolina website) indicate the season has shifted earlier in recent years. Adults now start flying in early to mid-May and disappear by early June. Gatrelle reared this butterfly from eggs. His larvae fed into mid- or late summer, diapaused, and then completed feeding in late April and early May.

Host plants

The only documented natural food plant for *Phyciodes batesii* is wavyleaf aster (*Symphyotrichum undulatum*, formerly *Aster undulatus*), a common woodland aster (Asteraceae) with blue flowers.

Habitat

Phyciodes batesii batesii was found mostly below 1,000 feet elevation (300 m), although some colonies in Pennsylvania were probably surviving at higher elevations. Habitats included old clearings, fields and pastures in wooded terrain, rocky riparian slopes, shale barrens, oak savannas, oak woodlands, alvar grasslands, and even pine barrens (Maine, New York). Habitats were within generally wooded areas, and substrates included limestone, shale, sand, and perhaps others. *Phyciodes batesii maconensis* is more of a forest butterfly than other *Phyciodes batesii* subspecies. Gatrelle states that, while adults occur in small meadows, glades, balds, roadsides, and other high-elevation openings in forested areas, they also occur within the forests; this could refer to relatively open woodland or along dirt roads.

Threats & management issues

If *Phyciodes batesii batesii* or transitional populations still exist in Ontario, overly abundant deer, prescribed burning on alvars, succession, development, and gypsy moth spraying would be among the management issues. As with almost any butterfly, unburned habitat refugia would be needed to protect colonies of the butterfly.

The issues are more or less similar for *Phyciodes batesii maconensis*, but loss of habitat to development is the main threat now. Private lands within the documented range are subject to increasing residential and second home development. The type locality for *Phyciodes batesii maconensis* has already been largely developed (Ron Gatrelle letter to Dale Schweitzer).

Gypsy moth spraying is an issue, but gypsy moth outbreaks themselves should pose little threat or could even benefit the food plant by increasing light on the forest floor. The U.S. Forest Service sponsored surveys and attempted to protect known occurrences of *Phyciodes batesii maconensis* from *Btk* applications during the recent Asian Gypsy Moth Eradication project (Hall *et al.* 1999) in Highlands, North Carolina. While it is not known whether late instars would be sensitive to *Btk*, they would usually be exposed, and should be presumed sensitive unless documented otherwise. Some of the habitats may be vulnerable to succession, but we cannot recommend appropriate management practices at this time given our lack of familiarity with these sites.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Brower (1974), Catling (1997), Cech and Tudor (2005), Clark and Clark (1951), Gatrelle (1998a, 2000), Glassberg (1993, 1999), Holland (1898), Howe (1975), Iftner and Wright (1996), Irwin and Downey (1973), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), McDunnough (1920), Opler (1985), Opler and Krizek (1984), Opler and Malikul (1992), Pague and Schweitzer (1991), Scott (1986, 1994), Shapiro (1966, 1974), Tietz (1952, 1972), Wahlberg *et al.* (2003).

Green comma (Appalachian populations)

Polygonia faunus smythi A. H. Clark

Identification

Adults of *Polygonia faunus smythi* can be separated from all other species of the genus by their more scalloped wing margins and the two rows of greenish chevrons visible near the hindwing margins beneath, some of which are prominent (Figure 173 and 174). Some blue-green banding may be visible near the margins on the underside. There are small yellow spots near the wing borders above, which are prominent at least on the hindwings. The dark spots on the hind-

Figure 173. Green comma (*Polygonia faunus smythi*) upperside male from Cooper's Creek Recreation Area, Union/Fannin county line, Georgia (James K. Adams photo).

Figure 174. Green comma (*Polygonia faunus smythi*) underside male from Cooper's Creek Recreation Area, Union/Fannin county line, Georgia (James K. Adams photo).

wing tend to be large and clearly visible in the orange background. The more common eastern comma (*Polygonia comma*) differs in having violet edges to the wings on the upper side, which *Polygonia faunus smythi* lacks. The violet wing edges are especially apparent in the winter form of the eastern comma. The whitish comma mark on the underside of the hindwing of the green comma is often (but not reliably) much smaller and not as hooked on the green comma as it is on the eastern comma (*Polygonia comma*). The gray comma (*Polygonia progne*) has more uniformly dark-gray, striated wings beneath, and much more black on the upperside of the hindwing. Sight records should no longer be accepted for this rare subspecies, but good images should be identifiable.

The larva of the green comma has rows of branching spines. Somewhat differing descriptions of the color pattern can be found in Opler and Krizek (1984) and Scott (1986).

Range

This disjunct southern Appalachian subspecies occurs in the mountains of northeastern West Virginia, and from southwestern Virginia and eastern Kentucky through western North Carolina and eastern Tennessee to extreme northern Georgia. There were also three isolated collections (year not stated) far out of range in the Ohio Valley of Meade County, Kentucky, that Covell (1999) attributed to subspecies *Polygonia faunus smythi*. The current range of *Polygonia faunus faunus* is primarily from northern New England and across Canada. In our region, *Polygonia faunus faunus* occurs south into northern Wisconsin and northern New York. Historically, *Polygonia faunus faunus* occurred sporadically farther south into Pennsylvania, and according to Farquhar (1934), across northern Massachusetts. *Polygonia faunus faunus and Polygonia faunus smythi* probably have not been in genetic contact in recent times. There are several other western subspecies of *Polygonia faunus* (Pelham 2008).

Rarity

NatureServe rank: G5T3.

Polybonia faunus smythi was apparently not a rare butterfly in its core range in the Appalachian region at least through the early 1970s. Clark and Clark (1951) considered it to be generally common where found. Adults were occasionally numerous even more recently, such as in Randolph County, West Virginia, in July 1968 (Dale Schweitzer observation) near its northern limit. Occasionally in the 1950s and 1960s *Polygonia faunus smythi* was found to be common in northern Georgia at the southern limit (Harris 1972). James Adams informs us that this butterfly still turns up in Georgia.

Otherwise, in the last decade or two, *Polygonia faunus smythi* has seldom been encountered, and only in small numbers (for example, Allen 1997, LeGrand and Howard Butterflies of North Carolina website, Covell 1999). There do not appear to be recent records for this species in Kentucky, where Covell (1999) refers to this subspecies as very rare. There are records from only four counties in West Virginia, but it may not occur in all of them now. There are confirmed records within the last 20 years for only four of the ten North Carolina counties from which *Polygonia faunus smythi* is known.

State ranks as of July 2008 include SH for Kentucky, S1 for West Virginia, and S2 for North Carolina. The current status in Virginia is not known (Steve Roble), and the rank of S3 for Virginia needs to be reconsidered. The green comma has not been encountered over the course of the All Taxa Biological Inventory in Great Smoky Mountains National Park, where the species was once common. Several individuals were photographed in Yancey County, North Carolina in 2008 and 2009, and their images appear online in LeGrand and Howard (Butterflies of North Carolina website).

We do not know why this butterfly has declined. In North Carolina, Fraser firs were killed off by exotic adelgids beginning in the 1970s, altering habitats. This may have been a factor in North Carolina, but not in West Virginia or at most Virginia localities which had spruce but lacked the Fraser fir. Southward, we are not sure how closely the decline of this butterfly corresponded with that of Fraser fir during the 1970s and 1980s, but *Polygonia faunus smythi* was apparently rare by about 1990. Mature Fraser firs were still abundant over vast areas in the early 1970s, when Dale Schweitzer observed *Polygonia faunus smythi* among them on Mt. Mitchell and at Richland Balsam. However, we note that some observations of this butterfly are from lower elevations than those where spruce and fir grow.

Some impact from the parasitoid, *Compsilura concinnata*, cannot be ruled out. However, as far as we know other species affected by the parasitoid, such as *Eacles imperialis*, *Citheronia* spp., or *Datana* spp., have not experienced population crashes in the range of *Polygonia faunus smythi*. With no other likely *Compsilura*-related impacts observed in the range, parasitism by this fly seems unlikely as a major factor in the decline of *Polygonia faunus smythi*. Furthermore, the decline of *Polygonia faunus smythi* pre-dated gypsy moth outbreaks as well as possible resultant high Compsilura densities and spraying in most, and probably all, of the range.

We do not know whether climate change was a likely factor.

Life history

While some authors have claimed that this butterfly has two broods, other populations of this species have only one brood, so we believe Allen (1997) is probably correct that *Polygonia faunus smythi* is single-brooded as well. Adults emerge mostly from about the end of June into August, and are seen into October. They reappear during the following spring when they mate and lay eggs. They apparently persist well into or throughout May. Adults may become inactive in late summer (Allen 1997), and remain so over the winter. Before the species became rare, July was a good month to see the green comma in West Virginia, North Carolina, and Georgia.

Adults occasionally visit flowers. They also sip water from moist soil and wet rocks in streams. Harris (1972) reports adults visiting carrion in Georgia. Like other *Polygonia,* they also feed at dung, and presumably also at sap flows and rotting fruit. Species of *Polygonia* and related genera come well to baits used to attract moths, and even better to rotting bananas. It is very likely that the use of such baits would increase the frequency of observations of this butterfly, and baiting would probably be a useful survey technique. It is possible that the adults might come to bait on warm winter days like some other *Polygonia* species frequently do elsewhere.

Host plants

The only confirmed larval food plant record for this subspecies is Gooseberry (*Ribes* sp.), noted by E. A. Smyth, for whom this butterfly was named. He reared five adults from caterpillars in his garden in Blacksburg, Virginia. Although this was reported by Clark (1937) when he described *Polygonia faunus smythi*, most recent literature omits this food plant, an exception being Opler and Krizek (1984). Birches are thought to be the preferred food plant for the species as a whole, as recorded in Klots (1951). Yellow and sweet (or black) birches (*Betula alleghaniensis* and *Betula lenta*, respectively) seem to be the most likely birches as food plants (see also LeGrand and Howard Butterflies of North Carolina website). The limited and similar distributions of both yellow birch and the green comma butterfly in West Virginia suggests that this tree is a primary food plant. Furthermore, David Wagner has found three larvae of *Polygonia faunus faunus* on this birch in New Hampshire. Klots (1951) reports sweet birch, but does not state which subspecies of the green comma uses it. Besides birches, *Polygonia faunus faunus* larvae have been reported from willows, alders, and blueberry.

Habitat

Adults have been observed or collected in cool, mid- and high-elevation Appalachian forests. The normal habitat for *Polygonia faunus smythi* is high-elevation northern hardwood forests containing spruce in West Virginia (Allen 1997) and Virginia, as well as spruce or Fraser-fir dominated (known as lashorn) forests (Clark and Clark 1951, Opler and Krizek 1984). The species has occasionally been observed in lower-elevation hardwood areas. LeGrand and Howard (Butterflies of North Carolina website) indicate hemlock/northern hardwood forests may be preferred in North Carolina, but there are few observations, and higher spruce-fir habitats are also used. Dale Schweitzer saw several *Polygonia faunus smythi* in Fraser fir forests in North Carolina in July 1971 and 1972. Bo Sullivan observed numerous adults near Brevard and flying at relatively low elevation with *Satyrium edwardsii* and *Speyeriia diana* along a Forest Service road through mesic/xeric forest.

Polygonia faunus faunus and the western subspecies are typically found in boreal or high-elevation montane (Canadian and Hudsonian Zone) conifer forests or in mixed northern hardwood/spruce forests (Klots 1951, Shapiro 1974, Scott 1986, Glassberg 1993, Layberry *et al.* 1998, Brock and Kaufman 2003) Adult *Polygonia* are powerful fliers and some species are migratory. *Polygonia faunus smythi* adults would be capable of easily making substantial altitudinal movements. Thus, in North Carolina populations, it is quite possible that the cooler, higher, spruce/fir forests are important, perhaps as summer habitats, at times during the adult life span, which can extend as long as 9 or 10 months.

In Georgia, *Polygonia faunus smythi* may not be as closely associated with fir as it is elsewhere. There is no native spruce in Georgia. Fraser fir is reported in only one of the three counties where the green comma is found (http://plants.usda.gov/java/county?state_name=Georgia&statefips=13&symbol=ABFR).

The green comma has often been seen along streams and on the boulders that emerge from the water. One can also encounter adults sipping moisture from dirt roads, in forest openings, and along paths in cool forests.

Threats & management issues

The cause of the decline of the green comma is unknown, so threats and management needs are difficult to assess. However, these probably include habitat and microclimatic changes due to mortality of Fraser firs and hemlocks caused by exotic adelgids, and recent climatic warming, at least southward.

None of the likely food plants have declined recently, and *Ribes* eradication efforts ended long before this butterfly became rare. It is possible that birches, ribes, or other possible food plants may even increase in places where large numbers of firs or hemlocks have been killed by adelgids.

With current practices, and given the habitats of this butterfly, gypsy moth and its control are unlikely to be threats now, except around campgrounds. Young larvae probably would be exposed if *Btk* were used for gypsy moth control in their habitats.

If somebody could develop a reliable way to find this species, surveys to better characterize the habitat and to evaluate the possibility of different seasonal habitats would be very useful in defining threats and improving management.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Clark (1937), Clark and Clark (1951), Covell (1999), Farquhar (1934), Glassberg (1993), Harris (1972), Klots (1951), Layberry *et al.* (1998), LeGrand and Howard (Butterflies of North Carolina website), Opler and Krizek (1984), Scott (1986), Shapiro (1974), Wright (1995).

Diana fritillary

Speyeria diana (Cramer)

Identification

This large (82 to 112 mm), beautiful butterfly has markedly distinct sexes (Figures 175-177). Males are bright orange with darker markings, but females are black with blue and resemble the pipevine swallowtail (*Battus philenor*). Unlike other eastern *Speyeria* species, the underside of the hindwing lacks silvery spots. This is arguably the most characteristic butterfly of the southern Appalachians.

The caterpillar is dark with branching spines that are red at the base (Figure 178), Allen (1997) and Allen *et al.* (2005).

Figure 175. Diana fritillary (*Speyeria diana*) upperside male from Montgomery County, Virginia (Marc Minno photo).

Figure 176. Diana fritillary (*Speyeria diana*) upperside female from Logan County, West Virginia (Marc Minno photo).

Figure 177. Diana fritillary (*Speyeria diana*) underside female from Logan County, West Virginia (Marc Minno photo).

Figure 178. Diana fritillary (*Speyeria diana*) larva from Union/ Fannin County Line, Georgia (David Wagner photo).

Range

The current range of the Diana fritillary is broken into two separate regions. In the eastern United States, this butterfly occurs in the Appalachian Mountains from the Virginias and Kentucky southward into north Georgia. It has also been reported from northeastern and central Alabama (Ogard and Bright 2010). In Missouri and Arkansas, it occurs in the Ozark and Ouachita mountains. The original range was much more continuous and included the Ohio Valley. Historically, there were also populations in southeastern Virginia and eastern North Carolina.

Rarity

NatureServe global rank: G3G4. Xerces Society rank: Vulnerable. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

The Diana fritillary is of concern in several national forests, at least westward. It is fairly widespread in Arkansas and its main Appalachian range (perhaps less so in West Virginia).

The Diana fritillary declined as its habitats were logged in the 19th and 20th centuries, but it has recovered to varying degrees in much of its core range. *Speyeria diana* is now very rare and sporadic or absent in some peripheral areas, and is probably no longer resident in Ohio, Indiana, Illinois, or along the Virginia-Carolina coastal plain. However, it could recolonize, especially in southern Ohio. The Diana fritillary no longer occurs in Pennsylvania or Maryland, but there is no real evidence that it was ever established in these states, nor in Louisiana. It is not actually imperiled in the Appalachians, although threats from gypsy moth spraying could resurface, and second-home development is claiming some of its habitat. Its abundance and distribution are very difficult to evaluate because adults are long-lived and are sometimes dispersive. Adults can be considerably more widespread in good years than in unfavorable ones, and it is the unfavorable years that determine the vulnerability of populations. It appears that there are presently dozens or perhaps hundreds of large occurrences centered in the southern Appalachians, as well as some substantial populations in the Ozarks and Ouachitas.

Life history

All *Speyeria* species are single-brooded, and their larvae feed on violets. Adult male Diana fritillaries appear in June throughout most of the range, but the females start emerging about two weeks later. Females probably mate soon after eclosion, but they do not lay eggs until late August or September. Males generally do not persist much past July.

The eggs hatch in the fall, but larvae do not feed until spring. Eggs are not usually laid directly on the host, but are laid in the vicinity.

The long-lived adults require an array of nectar flowers from about June to September, and some adults range widely to find them. Milkweeds (*Asclepias* species), ironweeds (*Vernonia* species), coneflowers (*Echinacea* species), joepyeweed (*Eupatorium fistulosum*), and other composites are often used. In North Carolina, Campbell *et al.* (2007) report adults nectaring on the flowers of sourwood (*Oxydendrum arboretum*), which is a small tree. Flower preferences vary regionally. For example, milkweeds are often used farther east, but they are not noted in the Arkansas study, and coneflowers are not usually available eastward, but joepyeweeds are probably used throughout the range. *Speyeria diana* adults also sip moisture from soil and scat.

Host plants

The larvae feed on violets (*Viola* species). Captive larvae will eat almost any species of violet, and as far as it is known all violets growing in forest understories are potential food plants.

Habitat

In most of the range, breeding habitat for the Diana fritillary is deciduous or mixed forest with violets in the understory. In Arkansas, breeding habitats also include oak woodlands and savannas. In most of the range, its habitats are generally mesic and below 3,500 feet (1,246 m) elevation. An example would be cove forests, but bottomlands are also used.

Adults forage for nectar in adjacent fields, grasslands, and other habitats, and along forest roads, although in the Appalachians and perhaps elsewhere they rarely wander more than a few dozen yards (or meters) from forests. Nectaring areas are an important part of the habitat. Eastward, roadside flowers may be important in heavily forested habitats. In Arkansas and elsewhere, breeding habitats and nectaring habitats may be quite different (Moran and Baldridge 2002).

Threats & management issues

Speyeria diana was included on the U.S. Fish and Wildlife Service C2 list primarily due to concerns about gypsy moth spraying, particularly the extensive *Btk* and Dimilin® spraying in the central Appalachians in the late 1980s and early 1990s. While this threat has not disappeared, current, more targeted applications would not be nearly as likely to eradicate Diana populations as those of earlier decades. Larvae of this species are highly sensitive to *Btk* (Peacock *et al.* 1998).

We cannot rule out some impact from parasitism by the introduced *Compsilura concinnata*, especially during or just after gypsy moth outbreaks. However, these flies hunt mostly in trees, and fritillary larvae feed near the ground. Gypsy moth larvae do not eat violets, but canopy defoliation would probably have an impact on violets and nectar plants for one season—and even longer if tree mortality occurred. This impact might be positive or negative.

Most eastern Diana fritillary breeding habitats are unlikely to burn, but some Arkansas habitats may require fire to persist (Campbell *et al.* 2007). In these cases, unburned refugia would be essential for larvae of this butterfly. Prescribed burning in prairie areas frequented by the adults can substantially improve nectar supply (Rudolph *et al.* 2006), and could also open up some marginal habitats making them more suitable for violets and therefore for breeding. Given the findings of Rudolph *et al.* (2006), the adequacy of nectar resources in heavily forested eastern habitats should be evaluated, and in some places prescribed burning might be useful for maintaining or creating openings for nectar flowers.

Campbell *et al.* (2007) report that mechanical thinning increases herbaceous cover, including violets, and that adults occur in thinned areas in North Carolina. Disturbances may be more important eastward than has been generally appreciated.

Much of the range of the Diana fritillary is presently on U.S. Forest Service and National Park Service lands. The primary management goal with this species should be to prevent another large-scale decline by maintaining healthy populations in the core of both parts of the range. This would primarily involve avoiding disturbances from which populations cannot recover in a few years, as well as avoiding certain practices, such as large-scale herbiciding, that destroy understory plants. In general, maintaining this species should be compatible with most normal forest management practices other than large-scale clearcutting. Clearcutting a large area would probably eliminate breeding in the affected area for several decades. While one might assume that all logging is detrimental, it is likely that thinning or even small clearcuts could increase violets or nectar plants. This in turn might increase Diana populations if the habitat remained forested enough for ovipositing females to use.

There could be conflicts with gypsy moth control, but populations should recover quickly if only a portion of the habitat is sprayed. Gypchek would be a safe alternative to chemical sprays or *Btk*.

Excessive deer browsing and roadside mowing could eliminate nectar plants, forcing adults to leave an area. It is not clear whether deer would seriously impact violets.

Non-native weeds such as stilt grass, kudzu, mile-a-minute, or garlic mustard that could impact forest violets might be the most serious long-term threat, but more information on their impacts on violets is needed.

Heavily used roads may be a localized threat to *Speyeria diana*. Adults probably use roads as flyways and concentrate on nectar plants growing along roadsides, possibly leading to significant mortality from vehicles. Perhaps more important, roadsides through forests can facilitate entry of invasive understory plants.

Collecting bans are not warranted, at least in the Appalachian portion of the range. There is no information suggesting actual impacts to populations of this species, some of which have been collected for nearly a century now. Nevertheless, it is worth remembering that in July and August fresh female *Speyeria* have not yet reproduced. Collectors should use common sense and collect females sparingly. Both collectors and photographers need to be careful not to damage nectar plants.

References

Allen (1997), Allen *et al.* (2005), Brock and Kaufman (2003), Campbell *et al.* (2007) Carleton and Nobles (1996), Cech and Tudor (2005), Connors (2002), Glassberg (1999), Hammond and McCorkle (1983), Holland (1898), Hovanitz (1963), Howe (1975), Irwin and Downey (1973), Klots (1951), LeGrand and Howard (Butterflies of North Carolina website), Moran and Baldridge (2002), Opler and Krizek (1984), Opler and Malikul (1992), Roble *et al.* (2000), Rudolph *et al.* (2006), Scott (1986), Wells *et al.* (2011).

Subfamily Charaxinae (leafwings)

Florida leafwing

Anaea troglodyta floridalis F. Johnson and W. P. Comstock

Identification

Anaea troglydyta floridalis is a large (65 to 73 mm), reddish butterfly with a short tail on the hindwing (Figure 179-181). The pattern and coloring of the undersides as well as the shape of the wings resemble a dead leaf. This butterfly has seasonal forms. The dry season form occurs from October to early May (Salvato and Hennessey 2003). The coloration is deeper red and the forewings are more pointed than the wet season form.

Anaea troglodyta floridalis is similar to the goatweed leafwing (*Anaea andria*), but the latter species has only rarely been found in southern Florida. On the wing from a distance it also re-

Figure 179. Florida leafwing (*Anaea troglodyta floridalis*) upperside male from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 180. Florida leafwing (*Anaea troglodyta floridalis*) upperside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 181. Florida leafwing (*Anaea troglodyta floridalis*) underside female from Big Pine Key, Monroe County, Florida (Marc Minno photo).

Figure 182. Florida leafwing (*Anaea troglodyta floridalis*) larva from Big Pine Key, Monroe County, Florida (Marc Minno photo).

sembles the gulf fritillary (*Agraulis vanillae*), which is orange on the upper sides of the wings, but unlike the leafwing, has silvery spots below. Glassberg (1999) and Glassberg *et al.* (2000) also illustrate the adult.

The larva is green with a yellow stripe on the sides, and some faint dark spots on the thorax and rear (Figure 182). The head has small pebbly protrusions, some of which are orange. Minno and Emmel (1993), Minno *et al.* (2005), and Allen *et al.* (2005) illustrate the larva.

Taxonomic notes

Anaea troglodyta floridalis is the only form of this butterfly found in the United States. Other similar subspecies occur in the West Indies.

Range

Anaea troglodyta floridalis historically occurred on the southeastern Florida mainland in Palm Beach, Broward, and Miami-Dade counties. In the Lower Florida Keys it once occurred on Big Pine Key, Monroe County (Savato and Salvato 2010b). It is currently known to occur on the mainland only at Long Pine Key in Everglades National Park.

Rarity

NatureServe global rank: G5T1.

Although the species is not rare elsewhere, the Florida subspecies is imperiled. *Anaea troglodyta floridalis* is currently being evaluated by the U.S. Fish and Wildlife Service for listing. This is one of the most imperiled butterflies in the eastern United States. It only occurs at a few sites, and population sizes are very small. Marc Minno conducted monthly surveys during 2006 and 2007, and at their peak abundance, he found less than ten adults per day at Everglades National Park and none on Big Pine Key, which was once a stronghold of this butterfly.

Life history

The round, pale, yellowish-green eggs of *Anaea troglodyta floridalis* are laid singly on the leaves of the host plant. The life cycle takes about 60 days to complete (Salvato and Hennessey 2003). Several generations are produced each year, and adults have been recorded every month of the year (Minno and Emmel 1993).

When they are not feeding, young larvae rest at the tip of a frass chain that the caterpillars construct with silk. It projects from the tip of the leaf midrib (Salvato 2008). Late instars sometimes make a leaf shelter in which to hide (David Wagner observation).

In Everglades National Park, a ceratopogonid fly (*Forcipomyia fuliginosa*) was observed feeding on a larva that later died (Salvato *et al.* 2008). Aerin Land photographed a native twig ant (*Pseudomyrmex pallidus*) killing a young larva (personal communication with Marc Minno, in February 2009).

Adult *Anaea troglodyta floridalis* feed on fermenting fruit and sip moisture from soil, but they do not usually visit flowers (Salvato and Hennessey 2003). They also visit sap flows, especially at yellow-bellied sapsucker holes on the lower trunks of willow bustic trees in winter and spring.

Use of rotting bananas or other baits might increase detectability of the adults during surveys. The adults seem to disappear when perched due to their cryptic coloring and preference for landing on dead leaves, branches, and the lower trunks of pine trees which have flaking bark.

The flight is strong and distinctive. Males are territorial at hammock edges, where trails cross, and at other ecotones near patches of the host plant.

Host plants

The larvae feed on the leaves of pineland croton (*Croton linearis*), a small shrub in the spurge family (Euphorbiaceae). Another imperiled butterfly, Bartram's scrub-hairstreak, is found in the same habitat and uses the same host.

Habitat

This butterfly is found in pine rocklands and at the edges of hammocks near patches of the host plant. In Everglades National Park, pineland croton occurs not only in typical pine rockland, but also in wetter sites at the edges of marl prairies.

Threats & management issues

The pine-dominated habitat of the Florida leafwing is maintained by fire, but in areas where this butterfly occurs, prescribed fire should be used with extreme caution. No stages of this butterfly are protected from fire. Jennifer Brown photographed a dead mature larva on a pineland croton scorched by a prescribed fire in Everglades National Park (Sue Perry personal communication with Marc Minno in January 2009). Known colonies should not be entirely burned at one time; refugia populated by the butterfly and including the host plant must be left unburned. Recovery time between fires should be long enough to allow rebound of the host plant and butterfly population. We recommend a minimum of four to five years between burns. Not burning within ten years is likely to harm the butterfly due to the growth of shrubs, hardwood trees, and palms that crowd or shade out the host plant.

Although key deer (*Odocoileus virginianus clavium*) are overly abundant on Big Pine Key, they do not normally browse pineland croton (Marc Minno observation).

Herbicides would be detrimental. If used near existing colonies they should be carefully applied in order to avoid harm to the host plant.

The effects of mosquito adulticides on *Anaea troglodyta floridalis* are unknown, but insecticides should not be used near existing colonies (Hennessey and Habeck 1991, Salvato 2001). Mosquito fish or carefully applied larvicides would not harm the butterfly.

Adults of *Anaea troglodyta floridalis* may be scarce enough that collecting could potentially impact this species.

As with South Florida butterflies and moths in general, there is concern that fire ants and other non-native invasive predators may be impacting this species.

References

Allen *et al.* (2005), Baggett (1982), Brock and Kaufman (2003), Cech and Tudor (2005), Gerberg and Arnett (1989), Glassberg (1999), Glassberg *et al.* (2000), Hennessey and Habeck (1991), Hernández (2004), Holland (1898), Howe (1975), Kimball (1965), Klots (1951), Lenczewski (1980), Matteson (1930), Minno and Emmel (1993, 1994), Minno *et al.* (2005), Opler and Krizek (1984), Opler and Malikul (1992), Riley (1975), Rutkowski (1971b), Salvato (2001, 2003a, 2005, 2008), Salvato and Hennessey (2003), Salvato and Salvato (2010b), Salvato *et al.* (2008), Scott (1986), Smith *et al.* (1994), Tietz (1972), Worth *et al.* (1996).

Subfamily Satyrinae (wood-nymphs and satyrs)

Mitchell's satyr (or St. Francis' Satyr)

Neonympha mitchellii mitchellii French (Mitchell's satyr)

Neonympha mitchellii francisci Parshall and Kral (St. Francis' satyr)

Identification

This medium sized (40 to 45 mm) butterfly is plain dark brown above (Figure 183). The undersides of the wings are brown with rounded eyespots and orange lines (Figure 184 and 185). *Neonympha helicta* and *Neonympha areolata* are similar, to *Neonympha mitchellii*. *Neonympha helicta* occurs within the range of *Neonympha mitchellii francisci*. The best character for tentative field identification of Mitchell's satyr is the row of eyespots on the underside of the hindwing. These are mostly very rounded and close together. Other species of *Neonympha* have the spots more separated and elongated, but some *Neonympha helicta* have similar, more rounded eyespots.

Figure 183. Mitchell's satyr (*Neonympha mitchellii mitchellii*) upperside female from Kalamazoo County, Michigan (Marc Minno photo).

Figure 184. Mitchell's satyr (*Neonympha mitchellii mitchellii*) underside female from Kalamazoo County, Michigan (Marc Minno photo).

Hall (1993) suggests that the following characters work well for field separation of these three *Neonympha* species. On the underside of the hindwing, the orange postmedian band (before the eyespots) is nearly straight in *Neonympha mitchellii francisci*, but has a pronounced bend following

Figure 185. Mitchell's satyr (*Neonympha mitchellii francisci*) from Fort Bragg, Cumberland County, North Carolina (Steve Hall photo).

Figure 186. Mitchell's satyr (*Neonympha mitchellii francisci*) larva from Fort Bragg, Cumberland County, North Carolina (Steve Hall photo).

the end of the cell in *Neonympha helicta*. This band is also much duskier in *Neonympha mitchellii francisci* than in *Neonympha helicta*, while the subterminal orange band (just beyond the eyespots) and the terminal band are not dusky and therefore much brighter than the postmedian band. In *Neonympha helicta,* all of these bands are of similar hue and intensity. Despite statements in some older books, the presence or absence of eyespots on the underside of the forewing is of very little value in separating these three species.

Neonympha mitchellii francisci is known only from one well-studied group of metapopulations in North Carolina, far removed from populations of *Neonympha mitchellii mitchellii* (Parshall and Kral 1989, Hall 1993, Kuefler *et al.* 2008). However, the possibility of discovering additional occurrences exists. Determining the species from photographs should not be difficult, but subspecies placement could be problematic without specimens, especially for a colony outside the known ranges of either subspecies. Collecting a specimen without a permit is a violation of the Endangered Species Act. Glassberg (1999) also illustrates an adult.

The larva is similar to other *Neonympha* species (Allen *et al.* 2005, Minno *et al.* 2005). It is green with two short points on the top of the head, and the rear end is forked (Figure 186).

Taxonomic notes

Two subspecies of Mitchell's Satyr are now recognized. *Neonympha mitchellii mitchellii* occupies most of the range and is not usually a woodland butterfly. However, *Neonympha mitchellii francisci* occurs in forest glades, as well as open sedge mires.

The genus *Neonympha* is in need of revision. One or more cryptic, undescribed species may be present in the eastern United States. Unpublished DNA and other analyses support treating

Neonympha mitchellii francisci as a valid taxon, and show no compelling reason not to retain the other populations of *Neonympha mitchellii* as a single taxon (Goldstein *et al.* 2004).

Range

The typical race, *Neonympha mitchellii mitchellii*, is found in northwestern Indiana, southern Michigan, and southwestern Virginia, and historically also northern Ohio and northwestern New Jersey. It has recently been found in Alabama (Glassberg 1999, Turner 2007, Ogard and Bright 2010) and Mississippi (Kuefler *et al.* 2008).

Neonympha mitchellii francisci, which is sometimes called the St. Francis' satyr, is known only from Fort Bragg, in Cumberland and Hoke counties, North Carolina.

Rarity

NatureServe global rank: G2T1; Xerces Society rank: Critically imperiled for this subspecies. Both *Neonympha mitchellii mitchellii* and *Neonympha mitchellii francisci* are listed as Endangered under the U.S. Endangered Species Act.

Neonympha mitchellii francisci is one of the rarest butterflies in the eastern United States, and is known only from a cluster of metapopulations on a military base in North Carolina. However, Federal listing has benefitted this butterfly, and given current protection, management, and largely compatible operations on the military base, it is not in imminent danger of extinction.

Life history

Neonympha mitchellii mitchellii had only one brood in New Jersey, and in the upper Midwest, but Southern populations are double-brooded (Ogard and Bright 2010).

Neonympha mitchellii francisci has two broods. Adult flight dates are early May to early June and late July to late August (Parshall and Kral 1989, Kuefler *et al.* 2008). The larvae feed on the leaves of the host and hibernate as partly grown caterpillars. Adults fly close to the ground and through stands of sedges and grasses. The feeding habits of the adults are largely unknown, but they appear to be at least facultatively able to do without nectar. In Alabama, the adults avoid direct sunlight and are most active late in the afternoon and on warm cloudy days (Ogard and Bright 2010). Mitchell's satyr does appear to have a true metapopulation structure based on studies by Steve Hall and Nick Haddad's group at North Carolina State University (Kuefler *et al.* 2008), with dispersing females founding new colonies and established ones sometimes dying out as their habitat changes.

Host plants

The larval hosts are poorly documented in the field, but grasses and/or sedges are used by all Satyrinae in the United States. *Neonympha mitchellii francisci* is thought to use *Carex* species. Oviposition has been observed on several species of sedges and grasses, including switchcane, but is not necessarily indicative of the actual host plants used by the larvae (Steve Hall and Erich Hoffman). A rearing study conducted by Steve Hall and Nick Haddad found that several species of *Carex* support larval growth to a varying extent, but that *Carex mitchelliana* – with which populations are closely but not exclusively associated, produced the best results using several different measures (Hall and Haddad 2005; Kuefler *et al.* 2008). Ogard and Bright (2009) found larvae of *Neonympha mitchellii mitchellii* eating a *Carex* species in Alabama. They also report that females have been seen laying eggs on climbing hempvine (*Mikania scandens*) and the leaves of a small grass.

Habitat

Mitchell's satyr (*Neonympha mitchellii mitchellii*) occurs in fens and sedge meadows in the upper Midwest, Virginia (Roble *et al.* 2001), and historically in New Jersey. In Alabama the adults occur in the shrubby transition between open sunny wet meadows and shady swamps, often in beaver-created wetlands (Ogard and Bright 2009, 2010) . *Neonympha mitchellii francisci* is known only from a few sedge wetlands, usually old filled-in beaver ponds, located in close proximity to fire-prone southern pinelands (Hall 1993, Kuefler *et al.* 2008). The habitat is successional or disclimax. Although originally created either by beavers or human activities, the habitat is usually maintained by fire. Colonization of new habitat and elimination of colonies by renewed beaver activity have been observed (Steve Hall). Fires can cause direct mortality and create or restore habitat.

Threats & management issues

Land managers should contact the U.S. Fish and Wildlife Service for guidance on management activities that may affect the Federally listed Mitchell's satyr and St. Francis' satyr (Murdock 1996, U.S. Fish and Wildlife Service Species Profile website). Land management issues for the Mitchell's satyr include prescribed fire, timber planting and harvesting, use of herbicides, and invasive plants.

Threats appear to include small population size, habitat change from lack of fire (especially for subspecies *francisci*), and disruption of hydrology. Individual colonies can be temporarily reduced or eliminated by fire, but with subspecies *francisci* these sites are generally recolonized.

So far, invasive plants do not appear to be an issue for St. Francis' satyr although some colonies are being taken over by native switchcane.

This is the only species in this book for which there is credible evidence of significant impacts from collecting. Mithcell's Satyr is very localized, very easy to catch, and was available to collectors in only about two places east of Michigan, both in New Jersey, so even accumulated impacts of repeated modest collecting activity could have added up, and it is widely suspected, but not really well documented, that overcollecting was a factor in its demise in New Jersey. Collecting may have temporarily impacted one colony in North Carolina before listing, but this seems rather unlikely, and if such an impact did occur, the colony recovered. Collecting is now illegal and carries potentially heavy fines and other penalties under the U.S. Endangered Species Act.

References

Allen *et al.* (2005), Brock and Kaufman (2003), Cech and Tudor (2005), Glassberg (1993, 1999), Goldstein *et al.* 2004; Hall (1993), Hall and Haddad (2005); Kuefler *et al.* (2008), Ogard and Bright (2009, 2010), Parshall and Kral (1989), Roble *et al.* (2001), Tolson (2008), Turner (2007), U.S. Fish and Wildlife Service (1996, Species Profile website).

Moths

Family Hepialidae (ghost moths)

Gazoryctra sciophanes (Ferguson)

Identification

This is a medium-sized (31 to 42 mm), blackish moth, often with a silvery white spot in the middle of the forewings (Figure 187). Hepialids have extremely short, beaded antennae. Only about 20 species occur in the United States. *Gazoryctra sciophanes* is the only member of the genus found in the central and southern Appalachians and should be immediately identifiable from the image we provide here. Males are mostly charcoal-colored, but the costal margin of the forewings has alternating patches of tan to pale orange, and dark scales. Females are tan to light brown with less charcoal-colored scaling. About 80% of the individuals also have an irregular silvery white spot that extends from the cell to the inner margin. Another hepialid, *Korscheltellus gracilis*, flies with *Gazoryctra sciophanes* in the Appalachians, but can be recognized by its smaller size (all but exceptionally large females are under 30 mm in wingspan), checkerboard-like patterning, and the absence of a silvery white spot on the forewing.

Figure 187. *Gazoryctra sciophanes* from Klingman's Dome, Swain County, North Carolina (David Wagner photo).

Range

Gazoryctra sciophanes occurs at higher elevations in the Appalachian Mountains of North Carolina, Tennessee, and West Virginia.

Rarity

NatureServe global rank: GU. This rank reflects mostly uncertainty about the threat or impacts from habitat changes due to the loss of Fraser firs.

Gazoryctra sciophanes is apparently not uncommon in its limited range, and we have no actual evidence of any decline, despite the on-going changes to its habitat. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995. *Gazoryctra sciophanes* is only known from about a dozen locations in the high Appalachians, but many more populations probably exist in remote unsampled sites.

Gazoryctra sciophanes is a classic glacial relict species. Related species in this genus occur far to the north or in high mountains of the West.

Life history

The adults appear in July, and are active for about 30 minutes at dusk. The first individuals arrive at artificial lights around the time when there is no longer enough daylight to see. Both males and females are attracted to light, although the former outnumber females by more than 10 to 1 in our collections. Ferguson's type series of 19 adults included only one female.

The life history of *Gazoryctra sciophanes* is unknown, but based on David Wagner's observations of other *Gazoryctra* species, the first winter is likely to be passed as an egg and the second as a late instar larva.

Pupation presumably takes place in the silk-lined terminus of the larval tunnel.

Host plants

The host plants are unknown, but the larvae are presumably generalized feeders on roots and other organic matter (Wagner 1985). Tim McCabe and Wagner (1989) report that *Korscheltellus gracilis* bores in the roots of several species of ferns. However, *Korscheltellus gracilis* is not closely related to *Gazoryctra sciophanes*.

Habitat

Gazoryctra sciophanes occurs in the high elevation forests of the central and southern Appalachians. Most records come from elevations over 4,922 feet (1,500 meters), although the moth occurs as low as 3,609 feet (1,100 meters) in Pocahontas County, West Virginia. It is locally common in Appalachian high-elevation Fraser fir/red spruce forests. The West Virginia locality is not within the range of Fraser fir, but is within that of balsam fir (*Abies balsamea*).

Threats & management issues

The decline of Fraser fir due to the balsam woolly adelgid (*Adelges piceae*) probably poses a substantial threat to this moth. Much of the Fraser fir/red spruce forest in the southern Appalachians has been lost or dramatically changed by this non-native invasive pest. Mature Fraser firs have been largely killed and replaced by dense stands of juvenile plants. Much of the former forest understory habitat that was rich in ferns and forest-floor herbs no longer exists. Temperature, sunlight, nutrient, and moisture conditions are now substantially altered. Too little is known of the biology of *Gazoryctra sciophanes* to predict the long-term consequences of such dramatic habitat changes.

Climate change, in particular global warming, poses yet another severe threat to this and other mountaintop species of the southern Appalachians.

References

Ferguson (1979), McCabe and Wagner (1989), McDunnough (1911), Wagner (1985), Wagner and Rosovsky (1991).

Family Crambidae (sod webworm moths)

Subfamily Crambinae

Daecke's silverstreak

Crambus daeckellus Haimbach

Identification

At 27 to 31 mm, this is the largest *Crambus* species normally found in its range. The beak-like palpi that are characteristic of the genus, and the combination of size, silvery streaks (Figure 188), and other details (as illustrated here), should be diagnostic. Although several smaller crambine species are similar, they have slightly different silvery markings.

Figure 188. *Crambus daeckellus* (Daecke's silverstreak) from Ocean County, New Jersey (David Wagner photo).

Range

Crambus daeckellus is known only from the New Jersey Pine Barrens, but its suspected food plant also occurs in the southern Appalachians. The historical range extends from the Lakehurst area to Clementon and DaCosta, which includes portions of Burlington, Ocean, Camden, and Atlantic counties. This moth is common at Fort Dix, where there are two or three somewhat separate populations in and adjacent to the weapons impact area. In 1988, a colony that may still be extant was discovered in a recently burned area on the adjoining Lakehurst Naval Station. Surprisingly, no specimens turned up in the Atsion area after a major fire in 1983, but collecting effort was spotty. All other known specimens were taken before 1940, except for several near Warren Grove in 2011 (Steve Johnson).

Rarity

NatureServe global rank: G1G3. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

Crambus daeckellus is known from only three or four sites on U.S. military lands in New Jersey. (Steve Johnson discovered another population in a recently burned tract near Warren Grove in May 2011.) The most likely cause of its decline is a major reduction in fire frequency in the Pine Barrens in the mid and late 20th century. This has caused most habitats to become overgrown with tall shrubs. Furthermore, when wild fires do occur in these long-unburned places, with the increased fuel load, they can be so intense that heat penetrates into peat and soil. This heat can actually kill, rather than merely top kill, plants such as turkeybeard.

Life history

Very little is known about the biology of *Crambus daeckellus*. Adults are often found a few months after fires, suggesting that the caterpillars and pupae live underground. All of the adult specimens that we examined were collected between 7 May and 29 June, but Forbes (1923), states that they occur in September.

The adults are most easily found at night with a flashlight as they fly slowly among patches of turkeybeard, the suspected food plant. Adults are also attracted to blacklights. They have not been seen visiting flowers.

Host plants

Larvae of many species in this genus and family feed on the roots of grasses (Robinson *et al.* 2002) and other monocots. The close association of the adults with eastern turkeybeard (*Xerophyllum asphodeloides*), a grass-like herb in the lily family (Liliaceae), suggests that it may be the food plant.

Habitat

This moth is found in pitch pine (*Pinus rigida*) lowlands and reedgrass (*Calamovilfa brevipilis*) savannas. All documented recent sites had burned within the previous 1–5 years, and some occupied patches burn almost every year. Eastern turkeybeard can persist for decades without fires, but its vigor generally declines within ten years after fires. It is likely that frequent fires are important to *Crambus daeckellus*.

Among other rare species occurring with it at one or more of the recent sites are *Hesperia attalus slossonae, Atrytone arogos arogos*, both unnamed *Crambidia* species described in Forbes (1960), *Spartiniphaga carterae, Dichagyris reliqua,* and *Agrotis buchholzi*.

Threats & management issues

Fire is the obvious management issue for *Crambus daeckellus*, especially if this species turns up again outside of active military use areas. The habitat of *Crambus daeckellus* seems to require frequent fires to be maintained. However, substantial adult and egg mortality could occur, or Daecke's silverstreak might be forced to emigrate due to lack of oviposition sites, if fires were in May or June. Mortality from fires is not a major concern in other months. The random fires typical of military weapons ranges probably provide a secure and ideal habitat for this moth.

If eastern turkeybeard is the food plant, deer are a serious long-term threat. In recent years, deer have consumed most developing turkeybeard seeds and flowers in much of the current and historical range of *Crambus daeckellus*, including at Fort Dix (Dale Schweitzer observation). While the moth does not appear to require flowers or seeds directly and occurs in these browsed areas, eventually the plant will decline due to deer grazing if present trends continue. In some areas where the moth occurs deer hunting is not a viable option due to safety concerns.

References

Forbes (1923), Robinson *et al.* (2002), Schweitzer and McCabe (2004).

Family Geometridae (inchworm moths)

Subfamily Ennominae

Swamp anacamptodes

Anacamptodes cypressaria (Grossbeck)[6]

Identification

Anacamptodes cypressaria is a variable species that co-occurs with several other *Anacamptodes* species that are also quite variable, including *Anacamptodes pergracilis* (with which it is most often confused) as well as *Anacamptodes ephyraria* and *Anacamptodes defectaria*. While there is no single pattern character that is universally diagnostic for every specimen of *Anacamptodes cypressaria*, most fresh individuals can be recognized by the shape of the anterior postmedial line on the dorsal forewing (anterior to the lower edge of the reniform spot), and the dark shading in the reniform spot (Figures 189 and 190).

Figure 189. *Anacamptodes cypressaria* male from Apalachicola Bluffs and Ravines Preserve, Liberty County, Florida (Marc Minno photo).

Figure 190. *Anacamptodes cypressaria* male from Apalachicola Buffs and Ravines Preserve, Liberty County, Florida (Marc Minno photo).

In *Anacamptodes cypressaria* the anterior portion of the dorsal forewing antemedial line is at most very slightly undulated and lacks any prominent distal protruding bulges. This will separate it from all specimens of *Anacamptodes defectaria* and *Anacamptodes ephyraria* and most, but not all, specimens of *Anacamptodes pergracilis*. *Anacamptodes defectaria* and *Anacamptodes ephyraria* always have a prominent distally protruding bulge to the postmedial line, whereas *Anacamptodes pergracilis* usually has a double protruding bulge. In the most extreme specimens of *Anacamptodes pergracilis* the condition of the postmedial line approaches the condition of *Anacamptodes cypressaria*. Also, most specimens of *Anacamptodes cypressaria* are distinct from other eastern *Anacamptodes* in having a dark contrasting reniform spot that is entirely or predominately filled with black scaling. *Anacamptodes pergracilis* has a faint reniform spot with an open center and diffuse

[6] This account was written by Hugo Kons Jr.

border. However, some specimens of *Anacamptodes cypressaria*, especially when worn, are very similar to *Anacamptodes pergracilis*. Some of these specimens may need to be dissected for positive identification.

The specimen illustrated as *Anacamptodes cypressaria* in Kimball (1965) (Plate VI Figure 13) shows the typical postmedial line shape of *Anacamptodes cypressaria*, but is extreme in having a much less strongly contrasted reniform spot than most specimens Kons has seen from the gulf states. The specimen of *Anacamptodes pergracilis* shown on the Kimball (1965) plate is also an extreme form, with very strongly contrasting antemedial and postmedial lines. The cotype male/ lectotype of *Anacamptodes cypressaria* shown in Rindge (1966) is a more typical, although many specimens have more extensive dark shading in the reniform spot. Characters like the degree of contrast in the antemedial and postmedial lines and the extent of brown shading are highly variable in both *Anacamptodes cypressaria* and *Anacamptodes pergracilis* and are not diagnostic. However, *Anacamptodes pergracilis* has a broader range of variation and is the most variable of all of the eastern *Anacamptodes* species in pattern. Whereas *Anacamptodes cypressaria* shows little variation in size, *Anacamptodes pergracilis* is much more variable. Specimens of *Anacamptodes cypressaria* are within the normal range of size variation of *Anacamptodes pergracilis* where they fly together in northern Florida.

Vernon Brou has collected an aberrant specimen from southern Louisiana where the entire forewing median area between the antemedial and postemedial lines is filled in with blackish shading.

Range

Anacamptodes cypressaria is known from peninsular Florida, the Florida Panhandle, southern Louisiana, eastern Texas, and eastern North Carolina. Records suggest it occurs in a few limited populations in the Gulf States and on the Atlantic coastal plain.

Rarity

NatureServe global rank: G2G4.

While *Anacamptodes cypressaria* and *Anacamptodes pergracilis* co-occur in cypress habitats, *Anacamptodes cypressaria* is recorded from far fewer localities and within a subset of the total *Anacamptodes pergracilis* range (Florida to east Texas north to Delaware and southern Indiana inland).

A degree of false rarity is likely for *Anacamptodes cypressaria* due to its short univoltine flight season, relative to the multivoltine *Anacamptodes pergracilis*. Also, it is possible *Anacamptodes cypressaria* has been overlooked because it flies with more common similar species, especially *Anacamptodes pergracilis*.

Kons and Borth (2006) reported four localities for *Anacamptodes cypressaria* among recent surveys in northern Florida. At least 28 specimens were taken in ultraviolet light traps and at mercury vapor light with a sheet in northern Florida by Hugo Kons and Robert Borth in the interval from 1999 to 2007. Kimball (1965) reported eight localities for central and southern peninsular Florida. However, Kimball's Homestead record may not be correct, because the reported date of August seems unlikely.

Vernon Brou (personal communication with Dale Schweitzer in 2010) has collected about 70 specimens from two sites in southern Louisiana.

The Georgia Lepidoptera website (http://www.daltonstate.edu/galeps/) lists the species, but indicates that no Georgia specimens have been located.

In North Carolina, it had been found at nine sites spread over eight counties, including sites in the Fall Line Sand Hills and at sites in the northern and southern portions of the Outer Coastal Plain (Steve Hall personal communication with Dale Schweitzer). Bo Sullivan reports *Anacamptodes cypressaria* to be very common in the right habitats in North Carolina (personal communication with Dale Schweitzer in 2010).

This species is very poorly known in Texas. Hugo Kons and Robert Borth collected only a single specimen from Martin Dies Jr. State Park in Jasper County during their east Texas surveys. Rindge (1966) reported a possible specimen from Harris County, Texas, but stated that the identification should be verified.

Life history

Nothing is known of the immature stages of *Anacamptodes cypressaria.* Kons and Borth (2006) report the species as univoltine for northern Florida. Records by Vernon Brou in Louisiana and Bo Sullivan in North Carolina also suggest a univoltine flight. These reports and records run contrary to the long flight reported in Rindge (1966) and Heppner (2003). Twenty-eight north Florida specimens were collected by Hugo Kons and Robert Borth between 20-29 May. They looked for *Anacamptodes cypressaria* at other times of the year at some sites, but the only time they found adults was in May. With the exception of a doubtful August record from Homestead, Kimball's (1965) records for central and south Florida are between 10 March and 5 May. This suggests a trend of progressively earlier emergence farther south down the Florida peninsula.

Vernon Brou (personal communication with Dale Schweitzer in 2010) reports May-June as the flight season in Louisiana, based on about 70 specimens. Bo Sullivan (personal communication with Dale Schweitzer in 2010) reports the North Carolina flight season as 2 June through 21 June, and that it is best to concentrate efforts from 7-16 June.

A univoltine flight concentrated in May is unusual for the Florida geometrid fauna, and there are few other univoltine species in this family on the wing in May (Kons and Borth 2006). The univoltine *Anacamptodes ephyraria* overwinters as an egg. The other species of the *Anacamptodes* and *Iridopsis* have two or more broods and overwinter as pupae (Maier *et al.* 2011, Wagner 2005, Wagner *et al.* 2001).

Host plants

While the larval host is unknown, it is likely to be one or both species of cypress or some plant that grows in the same habitats as cypress, since all specimens we are aware of have been collected in or very near cypress habitats. There are few trees besides cypress that occur in all of the habitats.

Kimball (1965) reports "Okeechobee County: three on bald cypress, Coop. Econ. Ins. Rept. 4:890." However, the repository of the specimens is not stated, and due to the confusion between *Anacamptodes cypressaria* and *Anacamptodes pergracilis,* which is known to feed on cypress, it would be critical to examine voucher specimens before accepting a host record.

Habitat

The type series was collected in a cypress swamp in Collier County, Florida (Rindge 1966). Most specimens reported by Kons and Borth (2006) from northern Florida come from floodplain hardwood-cypress forest along the Apalachicola River. *Anacamptodes cypressaria* also occurs in herb bog/cypress swamp complexes in Florida. Only a small portion, if any, of the floodplain forest habitats typically have standing water when the species flies during the latter part of May. At the Apalachicola Bluffs and Ravines Preserve, 19 of 21 specimens collected were in ultraviolet light traps in the floodplain forests, and only two specimens were found just outside it. Other Florida collection sites have been hardwood/ cypress swamp or coastal swamp containing cypress along with pine, red cedar and palm. The Jasper County, Texas specimen comes from an area of extensive hydric hardwood forest with cypress in addition to cypress swamp. North Carolina specimens have been collected in riverine swamps, non-riverine swamps, tidal swamps, and cypress savannas. The majority of specimens come from non-riverine habitats that are seldom deeply or persistently flooded. Even within the large riverine swamp along the lower Roanoke River, this species has been collected only from levees or floodplain ridges, and not out in the vast tracts of cypress/gum swamps (Steve Hall personal communication with Dale Schweitzer). Bo Sullivan (personal communication with Dale Schweitzer in 2010) has found them most commonly in North Carolina in hardwood areas containing tall cypress.

Threats & management issues

Too little is known of this moth to evaluate management issues.

Prescribed fire is used as a management tool in wetlands as well as uplands in Florida. It is unknown how the timing, intensity, and frequency of burning affects *Anacamptodes cypressaria*.

Swamp forests in the northeastern portion of North Carolina, including the Roanoke River floodplain, now have established populations of gypsy moths. These are subject to periodic spraying with *Btk* in April (Hall 1999), when young larvae would likely be present if *Anacamptodes cypressaria* overwinters as eggs. Fortunately, sites in Florida, southern Louisiana, and eastern Texas are not threatened by spraying for gypsy moths.

References

Hall (1999), Hall *et al.* (1999), Heppner *et al.* (2003), Kimball (1965), Kons and Borth (2006), Rindge (1966).

Apodrepanulatrix liberaria (Walker)

Identification

This medium-sized (30 to 35 mm), rusty to light-brown geometrid (Figure 191) is usually found near patches of New Jersey tea (*Ceanothus americanus*) in late summer. Although there is variation in the extent of dark brown shading, the general color, pointed apex on the forewing (as illustrated here), and late-season flight period should be diagnostic in our coverage area where there are no similar species.

The caterpillar of *Apodrepanulatrix liberaria* is green (Figure 192) and is the only inchworm on New Jersey tea that coils into a ball when disturbed. Wagner *et. al.* (2001) illustrate the larva and adult. Other illustrations of adults include Ferge and Balogh (2000), Handfield (1999), and McGuffin (1981).

Figure 191. *Apodrepanulatrix liberaria* from Albany County, New York (David Wagner photo).

Figure 192. *Apodrepanulatrix liberaria* larva from Greenbrier County, West Virginia (David Wagner photo).

Range

This moth is spottily distributed from extreme southern Quebec and southern Ontario southward into northern Florida and Mississippi. There are no records from some states within that range, including Maryland (Wagner *et al.* 2001) and Delaware. More western records in older literature refer to other species.

Rarity

NatureServe global rank: G3.

Apodrepanulatrix liberaria has persisted at a few more places in the Northeast than the other two Macrolepidoptera that specialize on *Ceanothus americanus* in our region. In fact, *Apodrepanulatrix liberaria* is the only one still extant in New England. Overall, it may have been the least common of the three species originally. Forbes (1948) regarded *Apodrepanulatrix liberaria* as uncommon in most of its range. While Smith (1910) reported *Erastria coloraria* from throughout New Jersey, and *Erynnis martialis* is vouchered for at least nine counties, he had records of *Apodrepanulatrix liberaria* only from Newark. There are a few later specimens from elsewhere (e.g. Muller 1965). Only a single specimen is known from Kentucky (Covell 1999), which is near the center of this moth's range. On the other hand, Tietz (1952) reports *Apodrepanulatrix liberaria* from five localities across southern Pennsylvania, compared to one different locality farther north for *Erastria coloraria*. Two other sites near the southern border in Chester County Pennsylvania still have both geometrids, and both also had *Erynnis martialis* in 1985 but not a decade later. *Apodrepanulatrix liberaria* might be more likely than the other two to be overlooked because of its late summer flight season, when few butterflies of interest to collectors are present. However, it is relatively easy to find adults and larvae.

Apodrepanulatrix liberaria is still locally common on shale barrens in parts of West Virginia, and has turned up at several places in Virginia (Steve Roble). As of 2008, there is a large population in Clinton County in northern New York (David Wagner observation). We do not have good recent information from south of the Virginias, except that a specimen or two still turns up about every other year in northern Georgia (James Adams). Three extant populations are known in Massachusetts, compared to none for the other two *Ceanothus* specialists. While *Apodrepanulatrix liberaria* occurred in several places in southern Ontario in the 1970s and 1980s (McGuffin 1981, Don Lafontaine email to Dale Schweitzer on 4 July 2008), we do not know its current status there. The moth's legal status in Connecticut, where a colony still exists on a limestone ridge in Canaan (David Wagner observation), was recently upgraded to endangered. New England, New York, and eastern Pennsylvania now harbor fewer than ten known populations, and there are not many other potential habitats in those states.

Apodrepanulatrix liberaria may no longer occur in New Jersey, and we are not sure if it still does in New Hampshire. Unlike the other two *Ceanothus* specialists we discuss, *Apodrepanulatrix liberaria* has not been found in Florida (Kons and Borth 2006), but it may possibly be present in the Panhandle or northern peninsula. Today this moth is local and uncommon to very rare in most of its range, although it is still considered characteristic of Wisconsin pine barrens by Ferge and Balogh (2000).

Life history

There is one brood per year. The eggs overwinter and hatch in spring.

McGuffin (1981) notes that captive females lay eggs singly or in lines on the sides or bottom of the container, even when leaves of the food plant are provided. In the wild they probably place eggs on the stems of the food plant.

Larvae occur in May and June, becoming prepupal as early as late May in West Virginia, and in late June in Massachusetts. When mature, they spin a loose cocoon in the litter or at the soil surface.

The pupae aestivate, except perhaps in the far north, with the adults eclosing as early as late August northward, and progressively later southward, probably around early October in southernmost areas. Even as far north as Albany, New York, some females persist into October.

The adults are mostly nocturnal and come to lights, and occasionally also to baits. Presumably, they visit flowers for nectar. Adults often rest in patches of the food plant, and can sometimes be flushed in the daytime.

Habitat

Populations occur in habitats where the food plant is abundant or at least widely distributed. This includes dry sandy habitats like remnant oak savannas, openings in oak woodlands, pine barrens, rock outcrops (for example on shale, limestone and serpentine), and in open ridge-top woods.

Some historical populations were on more disturbed sites such as an old gravel pit in New Haven County, Connecticut (in the late 1970s). Powerlines through barrens often provide habitat today. The sand plains of Wisconsin and probably Michigan, along with Appalachian shale barrens, are probably the strongholds for *Apodrepanulatrix liberaria* now.

Threats & management issues

Threats and management considerations are the same as for the spring broods of *Erynnis martialis* and *Erastria coloraria.* These species sometimes occur with *Apodrepanulatrix liberaria*, and we provide accounts for both.

Threats include deer herbivory, too much or too little fire, and probably gypsy moth spraying. Since populations of *Apodrepanulatrix liberaria* persist in a few more places northeastward, this species may be less sensitive to other habitat changes if the food plant persists. Larvae of *Apodrepanulatrix liberaria* would probably be feeding at the time that *Btk* would be applied to suppress gypsy moths, but we are not certain of this.

References

Covell (1999), Ferge and Balogh (2000), Forbes (1948), Handfield (1999), Kons and Borth (2006), McGuffin (1981), Muller (1965), Smith (1910), Tietz (1952), Wagner *et al.* (2001).

Erastria coloraria (Fabricius)

Identification

This is a medium-sized (30 to 35 mm) moth. The shape, size, and diffuse but obvious lines on the forewings (as shown in our illustration) are diagnostic (Figure 193 and 194). Males have pectinate (comb-like) antennae. The yellow and pink coloring beneath is distinctive for the genus, and this is the only species of *Erastria* in most of our coverage area. Adults were also illustrated by Covell (1984) and McGuffin (1981).

Figure 193. *Erastria coloraria* (spring brood) from Chester County, Pennsylvania (David Wagner photo).

Figure 194. *Erastria coloraria* (Summer brood) from Chester County, Pennsylvania (David Wagner photo).

In the field, the pale or grayish adults can be flushed from the vicinity of New Jersey tea plants in spring or early summer. Adults of the spring brood are much darker grayish than the summer generation.

The caterpillar should be recognizable based on food plant in combination with the photograph provided here (Figure 195) and by Wagner *et al.* (2001). In a brood reared by McGuffin (1977), the caterpillars were sexually dimorphic in the penultimate instar. Males were much like the last instar, and females were more reddish.

Figure 195. *Erastria coloraria* larva from Chester County, Pennsylvania (David Wagner photo).

Taxonomic notes

Erastria coloraria was formerly placed in the genus *Catopyrrha*. Unfortunately, the name "*Erastria*" was applied to a group of small Noctuidae for decades. McGuffin (1981) also caused confusion by using the specific epithet "*cruentaria*," for *Erastria coloraria* which nearly all other authors have applied to a more common southern species. *Erastria cruentaria* ranges north to northern Georgia and North Carolina.

Range

The distribution of this moth is uncertain southward, but it historically occurred from the Concord, New Hampshire pine barrens (collected by Dave Winter in 1976, specimen at the Museum of Comparative Zoology at Harvard University) and western Connecticut to northern Florida, and westward to about Minnesota, the Loess Hills of Iowa (extant in 2011, Aaron Brees personal communication with Dale Schweitzer) and Texas, including western Missouri and adjacent Kansas according to James Adams. Wagner *et al.* (2001) also report it from Colorado.

We suspect that most reports from Florida refer to *Erastria cruentaria*, but Hugo Kons has a specimen of *Erastria coloraria* from Blackwater River State Forest in the Panhandle, and one specimen from Alachua County. *Erastria coloraria* has not been found in New England since the 1970s; it is believed to have been extirpated by deer from the last known New Jersey site. We do not know if it is still extant in Canada. *Erastria coloraria* is extant in the Albany Pine Bush in New York, and on two serpentine barrens in southeastern Pennsylvania. Albu and Metzler (2004) report collections in Kanawha County, West Virginia from 1988 to 2002. James Adams knows of no recent Georgia collections.

A stronghold for this moth is the extensive sand plains of central and northern Wisconsin. Apparently, it was once fairly common northward and eastward in our region, but uncommon to rare in the interior. Despite records for only two far eastern Pennsylvania counties, Smith (1910) regarded this moth as generally distributed immediately to the east in New Jersey where the food plant was common (and at one time commercially important), in much of the state. The Rutgers University collection has specimens from four northern New Jersey counties. Similarly, Forbes (1948) regarded *Erastria coloraria* as too widespread to bother listing localities in adjacent southern New York. Rupert (cited by Dirig 1986) found *Erastria coloraria* at Horseheads and Albany, New York. In contrast, Covell (1999) reported only one locality and two specimens of *Erastria coloraria* from Kentucky, which is near the center of the overall geographical range. Butler *et al.* (2001) report recent captures in Augusta County, Virginia, and this moth probably occurs more widely than has been documented in the Appalachian shale barrens region. Steve Roble informs us of another recent report from Tazwell County, Virginia.

Rarity

NatureServe rank: G3G4.

Don Lafontaine could provide no recent records from Ontario, Canada. The Port Franks Estates site in Ontario, where this moth was common in July 1984 (Dale Schweitzer observation), is now partly developed (Packer 1994). Deer had eliminated any habitat remnants in nearby Pinery Provincial Park in Ontario, Canada by 1993 (site visit by Dale Schweitzer).

The rarity of the moth in Pennsylvania may be natural. Tietz (1952) reports the species only from Monroe County, Pennsylvania, where some of the cliffs along the Delaware River are much too steep for deer, so possibly still harbor this moth.

Erastria coloraria is believed to be extirpated from New England. Like *Erynnis martialis*, *Erastria coloraria* was probably already gone from southern New England before the gypsy moth became a widespread problem, but persisted into the 1970s near Concord, New Hampshire.

Compsilura is not suspected as a factor in the decline of *Erastria coloraria*, in part because the larval food plant is a low shrub, and *Compsilura* prefers to attack caterpillars in trees.

The last known New Jersey population was present in Passaic County in 1986, but given the recent deer impacts to the flora in the area, it is now probably not extant. However, perhaps a few colonies remain on the New Jersey side of the Delaware River, where cliffs along the river are too steep for deer.

Erastria coloraria is not as rare in Wisconsin as it now is to the east. The moth is characteristic of pine barrens (Ferge and Balogh 2000), and was common in an area of scrub forest/ barrens mosaic in Burnett County in the 1990s (Hugo Kons). In Kentucky, this moth may be naturally rare (Covell 1999).

We do not know the current status of *Erastria coloraria* in the southeastern United States, but this moth is historical in Georgia. Steve Hall has two recent collections from Fort Bragg in the North Carolina Fall Line Sand Hills, and according to Hugo Kons, Jr., it still occurs in Florida.

There are three rare species of Lepidoptera that feed on *Ceanothus* in our region. They are *Erastria coloraria,* the mottled duskywing, *Erynnis martialis,* and *Apodrepanulatrix liberaria,* also a geometrid moth. The current and historical status of *Erastria coloraria* is similar to that of the mottled duskywing butterfly (*Erynnis martialis*) in many areas from Wisconsin to New Jersey. However, this is apparently not so in Kentucky, where *Erastria coloraria* seems to be much rarer than *Erynnis martialis* (Covell 1999), or in Georgia, where *Erastria coloraria* is historic. These three species often occurred together in the northern United States, and still do at the Albany, New York Pine Bush and in Wisconsin. *Erastria coloraria* persisted about 90 years longer than the mottled duskywing in New England and about 10 years longer in New Jersey. However, *Apodrepanulatrix liberaria* outlasted both and still occurs in Connecticut and Massachusetts. Both moths still occur on two Pennsylvania serpentine barrens where the mottled duskywing has not been reliably documented since 1985, before extensive herbivory by deer.

Life history

Erastria coloraria adults emerge in late April or May in most of the range. The summer brood starts between mid-June and mid-July in most places, overlapping the two broods of mottled duskywing (*Erynnis martialis*). Adults are somewhat diurnal, and can be flushed from the vicinity of the food plant in the daytime. They also are active at night and come to lights. In the summer, the adults visit sugar baits and flowers. Jones (1928-1932) reports that the male's mating flight is diurnal. Pupae overwinter.

Host plants

The larvae feed on New Jersey tea (*Ceanothus americanus*), and *Ceanothus herbacea*, both small, semi-woody shrubs in the buckthorn family (Rhamnaceae). Reports of other plants being used by this species are summarized by Robinson *et al.* (2002), but these references are old and probably refer to *Erastria cruentaria*. McGuffin's (1981) *Ceanothus* host record for *Erastria cruentaria*, which Robinson *et al.* repeated, actually refers to *Erastria coloraria*.

Habitat

Although this moth originally occurred in other habitats eastward, the few occurrences in the Northeast that we know to be extant are all in pitch pine barrens, where the food plant occurs in grassy openings including old quarries and powerlines. Two occurrences were found on serpentine outcrops, and one on sand. At one of the Pennsylvania sites, lack of fire has largely relegated the food plant and moth to a powerline since the 1980s. Steve Johnson informs us that healthy New Jersey tea plants at this site are now found mostly in spots where cat brier (*Smilax rotundifolia*) limits access by deer.

Erastria coloraria also occurs in Appalachian shale barrens. Rupert (in Dirig 1986) provides a description of the Horseheads, New York site, where *Glaucopsyche lygdamus nittanyensis*, a very characteristic shale barren butterfly, was also found. In North Carolina, *Erastria coloraria* occurs in sandhill habitats and terraces along small rivers in the Fall Line Sand Hills. In Wisconsin, occupied habitats include pine and oak barrens, and in Florida it occurs in long leaf pine/wiregrass savanna. Other habitats where the food plants are abundant may also harbor populations.

Threats & management issues

The threats to *Erastria coloraria* are similar to those of the mottled duskywing butterfly, which has an almost identical phenology, the same food plant, and similar habitat needs. Where this moth still persists, deer, prescribed burning, and gypsy moth spraying are probably the main management issues.

Deer currently threaten at least one of the two known Pennsylvania colonies, and are a potential threat almost everywhere. Deer severely impacted the last known habitat in New Jersey and will probably eliminate this moth soon in Ontario if it is not gone already.

Both lack of fire and too much prescribed burning are detrimental to this moth. It is unknown whether the pupae are in the soil and therefore protected from most fires, or if the pupae are in the flammable litter, and not protected. In either case, *Erastria coloraria* should usually do well in places managed by use of prescribed fire if unburned refugia are provided, and if deer are controlled. Steve Hall reports that the Fort Bragg sites with *Erastria coloraria* are heavily hunted for deer and are burned on a three-year rotation. The seeds of *Ceanothus americanus* are stimulated to germinate by fire.

It is not known whether larvae would be sensitive to *Btk* used to suppress gypsy moth larvae. Exposure of *Erastria coloraria* larvae to *Btk* would depend on the application date. In most cases some larvae should hatch after the *Btk* residue is largely off the foliage.

For information on other rare species feeding on Ceanothus, see our accounts for *Erynnis martialis* and *Apodrepanulatrix liberaria*, and the Impacts of White-tailed Deer section.

References

Butler *et al.* (2001), Covell (1984, 1999), Dirig (1986), Ferge and Balogh (2000), Forbes (1948), Jones 1928-1932, McGuffin (1981), Kons and Borth (2006), Packer (1994), Robinson *et al.* (2002), Smith (1910), Tietz (1952), Wagner *et al.* (2001).

MILNE'S EUCHLAENA

Euchlaena milnei McDunnough

IDENTIFICATION

This medium-sized (about 36 mm) moth has a partially yellow median area contrasting with the dark basal and outer portions of the wings (Figure 196). The postmedian line on the forewing is straight. Adults should be easily recognized from our illustration. This species is smaller and darker than *Euchlaena serrata*, and not orange like *Euchlaena tigrinaria*, both of which are illustrated by Covell (1984). The amount of yellow varies substantially. The largely yellow median area includes some brown on all wings, especially on the inner portion of the forewing and on the hindwing. Sometimes there is much less dark suffusion in the median areas of all of the wings. Compare our image to that of Ferge and Balogh (2000). The dark basal area on the forewing is much smaller on *Euchlaena serrata*, which has virtually no brown in the yellow median area.

Descriptions of the immature stages of *Euchlaena milnei* have not been published, but we illustrate the larva (Figure 197).

Figure 196. *Euchlaena milnei* (Milne's Euchlaena) from Virginia (David Wagner photo).

Figure 197. *Euchlaena milnei* (Milne's Euchlaena) larva from Timberville, Virginia (John Coffman photo).

RANGE

Euchlaena milnei is known mostly from the mountains of Virginia, where it is somewhat widespread, but local. *Euchlaena milnei* has also been found in Grant County, Wisconsin, Scioto County, Ohio (Eric Metzler), and western North Carolina. Steve Hall reported to us that three adults were collected at Fontana Lake, North Carolina, in 2004. We know of no recent collections of this moth in Ohio, and the species has apparently not been collected in Kentucky (Covell 1999) or southern West Virginia (Albu and Metzler 2004). It did not turn up in an extensive recent inventory of Great Smoky Mountains National Park.

RARITY

NatureServe global rank: G2G4. This species has rarely been encountered, and very little is known about it. *Euchlaena milnei* is not known to be associated with any rare habitat.

LIFE HISTORY

The life history of *Euchlaena milnei* is unknown, except that there is one generation per year, with adults occurring in June and July. Other species in this genus hibernate as larvae, but the specific instar of hibernation varies among species. The flight season implies that one of the middle instars of *Euchlaena milnei* overwinters. Because hibernation in this genus appears to be in the leaf litter, larvae may ascend to feed on a species of tree or shrub in spring that is different from the one that they fed on in summer.

HOST PLANTS

John Coffman has reared this species in captivity from eggs obtained from females that he collected near his home in Timberville, Virginia. The larvae preferred to eat willow leaves, but also fed on other trees.

The natural food plants are unknown. Most *Euchlaena* species feed on a variety of trees and shrubs (Wagner *et al*. 2001).

HABITAT

Collection sites for *Euchlaena milnei* are usually in or adjacent to hardwood forests in hilly to mountainous regions. The habitat where this species was numerous at blacklights, the Goshen Wildlife Management Area, Virginia, is acidic oak and mixed woods. The Ohio specimens were collected near the Ohio River, and at least some of the Appalachian sites are near rivers, for example the Conestee Falls, North Carolina site (Forbes 1948). However, we cannot associate this moth with a specific habitat or plant. Virginia Natural Heritage staff have collected it mainly in mesic deciduous forests.

THREATS & MANAGEMENT ISSUES

Gypsy moth spraying could impact this species, because the larvae feed on the leaves of trees some time during July to September and April to June. The threat from Dimilin® would be very high; it would cause massive mortality of larvae for two generations (in May and again in summer if any survived in May and produced moths). Colonies could be extirpated if the entire habitat were to be sprayed. The status of *Euchlaena milnei* in West Virginia, after the extensive late 1980s Dimilin® spraying, is unknown.

Impacts from *Btk* are unknown, but larvae would likely be exposed to it. Late instars of *Euchlaena obtusaria* in May were completely insensitive to *Btk* in laboratory assays (Peacock *et al*. 1998). However, sensitivity was shown to vary greatly within several other genera. If the food plant is eaten by gypsy moth larvae, defoliation could impact *Euchlaena milnei* populations during severe outbreaks. Specifically, late instars in spring might starve, females in June might have difficulty locating suitable oviposition substrates in defoliated forests. Hatching larvae might face a food shortage, or leaves of refoliated plants could have altered chemistry which may be detrimental to caterpillars. There is no basis to predict whether the impact of defoliation or *Btk* would be worse, or even if either would be potentially significant.

Prescribed burning is conducted in some habitats near the Wisconsin collection site, and would cause very high mortality of any stage in the litter. However, prescribed burning it is not likely to be a management practice elsewhere within the range of *Euchlaena milnei* where its habitats are hardwood forests.

If the food plants are mostly shrubs, then deer and invasive shrubs and vines are, or soon will be, issues for the long-term survival of this moth in most of its range.

References

Butler *et al.* (2001), Forbes (1948), Ferge and Balogh (2000), Peacock *et al.* (1998), Wagner *et al.* (2001).

Ohoopee inchworm moth

Fernaldella georgiana (Covell, Finkelstein and Towers)

Identification

This is a small (19 to 26 mm), pretty, day-flying moth. The bright, silvery, white spots and line on the hindwing and on the apical part of the forewing beneath are unique (Figure 198 and 199). The upperside is mostly dark brown, with a much reduced pattern. There is no similar moth in eastern North America.

The late instar larvae are green with yellowish striations, and they sometimes have an irregular, yellowish lateral line (Covell *et al.* 1984).

Figure 198. *Fernaldella georgiana* upperside from Tattnall County, Georgia (Marc Minno photo).

Figure 199. *Fernaldella georgiana* underside from Ohoopee Dunes, Tattnall County, Georgia (Marc Minno photo).

Taxonomic notes

This moth was originally placed in the genus *Narraga,* but Ferguson (2008) transferred it to *Fernaldella*.

Range

Fernaldella georgiana is known only from the inland sand dunes of Tattnall and Emanuel counties in eastern Georgia, cited in its original description (Covell 1984). However, a few colonies besides the original two have been found (James Adams), and there is one old specimen from Appling County, Georgia (Ferguson 2008) about 45 miles (75 km) from the location of the more recent specimens.

The host plant is much more widely distributed than the moth. Steve Hall and Bo Sullivan and others have checked most of the larger populations of the food plant in North Carolina, but have not found the moth.

Rarity

NatureServe global rank: G1G3.

This moth is known recently only from the Ohoopee Dunes Natural Area, Georgia, but the rank given reflects the possibility that a few more occurrences will be discovered. The food plant occurs along the roads between sites in Tattnall and Emanuel counties, yet the moth apparently does not, according to James Adams. Much of the known habitat of *Fernaldella georgiana* is protected in the Ohoopee Dunes Natural Area.

Life history

Adults are mostly diurnal, and James Adams and Irving Finkelstein have observed them as early as 8:30 a.m., and late in the afternoon. The adults of the second and third generations are also attracted to blacklights at night. Peak times for the adults are from early to mid-April, mid- to late June, and from late August to early September, but some adults occur between these peaks as well.

The larvae feed on the leaves of the host. Eggs obtained from a captive female hatched in nine to 16 days in April, and six to seven days in the summer. The larvae matured in about a month.

Some captive-reared larvae burrowed into the sand to pupate, others did not. Larvae from a female collected in April, and reared outdoors, pupated in late May and produced adults from June to October. Thus some of the pupae went into diapause, but others did not. The pupae probably overwinter, but under captive rearing conditions, adults emerged by November.

Host plants

Woody goldenrod (*Chrysoma paucifloculosa*), a small bushy shrub in the aster family (Asteraceae), is probably the only food plant. This plant is common along the Gulf Coast of the Florida Panhandle, and is spotty in distribution along the Atlantic coast from Georgia to North Carolina.

Habitat

The habitat consists of openings in stunted longleaf pine-turkey oak forests on the ancient inland sand dunes in and near the Ohoopee Dunes Natural Area. Adults avoid the woods, and stay close to the food plant in open areas. *Fernaldella georgiana* can utilize somewhat degraded habitats, according to James Adams. Other species of *Fernaldella* largely occur in arid, open habitats.

THREATS & MANAGEMENT ISSUES

One of the sites from which *Fernaldella georgiana* was described is unprotected and could be lost to development (James Adams personal communication with Dale Schweitzer in March 2009).

This species is best regarded as fire sensitive unless underground pupation is confirmed to be common.

Gypsy moths are likely to become established in this part of Georgia, but experience in comparable pine/oak scrub on xeric white sand in New Jersey, and to some extent south of there, suggests severe defoliation may not occur in these habitats even if it does in surrounding forests. Among other factors, oaks growing in such environments tend to leaf out too late for gypsy moth hatchlings to become established (Schweitzer 2004). It is very unlikely that a shrubby composite will prove to be a favored, if even marginally acceptable, food plant for gypsy moth caterpillars.

Early instars of *Fernaldella georgiana* would probably be highly sensitive to *Btk* (Peacock *et al.* 1998), so large-scale applications in early to mid-April and possibly later (depending on sensitivity of mid- and late instars) could jeopardize a population.

REFERENCES

Covell, Finkelstein, and Towers (1984), Ferguson (2008).

BUCHHOLZ'S GRAY

Hypomecis buchholzaria (LEMMER)

IDENTIFICATION

This medium-sized (30 to 40 mm) moth is black or brownish black with darker markings (Figure 200). *Hypomecis buchholzaria* is also illustrated by Rindge (1973). South of New Jersey, specimens should be verified by examining the genitalia.

Larvae vary in color from pale greenish to dark brown and Forbes (1948) described some as being "mottled light brown or red brown flecked with yellow". Figure 201 is fairly average.

Figure 200. *Hypomecis buchholzaria* (Buchholz' gray) from Burlington County, New Jersey (David Wagner photo).

Figure 201. *Hypomecis buchholzaria* (Buchholz' gray) larva from Burlington County, New Jersey (David Wagner photo).

Taxonomic notes

Species of this genus were placed in *Pseudoboarmia* by Rindge (1973) and Forbes (1948). According to Hugo Kons there are two dark *Hypomecis* species in Florida. The other of these is widespread in sandhill scrub habitats, and reported (as *Hypomecis* sp.) from 13 localities by Kons and Borth (2006).

Range

Hypomecis buchholzaria is known from Plymouth County, Massachusetts, as well as the northern half of the New Jersey Pine Barrens, where it is widespread and not rare. In the South it is found in scattered localities in the Coastal Plain and Sand Hills from southern North Carolina to central Florida, and westward along the Gulf Coast to Texas. Except for several more New Jersey and Florida localities, and one or two more in southeastern North Carolina, the map given by Rindge (1973) approximates the known distribution in our coverage area. Rindge stated that two of Kimball's Florida records were incorrect.

Rarity

The current NatureServe global rank is G3G4.

Steve Hall suggests that the rank of Buchholz's gray should be G3, considering the apparent rarity of this moth outside of New Jersey. Based on specimens we have seen in collections and Rindge's records, this is a rare moth. Nevertheless, in New Jersey it is still frequently found in portions of the Pine Barrens (Burlington, Ocean, and northwestern Atlantic counties), and any suitable habitat in New Jersey north of the Mullica River probably supports *Hypomecis buchholzaria*. The area of occupancy in the New Jersey Pine Barrens is probably more than 150,000 hectares. In Massachusetts, it has been found only in Plymouth County, as first reported by Rindge (1973) Mike Nelson also found a few in Plymouth County, Massachusetts on several occasions from 2001 to 2005. This population appears to occupy much of the extensive pine barrens (ca. 10,000 hectares) in that area. It is not clear if this species ever occurred more widely in Massachusetts, but the habitat does.

This moth is rare in North Carolina, and as far as we know, collections in South Carolina, Georgia, and Mississippi occurred prior to 1973, but surveys are needed to confirm its status in these states. Hugo Kons informs us that most of the sandhill specimens in Kons and Borth (2006) are another species, but that he has recent *Hypomecis buchholzaria*(including males verified by dissection) from Florida. These include specimens from the Ordway Preserve in Putnam County, and Apalachicola Bluffs in Liberty County, and he supplied an image of a female specimen from the latter site as well. Both sexes come to blacklights in New Jersey, usually before midnight.

Life history

In Massachusetts this moth has one brood with adults emerging in June and July. In New Jersey there is a large second brood, although a few pupae from first brood larvae overwinter. In New Jersey, adults occur mostly from late May to mid-June and again two months later. There are probably three broods southward. Adults first appear in April in the Carolinas. In Florida they appear in January to March, and again in May and July (Heppner 2003). A few adults will usually be attracted to blacklights in season in New Jersey, but elsewhere the species is usually not found in blacklight samples from seemingly suitable habitats.

Eggs hatch in about ten days. Larvae of *Hypomecis buchholzaria* feed on mature foliage, but will eat younger leaves at least in the early instars. The caterpillars apparently stay on the food plant when not feeding.

Both *Hypomecis buchholzaria* and *Hypomecis umbrosaria* (or *Hypomecis gnopharia*) overwinter as pupae. The latter pupates underground. Second brood *Hypomecis buchholzaria* larvae mature by early October in New Jersey. The first flight is very brief in any given year, and this species has the most synchronous eclosion (five days, n=41) of 101 species of Macrolepidoptera for which Dale Schweitzer has data from overwintered pupae.

Host plants

The host reported in the literature is sweet fern (*Comptonia peregrina*), a small shrub in the bayberry family (Myricaceae), and larvae are easily reared on sweet fern and the related bayberries (*Morella* species). However, in New Jersey, Myricacae are not characteristic of most localities for the moth, and sweet fern is not reliably present. Pines and several genera of Ericaceae were found to be unacceptable to hatchlings. Scrubby oaks will probably prove to be the normal food plants. Bo Sullivan reared one from a larva found on turkey oak (*Quercus laevis*) in North Carolina. Bear oak (*Quercus ilicifolia*) is probably the usual food plant in New Jersey, although we have only one record of a wild larva. Bear oak is almost certainly the food plant in Massachusetts. At least one other *Hypomecis* is also an oak feeder (Forbes 1948, Dale Schweitzer and Bo Sullivan observations), but we are not sure which one.

Habitat

Northward this species is found in large tracts of stunted, open pitch-pine/bear-oak or blackjack oak barrens near the coast. In New Jersey it has also been collected in burned-over pitch-pine lowlands, but perhaps these individuals were merely flying in from surrounding oak scrub. The habitat southward includes turkey oak sandhills. Xeric white sand and scrubby oaks seem to be constant habitat features, at least in and north of North Carolina.

Threats & management issues

Because we are not certain where this species pupates (litter or in soil), its vulnerability to fires is unknown. Most habitats probably require occasional to frequent fires to persist, but generally only a few per century should suffice.

Forestry practices that eliminate or thin scrubby oaks would reduce available food plant.

Because the larvae would not appear until several weeks afterward (mid-June in New Jersey), *Btk* applications aimed at controlling gypsy moth larvae probably do not pose a threat.

Defoliation by gypsy moth caterpillars undoubtedly would be detrimental, but because young larvae will eat new leaves, some should find suitable replacement foliage when they hatch. In New Jersey and Massachusetts at least, these habitats are not often defoliated by gypsy moth or anything else other than late-spring freezes.

All observations suggest this species requires a sparse or absent pine canopy and abundant scrubby oaks, so it would not likely occur in areas managed primarily for timber.

Urban development and fire suppression have reduced habitat somewhat in New Jersey. Large-scale loss of habitats to development and conversion to pine plantations has greatly reduced this species' habitats southward. Upland scrub is disappearing rapidly in Florida, except in fragmented preserves and some managed forests.

Given that *Hypomecis buchholzaria* still exists on mainland Massachusetts, and the moth is not known to have been more widespread or numerous in the past, parasitism by *Compsilura* does not seem likely to have had a major impact northward.

References

Forbes (1948), Heppner (2003), Kons and Borth (2006), Kimball (1965), Rindge (1973).

Smokies carpet

Ligdia wagneri Ferguson and Adams

Identification

This small moth (22 to 24 mm) has a black and white pattern that is unique in our hemisphere and easily recognized from our illustration. The basal quarter of the forewing is black with a few raised scales that give the wing metallic reflections (Figure 202). The medial area of the wing is white, except for a sooty costal bar and a peppering of elongate spots. The outer third of the wing is gray, with a smoky to blackish patch running from the medial area to the outer angle. Fresh individuals have faint orange-brown antemedial and postmedial bands. The outer margin of the forewing is somewhat checkered. The anterior abdominal segments bear tufts of black scales, but the first segment is white. The antennae are simple (ciliated). This moth superficially resembles the larentiine, *Mesoleuca ruficillata*; however, the outer edge of the basal black area is deeply undulate in *Mesoleuca* species, and smoothly convex in *Ligdia* species. Also, the outer fourth of the hindwing is heavily patterned with black in *Mesoleuca*, but mostly devoid of black scales in *Ligdia*.

Figure 202. *Ligdia wagneri* (paratype) from Great Smoky Mountains National Park, Tennessee (David Wagner photo).

The only caterpillar of the Smokies carpet that we know of was green and nondescript. The larva of *Ligdia adustata*, a European species, is lime green with a small brown lateral patch between the second and third abdominal segments (Porter 1997).

Range

The Smokies carpet is presently known only from two valleys on the Tennessee side of Great Smoky Mountains National Park, although the apparent food plant is much more widespread.

Rarity

NatureServe global rank: The Smokies carpet is currently unranked, but seems likely to merit G1.

The moth, first discovered by James Adams in 2001, and named by him and Ferguson (2008) for David Wagner, appears to be among the most narrowly restricted moths in eastern North America. The species is known from about 30 male specimens. It is an ancient relict species, and the only representative of its tribe (Abraxini) in the New World.

Life history

So far as is known, there is a single spring generation that flies during the middle of May. Initial efforts to document a second generation in July and August have not yielded any examples, but at least some Old World *Ligdia* species are double-brooded. All but one of the known specimens have come to lights with sheets or light traps. Over one 3-day period, most adults arrived at lights between 9:45 and 11:00 p.m. Diurnal searches of suitable habitat (principally to locate females for breeding stock) have resulted in the flushing of only one male. The absence of females suggests they are very sedentary or even flightless.

Host plants

A single larva was found on running strawberry bush (*Euonymus obovatus*) in the stafftree family (Celastraceae) (David Wagner). Some Old World *Ligdia* species also specialize on *Euonymus* species (Porter 1997, Ferguson 2008).

Habitat

The Smokies carpet occurs in mid-elevation, southern Appalachian hardwood forests on boulder-fields. This community type is ranked as G3 in NatureServe's (2007) national hierarchical vegetation classification. *Euonymus obovatus* is a typical dwarf shrub in these forests. All sites where *Ligdia wagneri* has been found are open understories in mature forests with closed canopies. Trees include buckeye (*Aesculus* species), red oak (*Quercus rubra*), elm (*Ulmus* species), and basswood (*Tilia americana*). Most specimens were collected at around 3,100 feet (945 m) elevation according to James Adams, who discovered this species.

Threats & management issues

The known sites for this moth are within Great Smoky Mountains National Park, thus are protected. These valleys and surrounding mountains would seem to be well buffered from immediate threats. Other *Euonymus* species are favored browse plants for deer. If the food plant is similarly favored, deer could become a serious threat.

References

Ferguson (2008), Porter (1997), Rupert (1944).

TWILIGHT MOTH (NORTHEASTERN POPULATIONS)

Lycia rachelae (HULST)

IDENTIFICATION

The male *Lycia rachelae* is a medium-sized (usually 35 to 37 mm) dark colored moth. It is easily recognized from our illustration, and cannot be mistaken for anything else in our region (Figure 203). Males from New England and Pennsylvania appear to be larger and more heavily marked than most illustrated western specimens. Females are rarely encountered and are hairy looking and essentially wingless. They are larger than other wingless spring moths. One is illustrated by McGuffin (1977). Covell (1984) also illustrates the male.

The caterpillar is illustrated in Figure 204 and by Wagner *et al.* (2001).

Figure 203. *Lycia rachelae* from Ossipee Pine Barrens, Carroll County, New Hampshire (David Wagner photo).

Figure 204. *Lycia rachelae* larva from Canada (Canadian National Collection photo).

RANGE

Lycia rachelae is widespread from Alaska southeastward through western Canada to southern Manitoba, and in the mountains of the western United States southward to Colorado. It has recently been found in far northern Quebec in May (Handfield 1999). Relict populations occur locally in pine barrens in two limited parts of our region. One area of occurrence is Oxford and York counties in Maine, west through Carroll, Merrimack, and Strafford counties in New Hampshire, and south to Essex and Middlesex counties in Massachusetts. It also occurs disjunctly in northeastern Pennsylvania, specifically in Luzerne, Monroe, and Lackawanna counties. The Strafford County specimen was collected in 1965, and the Luzerne County specimens (Forbes 1948) were taken well before 1940. All other counties in our region where *Lycia rachelae* was found have records from 1984 to 2007.

RARITY

NatureServe global rank: G4G5.

This is a widespread, and as far as we know, fairly common moth from Alaska to southern Manitoba and in the mountains to Colorado. A record in northern Quebec (Handfield 1999) suggests that this species might be widespread eastward in boreal forests or taiga habitats where it could be overlooked due to its early flight season. However, currently there are no other collections within more than 1,000 km of that Quebec locality. Covell (1984) noted that *Lycia rachelae* is thought to be rare, but probably is not often sought in season. Actually, it has been rather extensively looked for in recent decades in our region, but the species has not turned up far from the historic sites. We include this distinctive moth because of very disjunct populations in our region in only two small areas.

While they have not been formally recognized as a subspecies, and we see no reason to do so here, these New England and Pennsylvania populations are probably at least as evolutionarily significant as many butterfly subspecies, and if treated as such would merit a rank of T2 or T2T3.

The twilight moth has probably declined in Massachusetts, but elsewhere, there is no evidence that it was more widespread than it currently is. In the mid- and late 1980s, Dale Schweitzer and Lars Crabo found this moth at three sites in Maine and New Hampshire, with one to over 25 adults coming to lights on six of eight nights. However, they were unable to find any *Lycia rachelae* adults on four occasions in the Melrose-Medford area just north of Boston, an area with pre-1934 records from at least four places (Woburn, East Woburn, Melrose, and Melrose Highlands) and extensive remaining habitat.[7] *Lycia rachelae* regularly occurs at the known Pennsylvania sites. Records known to us since 2000 from eastern Massachusetts are from localities farther north, near Andover and Ayer, the latter being a few kilometers west of the historical Chelmsford locality.

Life history

In our experience, male twilight moths occur for about a week, typically in the first or second warm spell after snow melt. Except for one collected in New Hampshire on 30 April, all other records that we know of in our region, spanning more than a century, are from 29 March to 19 April. Males come readily to lights, at least in mild weather, typically an hour or two after sunset in our region, but they are reported to fly before sunset in Manitoba (McGuffin 1977). Forbes (1948) reports that they frequently fly during snow storms.

The eggs are laid, often in groups, under loose bark (Forbes 1948, McGuffin 1977). The slow-growing larvae are apparently polyphagous on trees and shrubs. They apparently do not pupate until September or October (McGuffin 1977). Most of the year is spent as pupae in the soil, and like other spring *Lycia* species (Farquhar 1934, Young 1997), some pupae probably overwinter two or more years.

Host plants

Farquhar (1934) credits several Massachusetts records of *Lycia rachelae* to staff of the Gypsy Moth Laboratory at Melrose Highlands, undoubtedly based on larval collections between about 1911 and 1931. Therefore, his food plant records represent plants used in nature. Farquhar (1934) reports willow (*Salix* species), probably one of the shrubby pussy willows like *Salix*

[7] Whatever the explanation, the difference in detectability between the Boston area sites (zero successes in four attempts) and the more northern sites (six successes in eight attempts) is statistically significant (Fisher's exact p=0.03).

discolor, aspen and poplar (both probably *Populus tremuloides*), gray birch (*Betula populifolia*), elm (*Ulmus americana*), and hazelnut (*Corylus americana*) for the Boston area. Forbes (1948) stated willow, poplar, and rarely elm, were used. A few other genera are reported from western Canada (McGuffin 1977). Barrens where this moth occurs generally have many small birches (*Betula papyrifera* or *Betula populifolia*) and/or aspens (*Populus* species).

HABITAT

All recent New England and Pennsylvania specimens of *Lycia rachelae* were collected in pitch pine-bear oak barrens, except at Andover, Massachusetts, where the moth was found less than a kilometer from a small remnant barren. Such barrens are on sand plains in New England, but occur on cold, windy ridgetops and glacial till in Pennsylvania. Some of these sites have few trees. The till barrens are wet enough in spring to have substantial rhodora (*Rhododendron canadense*), a bog shrub, growing with the bear oaks. Other sites are xeric.

It is unlikely that Massachusetts populations were restricted to sandy places, because pre-1934 records indicate that this moth was rather widespread north of Boston (Farquhar 1934 and specimens in Harvard University's Museum of Comparative Zoology), in towns that still have considerable potential habitats on granite hills that appear similar to those used in Pennsylvania, and where limited sandy areas were most likely plowed or built upon before 1830.

THREATS & MANAGEMENT ISSUES

Some Massachusetts populations of *Lycia rachelae*, but maybe not those near Boston, survived the initial invasion of gypsy moths in the late 1800s. In addition, nearly a century of exposure to *Compsilura*, and various other gypsy moth control efforts did not drive them to extinction. With a relatively large caterpillar apparently present through the summer (McGuffin 1977, Wagner *et al.* 2001), parasitism by *Compsilura* would seem likely.

Some starvation of larvae during gypsy moth outbreaks would be likely due to defoliation, and larvae would be exposed to spraying to suppress such defoliation. Although in recent decades such spraying has been minimal in known habitats, this was not necessarily the case 25 or more years ago. Melrose, Massachusetts, where *Lycia rachelae* was found about 100 years ago, is very near the point of introduction for the gypsy moth and *Compsilura* in North America. The first gypsy moth outbreaks occurred around Melrose before 1890, and these forests were partially sprayed for gypsy moth control until about 1980. If *Lycia rachelae* did not survive in that area, all of the above factors probably contributed to its demise.

We do not know whether the young larvae would be susceptible to *Btk* or not.

Over half of the known remaining habitats in our region are largely protected from development.

Because this is a boreal relict species found mostly in much colder climates, global warming is a very likely threat in our region.

REFERENCES

Covell (1984), Farquhar (1934), Forbes (1948), Holland (1903), Handfield (1999), McGuffin (1977), Rindge (1975), Tietz (1952), Wagner *et al.* (2001), Young (1997).

Lytrosis permagnaria (Packard)

Identification

Females of this genus are the largest (755 mm) geometrids in our region. Male *Lytrosis permagnaria* are unmistakable in having a uniform ground color with a prominent, black postmedian line on both wings and feathery antennae (Figure 205). Some females of *Lytrosis unitaria* are similar in color, but have a narrower postmedian line, especially on the hindwing, and the other lines are more evident. Females of this genus have filamentous antennae.

The last two instars of the larva, and probably earlier ones, are very easily separable from other *Lytrosis* species by the simple pattern and lack of bud-mimicking ornamentation on the body (Wagner *et al.* 2003a). *Lytrosis permagnaria* larvae (Figure 206) could easily be mistaken for a species of the closely related genus *Euchlaena*, although at maturity the larger size (40-50 mm) might be diagnostic. Wagner *et al.* (2003a) discuss other differences visible with a dissecting microscope.

Figure 205. *Lytrosis permagnaria* from Rockbridge County, Virginia (David Wagner photo).

Figure 206. *Lytrosis permagnaria* larva from Rockbridge County, Virginia (David Wagner photo).

Range

Lytrosis permagnaria is primarily a species of low- to mid- elevation hardwood forests in the southern Appalachian Mountains. It ranges from Augusta, Dickerson, and Rockbridge counties, Virginia (Butler *et al.* 2001, Wagner *et al.* 2003) and southeastern Kentucky (Covell 1999), southward into northwestern Georgia and northeastern Alabama. It has not been found in South Carolina. *Lytrosis permagnaria* was described from Missouri. There are old records for Oxford County, Mississippi (1949), Cleveland, Tennessee (1970), and Atlanta, Georgia (Rindge 1971). Since the 1980s there have been collections in the Ozarks of Missouri by J. R. Heitzman, and in Kentucky (Covell 1999). Bo Sullivan has taken specimens in North Carolina only in Haywood County at an elevation of about 3,000 feet (909 meters). James Adams and others have recently found the species at several localities in western North Carolina and in northern Georgia. Some Georgia localities are in low foothills rather than in the mountains.

Rarity

NatureServe global rank: G3G4.

This rarely encountered moth has been found at scattered localities over a broad portion of the central and southeastern United States. *Lytrosis permagnaria* can be numerous at times, where present. To date, no one has been able to associate it with any specific plant, and it occurs in common habitats. Most similar habitats are unoccupied. There is no basis to estimate the actual number of occurrences, but undiscovered populations surely exist. This species is not rare in a core range that includes northern counties of Georgia and Alabama, eastern Tennessee, and Macon County, North Carolina. More than a dozen localities have recently been recorded in that region (James Adams). Furthermore, Hugo Kons informs us that there are recent specimens from Tennessee and Mississippi at the Mississippi Entomological Museum.

Lytrosis permagnaria seems to be absent from most places in North Carolina for which there has been appropriate effort to locate it. Aside from this core range, it has been found at only about a dozen localities elsewhere, including the three in Virginia. Unlike almost every other species covered in this book, this one is collected in seemingly ordinary forests, and there is no evidence of a major decline. Rather, this species seems to be naturally rare for completely unknown reasons.

LIFE HISTORY

Lytrosis larvae are extremely cryptic stick mimics (Wagner *et al.* 2001, 2003). Larvae in this genus typically feed from June until about August. They reduce feeding in the antepenultimate instar, and begin to enter diapause in September, then overwinter. In spring they molt, resume feeding, molt once more, and pupate by early June.

In New Jersey, *Lytrosis sinuosa* Rindge larvae apparently overwinter exposed on small branches in the trees. Larvae of *Lytrosis sinuosa* offered leaf litter in a Styrofoam box crawled and rested on the sides and lid until given oak branches, on which they settled for the winter. All of twelve *Lytrosis sinuosa* larvae sleeved for the winter on post oak in New Jersey survived, and Wagner *et al.* 2003 reported two of three *Lytrosis permagnaria* survived similar treatment in Tennessee. Wagner (2005) mistakenly reported that the pupae of *Lytrosis unitaria* overwinter.

Females of this genus can lay well over 500 eggs. *Lytrosis permagnaria* adults start to fly in late May or early June in most places, but mostly about mid-May below 2,200 feet (671 m) in Georgia (James Adams).

The Oxford, Mississippi specimen was supposedly collected in August which would be a second brood, but unless this is verified by other reliable records, we treat this date as a probable error. All species of this genus appear to be single-brooded, except Heppner (2003) reports a second flight in July for *Lytrosis sinuosa* in Florida. On the other hand, Hugo Kons has found no evidence of such a second brood there.

Flight periods for two species of this genus last about two to three weeks most years in New Jersey, except for a few worn, persistent females. *Lytrosis permagnaria* adults often appear about a week earlier than other *Lytrosis* species in some areas.

Males, and less often females, come to lights. This species has yet to be taken at baits, but worn, largely spent, old females of *Lytrosis unitaria* come to bait in New Jersey, after the males have disappeared. With a good meal, such females will lay viable eggs. Male *Lytrosis permagnaria* come to lights from about 11:30 p.m. to 1 a.m. (J. R. Heitzman) and thus should turn up in normal collecting efforts. However, a short flight season could cause them to be overlooked in infrequently collected areas.

Host plants

The hosts are unknown, but David Wagner reared larvae in captivity mostly on red oak (*Quercus rubra*). The larvae also accepted other oaks and hickory (*Carya* species). Oaks are commonly used food plants for *Lytrosis unitaria*, and post oak (*Quercus stellata*) is probably the main food plant for *Lytrosis sinuosa* in New Jersey. Both of these species will also accept other genera in captivity. *Lytrosis unitaria* uses other plants in nature, at least in spring after hibernation. It should not be assumed that oaks are the normal food plant for *Lytrosis permagnaria*, which is likely to be at least facultatively polyphagous in nature.

Habitat

The habitat is usually low- to mid-elevation oak and mixed hardwood forests, but many places similar to known sites lack this moth. Rindge (1971) described the habitat as oak, hickory, and pine forests. The Georgia localities are very ordinary, with no unusual trees being exceptionally abundant. Wagner *et al.* (2003a) describe a similarly ordinary habitat where this moth has been collected commonly in Virginia.

Threats & management issues

Known habitats are oak-dominated, and are vulnerable to gypsy moth outbreaks. It would be useful to know how sensitive the older larvae are to *Btk* in spring. Given the flight season of the moths, overwintered larvae should complete feeding before defoliation by gypsy moth caterpillars becomes severe. However, it is possible that the eggs would hatch before replacement foliage of the food plant has matured. It is unknown whether young larvae will feed and grow normally on immature replacement leaves. Mature re-foliated leaves are nutritionally inferior to normal summer foliage. Therefore, if older larvae are not very sensitive to *Btk*, its use might protect occurrences of this moth during severe gypsy moth outbreaks.

Direct mortality to eggs and larvae should be low in light understory fires, assuming the food plant is a tree and larvae remain there for the winter. However, pupae and adults would be vulnerable to fire in spring if, as we suspect, they are in the leaf litter. Prescribed burning would not be a likely practice in the known habitats of this species.

References

Covell (1999), Forbes (1948), Rindge (1971), Wagner *et al.* (2001), Wagner *et al.* (2003a), Wagner (2005).

Dingy Metarranthis

Metarranthis apiciaria (Packard)

Identification

This medium-sized moth (35 mm) is one of the few species of *Metarranthis* in the northeastern United States that is easily recognized. The color is much duller, and usually paler, than other species with similar wing shape (Figure 207 and 208). However, even relatively dark individuals like that illustrated by Metzler *et al.* (2005) can be recognized by the lack of any red, orange or violet tint above. The upperside is most similar in color to the more northern *Metarranthis warnerae*, illustrated by Handfield (1999), but the wing shape, and course of the lines differ. Upon closer examination, the details of the pattern of *Metarranthis apiciaria* closely match those of the *Metarranthis lateritiaria-pilosaria* complex.

Figure 207. *Metarranthis apiciaria* male from Kankakee County, Illinois (Douglas C. Ferguson photo).

Figure 208. *Metarranthis apiciaria* female from Kankakee County, Illinois (Douglas C. Ferguson photo).

Range

The range of *Metarranthis apiciaria* extended from northern Illinois north to Toronto, eastward to the Atlantic coast from Long Island, New York, to coastal Maine (an inland record from Lincoln is unverified). Old records are concentrated in eastern New England, mostly around Boston, Massachusetts. Records in Farquhar (1934) and Metzler *et al.* (2005), and specimens seen by us from eastern Massachusetts in Malden, Brockton, Holliston, Sherborn, Hyde Park, Dorchester, Framingham and Salem, indicate that it could not have been a rare moth in the Boston area a hundred years ago. This species has become much rarer since the 1910s to 1930s.

Metzler *et al.* (2005) show a dot near Plymouth which probably refers to four misidentified *Metarranthis pilosaria* from East Wareham at the American Museum of Natural History (Dale Schweitzer observation). With collections in Connecticut, western Pennsylvania, and West Virginia, the range was not as disjunct as shown on the map by Metzler *et al.* (2005). Numerous specimens were collected by R. E. Carter in Beaver County, western Pennsylvania, from at least 1966 to 1971 (specimens in several collections including those of Eric Quinter and Dale Schweitzer), and one or more in Monongalia and Greenbrier counties, West Virginia (Linda Butler, West Virginia University), Litchfield County, Connecticut (one specimen at the Yale Peabody Museum), and Windham County, Connecticut (specimen at the American Museum of Natural

History). A series of eight individuals was taken in June 2008 in Killingly, Windham County, Connecticut (David Wagner collection).

Metarranthis apiciaria is also extant (1993 to 1998) and widespread in the bear oak scrub of Martha's Vineyard island, Massachusetts (five trap sites, *fide* Mike Nelson), which is curious because it has never been found on the adjacent Cape Cod mainland where extensive pine barrens exist. Also, Jim Vargo has collected specimens in Iroquois County, Illinois, adjacent Newton County, Indiana, and slightly to the east in Pulaski County, Indiana, between 1997 and 2006. Despite almost nightly efforts with mercury vapor lamps and blacklights by Tim McCabe and substantial efforts at nearby sites, *Metarranthis apiciaria* was not collected at the Albany, New York, pine barrens from the late 1970s through 2008. The last collections there (usually reported as Centre, New York) were in the 1870s, coinciding with the last local collections for *Catocala pretiosa* (Schweitzer 1982a) and *Lithophane lepida lepida,* among other rarities.

Rarity

NatureServe global rank: G1G3.

Metarranthis apiciaria has not been collected in 35 to over 100 years in most of its range, and we know of only the above occurrences verified in the last 25 years (all since 1997). Furthermore, its Midwestern savanna habitats are uncommon. Several of the specimens from Indiana, and all of the Maine, eastern mainland Massachusetts, Ontario, and New York specimens that we have seen, were collected between 1876 and 1937. West Virginia, Pennsylvania, New Hampshire, and central Massachusetts records from 1963 to 1980 may not represent extant populations, and subsequent efforts have failed to relocate this species at Hudson, New Hampshire, Montague, Massachusetts, or around Boston. Eastern West Virginia was extensively sprayed with Dimilin® in the late 1980s and early 1990s. We do not know if this moth still occurs there.

Based on specimens in collections, *Metarranthis apiciaria* appears to have disappeared from most of its range before 1940. The loss of oak savanna in the upper Midwest seems like an adequate explanation for current rarity in that region where some remnant habitats still support populations. The Albany, New York, Pine Bush was greatly reduced in size by urban development in the 20th century, although there is still substantial habitat remaining. Habitat loss does not seem to be an adequate explanation for its decline in Massachusetts, where there are still several extensive seemingly suitable habitats in the granite hills around Boston.

Metarranthis apiciaria seems to have declined in the Boston area within a decade or two after *Compsilura* was introduced in 1906. The most recent Boston area specimen that we have seen is one at the National Museum of Natural History collected at Hyde Park (now part of Boston) on 15 June 1920. This is ten years after the last *Citheronia sepulchralis* specimen known to us was collected in the area, during the regional collapse of the browntail moth (Elkington *et al.* 2006), and a year after the first reports (Culver 1919) of impacts by *Compsilura* to other moths. Unlike in the Boston area, there is no evidence that *Metarranthis apciaria* was ever common in Connecticut. There is a 1963 collection of *Metarranthis apiciaria* by Alexander Klots at Putnam, Connecticut, probably in his yard, and the one in Litchfield County in 1968 in addition to the 2008 records. In 1974, when *Metarranthis apiciaria* was collected there, the pine barrens at Montague Massachusetts were a local refuge for *Automeris io*, which had become very rare regionally (Morrell 1979, Dale Schweitzer observation). *Schizura apicalis* was present then and still is. While the timing of the decline appears consistent with *Compsilura* around Boston, evidence is weak elsewhere. One would not expect a caterpillar that presumably spends the day at the base of shrubs to be readily available to *Compsilura*. If *Compsilura* was indeed a major factor in its decline, perhaps the 2008 collection of *Metarranthis apiciaria* in Connecticut is an indication that it has recovered somewhat in the last 20 years, as some species of Saturniidae and *Datana* have done. Although several efforts with blacklights and many daytime visits failed to turn up *Metarranthis apiciaria* in the 1980s (Dale Schweitzer observation), this moth should be sought in the Boston area again, particularly in the Middlesex Fells and Blue Hills Reservations.

Life history

The biology of *Metarranthis apiciaria* is known only from laboratory rearings. As with other species of the genus (Wagner *et al.* 2001, Robinson *et al.* 2002, Wagner 2005), the larva is likely to be oligophagous or polyphagous on shrubs or small trees.

Except for *Metarranthis homuraria*, all eastern species of this genus are single-brooded rangewide with adults of most species appearing in late spring. Adults of *Metarranthis apiciaria* have been collected from 31 May to 6 July. According to Jim Vargo, *Metarranthis apiciaria* comes to light mostly after midnight, and could be overlooked by collectors whose efforts terminate earlier. Like several species of *Metarranthis*, this one is occasionally flushed in the daytime, such as Dave Winter's Hudson (labeled Nashua), New Hampshire specimen.

The eggs laid by captive females were not attached to any substrate (David Wagner observation), and so probably are either laid in the litter or soon end up there. Based on observations with other *Metarranthis* species, middle and late instar larvae probably spend the day hiding at the base of shrubs, or in the litter (Wagner *et al.* 2001, Dale Schweitzer observation). Based on four congeneric species reared by us, the egg stage probably lasts ten to 16 days, and larvae are probably slow-growing (at least six weeks).

The pupae overwinter in a cocoon spun in the leaf litter.

Host plants

David Wagner reared this species in captivity in 2006 on the leaves of black cherry (*Prunus serotina*) in the rose family (Roseaceae), and on birch (*Betula* species), in the birch family, from eggs obtained in Indiana by Jim Vargo. Neither of these plants is likely to be the usual hosts for this species. Of plants growing abundantly at the recent Connecticut site, *Corylus* and various Ericaceae seem like particularly plausible food plants.

Habitat

Habitats of *Metarranthis apiciaria* include oak savanna-prairie complexes in Indiana, Illinois, and Ohio (Metzler *et al.* 2005, Jim Vargo personal communication with Dale Schweitzer in 2005), and probably at Toronto, Canada. Eastward, this moth was often associated with barrens, shrublands, or other habitats with bear oak (*Quercus ilicifolia*) growing on sand, shale, and probably granite substrates. The understory vegetation in such places consists primarily of heaths eastward, and is more prairie-like westward. The collections from Centre, New York (1870s), Montague, Massachusetts (1974), and some Martha's Vineyard (1990s), were from well-known pitch pine-bear oak barrens. The Putnam, Connecticut (1963), collection site was a few kilometers from remnants of similar habitats. The Killingly, Connecticut, site is a shrubby powerline corridor dominated by hazel (*Corylus* species), huckleberry (*Gaylusaccia* species), sheep laurel (*Kalmia angustifolia*), and other heaths, with some scattered bear oak. The Hudson, New Hampshire (1973), specimen was captured during the daytime on a dry powerline with bear oak near Otternick Pond.

Most older New England records are not associated with known classic barrens or sand plains. The absence of *Metarranthis apiciaria* specimens from the Plymouth-Cape Cod area (Museum of Comparative Zoology at Harvard and the American Museum of Natural History collections, Farquhar 1934, Mike Nelson personal communication with Dale Schweitzer in 2005) suggests that *Metarranthis apiciaria* was not using sandy habitats widely on the eastern Massachusetts mainland. The recorded localities are now mostly urbanized, but there are still hundreds of hectares of preserved and frequently burned (accidently or otherwise) oak-heath woodland, bear oak scrub, and balds on the surrounding granite hills, such as Stony Brook, Blue Hills, Middlesex Fells[8] and other reservations. These dry rocky habitats are substantial enough to still support a nearly endemic tiger beetle subspecies, *Cicindela rufiventris hentzii*, and are probably representative of *Metarranthis apiciaria* habitats in the Boston area nearly 100 years ago.

At least one of two West Virginia specimens was taken near shale barrens (Linda Butler). Shale barrens are often surrounded by and contain scrubby oaks such as bear oak. The habitat at Steep Rock Preserve, Litchfield County, Connecticut (1968 specimen in Yale Peabody Museum), is unknown. No unusual habitat is known near the 1960s Pennsylvania site given on specimen labels as "6 mi. sw. Darlington, Beaver County," but a variety of forest types with oaks are present. In 1987, Dale Schweitzer visited what remains of the pitch pine habitats at Brunswick, Maine, near where Packard collected *Metarranthis apiciaria* about 100 years earlier, and found very few oaks and no *Quercus ilicifolia*. There are still extensive pitch pine-bear oak barrens on sand plains in two adjacent counties in Maine, but no *Metarranthis apiciaria* were found by Dale Schweitzer and Nature Conservancy and Natural Heritage Program staff in several efforts with overnight blacklight traps in the 1980s and 1990s.

Threats & management issues

Some known habitats of *Metarranthis apiciaria* are or were probably maintained by occasional fires. Succession from lack of fire could eliminate the moth's habitats, but survival of any life stage would be very low at best in prescribed burns. Therefore, refugia and a reasonable interval between burns are needed.

It is not likely that *Metarranthis apiciaria* would be impacted by *Btk* used to control gypsy moths, because the larvae would hatch more than a month after application. Such treatment could be beneficial to the extent that defoliation of the food plant is prevented. However, a chemical biocide with a longer lethal residue such as Dimilin®, would be a threat.

8 This Reservation is partially in Medford, the point of entry for the gypsy moth in North America, and is about 2 km from the actual porch where the infamous escape of the caterpillars occurred. Thus, these woods have had gypsy moth outbreaks since the 1870's.

References

Covell (1999), Elkington *et al.* (2006), Farquhar (1934), Ferguson (1972), Forbes (1948), Morrell (1979), Rindge (1971), Wagner *et al.* (2001), Wagner *et al.* (2003a), Wagner (2005).

Southern Metarranthis

Metarranthis lateritiaria (Guenée)

Identification

This is a medium-sized moth (35 mm +), but is one of the larger geometrids covered in this book. It is bright orange beneath. Among *Metarranthis* species, true *Metarranthis lateritiaria* is easily recognized by its larger size and general lack of variation other than some sexual dimorphism (Figure 209 and 210). Females of the undescribed *Metarranthis* species 1 are similar, but much smaller, slightly darker, and have a more scalloped hindwing.

The larva has not been described.

Figure 209. *Metarranthis lateritiaria* male from Charleston County, South Carolina (Douglas C. Ferguson photo).

Figure 210. *Metarranthis lateritiaria* female from Charleston County, South Carolina (Douglas C. Ferguson photo).

Taxonomic notes

Very few literature citations using this name actually refer to *Metarranthis lateritiaria*. Kimball (1965) and Heppner (2003) recorded the species from Florida as both *Metarranthis lateritiaria* and *Metarranthis pilosaria*. Kons and Borth (2006) reported it as *Metarranthis* species. The species treated by Forbes (1948) as *Metarranthis lateritiaria* is unnamed and occurs mostly near the coast from Nova Scotia to New Jersey. Identifications of females of *Metarranthis lateritaria* from North Carolina and Florida as *Metarranthis pilosaria* at the American Museum of Natural History (Kimball 1965) in the 1960s and 1970s may have been a source of much of this confusion. *Metarranthus pilosaria* occurs along the coast from Massachusetts to New Jersey. There is a second unnamed species in this complex which we discuss below.

Range

True *Metarranthis lateritiaria* has been recorded from sites on the eastern Coastal Plain from southeastern North Carolina southward to the Florida Panhandle and westward to southern

Louisiana. Also, a single somewhat unusual specimen (currently in the Dale Schweitzer collection) collected on 4 June 1975 at Indian Mills, Burlington County, New Jersey, in the heart of the Pine Barrens, could be no other known species.

Rarity

NatureServe global rank: G3G4. Certainly this moth is not now imperiled, but it is still known from relatively few places, and is often found in uncommon and declining habitats, at least northward. More collecting in the Southeast might show this moth to be fairly widespread and secure, but we include it here, since it is poorly known.

Life history

Metarranthis lateritiaria has not been reared, and its larva is unknown. Adults occur in April and early May, except for the one New Jersey specimen. Based on the biology of related species, the larvae are likely to appear in late April or May in most places. Larval periods of other late spring *Metarranthis* species vary from about 5–11 weeks in New Jersey, so we do not know when larvae of *Metarranthis lateritiaria* are mature.

Metarranthis overwinter as pupae in a cocoon in leaf litter on the ground.

Host plants

Vernon Brou (personal communication with Dale Schweitzer in 2008) found larvae in Louisiana on swamp bay (*Persea palustris*), a small tree in the laurel family. Except for the New Jersey specimen, all collections are from within the range of this plant. Larvae of *Metarranthis* have rarely been found in the wild, but as far as is known, they are oligophagous to polyphagous, mostly on shrubs. Several genera of heath family plants (Ericaceae) and other shrubs are prevalent in the habitats where *Metarranthis lateritiaria* occurs, and some of these may be food plants. Late instars probably spend the day around the base of the food plant, if it is a shrub.

Habitat

This species is usually found in pine flatwoods, wet pine savannas, and other shrubby wetlands, and at least occasionally in cypress and hardwood swamps.

Threats & management issues

No life stage of this genus lives underground and, unless protected by soggy substrate, all stages would incur high mortality in fires. Therefore, unburned refugia are needed, except in the wettest habitats. The habitat might be suitable (maybe even optimal) within a year after a fire, because the shrubs sprout back quickly. Some known habitats for this moth require occasional to frequent fires to remain open, but it is not known to what extent populations also occur in swamp forests.

Btk used to kill gypsy moth caterpillars could pose a risk, depending on whether young larvae are present, and their sensitivity. Mortality to larvae hatching more than a week after application would probably be low.

Most habitats of *Metarranthis lateritiaria* are not vulnerable to damage by gypsy moth larvae.

If *Metarranthis lateritiaria* really is a *Persea* specialist, then it is threatened with loss of its food plants to laurel wilt disease.

References

Most, if not all of the 20th century references to this species known to us actually refer to an unnamed northern species. However, based on specimens that we have examined or seen images of, records listed by Heppner (2003) and Kimball (1965) under this name may be correct. Some or all specimens listed under *Metarranthis pilosaria* in Kimball (1965) also are *Metarranthis lateritiaria*. The most useful reference is Kons and Borth (2006).

Mid-Atlantic Metarranthis

Metarranthis species 1 (not formally described)

Identification

This is a medium-sized moth (27 to 30 mm), about average-sized for a *Metarranthis* species, and much smaller than *Metarranthis lateritiaria*. It is similarly bright orange beneath. It is most similar to the unnamed species described by Forbes (1948) as *Metarranthis lateritiaria* (NatureServe, *Metarranthis* species 2), but darker, of lower contrast, and the postmedian line on the forewing is less sharply angled (Figure 211 and 212). The ranges of these two species and *Metarranthis pilosaria* overlap in New Jersey, and worn specimens from this area may be difficult to separate. Variations in the color of the larva are shown in Figures 213-215.

Figure 211. Mid-Atlantic *Metarranthis* (*Metarranthis* species) male from Cumberland County, New Jersey (Douglas C. Ferguson photo).

Figure 212. Mid-Atlantic *Metarranthis* (*Metarranthis* species) female from Cumberland County, New Jersey (Douglas C. Ferguson photo).

Range

This moth has been collected in the Pine Barrens and Delaware Bay regions of southern New Jersey, and from southeastern Virginia to southeastern North Carolina. Also, an image which can be seen on the Georgia Lepidoptera website, of a spread female specimen from Griffin Ridge Wildlife Management Area in Long County, Georgia, along the Altamaha River (James Adams), appears to be this species.

Figure 213. Mid-Atlantic *Metarranthis* (*Metarranthis* species) larva from Cumberland County, New Jersey (David Wagner photo).

Figure 214. Mid-Atlantic *Metarranthis* (*Metarranthis* species) larva from Cumberland County, New Jersey (David Wagner photo).

Figure 215. Mid-Atlantic *Metarranthis* (*Metarranthis* species) larva from Cumberland County, New Jersey (David Wagner photo).

RARITY

NatureServe global rank: G3G4.

This undescribed and poorly known *Metarranthis* species is still rare in collections, but might prove to be widespread in southern swamps. Less than 40 field-collected specimens are known to us, and most are in poor condition.

Steve Hall and Bo Sullivan suggested to Dale Schweitzer the possibility that this taxon may be two undescribed species, although this is far from certain. Specimens from the Fall Line Sand Hills region around Ft. Bragg, and one from Bladen County in the southeast, more closely resemble those from New Jersey than do most specimens from Dare County, and most from the southeastern counties of North Carolina.

With recent collections in Delmarva Peninsula swamps and in Georgia, this moth is not as restricted as once thought, but is absent from many well-collected places, even in New Jersey and North Carolina. As of 1998 there were three known occurrences in Virginia.

LIFE HISTORY

This moth is univoltine, like almost all other species in the genus. The adults fly in the New Jersey Pine Barrens from about mid-June to early July. Slightly to the south in Cumberland County, New Jersey, they begin to emerge at the end of May. Adults begin to appear around late April southward and are mostly worn in late May and early June. Dates for North Carolina run from 21 April to 27 June, a remarkably large span for a *Metarranthis*, although these are from several counties and different years and possibly include two species. Reared adults (from New Jersey) eclosed over less than two weeks. At least in North Carolina, adults occur mostly later than *Metarranthis lateritiaria*.

This species seems to be easily missed in light trap sampling in New Jersey, possibly because the flight season is very short in any given year, and repeated efforts are recommended when looking for new occurrences.

No larvae have been found in the wild, but two cohorts were reared from eggs laid by captive females. Eggs were laid singly and were tightly attached to substrates, often the side of the jar. They hatched in 13 to 16 days.

Hatchling larvae preferred, but did not require, soft young foliage. The larvae developed slowly, hatching mostly in late June and maturing mostly in September, and extending into late September in droughty conditions. Older larvae descended the food plant, and at least in sleeves, rested during the day as low as possible on stems. They may hide in leaf litter on the ground in nature.

The larvae did not burrow into the soil to pupate, even when suitable substrate was provided, but spun cocoons among dead leaves, in which they overwintered. Adults come to blacklight, usually before midnight, and females sometimes come to bait.

Host plants

Plants on which larvae were reared to maturity in sleeves by Dale Schweitzer include gallberry (*Ilex glabra*) in the holly family (Aquifoliaceae), coastal sweetpepperbush (*Clethra alnifolia*) in the Clethraceae, as well as maleberry (*Lyonia ligustrina*) and swamp doghobble (*Leucothoe racemosa*) in the heath family (Ericaceae), all common shrubs of habitats where this species occurs. Highbush blueberry (*Vaccinium corymbosum*) and northern bayberry (*Morella pensylvanica*) were not rejected, but the larvae grew slowly and suffered high mortality on these hosts. The leaves of red chokeberry (*Aronia arbutifolia)*, oaks (*Quercus* species), swamp azalea (*Rhododendron viscosum*), American holly (*Ilex opaca*), and sweetbay magnolia (*Magnolia virginiana*) were rejected by the larvae, or nearly so. Black cherry (*Prunus serotina*) was also rejected, except for the leaves from one particular tree. Larvae reared on this tree matured almost one month faster than those reared on the other plants, but they rejected leaves from other black cherry trees.

Habitat

In New Jersey, this species has been found in a variety of swamps and shrubby bogs with Atlantic white cedar (*Chamaecyparis thyoides*), pitch pine, and hardwoods such as red maple (*Acer rubrum*), black gum (also called tupelo) (*Nyssa sylvatica*), and sweetbay magnolia (*Magnolia virginiana*). The tree canopy varies from sparse to very dense. Shrubs, ranging in height from half a meter (in open habitats) to, more usually, over two meters tall, are always abundant.

Southward, the habitat seems to be peatlands such as non-riparian swamp forests and pocosins (Steve Hall). This is the only moth that we know of in the *Metarranthis lateritiaria- Metarranthis pilosaria* complex that regularly occurs in forested wetlands.

The mid-Atlantic *Metarranthis* also turns up in boggy sections of powerlines and in shrub swamps in New Jersey, but does not seem to prefer leatherleaf-cranberry bogs where the unnamed species called *Metarranthis lateritiaria* by Forbes (1948) and *Metarranthis pilosaria* can be abundant.

In New Jersey this moth occurs in some of the same swamps that harbor *Catocala pretiosa*, but the *Metarranthis* species 1 is also found in more open habitats in the Pine Barrens.

Threats & management issues

No stage of this genus is underground. Unless they are protected by wet substrate, all stages could be killed by fire. Unburned refugia are needed for this moth to persist in most places, and the habitat at some sites may require fire. However, since this moth turns up regularly in forested wetlands, succession in these fire-maintained habitats may not be a threat.

Btk used for gypsy moth control should pose no risk, because application would probably be more than a month before the larvae of the Mid-Atlantic Metarranthis appear. Given the habitat and phenology, it is unlikely that gypsy moth defoliation would affect this species significantly.

References

None, but see Forbes (1948) for some related species.

Boreal pine looper[9]

Nepytia pellucidaria (Packard)

Identification

Fresh males and probably females of this rather large geometrid are easily recognized by their size (35-40 mm) and the well-developed wing pattern, but we have not seen females collected more recently than 1919. Fresh males of *Nepytia pellucidaria* should be easy to identify from our illustration (Figure 216). *Neyptia pellucidaria* is also illustrated by Handfield (1999). *Nepytia pellucidaria* flies relatively late in the autumn.

Figure 216. *Nepytia pellucidaria* from Carroll County, New Hampshire (David Wagner photo).

Old faded specimens resemble the much smaller (< 30 mm) unnamed species, *Nepytia* species 1 (as designated in the NatureServe database, see also Forbes 1948, p. 104). . This unnamed species flies as late as early August at its northern limit on the southern coast of Massachusetts.

The colorful larvae of *Nepytia pellucidaria* and *Nepytia* species 1 are similar, but Maier *et al.* (2004) report some possible differences. The latter is also illustrated by Wagner (2005).

9 This species is called the false pine looper by Maier *et al*. (2004), but since it is closely related to several other pine loopers, and so not false, we suggest an alternate common name here.

Taxonomic notes

Holland (1903) listed *Nepytia pellucidaria* as a synonym of *Nepytia semiclusaria,* but his illustration appears to be *Nepytia canosaria*. *Nepytia pellucidaria* is similar to *Nepytia semiclusaria* of the southern coastal plain, approximately South Carolina to Texas, and if the intervening taxon were not so dissimilar in size and phenology, one might consider them to be the same species. Furthermore, *Nepytia semiclusaria* is well known as the pine conelet-looper, a pest of developing pine cones in Florida. By contrast, *Nepytia* species 1 feeds mostly on young pine needles.

We know little about the feeding habits of *Nepytia pellucidaria* other than last instars eat pine needles. Farquhar's (1934) records of *Nepytia semiclusaria* refer to *Nepytia pellucidiaria* in Maine and New Hampshire at least. The Long Island, New York record for *Nepytia pellucidaria* in Forbes (1948) probably refers to the undescribed *Nepytia* species 1, which is known to occur there.

Range

Nepytia pellucidaria occurs in Wisconsin (Ferge and Balogh 2000), especially in the sandy central pine barrens, and Hugo Kons reports recent collections in Portage and Marinette counties. Moore (1955) did not report it from Michigan.

The species ranged eastward very locally to Nova Scotia including Maine, New Hampshire, and Albany, New York. It has been collected at about five scattered localities in Ontario (Don Lafontaine), including at Manitoulin Island (2004 to 2006) and the east end of Algonquin National Park (Christian Schmidt) near the 1974 Pembroke locality (Canadian National Collection). Handfield (1999) reports it from seven places in Quebec.

Most specimens that we have examined are from New Hampshire. Despite other records given by Brower (1974) for Maine, according to Doug Ferguson (letter of 10 June 2000 to Dale Schweitzer), only a single Maine specimen, from Eastport (which is within the current range), collected on September 23, 1940, was in the Brower collection. Most other Maine records were probably misidentifications, but Alpheus S. Packard Jr. did collect specimens at coastal Brunswick in the late 1800s, and Farquhar (1934) reports the species (as *Nepytia semiclusaria*) at Enfield. Specimens tentatively identified as *Nepytia semiclusaria* by Farquhar (1934) from eastern Massachusetts might also have been *Nepytia pellucidaria*, and are outside of the known ranges of both that species and *Nepytia* species 1. Ferguson (1955) lacked records from Nova Scotia, but there is an old specimen from that province in the Canadian National Collection.

Rarity

NatureServe global rank: GU.

Apparently, this species has always been rare, or maybe more accurately very local, except in Wisconsin and possibly New Hampshire and southern Maine. We know of no New York collections since before 1900, despite extensive collecting in suitable habitats since then by Tim McCabe and others. Handfield (1999) refers to it as very rare in Quebec, and the specimens he illustrates were collected in 1941. There are only eight specimens in the Canadian National Collection, including three from Pembroke, Ontario, collected in 1974 (Don Lafontaine email to Dale Schweitzer on 17 June 2008), and five much older specimens from Nova Scotia, Quebec, and Ontario. Don Lafontaine also notes that the food plants are very common in Ontario, including behind his house where he runs light traps routinely, but has never encountered this moth, anywhere.

After 1919, the only 20th century collections we know of in New England were Brower's example from Washington County on the Maine coast in 1940, and several collected by M. A. Roberts in the same county from 1989 to 1997. Maier *et al.* (2011) found larvae in Washington County and illustrated one collected on red pine on 30 July 1997. Presently this species extends eastward into adjacent New Brunswick, Canada, where six specimens were collected at two localities near Fredricton by A. W. Thomas in 2000 and 2003.

Notably, Proctor (1946) did not collect it in his extensive surveys at Mt. Desert Island on the Maine coast, and at the range limit for pitch pine. While he states that Brower did collect one there in 1936, as noted above, we have not been able to locate the specimen to confirm the identification.

Nature Conservancy staff and Dale Schweitzer made several unsuccessful attempts to find adults and larvae in the extensive pitch pine barrens in York County, Maine, during the 1980s and early 1990s. Jeff Lougee did not get it in light trap samples at Ossipee barrens, New Hampshire a few kilometers from the old Conway region, on September 9, 2002, nor did Lars Crabo on 2 October 1985, although these two efforts were not optimally timed. In September 2000, Reginald Webster found *Nepytia pellucidaria* abundantly at lights in the barrens near Freyburg, Maine, about 10 miles (17km) east of the old Conway and Intervale localities where the species was still abundant in 1919. In 2007 and 2008 Rick van de Pol trapped 46 males (one of which we illustrate), in Effingham about 25 miles (42 km) south of Freyburg, and in the greater Ossipee-Conway-region pine barrens. While several other species in the tribe Cingiliini are prone to large fluctuations, and *Nepytia pellucidaria* is probably irruptive (Christian Schmidt email to Dale Schweitzer in June 2008), the other conifer-feeding species are easily collected in non-peak years. It is unlikely that natural fluctuations in populations caused its virtual absence in the Northeast for much of the 20th century, and large-scale loss of habitat simply did not occur. Apparently only one *Nepytia pellucidaria* was collected in New England from 1920 through 1987. None has been seen for over 130 years in New York, and it is apparently historic in Quebec. The boreal pine looper was apparently not seen for several decades in the Canadian Maritimes either.

The last historic collections of *Nepytia pellucidaria* in the Conway, New Hampshire, area in 1919 coincided with the rapid disappearance of the browntail moth (*Euproctis chrysorrhoea*) there sometime after 1914 but before 1922 (Elkington *et al.* 2006, Fig.1). Prior to its rapid disappearance, the browntail moth was considered to be more of a forest pest than the gypsy moth. Elkington *et al.* (2006) present a compelling multi-faceted case for *Compsilura concinnata* as the cause for reduction of its North American range from around 160,000 km^2 in 1914 to two tiny coastal sites today. *Compsilura* had been introduced near Boston in 1906. They also document that the browntail moth generally persisted longer in coastal areas than inland. Like *Nepytia pellucidaria* in Washington County, the browntail moth still persists on the Maine coast. One of its two remaining North American outposts is at Maine's Casco Bay (Elkington *et al.* 2006).

The decline in the browntail moth and *Nepytia pellucidaria* in New England were similar in location, timing, and both had refugia on the Maine coast. Such close spatial and temporal similarity in their fates suggest a common cause. *Cingilia catenaria*, a close relative of *Nepytia pellucidaria* (congeneric in the opinion of Forbes 1948), was an early documented host for *Compsilura* (Arnaud 1978, Webber and Schaffner 1926). *Cingilia catenaria* also declined in New England. The related conifer-feeding *Nepytia canosaria, Lambdina fiscellaria* and *Lambdina fervidaria*, which are sympatric with *Nepytia pellucidaria*, are notably smaller than *Nepytia pellucidaria* and *Cingilia catenaria*. Their small size might make them less suitable hosts for *Compsilura*. While we will probably never know for sure, *Nepytia pellucidaria* might have been the first native moth to have been severely impacted by *Compsilura* beyond the Boston area.

Whatever happened to *Nepytia pellucidaria* during most of the last century, it appears to have persisted in coastal "down east" Maine and since 2000 has been recovering elsewhere in Maine and New Hampshire. Besides eastern coastal Maine, there might have been another refugium in the pine barrens of the Conway-Ossipee-Freyburg area. Notably these barrens are only about 100 kilometers west of coastal Cumberland County, Maine where Packard collected *Nepytia pellucidaria* before 1900 and where the browntail moth still occurs on Casco Bay. There are substantial areas of pitch pine barrens and forest in Cumberland and adjacent York counties.

Life history

Adults occur from the end of August into October in Wisconsin, and apparently also in Quebec. In New England adults occur mostly in mid- and late September.

Eggs overwinter, and larvae hatch sometime in the spring or early summer. The 27 July date for the larva illustrated by Maier *et al.* (2011) suggests they probably mature in August, when they probably pupate in webbing among living pine needles like *Nepytia* species 1.

Host plants

The caterpillar of *Nepytia pellucidaria* is a specialist on pines, including red pine (*Pinus resinosa*), pitch pine (*Pinus rigida*), jack pine (*Pinus banksiana*) (Maier *et al.* 2011, Christian Schmidt), and white pine (*Pinus strobus*) (three specimens at the Canadian National Collection).

Habitat

Nepytia pellucidaria occurs in extensive pine forests and barrens on sandy soils. It occurs in pitch pine barrens in western Maine, New Hampshire, and it historically did in New York. *Nepytia pellucidaria* still occurs with red pine and jack pine stands in coastal eastern Maine, New Brunswick, Ontario, and Wisconsin. The significance of white pine as a food plant is uncertain, but one would expect this moth to be much less localized if that were an important host. M. A. Roberts (personal communication with Dale Schweitzer) described the habitat for five of his Washington County, Maine, specimens as an old mixed planting of red pine and white pine. It is likely that, within its disjunct range, a few could turn up around any stand of pines.

Threats & management issues

Species in the genus *Nepytia* do not pupate underground. If all stages occur in the pines, as is the case with *Nepytia* species 1, survival should be substantial in fires that do not scorch the canopy.

It is not possible to suggest impacts from *Btk* applications aimed at gypsy moth or spruce budworm (*Choristoneura fumiferana*) without knowing more about the larval phenology of *Nepytia pellucidaria*. However, another species of this tribe is highly susceptible (Peacock *et al.* 1998).

REFERENCES

Brower (1974), Elkington *et al.* (2006), Farquhar (1934), Ferge and Balogh (2000), Forbes (1948), Handfield (1999), Maier *et al.* (2011), Morrell (1979), Proctor (1946).

PINE BARRENS SPERANZA

Speranza exonerata FERGUSON

IDENTIFICATION

This small (25 mm) moth looks like a less-colorful version of *Speranza inextricata*. The postmedian line is visible on the forewing of both sexes, but is not enlarged and darkened at the costa (Figure 217). This characteristic, in combination with the slightly yellowish (but never bright yellow) hindwing of the female and underside of both sexes should be diagnostic.

The larva has not been described.

Figure 217. *Speranza exornata* (pine barrens Speranza) (Douglas C. Ferguson photo).

TAXONOMIC NOTES

This moth, which was described by Ferguson (2008), has been misidentified as *Itame inextricata* in some collections, and recognized as an unnamed *Itame* in others. Forbes (1948) improperly applied the specific name *Itame inceptaria*. Ferguson (2008) transferred most North American *Itame* to *Speranza*.

RANGE

The primary range of the pine barrens *Speranza* includes parts of Ocean and Burlington counties, New Jersey, extending slightly into adjacent Camden and Atlantic counties, with an isolated population in Salem County, and also southeastern Massachusetts, including the island of Martha's Vineyard. Otherwise, scattered colonies occur on ridgetops and sand plains essentially from the limit of scrub oak in Maine, to Albany, New York, and southward to the Pocono Mountains of Pennsylvania and Long Island, New York. A few have also been collected in Rockbridge County, Virginia, and West Virginia.

RARITY

NatureServe global rank: G3G4.

Speranza exonerata has a limited range and there are few occurrences known outside of New Jersey and southeastern Massachusetts. It occurs mostly in high-quality pitch pine-bear oak barrens, a rare natural community. Furthermore, it is absent from some areas with seemingly good pine barrens habitat, such as those that existed into the 1990s at Concord, New Hampshire. This moth is quite scarce at other pine barrens localities, such as Albany, New York, where it has probably died out. Gypsy moth spraying from the 1950s to around 1980 might explain its apparent absence in the now depauperate Rhode Island pine barrens.

The pine barrens Speranza has recently been discovered on acid balds with bear oak in New York, Connecticut, and Massachusetts, including a few small sites, and in Virginia. It now seems likely that more populations will be found. *Speranza exonerata* will probably prove to be more secure (G4) than present information would suggest. However, there are still less than 20 documented occurrences outside of the New Jersey Pine Barrens, and the species was not found in, or failed to persist on, some large pine barrens, such as in Maine, New Hampshire, and Rhode Island.

Life history

Almost all adult captures have been between 20 June and 8 July in the New Jersey Pine Barrens, and between 29 June and 20 July north of this region. Adults have been collected in mid-June in Salem County, New Jersey and in Virginia. In Dale Schweitzer's experience, this is one of the few barrens species of *Speranza* that is not seen in the daytime, suggesting that the moth is completely nocturnal.

As with other *Speranza* species, the eggs overwinter, and larvae feed in spring.

This species was rarely collected before the widespread use of blacklights starting in the 1960s. Forbes (1948) knew of specimens only from Lakehurst, in the New Jersey Pine Barrens. Both sexes come to blacklight well, but not to bait.

Host plants

Tim McCabe has collected a few larvae on bear oak (*Quercus ilicifolia*) at Albany, New York. The distribution, especially in New Jersey, suggests that this species may be monophagous, or very nearly so, on bear oak.

Habitat

With some exceptions, this moth occurs in pitch pine-bear oak barrens. The Salem County, New Jersey, occurrence is among the smaller sites (200 hectares), but a few New England ridge-top occurrences are only about five hectares each (David Wagner observation). Paradoxically, the species has failed to turn up in some large pine barrens in Maine, New Hampshire, and Rhode Island.

Most occurrences are on sandy soils, but some are on granite and other rock outcroppings.

Threats & management issues

Only the brief pupal stage of *Speranza exonerata* might have any protection from fires. However, top-kill of the bear oaks during this period would probably cause females from surviving pupae to leave the area, rather than oviposit on the dead stems. Survival in fires at other seasons would be very low at best, so land managers should not burn the entire habitat at once.

Nevertheless, plant succession due to lack of fires is probably a much greater threat. Gypsy moth defoliation could be a threat if it were to occur before the larvae mature. This would be uncommon, but is possible, especially on ridgetops. While bear oak-dominated habitats in southern New Jersey and coastal New England generally escape serious defoliation, ridgetop stands are at high risk during outbreaks, and some Maine barrens can be subject to rather chronic defoliation of bear oaks. Gypsy moth spraying could be a threat, but there is no basis to suggest whether larvae would be sensitive to *Btk*. Larvae would be exposed, probably as middle instars, to *Btk* sprayed to control gypsy moth larvae.

References

Ferguson (2008), Forbes (1948).

Florida Speranza

Speranza inextricata (Walker)

Identification

This is a small to medium-sized moth (25 to 30 mm) that often flies in the daytime. No similar species occurs in its range, so identification should be easy from our illustration. The orange color of the females and most males is distinctive (Figure 218). Unusually dull males can be separated from other *Speranza* species by range. Holland's (1903) illustration is a misidentified *Mellilla xanthometata*. The larva of *Speranza inextricata* has not been observed.

Figure 218. *Speranza inextricata* from Ocala National Forest, Marion County, Florida (Marc Minno photo).

Taxonomic notes

In the past, *Speranza inextricata* has been placed in the genus *Itame*. Records of *Itame inextricata* from Virginia northward represent *Speranza exonerata*, except that the identity of the species that Brower (1974) reports from Maine is unknown to us.

Range

This pretty little moth has been collected throughout much of Florida, from the Panhandle (Escambia County) south to the Archbold Biological Station in Highlands County (Minno 1992b; Ferguson 2008), and at a few places in Georgia as far north as the Ohoopee Dunes in Tattnall County. Kons and Borth (2006) had not encountered it in northern Florida, but Kons has collected one since in Alachua County.

Rarity

NatureServe global rank: G3G4. Records in Kimball (1965) and Ferguson (2008) suggest that this moth is widespread, but generally uncommon. Upland areas of Florida are very quickly being converted to urban uses, and its habitat has undoubtedly been much reduced in recent times. Robert Belmont finds it uncommonly, and has usually seen only a few adults per visit to areas where it occurs. However, he notes that on occasion some collectors have briefly encountered hundreds of adults in the Ocala National Forest. We do not know whether Kon's and Borth's (2006) results are indicative of a recent decline.

Life history

Males of *Speranza inextricata* are much less common in collections than females. The bright orange coloring of the wings, especially the hindwings and undersides, suggest that this species is mostly active during the daytime. Adults have been collected from 13 March (unusually early and perhaps an error) to 28 May (Hugo Kons) in Florida. Most Florida specimens have been taken in April. In Tattnall County, Georgia, it has been collected in late May (23 and 24 May).

Although the life history is unknown, *Speranza inextricata* probably pupates underground for about two weeks in late spring. Eggs are probably attached to the food plant, but might be in the leaf litter if the food plant is a shrub. Larvae probably remain on the food plant. Unlike the closely related genus *Macaria,* which some authors combine with *Speranza*, most *Speranza* species are univoltine and overwinter as eggs.

Host plants

The host plant of the Florida Speranza is unknown. *Speranza* larvae feed on new growth of shrubs or small trees, with several species on plants in the heath family (Ericaceae), or currants (*Ribes* species, Grossulariaceae). Because its closest relative, *Speranza exonerata*, apparently feeds on bear oak, we suspect that *Speranza inextricata* also feeds on soft young oak leaves.

Habitat

This moth occurs in sandhill and scrub woodlands. The northernmost documented site is in the Ohoopee dunes, Georgia. This area hosts several other species treated in this book, including *Schinia arefacta* and *Fernaldella georgiana*, which is nearly endemic.

Threats & management issues

Prescribed fire could jeopardize *Speranza inextricata* populations if too much of the habitat is burned at once. Adults of this genus rest in the leaf litter, so survival of adults is likely to be very low, at best, in prescribed fires. Because *Speranza inextricata* probably pupates underground, the pupae may survive, but this is not certain. If eggs or larvae occur in the leaf litter or on a low-lying food plant, fire would be a threat. If the larvae and eggs are in trees, light ground fires probably would not kill all of them.

Habitat changes due to lack of fire could also be a threat.

References

Ferguson (2008), Heppner (2003), Kimball (1965), Minno (1992b).

Faded gray

Stenoporpia polygrammaria (Packard)

Identification

The faded gray is a medium sized moth (wingspan 35-40 mm), with females consistently larger than males. The ground color of the forewings is smoky white (Figure 219 and 220), and is appreciably whiter than most other grays (grays are members of the tribe Boarmini). The basal and medial bands are often at least partially doubled, especially the latter. The discal spot in the hindwing is elongate. The wing margins have a distinct, scalloped terminal line, to the extent that the hindwing appears scalloped in some individuals. The undersides of the wings of *Stenoporpia polygrammaria* are without obvious patches of the dark scales (such as on the forewing apex) that often occur on other grays. The hindwings are pale and unmarked, except for a faint discal spot. In males, the (feathery) antenna pectinations end about a dozen segments before the apex. Adults of this species are also illustrated by McGuffin (1977) and Wagner *et al.* (2001). The larva is illustrated in Figure 221 and in Wagner *et al.* (2001).

Figure 219. *Stenoporpia polygrammaria* male from Dukes County, Massachusetts (David Wagner photo).

Figure 220. *Stenoporpia polygrammaria* female from Dukes County, Massachusetts (David Wagner photo).

Figure 221. *Stenoporpia polygrammaria* larva from Dukes County, Massachusetts (David Wagner photo).

Taxonomic notes

Stenoporpia polygrammaria was sometimes placed in the genus *Glena* (Forbes 1948).

Range

This is primarily a western species. The faded gray is found from southeastern Saskatchewan across southern Manitoba to central Wisconsin, with one collection site in eastern Ontario (McGuffin 1977). Published records, mostly pre-1900, include Ithaca and Rhinebeck, New York (Forbes 1948), and Amherst, Massachusetts (type locality). All three of these localities are well inland. Historically the faded gray was found in several places along the coast in eastern Massachusetts to

Kittery, Maine (Farquhar 1934). Between 1988 and 2002 it was found in Kentucky (Covell 1999), North Carolina (Wagner *et al.* 2001, Bo Sullivan personal communication with Dale Schweitzer), and Kanawha County, West Virginia (Albu and Metzler 2004). We have not examined Kentucky or West Virginia specimens. There are also reports from Georgia and Arkansas, but the Georgia Lepidoptera website (as of 2011) does not list this species.

Few specimens are available from most of its eastern range, except for Massachusetts and one site in North Carolina. No specimens are known from New Jersey, Connecticut, Rhode Island, Pennsylvania, Delaware, Maryland, or Virginia.

The species was apparently widespread in coastal Maine, New Hampshire (American Museum of Natural History), and Massachusetts in the late 1800s and very early 1900s. Roland Thaxter began collecting at Kittery, Maine in about 1884 (Brower 1974) and took *Stenoporpia polygrammaria* there. Farquhar (1934) credited two of four Boston area localities to Thaxter. Grote named *Psaphida rolandi* and *Psaphida thaxteriana* in 1874 from specimens that Thaxter collected in that area, suggesting that his *Stenoporpia polygrammaria* specimens were collected before 1880. Based on specimens we have seen, we suspect none of the New England records in Farquhar (1934) were after the 1910s, but there is one remarkably recent specimen from West Sandgate, Vermont, collected in 1957 (American Museum of Natural History).

Rarity

NatureServe global rank: GU. Apparently, this species has declined drastically in the eastern United States. Information for the western portion of the range, where it might not be rare, is insufficient for ranking.

Aside from the one Vermont specimen in 1957, none are known to have been collected on the New England-New York mainland in about 100 years. Even if this is a bear-oak specialist, habitat loss in New England is not a plausible explanation for a decline of this magnitude. It persists on Martha's Vineyard Island, which would be completely typical for suspected *Compsilura* victims. *Stenoporpia polygrammaria* has a summer caterpillar found in trees. However, this species might already have been gone before the introduction of *Compsilura* in 1906.

Life history

Adults occur in June in New England, where larvae are reportedly mature in September. There are two broods in North Carolina. The 24 July collection date in Kentucky (Covell 1999) also suggests a second brood.

Host plants

The only documented food plants for this moth are oaks, but we do not know if it is an oak specialist. The caterpillars of *Stenoporpia polygrammaria* eat the leaves of bur oak (*Quercus macrocarpa*), the only oak present in the northwestern portion of the range, and probably bear oak (*Quercus ilicifolia*) eastward. Tietz's (1972) report of bedstraw (*Galium* species) is almost certainly incorrect, and is probably an error for the common and similar *Anavitrinella pampinaria*.

Bear oak predominates in the Martha's Vineyard habitats for this moth. The Stokes County, North Carolina, site is one of only four places in that state with bear oak, but the moth was common several dozen meters lower than where this oak grows (Bo Sullivan). Bear oak is fairly common in the eastern New England portion of the range, including in York County slightly northwest of Kittery, Maine. Bear oak still occurs in at least three directions on ridges and sand plains within a few kilometers of Amherst, Massachusetts. It is unlikely that bear oak would have occurred at Ithaca, New York, Sandgate, Vermont, or on Grandfather Mountain, North Carolina, and collection sites south and west of North Carolina are beyond the documented range of this plant.

Habitat

Wagner *et al.* (2001) describe the habitat as barrens and woodlands. The Martha's Vineyard habitats are mostly pitch pine-bear oak barrens. Hugo Kons has collected one in Burnett County, Wisconsin, in a scrub forest/barrens mosaic, with bur oak, jack pine, and red pine.

Threats & management issues

Fire is a potential issue, but this moth probably pupates and overwinters underground. If so, survival of pupae would be high, but other life stages would be vulnerable to summer fires. Most places dominated by bear oak, such as pine barrens, are fire-adapted natural communities.

Btk applications against gypsy moths would probably not impact this species, because the larvae would appear more than a month later than the normal spray period. Severe defoliation of oaks by gypsy moth caterpillars could cause very high mortality of *Stenoporpia polygrammaria* larvae or force adult females to seek oviposition sites elsewhere. Many larvae would probably hatch while oaks were still defoliated, and we do not know whether young replacement foliage would be acceptable for those hatching late enough to access it. If widespread severe defoliation is expected in a habitat, spring application of *Btk* or Gypchek should be considered to protect populations of this rare moth.

References

Albu and Metzler (2004), Brower (1974), Covell (1999), Farquhar (1934), Ferge and Balogh (2000), Forbes (1948), McGuffin (1977), Smith (1910), Tietz (1972), Wagner *et al.* (2001).

Subfamily Sterrhinae

Cyclophora culicaria (Guenée)

Identification

This is a small (about 15 mm), nondescript moth. We provide this account primarily to illustrate this species, to clarify the taxonomy regarding the closely similar undescribed species in the following account (*Cyclophora* species near *culicaria*), and to alert collectors to watch for it.

Adults of *Cyclophora culicaria* are quite variable; some are essentially tan (Figure 222), many have a pinkish median line and fringes, and at least one has prominent pink striations on the outer portion of the forewing (Figure 223). The discal spot is relatively wide. The antemedian and postmedian lines are obsolete or represented by a series of dots on the veins, rather than an actual line. Specimens with minimal pink resemble *Cyclophora packardi* more than the next species, and the ground color is apparently similar.

Cyclophora species near *culicaria* is apparently paler and less tan, but we hesitate to compare based on images, and we have not compared recently collected specimens of *Cyclophora culicaria* to other species. *Cyclophora culicaria* is not known to have a completely pink form as does *Cyclophora* species near *culicaria*.

Figure 222. *Cyclophora culicaria* male from Apalachicola National Forest, Liberty County, Florida (Marc Minno photo).

Figure 223. *Cyclophora culicaria* female from Apalachicola National Forest, Liberty County, Florida (Marc Minno photo).

Taxonomic notes

For many years, this species was known only from two syntypes from "Georgia," collected before 1852. An old typed note with these syntypes from H. W. Capps (who also prepared a genitalia slide of one) states that a series of adults from Lakehurst, New Jersey (see next species account), does not represent the same species. Doug Ferguson and Dale Schweitzer examined these syntypes and the New Jersey specimens on 4 March 1999, and concurred with Capps. The syntypes show no pink, but most modern specimens have pinkish fringes (at least one apparently does not).

Range

Recent collections have been in Liberty, Alachua, and Dixie counties in northern Florida (Kons and Borth 2006), and Ware and Brantley counties in Georgia (James Adams). The syntypes were from "Georgia," but lack more exact locality information. Hugo Kons and Robert Borth have at least 27 specimens from sites in the Apalachicola National Forest, and one from the nearby Bluffs and Ravines preserve. It appears to be widespread in the Apalachicola River region, which accounts for four of the six localities. A single adult collected in 1960 at Lakeland, Florida, and now in the Florida State Collection of Arthropods, might be *Cyclophora culicaria*, but the specimen is in very poor condition. Another labeled "Lake City FL VIII 1963 CP Kimball 4207" has a seemingly more prominent white discal dot on the forewing, and may be the common *Cyclophora packardi*, but is also in very poor condition. Records of *Cyclophora culicaria* published by Forbes (1948) from New Jersey and North Carolina actually refer to an undescribed species. We do not know what species the record from West Virginia published in Albu and Mezler (2004) under *Cyclophora culicaria* represents.

Rarity

NatureServe global rank: GU. Available evidence suggests this species is very localized within a limited range, with 28 of 34 modern specimens we know of come from the near the Apalachicola River in Liberty County, Florida. Even there, 27 were found at a few sites in the National forest. Hugo Kons and Robert Borth have recently collected over 30 specimens in northern Florida, mostly in Liberty County, and we base our descriptive notes on images of nine of these.

The lack of known specimens from Torreya State Park, where many persons collected moths in the 1970s and 1980s, seems noteworthy. *Cyclophora culicaria* might be overlooked by some collectors, but specimens with a lot of pink do not closely resemble any species common in its range. The species does not come abundantly to lights, with Hugo Kons reporting a maximum of four in one night with a 400-watt Mercury vapor lamp, and only up to two have been collected in single light trap samples. Still, no unusual effort would seem necessary to detect this species if it is present in a regularly collected area.

John Abbott probably collected the syntypes in Screven or Burke County near the Savannah River, in Georgia shortly before 1800. Kimball (1965) listed four specimens that he thought were this moth, of which we discuss two above.

Life history

The life history of *Cyclophora culicaria* is unknown. Except for the Ware County, Georgia collection on March 9-10, 2006, adults have been found from 27 April to 22 June. This species could be univoltine, which would be unusual for a *Cyclophora*, but Kons and Borth (2006) consider the number of broods to be uncertain.

Host plants

Unknown.

Habitat

Unknown, but Kons and Borth (2006) conclude that it is probably a wetland species.

Threats & management issues

Probably refugia would be needed for populations to survive prescribed burns, if all stages are above ground, as they are in other species of the genus and subfamily. Collecting restrictions would be a particularly bad idea with this very poorly known species.

References

Kons and Borth (2006). Some Kimball (1965) and Minno (1992b) records might refer to this species. Forbes' (1948) account does not.

Sand myrtle pink

Cyclophora species near *culicaria* (not formally described)

Identification

This is the small (15 mm), highly variable, pinkish moth to which the name *Cyclophora culicaria* was generally applied in the 20th century (see the preceding account for *Cyclophora culicaria*). Wing color varies from pale tan with some pink in the median area (Figure 224) to almost solid pink, but the pattern is rather constant. The postmedian line varies in intensity, but is not merely a series of dots. The larva is shown in Figure 225.

Figure 224. Sand myrtle pink (*Cyclophora* species) from Burlington County, New Jersey (David Wagner photo).

Figure 225. Sand myrtle pink (*Cyclophora* species) larva from Gloucester County, New Jersey (Eric Hossler and David Wagner photo).

Taxonomic notes

In the past this undescribed species has been included in *Cyclophora culicaria*. Forbes (1948) called it *Cosymbia culicaria*.

Range

This moth occurs in two widely disjunct areas. The largest population cluster is found in the New Jersey Pine Barrens, north of the Mullica River. The range includes much of Burlington and Ocean counties, eastern Camden County, and extreme northwestern Atlantic County. It is also found in Brunswick County, North Carolina. This moth occupies at least two of the three main Brunswick County concentrations of the host plant, and might yet turn up in the Fall Line Sand Hills around Fort Bragg (Hall *et al.* (1999). In both parts of the range, adults can be locally abundant around the food plant.

This species illustrates a familiar pattern of disjunction and endemism (Schweitzer and McCabe 2004), but most of the other disjunct species are or were more widespread in the Carolinas than this one seems to be. The food plant also grows on mountain rock outcrops in a limited area of Tennessee, North Carolina, and Georgia, but so far the moth has not been found there.

Rarity

NatureServe global rank: G3.

This undescribed species has a very limited range in New Jersey and North Carolina. A large majority of its habitat outside of New Jersey has been destroyed. Fire suppression since about 1965, and to a lesser extent development, have also reduced its habitat in New Jersey. This moth is becoming scarce in places that for decades have been unburned, and its decline in New Jersey is very likely to continue. The global area of occupancy for this moth is probably less than 50,000 hectares, with over 95% of this in four New Jersey counties.

Life history

Adults come readily to lights at night, and during the daytime, they are often flushed from in or near patches of host plant. The flight season is mid-April through September in New Jersey, and early March into November in North Carolina, suggesting 3–5 annual generations.

Pupae of this genus somewhat resemble those of pierid butterflies, but are enclosed in a minimal cocoon among leaves, either on the plant or in the leaf litter on the ground. Winter is most likely passed as a pupa in the leaf litter (Wagner *et al.* 2001).

Host plants

The primary larval food plant is sand myrtle (*Leiophyllum buxifolium*), a small shrub in the heath family (Ericaceae). Larvae have been collected by David Wagner on this plant in the wild in New Jersey.

Habitat

The habitat is open low heath patches on white sand areas within pitch pine (*Pinus rigida*), pond pine (*Pinus serotina*), or longleaf pine (*Pinus palustris*) woodlands—especially in pitch pine lowlands. This moth is found near sand myrtle. In North Carolina, one habitat contains substantial wiregrass (*Aristida stricta*). The lack of closed canopy seems important to this species, and it is not usually found where the food plant is being overtopped by taller shrubs.

Associated rare Lepidoptera include many other species covered in this book, but especially *Agrotis buchholzi, Agrotis carolina*, and *Spartiniphaga carterae*. In New Jersey at least, another localized geometrid moth, *Stenaspilatodes antidiscaria*, also feeds on sandmyrtle (David Wagner observation). However, from North Carolina to Florida, what appears to be the same moth species occurs where this plant does not grow.

Threats & management issues

Except for one small colony on a North Carolina powerline, all known or potential habitats are fire-maintained communities. Nonetheless, like many Lepidoptera found in such places, no life stages of this species are protected from fires.

This moth has multiple generations, and is abundant in good habitats, which should greatly facilitate recolonization and recovery from unburned refugia. Some pupae probably survive low intensity fires, especially in wetter spots or among succulent vegetation.

Sand myrtle pink is present but somewhat scarce in the weapons ranges areas of Fort Dix, which burn at approximately one- to three-year intervals. Elsewhere it can be abundant a few years after fires, but eventually declines if fires do not recur. The food plant re-sprouts after most fires and the habitat should be suitable again 2–3 months after growing-season fires. In New Jersey, litter buildup resulting from lack of fire can lead to an inferno, which can kill root systems of the food plant.

We do not know whether *Btk* applications against gypsy moths could kill larvae, but this species did survive the Asian Gypsy Moth Eradication project in North Carolina (Hall *et al.* 1999). Based on data on other Geometridae, the first instar is presumably highly vulnerable, but later instars might not be (Peacock *et al.* 1998). Many eggs would be laid after *Btk* application following gypsy moth outbreaks, making serious impact unlikely due to the short lethal residue period for *Btk*.

Defoliation of host shrubs by gypsy moth caterpillars is not an issue in most New Jersey habitats, even if they would eat sand myrtle--which is unknown.

References

Forbes (1948), Hall *et al.* (1999), Peacock *et al.*,(1998), Schweitzer and McCabe (2004), Wagner *et al.* (2001).

Subfamily Geometrinae

Synchlora cupedinaria (Grote)

Identification

This small (7 to 10 mm) green moth is prominently purplish-brown along the edges of the wings, including the costal margin of the forewings (Figure 226). *Synchlora gerularia* (Hübner) is similar, but also has some purplish-brown spots on the forewings.

Range

This moth occurs in southern Florida north to about Highlands County, and in the Bahamas. We do not know whether Hugo Kons' collection of a specimen in very fresh condition much farther north in Alachua County represents a stray, or whether a population occurs there.

Figure 226. *Synchlora cupendaria* from No Name Key, Monroe County, Florida (Marc Minno photo).

Rarity

NatureServe global rank: None.

We include this moth on the recommendation of Robert Belmont, who has collected geometrid moths in Florida for many years.

This species is poorly known and might or might not be quite rare. As with most nocturnal South Florida moths, we have little current information on this species. This is in large part because of restrictions on collecting in Florida since the 1990s.

Life history

Very little is known about this moth, except that the adults have been collected from September to July in Florida, suggesting that the species breeds continuously.

Larvae of this genus feed mostly on flowers. If there is any diapause, it would probably be in one of the later larval instars.

Host plants

Tietz (1972) lists Lantana (*Lantana camara*), a non-native shrub in the verbena family (Verbenaceae), as a host. There are native species of *Lantana* present in coastal areas of southern and central Florida (Wunderlin and Hansen 2003). Other species of *Synchlora* are oligophagous to polyphagous on flowers (Ferguson 1969, 1985).

Habitat

This moth occurs in pine rockland habitats in the Florida Keys, but it has also been taken at the Archbold Biological Station in Highlands County. The habitats at the Archbold Biological Station consists for the most part of scrubs, flatwoods, sandhills, and other sandy habitats. The Alachua County collection was also in xeric oak-pine woods.

Threats & management issues

Inappropriate prescribed fire, lack of fire, mosquito adulticiding, and development are among the possible threats.

No life stage goes underground in this genus, so entire habitats should not be burned at one time.

Gypsy moth is not a potential issue in southern Florida, but excessive deer herbivory could be.

Exotic predatory ants may be a threat to this species.

References

Ferguson (1969, 1985), Kimball (1965), Kons and Borth (2006), Minno (1992b), Tietz (1972).

FAMILY SATURNIIDAE (GIANT SILKMOTHS, REGAL MOTHS, BUCK MOTHS)

SUBFAMILY CERATOCAMPINAE (REGAL MOTHS)

CANADIAN IMPERIAL MOTH

Eacles imperialis pini MICHENER

IDENTIFICATION

This is a very large yellow moth with variable amounts of purplish brown markings (Figures 227 and 228). The male forewing length ranges from 42 to 48 mm, and females range from 47 to 54 mm. Large as it is, on average, this is a smaller, more darkly frosted version of the typical imperial moth (*Eacles imperialis imperialis*).

Figure 227. *Eacles imperialis pini* (Canadian imperial moth) male from Otsego County, Michigan (Marc Minno photo).

Figure 228. *Eacles imperialis pini* (Canadian imperial moth) female from Otsego County, Michigan (Marc Minno photo).

Ferguson (1971), Handfield (1999), and Tuskes *et al.* (1996) also give illustrations and discuss the variation. No single character seems fully reliable to separate adults of the typical race from the Canadian imperial moth. However, the heavy postmedian line on the underside of all wings works in most specimens.

Larval differences are perhaps more consistent (see Tuskes *et al.* 1996).

TAXONOMIC NOTES

The treatment of this moth as a subspecies of *Eacles imperialis* follows Ferguson (1971) and Tuskes *et al.* (1996). The range of *Eacles imperialis imperialis* apparently did not extend into that of the Canadian imperial moth in historical times, but approached it in New York and Michigan.

RANGE

The Canadian imperial moth has a limited range in the northern Great Lakes region. It occurs from the north shore of Lake Superior through northern Michigan, southern Ontario, and adjacent Jefferson County, New York (three collected in 1991 by Tim McCabe), to extreme southwestern Quebec and into the Lake Champlain-Lake George region of New York (Clinton, Washington, and Warren counties) and Vermont (Grand Isle and Chittenden counties). Populations in northeastern New York and Vermont could be considered somewhat intermediate to *Eacles imperialis imperialis* (Tuskes *et al.* 1996). Two males from northeastern New York and Vermont are illustrated by Hedbor (2006).

Rarity

NatureServe global rank: G5T3T4.

Eacles imperialis pini is not now imperiled in most of its range, but was nearly extirpated from the eastern part by the late 1950s. The introduced parasitoid, *Compsilura concinnata,* was likely a major factor. The Canadian imperial moth seems to be recovering somewhat since about 2001.

A larva collected around 2002 at Plattsburgh was the first *Eacles imperialis pini* in eastern New York in over 40 years, and David Wagner captured one adult at blacklight at nearby Clintonville in 2008.

The first records of *Eacles imperialis pini* for Vermont since 1896 are a male found at light at Grand Isle across Lake Champlain in 2001 by Scott Griggs, and three at nearby South Hero by James Hedbor in 2006. Northwestern Vermont was a well-collected region in the 1980s and 1990s (Grehan *et al.* 1995). Both Vermont localities had several trap-years of effort prior to 2001.

Since the common white pine is among the food plants of *Eacles imperialis pini*, habitat loss, as alleged in Tuskes *et al.* (1996), does not appear to be a plausible explanation for the sudden disappearance of the Canadian imperial moth in parts of northeastern New York in the late 1950s. The recent Vermont collections were in rather ordinary forests with white pine, and were not associated with any remnant pine barrens, unlike the recent New York records. *Eacles imperialis* (both subspecies) became very rare in, or disappeared from, much of New England by or before the mid-1950s. *Eacles imperialis* is still encountered on parts of Cape Cod and the Massachusetts Islands, which fits the pattern of sandy coastal refugia from *Compsilura* documented by Elkington *et al.* (2006). Similarly, both Vermont localities are on an island in Lake Champlain, and Plattsburgh, New York is on its western shore. *Eacles imperialis* has not been found elsewhere in New England since a collection of *Eacles imperialis imperialis* in coastal southern Maine in 1971 (Brower 1974; Morrell 1979).

Life history

Eacles imperialis pini adults emerge early in July, but a few are found in June and early August. Recent dates are from 1-28 July in Vermont, and 26 June at Clintonville, New York.

The egg stage probably lasts about 12–15 days. The larval stage probably extends over a month, considering the cool climate where average July lows are around 15º C (59º F).

Pupation is underground, and there are no reports of any pupae overwintering more than one year, although several other Ceratocampinae do so in New Jersey (Dale Schweitzer observation).

According to Handfield (1999) and Tuskes *et al.* (1996), Canadian imperial moths mate and come to light mostly between midnight and 2:30 a.m. This is more than an hour later than is typical of imperial moths (*Eacles imperialis imperialis*) in southern New Jersey, even when adjusted for longitude and sunset 13 minutes later at Plattsburgh, New York, than Millville, New Jersey, on 1 July.

Host plants

Canadian imperial moth larvae feed almost exclusively on the leaves of trees in the pine family (Pinaceae), including eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), pitch pine (*Pinus rigida*), and occasionally other pines and white spruce (*Picea glauca*). In contrast, larvae of the typical imperial moth commonly eat oaks, maples, and many other trees, in addition to pines, and often occur in habitats without conifers.

Habitat

The Canadian imperial moth seems to occur mostly in sandy pine forests and pine plantations, and sometimes the larvae have been noted as significant defoliators. *Eacles imperialis pini* also occurs in mixed forests with an abundance of white pine in Canada and Vermont. Sandy soils may be important to pupal survival in the cold climate where this moth occurs.

Threats & management issues

Compsilura concinnata is the greatest concern, and this threat could worsen as the climate warms. Monitoring this parasitoid and its hyperparasites would be useful.

Climate change may be a threat to *Eacles imperialis pini*. While the typical imperial moth thrives in hot temperate and subtropical climates, Tuskes *et al.* (1996) report that Canadian imperial moth larvae are sensitive to high temperatures. *Eacles imperialis imperialis* can be expected to move northward into at least the Michigan portion of its range with unknown consequences.

Timber harvest could be an issue, although populations should recover in a few decades if pines are replanted or return naturally.

Spring applications of *Btk* should have little impact on Canadian imperial moth larvae that emerge in July or early August, nor should gypsy moth defoliation seriously affect a pine feeder.

Some pine-dominated habitats favored by *Eacles imperialis pini* are fire maintained, and all stages except for the underground pupa are vulnerable to summer fires that scorch the crowns of the pines. Pitch pines generally re-sprout from the branches and trunk, but with white, jack, or red pine, a complete crown burn would probably kill enough pines to eliminate Canadian imperial moths for a decade or more. Jack and pitch pine often colonize burned areas.

References

Ferguson (1971), Handfield (1999), Hedbor (2006), Michener (1950), Tuskes *et al.* (1996).

Family Sphingidae (sphinx or hawk moths)

Graceful clearwing sphinx

Hemaris gracilis (Grote and Robinson)

Identification

This medium-sized moth (only about 45 mm) (Figure 229) is similar to the common *Hemaris thysbe*, but is usually noticeably smaller, and has a prominent reddish-brown stripe on each side of the thorax under the wings, and reddish legs. On *Hemaris thysbe*, the legs are black and there are no such stripes. On *Hemaris gracilis*, the dark markings on the wings are edged inwardly with white, and the inner edge of the dark outer margin on the forewing is smooth (Figures 230). On *Hemaris thysbe*, the inner edge of the dark outer margin on the forewing can be smooth or jagged. The larva is mostly green with a short dark horn (Figure 231, Williams 1979, and Wagner 2005). The food plant (lowbush blueberry) will separate it from other *Hemaris* species.

Figure 229. *Hemaris gracilis* (graceful clearwing) upperside, Montcalm County, Michigan (Marc Minno photo).

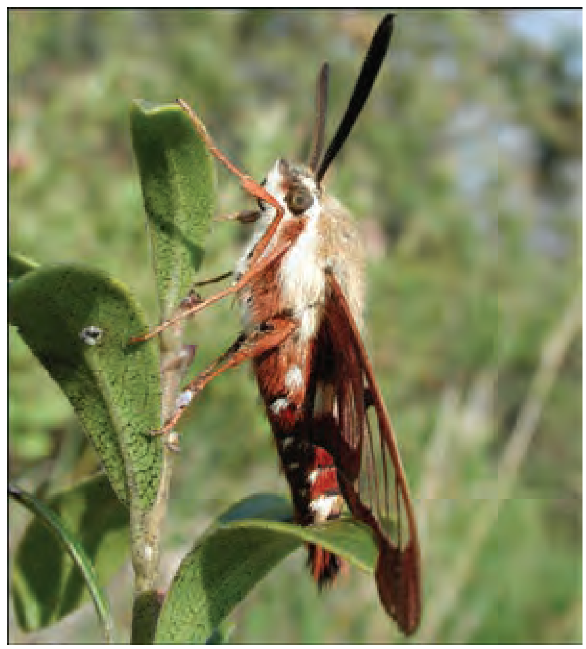

Figure 230. *Hemaris gracilis* (graceful clearwing) underside, Massachusetts (Michael W. Nelson photo).

Figure 231. *Hemaris gracilis* (graceful clearwing) larva from Montcalm County, Michigan (James P. Tuttle photo).

Range

The Butterflies and Moths of North America website (http://www.butterfliesandmoths.org/species?l=3438) presents a realistic map of the United States portion of the range of this moth, although the range in New Jersey and Wisconsin is slightly underrepresented (http://www.butterfliesandmoths.org/species?l=3438).

Hemaris gracilis is found in areas with acidic soils within about 200 kilometers of the United States coast from Maine to southern New Jersey, including all the New England states except Vermont. Inland, it occurs in acidic soil areas in Pennsylvania, New York, northern Ohio, Michigan, Wisconsin, and North Dakota. In Canada, it is widespread in the provinces of Nova Scotia, New Brunswick, Quebec, and Ontario, and also occurs in Manitoba. South of New Jersey this moth is apparently very rare. It has been collected in Carteret County, North Carolina, Horry and Charleston counties, South Carolina, and in Florida it has been collected in St. Johns, Highlands, Putnam, and Alachua counties (Kimball 1965, Kons and Borth (2006), Jeff Slotten). The Yale Peabody Museum has two specimens labeled "12 miles east of Steamboat Springs, Colorado, 14 August 1965," but occurrence in Colorado, especially in August, needs verification.

Rarity

NatureServe global rank: G3G4. We are not sure of the current status of *Hemaris gracilis*, especially in the United States, but we would not expect it to be as rare as recent records suggest.

Many moth collectors might tend to overlook a diurnal species that does not come to lights at night, but the adults are conspicuous at flowers in the daytime. In some areas of the Midwest and Canada it could be overlooked if it occurs with other species of the genus, but from Massachusetts southward it is usually the only one present in its habitats in late spring.

Hemaris gracilis is not imperiled range-wide, and may in fact be increasing in Pennsylvania and Connecticut, but it might still qualify as globally uncommon to rare (G3). Regardless, except in southeastern New England, Michigan, and Wisconsin, it is rare in our coverage area. It is historic in the Carolinas, and the only North Carolina specimen was in 1971.

Hemaris gracilis is one of the few moths in this book that is usually found in very small numbers even in the proper habitat. It is ranked as uncommon to rare (S3), but not imperiled, in Massachusetts, Wisconsin, and Ontario, and seems to be substantially less rare only in Quebec and New Brunswick (Reginald Webster). *Hemaris gracilis* is rare in southern New Jersey, but probably always has been so. Farther south it was reported from only six counties, being locally common near Myrtle Beach, South Carolina (Hodges 1971), but otherwise it is considered very rare. This moth failed to survive through the 1960s at the Albany, New York, pine barrens, and was apparently absent at the Concord, New Hampshire barrens in the 1980s. Currently, it inhabits powerline right-of-ways in Massachusetts, Connecticut, and New Jersey.

The status of this species in New England may have changed since the 1970s. Dale Schweitzer encountered only one in Massachusetts (Montague Plains) from 1973–1974, and another one (Plymouth; none near Boston) from 1983–1988. He did not find *Hemaris gracilis* in the extensive pine barrens and a large bog in York County, Maine, in the 1980s. Negative data include about a dozen efforts in late May and June from 1983 to 1988 in the Boston area (Medford, Melrose, Malden, Stoneham, Boston, and the Blue Hills) in seemingly ideal habitat. Farquhar (1934) gave records for two of these towns. In Connecticut, where from the 1920s to 1950s, *Hemaris gracilis* was known from at least three counties, none are known to have been collected in that state from 1960 into the 1990s. However, since 2000, it has been found in three counties in Connecticut.

Hemaris gracilis also seems to have become less rare in Pennsylvania since about 2000. Marc Minno found one adult of this species, in 2002, in Vinco, Cambria County. Rick Koval has collected singletons in Luzerne and Lackawana counties since 2000 (Steve Johnson email to Dale Schweitzer in February 2008). Otherwise, there are only pre-1950 records for two localities in Pennsylvania (Tietz 1952).

We find it difficult to believe that *Hemaris gracilis* would really be rare in the extensive blueberry barrens and bogs in Maine, but according to the Maine Natural Heritage Program, as of 2011 there have been no reports since Brower (1974).

Life history

Williams (1979) gives a detailed account of the life history. There appears to be only one brood in most of the range with an apparent partial second brood in Nova Scotia (Ferguson 1955) and Massachusetts (Williams 1979, Farquhar 1934).

The eggs are laid singly on the leaves of the host and hatch in about six days. The larvae mature about 30 days later and spin a cocoon on the soil surface. The pupae usually remain dormant until the following spring. It is likely that some pupae diapause over two winters, especially northward, as do a European congener and most eastern Canadian Sphingidae (Reginald Webster).

A website record from Richland County, South Carolina, dated 16 August 1981, is probably incorrect (http://facweb.furman.edu/~snyderjohn/sc-moths/species.htm); neither Tuttle (2007) nor the Butterflies and Moths of North America website have records in that area. Otherwise, there is no evidence of a second brood from Connecticut to Wisconsin and Florida.

Adults of *Hemaris gracilis* occur from late May to early July near the northern range limit in Quebec and Ontario (Tuttle 2007, Handfield 1999). They occur primarily in late May to mid-June from New Jersey to Nova Scotia and Wisconsin; some appear in early May in New Jersey, and some linger through June in Wisconsin. The partial second brood from Massachusetts northeastward occurs in late July and August. Adults occur in March in Florida (Heppner 2003, Kons and Borth 2006), in April in South Carolina, and one was collected on 4 May in North Carolina.

At least northward, the adults visit a variety of flowers (Tuttle 2007), and they can be seen visiting lilacs (Reginald Webster) in yards and gardens. In Wisconsin, *Phlox pilosa* is a favorite according to Hugo Kons. In eastern barrens habitats the few flowers available during the flight season would be Ericaceae such as blueberry (*Vaccinium* species), sheep laurel (*Kalmia carolina*) and a few others. In southern New Jersey, where adults fly mostly after the blueberries flower, Piedmont staggerbush (*Lyonia mariana*), also in the Ericaceae, would be one of the few flowers available. Except for two females laying eggs, all of about 20 adults observed there in the last 10 years were nectaring on this shrub. The New Jersey peak flight season is apparently tied to the flowering period of *Lyonia mariana*.

The adults are active during the daylight hours, and at least in New Jersey they seem to visit flowers mostly in the afternoon and are active on warm (above 21°C) overcast or cloudy days, as well as on sunny ones.

Host plants

The first larva was found on blueberry (*Vaccinium pallidum* or *Vaccinium corymbosum*) at New Lisbon, New Jersey, by Emlen P. Darlington; and the specimen that eclosed on 12 June 1935 is in the Yale Peabody Museum. The caterpillars eat the leaves of lowbush blueberries (Ericaceae) such as *Vaccinium pallidum* (formerly known as *Vaccinium vacillans*) in Massachusetts (Williams 1979) and New Jersey (Dale Schweitzer observation), and *Vaccinium angustifolium* in New Brunswick (Reginald Webster) and Michigan (Tuttle 2007). If this species breeds in bogs, there may be another food plant.

Neither of these blueberries occurs in the South Carolina and Florida portions of the range, although there are many other species of *Vaccinium* in Florida. Robinson *et al.* (2002) consider old reports of *Kalmia* species as larval food plants to be erroneous, but these are known nectar sources.

Habitat

The habitat is probably most often open pine woodland, including jack and pitch pine barrens, with an ericaceous understory. In Quebec, New Brunswick (Reginald. Webster), and Massachusetts (David Wagner), the habitat includes both bogs and dry open heathlands. In Connecticut, Massachusetts, and New Jersey powerlines through acidic oak or oak-pine forest would also be included. Hugo Kons found it in five out of six pine-oak barrens he surveyed in Wisconsin, but in no other habitats.

Hemaris gracilis is not confined to sandy or boggy places and occurs on rock outcrops and ridgetops in Massachusetts and Sussex County in northern New Jersey (Anthony McBride). A recent collection site in Luzerne County, Pennsylvania, is a partially boggy mountain heathland according to Steve Johnson. A major population in southern New Jersey is on an airport approach zone with abundant lowbush blueberry (*Vaccinium pallidum*) throughout, and *Lyonia mariana* at the edges of adjoining woods.

In places where adults are seen along powerlines in southern New Jersey, it is unknown if they also breed in the woods, but the scarcity of observations in wooded habitats, and the generally open habitats northward, suggest they probably do not. So far, the few observations in New Jersey suggest that the moths fly over rather than in wooded areas, but David Wagner has collected one nectaring on blueberry in a forest in Connecticut.

Naturally open habitats with blueberry in southern New Jersey occur mostly within ten years after fires, but similar habitats are maintained indefinitely by mowing on right-of-ways. Bogs do not have lowbush blueberries in southern New Jersey. In Florida, the habitats include wet pine flatwoods and xeric pine-palmetto scrub with abundant heaths.

Threats & management issues

All life stages of *Hemaris gracilis* are above ground and therefore more or less vulnerable to fire. On the other hand, habitat condition should be optimal, that is open with abundant flowering blueberries, for the first two or three seasons after a fire. Decline in fire frequency has reduced such open habitats in New Jersey by increasing dominance of oaks. However, we do not know whether the moth was formerly more common there than it is now. Suitable habitats occur there naturally following fires. The exact habitat needs of *Hemaris gracilis* southward are poorly understood, but pine flatwoods and most other open habitats with heaths are also fire-maintained.

Depending on their exact timing, *Btk* applications against gypsy moths (where habitats are adjacent to oaks), and spruce budworm, could be threats northward. However, in New Jersey, the *Btk* residue should be gone long before most *Hemaris gracilis* larvae appear. Gypsy moth larvae do eat blueberry, but defoliated plants refoliate quickly and would probably have some new leaves by the time most *Hemaris gracilis* females are ovipositing.

References

Butterflies and Moths of North America website, Brower (1974), Covell (1984), Farquhar (1934), Ferguson (1955), Handfield (1999), Heppner (2003), Hodges (1971), Holland (1903), Kimball (1965), Kons and Borth (2006), Metzler *et al.* (2005), Minno (1992b), Robinson *et al.* (2002), Selman (1975), Tietz (1952, 1972), Tuttle (2007), Wagner (2005), Williams (1979).

False-windowed sphinx

Madoryx pseudothyreus (Grote)

Identification

This large (66 to 70 mm) grayish moth has scalloped wing margins and a few white spots near the middle of the forewings (Figure 232). No similar species occur in our area. The caterpillar is brown with a short fleshy horn (Figure 233). When disturbed it displays eyespots on the thorax and yellow on the legs (Figure 234).

Range

This moth was described from Cuba, but it is also found in coastal areas of southern Florida and the Keys.

Figure 232. *Madoryx pseudothyreus* (false-windowed sphinx) from Collier County, Florida (Marc Minno photo).

Rarity

NatureServe global rank: G3G4. This rank may not reflect current status. It does reflect uncertainty about the status of this moth in Cuba and the possibility of it occurring elsewhere, and assumes it has not declined drastically like some south Florida butterflies have.

This tropical moth occurs in a limited habitat and would have ranked about S3 in Florida 20 years ago. However, as Hugo Kons reminds us, current information is limited because there has been very little effort directed at this or other nocturnal South Florida moths--because of collecting restrictions since the 1990s. It is locally common in some preserved areas of the Keys such as Biscayne National Park.

Life history

The eggs are laid singly on the leaves of the host plant. Small larvae feed on the young leaves, but mature caterpillars will eat old leaves. Unlike most other sphingids that pupate underground

Figure 233. Resting *Madoryx pseudothyreus* (false-windowed sphinx) larva from Biscayne National Park, Elliott Key, Miami-Dade County, Florida (Marc Minno photo).

Figure 234. Perturbed *Madoryx pseudothyreus* (false-windowed sphinx) larva from Biscayne National Park, Elliott Key, Miami-Dade County, Florida (Marc Minno photo).

or in the leaf litter, this species spins a cocoon on the trunk, branches, or among the leaves of the host (Minno and Emmel,1990). Its occurrence in mangrove swamps precludes it from pupating underground. At night, the adults visit flowers for nectar and are attracted to lights.

Host plants

The larvae feed on black mangrove (*Avicennia germinans*), an evergreen tree in the Avicenniaceae.

Habitat

This moth is closely associated with its food plant in mangrove swamps, shrubby salt marshes, and along shorelines.

Threats & management issues

Mangroves are protected by law in Florida, and in some places are being restored, thus the habitat is secure. However, adults that come to lights are likely to be eaten by birds, bats, lizards, frogs, and toads. We do not know if mortality due to lights would seriously affect populations. The immature stages are likely to be affected by non-native species of ants such as *Pseudomyrmex gracilis*. They may also be affected by parasitoids that have been accidentally or deliberately introduced into Florida.

The sensitivity of adults and larvae of this hawk moth to the various insecticides sprayed to control mosquitoes in Florida is unknown.

Sea level rise accelerated by global warming will alter the habitats, but it is difficult to predict the long term impacts.

References

Covell (1984), D'Abrera (1986), Hodges (1971), Kimball (1965), Minno and Emmel (1990), Struttmann (1996), Tuttle (2007).

Family Notodontidae (prominent moths)

Datana ranaeceps (Guérin-Méneville)

Identification

What passes for *Datana ranaeceps* from the Carolinas to Long Island is a medium-sized moth (45 to 50 mm). The adults usually have a distinctive frosty appearance (Figures 235 and 236). *Datana major* (Grote and Robinson) apparently also has a red color form in North Carolina and probably southward, and such specimens should be verified by examining the male genitalia (Forbes 1948).

Figure 235. *Datana ranaeceps* male, normal form, from Burlington County, New Jersey (David Wagner photo).

Figure 236. *Datana ranaeceps* male, red form, from Burlington County, New Jersey (David Wagner photo).

Forbes also provides an excellent key to last larvae of this genus. Last instars of *Datana ranaeceps* can be recognized by the combination of continuous yellow stripes, red head, and red posterior (Figure 237). We are not sure whether earlier instars of *Datana ranaeceps* and *Datana major* can be separated. Most larvae are brighter than the one illustrated by Wagner (2005), which is probably close to pupation. *Datana major* larvae, which Wagner also illustrates, have the lines broken into spots in the last instar. Larvae cannot be identified on the basis of food plant alone, because the main food plant is commonly eaten by *Datana major,* and occasionally also by *Datana drexelii*. *Datana ministra*, the only polyphagous species in the genus, and *Datana drexelii*, are immediately distinguishable by their black heads and posteriors.

Figure 237. *Datana ranaeceps* larva from Ocean County, New Jersey (David Wagner photo).

Taxonomic notes

Specimens of this genus are sometimes misidentified even in modern collections, and very commonly on websites. The taxonomy of this immediate group is uncertain. Coastal Plain populations from Long Island to North Carolina are clearly a single species, but may not be the true *Datana ranaeceps*. Hugo Kons informs us that even darker specimens from Florida appear to represent a separate species, and this may be the true *Datana ranaeceps*. This would be very consistent with the taxonomic comments given by Forbes (1948). Forbes also notes that New Jersey larvae have a "paler, bright red head" compared to Florida larvae, but we cannot be sure which species these larvae were.

Range

The species we tentatively refer to as *Datana ranaeceps* occurs primarily in Coastal Plain pinelands on Long Island, New York, in southern New Jersey, and from southeastern Virginia into Florida. However, we do not know how far into Florida it gets, or whether it extends west along the Gulf Coast. Forbes (1948) reports *Datana ranaeceps* from Arkansas. There is very little habitat in Maryland or Delaware, and so far this moth has not been confirmed in these states. It also has not been confirmed in Georgia. Unless there is an unrecognized sibling species, *Datana ranaeceps* also occurs in the mountains, because recent single specimens from Montgomery County, Virginia (Dale Schweitzer collection), and Fort Indiantown Gap, Pennsylvania (Betsy Leppo, Pennsylvania Natural Diversity Inventory), cannot be assigned to any other known species.

There are also old specimens supposedly from Delaware Water Gap, Pennsylvania, which we have not seen. A major stronghold is the New Jersey Pine Barrens. However, except in recently burned areas, this moth is usually not common even there.

While the food plant is present widely on the Piedmont of Virginia and the Carolinas, and ranges into Pennsylvania, it usually is not abundant over large areas, and so far this moth is known only from the Coastal Plain and mountains. The U.S. Department of Agriculture PLANTS database profile for the food plant (http://plants.usda.gov/java/profile?symbol=LYMA2) shows it absent on most of the Gulf Coast but present widely in Arkansas, where Forbes (1948) reports *Datana ranaeceps*.

Rarity

NatureServe global rank: G3G4. What we are calling *Datana ranaeceps* is localized with a naturally disjunct range, but it is not threatened in New Jersey or in coastal North Carolina.

In most of its southern range, a huge majority of habitat has been converted to other uses, and declining fire frequency is making this species more localized, even in New Jersey. We are not sure of the status or number of species in the *Datana ranaeceps* complex in Florida. The status of mountain populations and their food plant are also unknown.

Aside from recently burned areas in New Jersey and North Carolina where it can be abundant, this moth is usually not numerous where it is found. Unlike many *Datana* species, *Datana ranaeceps* has habitat requirements beyond presence of the food plant.

Life history

Adults usually occur in New Jersey from late May into July, with a partial second brood in early August. There appear to be two broods in the Carolinas.

The eggs are laid in masses on the undersides of food plant leaves. The egg stage lasts 9–11 days.

The larval stage takes about a month. When mature, the caterpillars burrow deeply into the soil to pupate. The pupae sometimes overwinter twice before developing into moths.

The young larvae are gregarious, but tend to wander away as they mature, and last instars often become solitary, especially if forced to move to other host plants when the original plant becomes defoliated. Larvae are abundant on sprouts of the host plant following fires, and also along roadways after mowing. In July 1984, *Datana ranaeceps*, along with *Datana major*, defoliated virtually all *Lyonia* and *Leucothoe* plants over nearly 400 hectares after a hot crown fire a year earlier at Atsion, New Jersey. On 15 May 1985, Dale Schweitzer collected 65 *Datana ranaeceps* adults at one blacklight, and saw more. It is worth noting that this is also the earliest-known date for any *Datana* in New Jersey, suggesting even greater abundance at this site a month later. While this outbreak was exceptional, small-scale defoliation of the food plant in individual patches or on most stems in a few hectares in burned areas in mid-summer is common, with *Datana ranaeceps*, and less so *Datana major,* being responsible.

Egg parasitism can be heavy, and probably is a factor in the collapse of outbreaks of this moth.

Host plants

The caterpillars feed on shrubs in the heath family (Ericaceae). Staggerbush, (*Lyonia mariana*) is the only normal food plant in New Jersey, and is a food plant on Long Island and in North Carolina. We suspect that other heaths may be used in Florida. Larvae reportedly also occasionally feed on blueberry if the *Lyonia mariana* bushes have been defoliated. Some last instar larvae will also eat *Leucothoe racemosa*, but most will not; this is not a normal food plant in New Jersey. The food plant in the mountains is unknown, but the Pennsylvania and Montgomery County, Virginia collections were outside of the range of *Lyonia mariana*.

Habitat

This moth occurs in mesic to xeric, relatively open pinelands with an abundance of the food plant, especially in the first few years after fires. Larvae also can be found on mowed right-of-ways through pine barren habitat.

Habitat in the mountains and foothills of Pennsylvania and Virginia is not known.

Threats & management issues

Because the larvae are usually found in very open habitats, and most often on sprouts, *Datana ranaeceps* probably requires recurrent fires or mowing to persist in its Coastal Plain habitats. Prescribed burning at any season should be beneficial where the pine canopy is sparse, but is probably irrelevant in shaded woods if the understory is burned without canopy thinning. At least in New Jersey and North Carolina, this species often occurs with rarer moths having similar or more exacting management needs. Decreasing wildfire frequency has substantially reduced the habitat in New Jersey since the 1960s, because prescribed winter burns there are not intense enough to thin trees. Because pupae are underground and some overwinter more than one year, this species should not be seriously impacted even from summer fires which would kill eggs, larvae, and adults.

Forestry practices that result in closed-canopy pine stands or destruction of the understory would severely impact this species, although it could be present initially in young plantings where there is native understory. Timber harvest should be beneficial in places with dense pine canopy, but only if the food plant is allowed to flourish afterwards.

Gypsy moth control measures are not likely to be a threat in the Coastal Plain habitats of *Datana ranaeceps*, because these areas usually do not have many oaks or other trees preferred by gypsy moth caterpillars. However, instances of habitats being sprayed are known. Gypsy moth spraying probably is an issue in mountain and foothill habitats. Few or no larvae would be exposed to typical single *Btk* applications aimed at gypsy moths, but some exposure would be possible from multiple applications. The use of Dimilin® would cause very high mortality of larvae for the rest of the season.

References

Forbes (1948), Heppner (2003), Kimball (1965), Minno (1992b), Profant (1989), Wagner (2005).

Sandhill prominent

Heterocampa varia (Walker)

Identification

This is a medium-sized moth; males are about 45 mm in wingspan, and females are about 50 mm. The name "varia" for this species is a misnomer, because it is among the least variable species of the genus. The common name we suggest describes the habitat in much of the range, although the term is not used in the core range in New Jersey. Unfortunately, this moth was misidentified by Kimball (1965) in his classic book on Florida Lepidoptera. He illustrated a pair of *Heterocampa obliqua* as *Heterocampa varia*, which has misled subsequent lepidopterists. Males are very difficult to distinguish from those of the common *Heterocampa obliqua* using characters of the wing patterning (Figure 238), and often the genitalia must be examined. Females should be easily recognized from our illustration (Figure 239) and are similar to the males, but are quite unlike those of *Heterocampa obliqua*. There is a good image of a New Jersey female on the Georgia Lepidoptera website (as of 2010). The last instar larva (illustrated by Wagner 2005) is

Figure 238. *Heterocampa varia* male from Cumberland County, New Jersey (David Wagner photo).

Figure 239. Heterocampa varia female from Cumberland County, New Jersey (David Wagner photo).

also easy to recognize (Figure 240), because the dorsal pale area is less constricted than in *Heterocampa obliqua*.

Figure 240. *Heterocampa varia* larva from Cumberland County, New Jersey (David Wagner photo).

Taxonomic Notes

This moth was also described by Dyar as *Heterocampa georgiana*, a synonym of *Heterocampa varia*.

Range

The sandhill prominent occurs on two islands off Massachusetts, and on eastern Long Island, New York, southward disjunctly along the coast, and in the Sand Hills to at least Georgia. Recently, Hugo Kons found populations of *Heterocampa varia* in sandhill habitats in Liberty and Putnam counties in northern Florida. In Massachusetts, it is reported only from two islands. Historically it was found on Martha's Vineyard (F. M. Jones specimens in the University of Delaware collection), and was recently collected there by David Wagner. It was found recently on Nantucket (Mark Mello in 2004). In the New Jersey Pine Barrens, *Heterocampa* varia is found from about Lakehurst southward to northern Atlantic County.

The distribution continues disjunctly to the south in Cumberland County in part of the Manumuskin River ultraxeric sand system, which is probably a long-term disjunction. This moth is known from three localities in the Fall Line Sand Hills and one in southeastern North Carolina, where it was probably once widespread and common. Historically it has been recorded from McClellanville, South Carolina (Wedge collection, not verified by us), and supposedly Atlanta, Georgia (Dyar 1921), although the latter more likely came from sandhill areas to the southeast of Atlanta. The National Museum of Natural History has a male supposedly from Washington, D.C., collected during the 19th century.

Heterocampa varia is not expected in Delaware or Maryland, but it probably did occur in southeastern Virginia. In 1990, Dale Schweitzer examined specimens at the Florida Department of Agriculture and Consumer Services collection (including many of Kimball's records) and the Archbold Biological Station collection, as well as Dave Baggett's collection a few years earlier, and none appeared to be *Heterocampa varia*. It is possible that an old "Florida" specimen cited as a syntype of *Heterocampa georgiana* was from present day Florida, but it could as easily have been from what is now Georgia. Forbes (1948), who understood this species, gave the range as Long Island to Georgia, and we are not aware of any specimens from outside of this region except for Kons' Florida specimens. Dale Schweitzer examined images of purported Texas specimens, courtesy of Ed Knudson, and they did not appear to be *Heterocampa varia*.

Rarity

The current NatureServe global rank is G3G4, but Steve Hall suggests that, considering the rarity of this moth outside of New Jersey, the rank should be G3.

This is a rare, or at least very localized, moth outside of southern New Jersey. It is possible that this species could be overlooked by collectors where it is scarce, because the occasional males attracted to lights could easily pass for *Heterocampa obliqua*. However, females do come fairly often to light, and these are easily recognized. Even Forbes (1948), who almost never used the term "rare," applied it to this moth.

The global area of occupancy of *Heterocampa varia* is probably on the order of 150,000 hectares in New Jersey, and known habitats elsewhere would not come to 10% of that total. We expect the species to turn up more widely in the Florida Panhandle at least. Outside of the New Jersey Pine Barrens and the Massachusetts islands, where it is locally common, *Heterocampa varia* is known from less than ten extant occurrences in three other states. It is historical in two of the seven states with verified records. Although it is obviously not currently imperiled in New Jersey, based on recent documentation, this species is reasonably considered globally uncommon. Some additional occurrences will likely be found in the Carolinas and perhaps in Georgia, most likely in the Fall Line Sand Hills. Modern collecting effort in the southern two thirds of Georgia has been spotty, but so far this moth has not turned up. While there is no precise figure, most (>90%) of its potential southern habitat has been destroyed. Probably over half of the original habitat in New Jersey and Massachusetts still supports this species. There is no evidence of a decline, or of a larger pre-*Compsilura* range in Massachusetts.

Life history

Adults have been collected in the New Jersey Pine Barrens from 15 May to 9 August, suggesting two broods. However, eclosion dates of reared moths and collection dates of wild adults suggest a shorter flight period of June through July for the more southern Cumberland County, New Jersey, colony, with a rudimentary second brood there in August.

Adults of *Heterocampa varia* emerge before midnight, and females probably will have mated by dawn. Males come to lights mostly after 1 a.m., but females are found mostly within 2 hours after dusk.

In captivity, the egg stage lasts 6 to 9 days. When sleeved in natural habitats, the larval period ranges from slightly under 4 to just over 5 weeks. The length of the larval stage varies slightly from year to year in New Jersey, with larvae sleeved on host trees taking at least 32 days in 1995, but most taking less than 30 days (minimum 26 days) in 1999. Dale Schweitzer has found significant but small differences in growth rate between cohorts of larvae reared on different post oak (*Quercus stellata*) trees. Drought and heavy Homoptera (usually aphid) infestations appear to add a few extra days to larval growth time. Larvae of *Heterocampa varia* also take a few days longer to mature if reared on dwarf chinquapin oak (*Quercus prinoides*). Larvae from Cumberland County, New Jersey, begin to mature in mid-July.

Of 106 pupae from three cohorts and three wild larvae, 73% overwintered twice and five of them overwintered three years before eclosing, but adults do occur every year. North Carolina specimens (National Museum of Natural History) include late August adults, suggesting a second brood there. Dyar (1921) gives dates for larvae from 2 June to 29 September from the vicinity of Atlanta, Georgia, again suggesting at least two broods.

Host plants

Several authors give the food plant as oak, probably based on Dyar (1921) who does not state the species involved. Eggs and larvae have been found in the wild on post oak (*Quercus stellata*) and dwarf chinquapin oak (*Quercus prinoides*) in New Jersey, and blackjack oak (*Quercus marilandica*) is probably a major food plant as well. Other oaks are likely used in New Jersey, where survival of sleeved larvae is normal on black oak (*Quercus velutina*), but last instar larvae clearly preferred post oak and bear oak over willow oak (*Quercus phellos*). Mark Mello has collected larvae from bear oak (*Quercus ilicifolia*) in Massachusetts. It is likely that any species of oak that is prevalent in the habitat is used. Post oak and turkey oak (*Quercus laevis*) are probably used in the South.

Habitat

All known habitats for this moth are xeric and sandy, with scrubby, often highly stressed, oaks. On Martha's Vineyard, Nantucket, and Long Island this moth is found in extensive bear oak barrens that are essentially treeless or have only scattered pitch pines (either normal or the dwarf variety). In the New Jersey Pine Barrens, similar pitch pine-oak scrub habitats with bear oak, blackjack oak, and post oak are commonly used. The pine canopy in these areas is usually under 50%. The disjunct colony in Cumberland County, New Jersey, occurs on very xeric sandy soils in sparse oak-shortleaf pine (mostly *Pinus echinata*) woodland. Post oak and black oak are abundant in the canopy and subcanopy, and dwarf chinquapin oak is a major component of the shrub layer. This site may be too xeric for bear oak or blackjack oak to thrive, and almost all oaks there are in poor condition. One other New Jersey site is an airport approach zone that has been mowed in winter every 1–2 years since the 1940s, so that bear oak has become the dominant species. At roughly 500 hectares, this is one of the smallest occupied northern habitats. The habitat in North Carolina is turkey oak sandhills.

Threats & management issues

From New Jersey northward, nearly all known occurrences occupy at least 500 hectares of high-quality oak scrub or woodland. Populations thrive in areas with burn frequencies ranging from several times per decade to no fires in over 50 years. *Heterocampa varia* pupates underground, and most pupae diapause for two or three years. Therefore, a population could not be extirpated by any single one-year event such as a summer wildfire.

Except for complete fire suppression (in some habitats) or annual summer burning, it is unlikely that fire negatively impacts populations of *Heterocampa varia* as long as the host oaks continue to resprout. In New Jersey areas cutover or burned in winter or spring are excellent habitat by the first summer, at least in the case of bear oak and blackjack oak scrub.

Optimal habitats in this region rarely support gypsy moth outbreaks, probably because the oaks leaf out too late in the spring, but some spraying is likely in New Jersey habitats. Based on phenology, *Btk* applications in spring would probably cause little or no mortality to *Heterocampa varia*, and would be beneficial if severe defoliation by gypsy moth caterpillars were prevented.

The main need seems to be maintaining xeric oak scrub with sparse or no pine cover. Obviously, silviculture practices that kill the oaks would reduce habitat. Timber harvest should not greatly impact populations as long as scrubby oaks are undamaged or allowed to re-sprout.

References

Dyar (1921), Forbes (1948), Kimball (1965), Wagner (2005).

Hyparpax perophoroides (Strecker)

Identification

This medium-sized (35mm) moth is easily recognizable by its distinctive reddish markings, and sometimes an overall reddish or pinkish tint (Figure 241). Males have large feathery antennae. Adults are somewhat similar to the related yellow and pink *Hyparpax aurora*, but the ground color is typically tan with a reddish or pink tint in fresh specimens, and the outer part of the hindwing is usually pink. Occasionally deep red or golden/yellow color forms occur (Kimball 1965). The larvae can easily be separated from those of *Hyparpax aurora* (illustrated by Wagner 2005) by their longer anal prolegs, much reduced dorsal humps, and by the lack of any red markings (Ferguson 1963). *Hyparpax perophoroides* probably has a brown larval form as does *Hyparpax aurora*. Holland (1903) and Kimball (1965) also provide illustrations of adults.

Figure 241. *Hyparpax perophoroides* from Duval County, Florida (Marc Minno photo).

Taxonomic Notes

While this moth looks quite different, and Ferguson (1963) found some apparent larval differences, this is possibly a Florida peninsular subspecies of *Hyparpax aurora*. Hugo Kons points out that similar specimens also occur in parts of Texas and Oklahoma, along with normal *Hyparpax aurora* phenotypes. Similarly, the status of more western populations of this genus is uncertain.

Range

This moth is locally distributed in most of Florida, west at least to Liberty County, into southern Alabama (Baldwin County) (Bo Sullivan personal communication with Dale Schweitzer) and southern Georgia.

Rarity

NatureServe global rank: G3G4. Kimball (1965) stated that this moth was not uncommon, but its habitat outside of public natural areas throughout its range is now threatened by urban development or conversion to pine plantations.

Life history

Adults might fly year-round in southern Florida, but almost certainly do not normally do so northward. Profant (1989) found adults in February and April in central Florida and, they occur from late March to June farther north.

The larvae feed on mature oak foliage. The egg stage probably lasts 5–10 days, and the larval stage is completed in about a month. Non-diapausing pupae of Notodontidae generally hatch in about three weeks. Any diapause would presumably occur as underground pupae (or possibly prepupae), as with *Hyparpax aurora*.

The widespread *Hyparpax aurora* is disproportionately scarce at lights compared to incidental encounters with adults and larvae in New Jersey and New York (Dale Schweitzer observation), but *Hyparpax perophoroides* is apparently more readily collected with lights.

Host plants

Ferguson (1963) reported that mature foliage of bluejack oak (*Quercus incana*) and turkey oak (*Quercus laevis*), but not live oak (*Quercus virginiana*), were acceptable to the larvae. Larvae reared in captivity by Ferguson developed poorly on the soft spring foliage of northern oaks.

Habitat

This species occurs mostly in sandhills and scrubs with abundant oaks.

Threats & management issues

Much of the habitat in Florida is rapidly being urbanized and fragmented. Small northern pine/bear oak barren remnants are especially vulnerable to losing rare species, so it is likely that Florida habitat remnants under 500–1,000 hectares are likewise vulnerable to losing rare species such as this one. Most fire regimens and other activities that perpetuate good quality oak scrub and woodland probably will maintain populations at least in larger habitats. But, without better understanding the habitat needs of this moth, it is difficult to recommend management practices.

References

Ferguson (1963), Holland (1903), Kimball (1965), Minno (1992b), Profant (1989), Tietz (1972).

Plain Schizura

Schizura apicalis (Grote and Robinson)

Identification

This is a medium-sized (26 to 32 mm) moth, although small for a notodontid, that is consistently plain in appearance (Figure 242). Covell (1984) also gives an illustration of this species. A quick check of websites in 2006 showed that *Schizura badia* is sometimes misidentified as this species.

As far as Forbes (1948) could tell from preserved specimens, the larvae of these two species are probably similar. Wagner (2005) illustrates the adult and larva of *Schizura badia* and *Schizura unicornis* and the larva of *Schizura apicalis* probably is similar.

Figure 242. *Schizura apicalis* from Tangipahoa Parish, Louisiana (Marc Minno photo).

Range

Schizura apicalis occurred in scattered areas from southern Quebec and southern Maine to Wisconsin and southward, including parts of Nebraska, Missouri, and Kansas, to Texas and Florida. *Schizura apicalis* appears to be historic with no records in 30 to over 60 years in Quebec, Maine, New York, New Jersey and Pennsylvania. We know of no recent collection in Connecticut, either. Curiously, there is no evidence that *Schizura apicalis* ever occurred regularly in the New Jersey Pine Barrens. There is a specimen from just outside the area in the Yale Peabody Museum and the American Museum of Natural History has another labeled merely Ocean County. Farther west and south it appears to be very local, but there is little evidence that its status has changed much. We presume a California record (http://www.butterfliesandmoths.org) is in error. Since 1985, the only inland occurrences known to us northeast of Georgia are at least two localities in the southeastern coastal plain (Hall *et al.* 1999) and another in the Fall Line Sand Hills in North Carolina, two in the Virginia Mountains in Rockbridge (U.S. Forest Service surveys) and Montgomery (Hugo Kons collection) counties, and on a sand plain pine barrens in Montague, Massachusetts.

Rarity

NatureServe global rank: G3G4. This moth has always been uncommon to rare (Forbes 1948), and it often occurs in specialized sandy xeric habitats like pine barrens, and sandhills. *Schizura apicalis* has apparently declined in the Northeast south to Pennsylvania, where there have apparently been no collections in more than 60 years. Farquhar (1934) reported it from seven localities in three New England states. Since 1970, despite much improved collecting equipment such as blacklights, only six other populations have been found, and only one of the early sites still has this species. Four of the seven current New England occurrences are on off-shore islands, one on a New Hampshire beach, and two on sandy pine barrens, one of which is coastal. Except for an adult from an island in Boston Harbor (Mark Mello), no recent specimens have been found in the Boston area, despite old records (Sherborn, Newtonville, Weston) and the presence of much shrubby habitat on the granite ridges. In New York, it has not been found in recent (1980s to 2005) samples collected at blacklights on Long Island by The Nature Conservancy staff (Dale Schweitzer observation). Tim McCabe took one in the Albany pine barrens during the early 1980s, but none since, with nearly nightly effort. In the Midwest, the species occurs regularly in the Wisconsin pine barrens (Ferge and Balogh 2000), and probably would be found more often if collectors targeted sandy savannas and brushy prairies farther south. However, oak savannas and prairies have been greatly reduced in most of its range. *Schizura apicalis* is rare or at least very local in northern Georgia (James Adams) and eastern North Carolina (Hall *et al.* 1999, Bo Sullivan), Kentucky (Covell (1999), Missouri and Oklahoma (Hugo Kons). Its status is unknown in Florida, where it was reportedly historically widespread (Kimball 1965, Heppner 2003), but some old Florida records could be incorrect. Kons and Borth (2006) found this species only in Liberty County in the Panhandle. With the habitat unclear in most places, there is little basis to estimate the number of occurrences. False rarity is unlikely because this species seems to come well to ultraviolet lights in the right habitats, as do most other *Schizura* species. However, *Schizura concinna* adults are rarely collected at lights even where larvae are commonly found.

The reasons for this moth's decline in the Northeast are undocumented, but its current distribution, mainly in coastal and island refugia in New England, suggests that the introduced parasitoid fly, *Compsilura concinnata* (Elkington *et al.* 2006), may be a major factor. Especially in the 1970s and 1980s, this moth shared refugia with *Cingilia catenaria, Sphinx drupiferarum, Antheraea polyphemus*, *Automeris io*, and even the originally rather rare *Metarranthis apiciaria*, all of which declined widely in New England since the establishment of *Compsilura*. Given the association of this species with open shrubby or even grassy habitats, habitat loss due to succession and other factors probably also affected this moth.

Life history

Adults of *Schizura apicalis* have been found from mid-June to early August northward, which implies that the larvae are present from late June into September, and from May to August in North Carolina. There seem to be two broods in Kentucky, with adults found from 7 May to 21 August. One was collected in Kentucky on 23 September, which would probably be too late for successful reproduction, given cool weather in October. Adults are reported from January to June in Florida (Heppner 2003).

Schizura larvae feed on mature summer foliage. Larvae of *Schizura apicalis* are probably solitary in the later instars, but might occur in small groups earlier. Assuming the life history is similar to related species, after about four weeks of feeding, the larvae wander to the ground and spin a tough but thin cocoon in the leaf litter or humus, where, as far as is known, they hibernate as prepupae.

Host plants

Farquhar (1934) stated the larva is "said to feed on bayberry" (*Morella pensylvanica*), which is an abundant coastal shrub in New England. Tietz (1972) lists wax myrtle (*Morella cerifera*) as a host. These plants were formerly placed in the genus *Myrica*. Thus, the related sweet fern (*Comptonia peregrina*) is also a likely food plant in pine barrens areas from New England to Wisconsin. The distribution of this moth does not coincide with any Myricaceae in the Virginia mountains, Missouri, or Kentucky. Tietz (1972) and Robinson *et al.* (2002) also report blueberry (*Vaccinium* species) in the heath family (Ericaceae), and poplar (*Populus* species) and willow (*Salix* species), both in the Salicaceae, as hosts. Willows and poplars may be used by western populations of this species, but given its preference for dry habitats, they seem unlikely to be normal food plants eastward. Blueberries are also scarce or absent in coastal scrub habitats, but are abundant in most pine barrens. Most other *Schizura* and related species are oligophagous to polyphagous.

Habitat

Recent records from the northeastern United States are all from beaches, islands, coastal scrub, or sand plain pine barrens. However, three of the seven New England localities given by Farquhar (1934) were not coastal, and are not known sand plain areas. For example, his sites at Newtonville and Weston were probably granite hills (also discussed above under accounts for *Hemaris gracilis, Lycia rachelae*, and *Metarranthis apiciaria*). Ferge and Balogh (2000) considered this moth characteristic of the sandy pine barrens of central Wisconsin, and sandy pine-bear oak barrens seem to have been the habitat at Albany, New York. The recent North Carolina collections were in sandhill habitat but near wetter areas with both willows and *Morella*, according to Steve Hall. Kons and Borth (2006) found it in dry turkey oak- longleaf pine sandhill habitat in Florida.

This species occurs in a variety of different habitat types throughout its large range. Nevertheless, xeric, oak scrub, oak-pine scrub, savanna, or barrens are in virtually all of these sites. The exceptions are some on the immediate New England coast, where some sites are coastal dunes or islands. Many specimens are from areas that also contain native grasslands. In Montgomery County, Virginia, Hugo Kons collected specimens in two large fields near hardwood forest, and one in the forest. Farther west, he reports (personal communication with Dale Schweitzer) finding this moth in upland tall grass prairie in St. Claire County, Missouri and sandy oak savanna in Oklahoma County, Oklahoma.

Coastal *Morella* scrub and thickets could well have been an important habitat from Massachusetts southward, and such places were not well-collected in New Jersey before most were converted 100 years ago to summer resorts.

Schizura apicalis often occurs with other species with accounts in this book (e.g. see Ferge and Balogh 2000). In Massachusetts it has occurred with *Hemaris gracilis, Metaranthis apiciaria, Apodrepanulatris liberaria, Callophrys irus,* and *Catocala herodias*, and Kons reports *Catocala herodias, Catocala messalina,* and *Derrima stellata* with it in Oklahoma.

Threats & management issues

Btk applied to control gypsy moth larvae should not be harmful, because the first *Schizura apicalis* larvae would appear a month or more later. To the extent that defoliation is prevented, *Btk* applied to control gypsy moth larvae should even be beneficial. Suppression of large gypsy moth populations might also lessen spillover parasitism from *Compsilura*.

Without being certain of its primary food plants, especially where Myricacae are absent, the potential impact of gypsy moth outbreaks is unknown. *Morella* species are not highly vulnerable to gypsy moth feeding, but can be defoliated in severe outbreaks, as can blueberries. Willows and aspens are highly favored by gypsy moth larvae.

Mortality would be high in most fires, assuming that, like other S*chizura,* the cocoons are in the litter and not underground. However, barrens shrubs and *Morella pensylvanica* recover quickly after fires, and the habitat could be optimal by the following year, or even late in the first summer. Pine barren habitats need occasional fires to persist, and succession resulting from lack of fires is a threat in these habitats.

Other threats include loss of coastal and island habitats to sea level rise, and increasing damage due to already frequent storms that are likely to become more severe as the climate warms.

References

Brower (1974), Covell (1984, 1999), Farquhar (1934), Ferge and Balogh (2000), Forbes (1948), Hall *et al.* (1999b), Handfield (1999), Heppner (2003), Holland (1903), Kimball (1965), Kons and Borth (2006), Metzler *et al.* (2005), Minno (1992b), Robinson *et al.* (2002), Tietz (1952,1972), Wagner (2005).

Family Erebidae (owlet moths, in part)

Subfamily Arctiinae (lichen, tiger, and wasp moths)

Lesser wasp moth

Pseudocharis minima

Identification

This medium-sized (30 to 35 mm) wasp mimic has a distinctive color pattern (Figure 243). The wings and body are black with white spots. The legs are black except for the tip of the tarsus, which is white. The hind legs are very long and have a patch of hair-like scales near the end of the tibia. The antennae of the males are black with orange tips, while those of the females are mostly orange (Fine 2007). In rare individuals, the spots are yellowish rather than white, according to Dave Baggett.

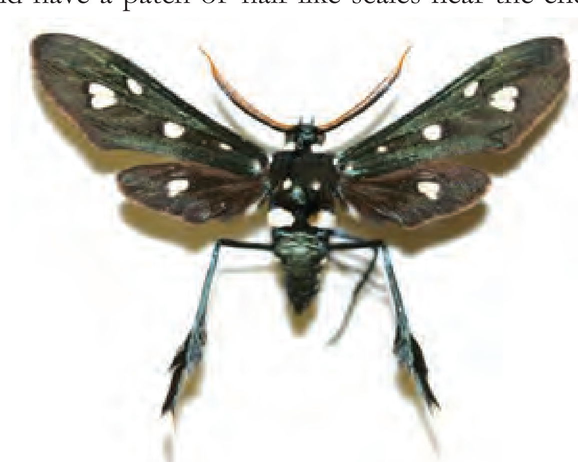

Figure 243. *Pseudocharis minima* (lesser wasp moth) from No Name Key, Monroe County, Florida (Marc Minno photo).

The lesser wasp moth is similar to the common polka-dot moth (*Syntomeida epilais*), but is much smaller and lacks red at the tip of the abdomen. The larvae are orange with tufts of black hairs (Figure 244), and resemble the larvae of *Syntomeida epilais* (illustrated in Wagner 2005), but are smaller. Covell (1984) also illustrates both moths.

Range

Pseudocharis minima occurs only in southern Florida and the West Indies. In Florida it has been found on No Name Key, Big Pine Key, Little Torch Key, Key Largo, and on the mainland in southern Miami-Dade County. According to Jeff Slotten, it had been most abundant on No Name Key, but Marc Minno has not seen any there recently.

Figure 244. *Pseudocharis minima* (lesser wasp moth) from Miami-Dade County, Florida (David Fine photo).

Rarity

NatureServe global rank: G2G4. This moth is rare and declining in Florida.

David Fine (2007) recently found a colony near the Miami Metro Zoo, where 15–20 adults were seen per day. It is exceedingly rare in the Florida Keys where Marc Minno has seen only three adults since 1982. However, two were recently found in the Keys: a female at the northern end of Big Pine Key on 16 February 2008, and another on 3 January 2009 on Little Torch Key. Its status outside of the United States is unknown.

Life history

Fine (2007) illustrated and described the life history of *Pseudocharis minima*. The adults are mostly day-flying, but do come to blacklights as well. Adults have been reported every month of the year (Kimball 1965, Fine 2007). The eggs are metallic-gold colored. Females lay the eggs in clusters on the undersides of the host leaves. The eggs hatch in four days. After about two weeks, the mature larva spins a cocoon of silk and larval hairs, sometimes on the stems and leaves of the host.

Two of the three adults observed by Marc Minno were visiting the flowers of narrowleaf yellowtops (*Flaveria linearis*). The female on Little Torch Key seen feeding at withered flowers of *Ipomoea indica* and *Bidens alba* in a weedy yard.

Host plants

The larvae of *Pseudocharis minima* eat the leaves of *Crossopetalum* species, shrubs with small red fruit in the stafftree family (Celastraceae) (Dyar 1897a, b, Tietz 1972, Fine 2007). Both Christmasberry (*Crossopetalum ilicifolium*), a prostrate shrub, and rhacoma (*Crossopetalum rhacoma*), an erect shrub, are used (Fine 2007). These plants are found in pine rocklands, but rhacoma also grows at the edges of tropical hammocks and in the ecotone between hammocks and salt marshes.

Habitat

This moth occurs near patches of the host plants in open pine rocklands and at the edges of tropical hammocks and salt marshes. The largest remaining areas with pine rockland are on Big Pine Key and in Everglades National Park at Long Pine Key.

Threats & management issues

Open pine rockland communities are fire-maintained, and change into forests of shrubs, palms, and hardwood trees without fire. All life stages of the lesser wasp moth are above ground, so mortality would be high during prescribed burns. While these habitats should be periodically burned, they should not be entirely burned in one season.

Invasive exotic plants such as Brazilian pepper will eliminate the host and moth if allowed to become too dense.

Mosquito spraying may cause some mortality, but no one knows how sensitive *Pseudocharis minima* adults or larvae may be to the various insecticides used in Florida.

Exotic predatory ants may be affecting *Pseudocharis minima*.

References

Covell (1984), Dyar (1897a, b), Fine (2007), Heppner (2003), Holland (1903), Kimball (1965), Tietz (1972).

Yellow-edged tussock moth

Pygarctia abdominalis Grote

Identification

This medium-sized (30 to 40 mm) grayish moth has orange/yellow along the costa and inner margin of the forewing, as well as on the abdomen (Figure 245). No species with similar adults occur in or near its known eastern range. Any densely hairy arctiine caterpillar on spurges along the Atlantic Coastal Plain or in Florida would probably be *Pygarctia abdominalis* (Figure 246).

Figure 245. *Pygarctia abdominalis* (yellow-edged Pygarctia) from Leon County, Florida (Marc Minno photo).

Figure 246. *Pygarctia abdominalis* (yellow-edged Pygarctia) larva from Putnam County, Florida (David Wagner photo).

Range

This moth is currently found from southeastern Virginia to central Florida, and according to Hugo Kons, west along the Gulf to east Texas at least. Populations in central Texas are of uncertain taxonomic status in our opinion and his. *Pygarctia abdominalis* historically occurred in the New Jersey Pine Barrens. The last New Jersey specimen (in the Yale Peabody Museum) was taken in Monmouth County on 21 June 1955, but *Pygarctia abdominalis* was collected regularly to the south in Ocean and Burlington counties a decade or two earlier.

Pygarctia abdominalis is extant in Isle of Wight County (2000) and in the City of Suffolk (2003) in southeastern Virginia (Steve Roble), eastern North Carolina (Steve Hall), and Florida (locally numerous). Kons and Borth (2006) reported it from eight localities in recent surveys, including peninsular Florida, the central Panhandle, and far western Panhandle. Potential habitat is limited in Maryland, and the species is not expected to occur in Delaware. There are records from Georgia and South Carolina, but none that we know of in the last 30 years. The Butterflies and Moths of North America website (http://www.butterfliesandmoths.org/species?l=3826) shows this as primarily a Texas species, and otherwise shows only one locality in Florida and two in South Carolina.

Rarity

NatureServe global rank: G3. This is generally a rare and poorly known moth that has declined in most of its range.

In Florida *Pygarctia abdominalis* is not as rare as northward, but it appears to be dependent on sandhill and scrub habitats (Kons and Borth 2006). *Pygarctia abdominalis* is one of three or four southern macromoths that were found regularly in the New Jersey Pine Barrens from the 1930s to 1950s, but probably no longer occur there. The extreme and prolonged cold in early 1961 was possibly a factor in their disappearance from New Jersey, but it seems more likely that for some reason *Pygarctia abdominalis* cannot persist on roadsides, railroad beds, and other artificial habitats where the food plant is now normally seen.

Grasses and forbs (such as the food plant) declined substantially in the Pine Barrens after the mid-20th century, probably due to declining fire frequency. This habitat change coincides well with the disappearance of *Pygarctia abdominalis*, as well as *Ptichodis bistrigata*, which seems to be associated with grassy habitats elsewhere.

Life history

In most of the current range of the yellow-edged tussock moth there are probably two broods from about April to mid-August. The two Virginia collection dates are 16 June and 13 July (Steve Roble), and adults probably start to appear there in late April. Most New Jersey records were in May and June, but may have been reared from wild larvae—the collectors involved usually omitted this information from their labels. March and October specimens from New Jersey were almost certainly reared, but records extend from February to September in Florida (Heppner 2003). The pupae overwinter in a cocoon at or near the surface of the ground. Adults come to blacklights and mercury vapor collecting lights.

Host plants

Larvae of this and related genera are all specialists on milky-sapped plants, mostly in the spurge (Euphorbiaceae) and dogbane (Apocynaceae) families (Forbes 1960, Covell 1984). James Adams has reared *Pygarctia abdominalis* and several congeners on *Chamaesyce maculata* (Euphorbiaceae), and *Euphorbia* species are known to be the natural food plant of the related *Pygarctia spraguei*. *Pygarctia abdominalis* presumably also feeds on Carolina ipecac (*Euphorbia ipecacuanhae*), which is the only plant in this family in its former New Jersey habitats. Steve Hall reports that Carolina ipecac, tread softly (*Cnidoscolus stimulosus*), and other spurges occur in its North Carolina habitats, but which of these are used as food plants is uncertain.

Habitat

This species occurs in sandhills, dry Coastal Plain and Sandhill pinelands, and coastal strand communities.

Threats & management issues

Much of the habitat for *Pygarctia abdominalis* has been destroyed by development, silviculture, or agriculture.

Inappropriate fire practices such as complete burns or lack of fire are probably the most important threats where this species still exists on public lands or preserves. Most habitats would be lost to succession without at least occasional fires. No stage is protected from fires, although if the fuel load is low, some might survive under the succulent leaves of the prostrate Carolina ipecac.

Gypsy moths could become an issue, but the xeric, sandy habitats of *Pygarctia abdominalis* might not support major outbreaks (Schweitzer 2004).

Based on the phenology of the adults, most larvae would appear late enough in spring to escape exposure to *Btk*, at least from a single application.

Timber harvest probably would not negatively impact *Pygarctia abdominalis*, providing disturbance to the ground cover is minimal. Selective thinning might be beneficial in dense stands where the food plants are now largely confined to edges and paths.

Deer do not seem to eat the host plants.

References

Covell (1984), Forbes (1960), Heppner (2003), Holland (1903), Kimball (1965), Kons and Borth (2006), Shuey *et al.* (1987b).

Subfamily Herminiinae

Gopher moth

Idia gopheri (J. B. Smith)

Identification

This medium-sized (35 mm) moth is the largest *Idia* species in our region. It looks like a very large, pallid version of the common *Idia lubricalis* (Geyer). The forewings are dull, not glossy (Figure 247).

Figure 247. *Idia gopheri* (gopher moth) from Volusia County, Florida (Marc Minno photo).

Range

Idia gopheri is known mostly from northern and central peninsular Florida. Its larva is a commensal inhabitant of gopher tortoise (*Gopherus polyphemus*) burrows. No one has conducted surveys for the moth throughout the tortoise's total range. The moth probably occupied much of that range, and a few specimens have been taken in west-central Mississippi which may be outside of the range of the tortoise (Stillwaugh 2006). Gopher tortoises are present on the Ohoopee Dunes in Emanuel County, Georgia, where Irving Finkelstein and James Adams collected *Idia gopheri* on September 3-5, 2010. Don Stillwaugh found 69 specimens from Florida, three from Georgia, and one from Mississippi, in older collections.

Rarity

NatureServe global rank: G2G3. *Idia gopheri* is a commensal inhabitant of gopher tortoise (*Gopherus polyphemus*) burrows, apparently armadillos (*Dasypus novemcinctus*), and perhaps other animals. The tortoise is also considered globally rare (G3) and the westernmost populations in Louisiana, Mississippi, and southwestern Alabama are Federally listed as Threatened. The gopher moth undoubtedly still occurs with many of the larger populations of its host.

Of the 73 adult moth specimens located by Stillwaugh in public and private collections, only 16 were collected since 1980, which does suggest a decline. The National Museum of Natural History collection contained over 40% of the specimens. However, in addition to the 2010 collections in Georgia, we are aware of collections in 1999 and 2000 in Alachua and Putnam counties in Florida (Hugo Kons personal communication with Dale Schweitzer).

Life history

Very little is known of this secretive moth. The larvae live in the burrows of gopher tortoises. Don Stillwaugh recently collected a few adults in funnel traps set at the entrance of gopher tortoise burrows in central Florida. Adults fly at night and, like other species of *Idia*, are attracted to lights and the usual fermenting baits (Dave Baggett). However, Kons did not get any at bait at the two sites where he found this species.

Adults of *Idia gopheri* have been collected in every month of the year, but most specimens were from February through April (Stillwaugh 2006). Two moths in the family Tineidae are also associated with gopher tortoises. *Acrolophus pholeter* lives in burrows, and larvae of *Ceratophaga vicinella* feed in a case on the keratin layer of the shells of dead gopher tortoises.

Host plants

The larvae feed on gopher tortoise droppings, which typically contain many grass leaves and stems. They also feed on detritus in the burrows of the tortoises.

Habitat

Idia gopheri occurs in scrubs, sandhills, and scrubby flatwoods, with gopher tortoises.

Threats & management issues

Upland areas in the southeastern United States are rapidly being converted to urban land uses. In Florida, where most gopher tortoises live, tortoises must be relocated to conservation areas before a property is developed, but the associated commensal animals are left behind and destroyed. There is so little is known about *Idia gopheri* that our only current recommendation is to maintain healthy tortoise populations through sufficient prescribed burning and other management practices.

References

Crumb (1934), Kimball (1965), Kons and Borth (2006), Minno (1992b), Stillwaugh (2006), Young and Goff (1939).

Woodrat nest moth

Idia majoralis (J. B. Smith)

Identification

This medium-sized (30 to 35 mm) moth is similar to the very common *Idia americalis* (Guenée), but averages much larger, although there is some overlap in size between the smallest *Idia majoralis* and largest *Idia americalis*. The hindwings are duller and darker in *Idia majoralis* (Figure 248), with the lines more wavy than in *Idia americalis*. The forewings are more evenly colored and the basal third is not paler as on *Idia americalis*. Rings *et al.* (1992) and Handfield (1999) also illustrate the adult.

Figure 248. *Idia majoralis* (woodrat nest moth) from Monogalia County, West Virginia (David Wagner photo).

Range

Forbes (1954) gave the range of *Idia majoralis* as Massachusetts to Montana and south into Mexico. This is consistent with the range of woodrats (*Neotoma floridana* and *Neotoma ma-*

gister) in our area and other *Neotoma* species farther west (Wilson and Ruff 1999). Larvae are known to be commensals in woodrat nests, but apparently not always.

In our area, the eastern woodrat (*Neotoma floridana*) occurs from southern Florida to the Carolinas and westward into southwestern South Dakota, eastern Colorado, and central Texas. The Allegheny woodrat (*Neotoma magister*) occurs in the Northeast and upper Midwest, including New York, New Jersey, Pennsylvania, western Maryland, Virginia, Tennessee, Kentucky, southern Illinois and Indiana.

Handfield (1999) reports *Idia majoralis* in Canada, well outside of the known range of woodrats, specifically from the Montreal area of Quebec (not recently). He illustrates a pair taken in 1932 at two sites in Ontario.

Among the relatively recent eastern records, Steve Johnson collected one in Northumberland County, Pennsylvania in 2004. Rings *et al.* (1992) had a 1988 record for Ohio. A few turned up in Rockbridge County, Virginia, in U.S. Forest Service samples collected in the early 1990s. Two were collected on 18 June 1996 in Stokes County, North Carolina (Bo Sullivan). A few have been collected since 2000 in Gilmer County, Georgia (Irving Finkelstein), and as recently as 2010 in Bartow County (James Adams). Adults were collected on 1 July 1967 (Yale Peabody Museum), October 1967, and 22 August 1968 in Charleston County, South Carolina. Although Dale Schweitzer collected two in July 1972 in Graham County, North Carolina, just outside the boundaries of Great Smoky Mountains National Park, none have been found in recent surveys of the Park (David Wagner observation). Its status farther west is not well known to us, but this species was found by Douglas Ferguson to be abundant on 17-30 July 1964 near Hill City, South Dakota (specimens in the Yale Peabody Museum). Hugo Kons and Robert Borth recorded it from six localities in Wisconsin during the early and mid 1990s, including the following counties: Outagamie, Winnebago, Brown, and Sheboygan. Hugo Kons and Robert Borth also found it in Oklahoma County, Oklahoma, in Montgomery County, Virginia in 2002, and at Atlanta State Park in extreme northeast Texas in 2004.

Rarity

NatureServe global rank: None. *Idia majoralis* would probably rank G4 even though it is a rare moth in the northeastern United States, and historic in Canada. Based on its range, this moth cannot be associated exclusively with woodrats, but its decline is probably linked to theirs. Both of the woodrat species found in the eastern United States (Wilson and Ruff 1999), as well as the moth, have declined, especially the northeastern Allegheny woodrat (*Neotoma magister*). *Neotoma magister* is ranked G3G4 and as S1 to S3 in twelve states from New York to North Carolina. We know of only one post-1950 record of *Idia majoralis* from the northeastern United States. Farquhar (1934) reported what may be the last records of *Idia majoralis* from New England, and Tietz (1952) listed only two Pennsylvania localities. The Eastern woodrat (*Neotoma floridana*) is still ranked G5 by NatureServe (as of June 2008), and the records above indicate that *Idia majoralis* is still found widely within at least southern portions of its range. Although collectors have not made any special effort to specifically survey woodrat nests for this species, the moths come to blacklights and rarely also to bait. The paucity of recent records in the range of *Neotoma magister*, appears to represent a real decline. Some element of false rarity is possible because this moth is usually found in small numbers, but several recent records do include more than one specimen.

Life history

Some Ohio specimens were reared from pupae found in woodrat nests, and we suspect this is their normal habitat, but it cannot be their only habitat. Perhaps nests of some other rodent were used in Ontario and Quebec, where wood rats are not known to have occurred, or perhaps the larvae occur in habitats other than rodent nests. Hugo Kons reports collecting a number of specimens in suburban Appleton, Wisconsin, where woodrat nests are also unlikely to be the habitat.

Adults occur mostly from about late June through September in most of their range, occasionally later southward. An April record from Ohio is probably based on laboratory rearings.

Habitat

Woodrats prefer to live around rock outcrops, caves, and cliffs, but *Neotoma floridana* also occurs in upland hardwood forests and swamps in the southeastern United States. Other species of woodrats occur in deserts in the western part of their range (Burt and Grossenheider 1980). The nests are built of sticks and other materials, usually on the ground around rocks, logs, or exposed roots, but sometimes also in trees or cacti.

Threats & management issues

Factors affecting woodrats, and thus the moth, include increased predation, widespread high mortality due to parasitism by raccoon roundworm, and habitat loss and fragmentation. There is a substantial recent literature on woodrat decline, including Hicks (1989) and Monty and Feldhamer (2002). LoGuidice (2000) concludes that raccoon roundworm has had a major impact on woodrats in New Jersey. Impacts to important food sources, such as acorns, may also be contributing to woodrat decline. Gypsy moth outbreaks create temporary food shortages for woodrats because acorn production ceases, or nearly so, for one or more seasons following defoliation by the caterpillars. Non-native diseases of mast trees, such as sudden oak death syndrome, are a potential threat to woodrats, and thus the moth.

References

Burt and Grossenheider (1980), Farquhar (1934), Forbes (1954), Handfield (1999), Hicks (1989), Monty and Feldhamer (2002), LoGuidice (2000), Rings *et al.* (1992), Tietz (1952), Wilson and Ruff (1999).

Subfamily Catocalinae

Genus *Catocala* (underwing moths)

Catocala are distributed across much of the Northern Hemisphere. Lafontaine and Schimdt (2010), following Gall and Hawks (2010), recognize 101 species for North America. Over 70 species occur in the eastern United States. Besides their attractive colors and patterns, their diversity has made underwing moths popular with North American collectors for more than a century (e.g. Holland 1903, Sargent 1976). As a result, this is one of the few groups of moths whose ecology has been studied in some detail (Sargent 1976, Schweitzer 1982b, Gall 1991a-c).

Occasionally a few hours of day time searching on a hot afternoon, a couple of hours at a bait trail, or an overnight light trap will produce 20 or more species of *Catocala*, and ten species in a few hours is not unusual in many states. The highest site total we know of is for Vernon Brou's property at Abita Springs, Louisiana , where 45 species, 41 probably resident, have been documented in a massive 28-year effort using lights and bait, including 12 of the 13 currently recognized North American Rosaceae specialists. The highest known total in our coverage area is 44 species[10] at Celina, Tennessee from 1970 to 1976 (but mostly in 1975 and 1976) (Miller 1977) using all three methods. Six counties in Ohio have 40 or more documented species according to John Peacock. A Robinson light trap at Amherst, Massachusetts that was operated only in 1979 produced 38 species (Sargent unpublished list). Regardless of methods used, from the 1950s to 2010, 35 to 41[11] species were found at the following sites over a decade or two (Sargent 1976 and personal communication with Dale Schweitzer,[12] Darryl Willis, and Eric Quinter personal communications with Dale Schweitzer, Joseph Muller collection now at the American Museum of Natural History): A small park and nearby yard in Holliston; forested residential sites at Leverett and West Hatfield, Massachusetts, Washington and Mansfield, Connecticut; and Lebanon, New Jersey. Three of these five sample sites produced 25 to 36 species annually for 10 to 12 years at lights in the 1960s and 1970s (Sargent 1976 and unpublished data).

Some portions of the Mid-Atlantic states where hawthorns and shagbark hickory are scarce or absent appear to have few species of *Catocala*. Only 12 to 21 Catocala species were documented by Steury *et al.* (2007), Ludwig (2001a, 2001b, and personal communication with Dale Schweitzer), Butler *et al.* (1991) with multi-year efforts in the Virginias, and H. G. Stevenson (specimens at the National Museum of Natural History) with almost nightly blacklight samples from 1986 to 1991 at Southaven, Maryland by H. G. Stevenson (specimens now at the National Museum of Natural History). While Albu and Metzler (2004) documented 30 species from southern West Virginia, intensively collected Kanawha County produced only 19, including *Catocala herodias* which has an account below. None of the species-rich New England or northern New Jersey localities produced any species rare enough to have accounts in this book, but

[10] Miller reports 41 species but *Catocala luctuosa, Catocala lineella,* and *Catocala carissima* are now known to be separate species.

[11] We added *Catocala lineella*, which was included in *Catocala amica* by Sargent (1976), for all of these sites.

[12] Samples in the book for West Hatfield and Leverett are through 1973, but efforts continued to 1979 with single individuals of *Catocala meskei* and *Catocala robinsoni* at West Hatfield in 1977, and a *Catocala meskei* at Leverett in 1975.

Catocala miranda was collected once at Celina, Tennessee, and *Catocala dulciola* is among the 40 species John Peacock has found in Marion County, Ohio. Brou's diverse locality in Louisiana has produced four *Catocala* species with accounts in this book, *Catocala atocala, Catocala marmorata, Catocala miranda*, and *Catocala lincolnana*. Hugo Kons and Robert Borth found at least 30 other species of *Catocala* with *Catocala marmorata* in Indiana. However, several *Catocala* species rare enough to have accounts in this book occur in species-poor habitats. The *Catocala* fauna of coastal pinelands and adjacent swamps, bog edges, or pocosins, from Massachusetts to New Jersey and in the Carolinas often contains only about 16 to 22 resident species, but among these may be *Catocala herodias gerhardi* on Cape Cod and Long Island, along with *Catocala pretiosa*, and historically *Catocala consors*, in New Jersey, and *Catocala grisatra* in Bladen County, North Carolina. Similarly peninsular Florida xeric oak scrub and dry upland woodlands support about 17 species, sometimes including *Catocala consors* and *Catocala delilah*. The uncommon *Catocala jair* occurs in oak scrub in all of these regions except Cape Cod.

Sargent (1976) discussed the effectiveness of the various methods used for collecting *Catocala* adults. Blacklights, especially if less than 20 watts, are often the least effective method, particularly for the larger species. Baiting trees is often a much more productive method than lights, but not always. By far the easiest way to find many large species in hot climates is by "tapping" trees, especially large hickories and oaks in shady places, during the afternoon and evening to flush resting adults from their perches (Sargent 1976, Willis 1991), but this method is seldom effective when the air temperature is below about 32ºC (90ºF). Adults of some species can be found at night resting or ovipositing on tree trunks.

Our ranges for this genus are based mostly on a set of unpublished maps created by Larry Gall and David Hawks from data on thousands of specimens in museums and private collections. As with moths in general, there are few records for Tennessee, most of Virginia, southern Georgia, and Alabama. Because their maps usually separate pre- and post-1950 records, range contractions or expansions are very apparent for some species.

All named species in our coverage area have been reared, and the immature stages of most have been described and illustrated. Wagner *et al.* (in press) illustrate many species with close-ups of their head capsules (see also Wagner 2005).

Several recent workers have carefully documented natural food plants, including Gall (1991a-c) and Schweitzer (1982b) mostly in the Northeast, and Dave Baggett, Robert Borth, Hugo Kons, and Jeff Slotten (all unpublished) in Florida. Rings *et al.* (1992) gave accurate food plants for the first time in a major regional list. Larvae of each species feed only on a single plant family, and most eat only species from one or two genera, or even just one species. Most require young spring foliage through at least the penultimate instar.

Catocala are single-brooded, and typically most of the year is spent in the egg stage. Females lay their eggs in bark furrows or other protected places on the food plant if it is a tree. Captive females of shrub feeders oviposit freely on or under twigs or dead leaves of the food plant.

The caterpillars of most species hatch a week or two after the leaves of the food plant begin to expand in spring, and mature in about three or four weeks, but caterpillars of a few species grow slowly in the late instars and require about six weeks. Mature larvae spin a weak cocoon, usually in the leaf litter, and pupate. A few pupate under loose bark, or at least occasionally, among living foliage. Adults emerge about three or four weeks later.

A substantial number of *Catocala* species specialize on hawthorns (*Crataegus*) and related genera of Rosaceae (in the subfamily Maloideae). Deer heavily browse the new growth of these small trees and shrubs, and loss of most or all foliage one or more times in a season often kills the plants after a few years. Even if the existing stems are too tall for deer to reach, browsing commonly eliminates stem replacement as the older stems eventually die. Invasive shrubs and vines may also be contributing to decline of these genera, and we do not know if there could be other factors. Hawthorns were fairly common in northern New Jersey into the 1970s or 1980s (Dale Schweitzer observation, Hupf 1983), but one would not expect to see any hawthorn during a field day now in most places.

Catocala grynea is one of the five Maloideae-feeding *Catocala* species that were widespread in northern New Jersey, and still are in New England. *Catocala grynea* is now associated primarily with ornamental crabapples. For the other four, we know of only three *Catocala praeclara*, three *Catocala blandula*, and no *Catocala mira* or *Catocala crataegi* collected in northern New Jersey forests after 1977. This includes almost nightly efforts by Anthony McBride from 2003 to 2011, and Joseph Garris from 2005 to 2010. Similarly, although these five plus *Catocala miranda* and *Catocala dulciola* are known from Greenbrier County (Gall and Hawks maps), Albu and Metzler (2004) collected none of these seven species in southern West Virginia from 1988 to 2002. With at least five, if not all seven, of the same species expected, Gall *et al.* (1991) took only seven *Catocala blandula*, among 1,034 *Catocala* of 23 species in Shenandoah National Park, Virginia in 1989.

Species with larvae that are highly specialized on *Crataegus* or other Maloideae could become increasingly threatened by excessive deer herbivory. In the following accounts, we group the Rosaceae (Maloideae) feeders together first, followed by the others in alphabetical order. Size data presented below are mostly taken from Sargent (1976).

Sweet underwing

Catocala dulciola Grote

Identification

At 40 to 45 mm, this underwing moth is among the smallest of its genus. There is little variation, and adults should be easy to recognize from our illustration (Figure 249). The larva is illustrated here for the first time (Figure 250). Covell (1984) and Sargent (1976) also illustrate the adult.

Figure 249. *Catocala dulciola* (sweet underwing) from Cass County Michigan (Marc Minno photo).

Figure 250. *Catocala dulciola* (sweet underwing) larva from Paulding County, Ohio (David Wagner photo).

Range

This moth occurs mostly in two regions:

1) a band from southern Michigan through northern Indiana, much of Ohio, and immediately adjacent Kentucky, eastward to West Virginia, western Virginia, and Allegheny County, North Carolina (Bo Sullivan);

2) an area along the Mississippi and Ohio Rivers in Illinois, Missouri, and western Kentucky, extending west along the southern boundary of Missouri.

Catocala dulciola is known from at least eight counties in Ohio and six in Missouri, but no more than three in other states. Pre-1950 collections far to the east in northern New York and northeastern Pennsylvania could have resulted from introduction as eggs on ornamental hawthorns, or may indicate a much larger former range.

Rarity

NatureServe global rank: G3. Although *Catocala dulciola* can be locally common in parts of Ohio (Rings *et al.* 1992, John Peacock), and is found regularly at some places in Michigan (Mo Nielsen) and Virginia (John Coffman), this species has been collected in only about 35 locations, including the old records. This rank is based primarily on the low number of documented modern occurrences, limited current range, and on the opinions of Larry Gall and Dale Schweitzer.

Covell (1999) regarded the species as uncommon to rare in the two counties in Kentucky for which he had records.

LIFE HISTORY

The larvae hatch in April and mature in May or early June.

Adults of this moth are usually found in June and early July (Rings *et al.* 1992, Covell 1999). John Peacock's collections of this species from north-central Ohio range from 22 June (freshly emerged) to 9 July (worn). Four collections from northern Kentucky range from 9 June to 2 July (Covell 1999). Hugo Kons and Robert Borth's records from Montgomery County Virginia are within this interval as well. The latest record appears to be a worn male collected on 29 July 1973, at 2,700 feet (707 m) elevation in Allegheny County, North Carolina, by Bo Sullivan.

Adults are collected mostly on bait, at least in Ohio, but do come to lights.

HOST PLANTS

John Peacock has reared this moth from larvae found on hawthorns (undetermined species), and one on an American plum (*Prunus americana*) that was growing among hawthorns in Ohio. Newly hatched larvae from that population rejected the closely related *Prunus angustifolia*, as well as leaves and blossoms of the apple, and *Amelanchier canadensis*, and were promptly poisoned by the crabapple *Malus X purpurea* (Dale Schweitzer rearing). According to notes from Larry Gall, Wayne Miller also had larvae reject seven potential food plants, but he was able to rear them on Washington hawthorn (*Crataegus phaenopyrum*). This species appears to be a specialist on certain hawthorns.

HABITAT

Catocala dulciola is found mostly in or at the edges of deciduous forests. It does not appear to be restricted to any obviously unusual habitat. John Peacock describes the two places where he collects this species regularly in Ohio as small woodlots "loaded with several species of hawthorn."

THREATS & MANAGEMENT ISSUES

The entire range of this underwing will soon be invaded by the gypsy moth. Gypsy moth spraying is a serious potential threat, at least in small fragmented habitats such as Midwestern woodlots. Because the larvae emerge early in the spring, they would usually mature before defoliation becomes severe during gypsy moth outbreaks. However, they would probably be middle or late instars during *Btk* applications, making any impact of such applications unpredictable (Peacock *et al.* 1998).

Deer herbivory will also probably prove to be a threat in some places. Likewise, invasive shrubs and vines may be a threat where the food plants are growing on rich soils in forest understories or edges.

Prescribed burning does not seem to be an issue with the habitats of this species, but no life stage has any protection from fires, and the food plants would require several seasons to reach sufficient size for ovipositing females to use them.

REFERENCES

Covell (1984, 1999), Forbes (1954), Peacock *et al.* (1998), Rings *et al.* (1992), Sargent (1976).

Grisatra underwing

Catocala grisatra Brower

Identification

At 48 to 50 mm, this moth is larger than most other Rosaceae-feeding *Catocala*, some of which have somewhat similar wing patterns. The frosted appearance of the gray parts of the forewing is usually distinctive, and most are grayer than our illustration (Figure 251). It perhaps could be confused with the much paler *Catocala clintoni* (illustrated by Sargent 1976, Covell 1984) by inexperienced persons. The caterpillars are extremely variable and, as we illustrate (Figure 252 and 253), may be very distinctively marked, or quite plain and can resemble those of several other species. The two that we illustrate look so different that we had Larry Gall verify that both really are this species. Adults should be reared for positive identification of larvae.

Figure 251. Catocala grisatra (Grisatra underwing) from Liberty County, Florida (Marc Minno photo).

Figure 252. Catocala grisatra (Grisatra underwing) larva from Liberty County, Florida (Larry Gall photo).

Range

This species has the most restricted documented range of all of the named eastern *Catocala* species. Gall and Hawks indicate records for nine counties across northern Florida, including four in the Panhandle, near Athens, Georgia (holotype specimen collected more than 70 years ago), and recently in Bladen County, North Carolina (Cromartie and Schweitzer 1997). Unfortunately, the latter site was clear-cut and sprayed with herbicide to suppress hardwood regeneration a few years later. *Catocala grisatra* should occur in South Carolina.

Figure 253. Catocala grisatra (Grisatra underwing) larva from Liberty County, Florida (Jeffrey R. Slotten photo).

Rarity

NatureServe global rank: G1G3. *Catocala grisatra* is a rarely collected species with a restricted range that occurs in a specialized and dwindling habitat.

This moth is currently known to be extant only in northern Florida, where upland woods and scrub are being rapidly lost to development and clear-cutting. Efforts by Jeff Slotten and others to locate adults and larvae in North Carolina in 2008 near the historic site were unsuccessful.

Hugo Kons reports that adults of this species are difficult to survey for by standard collecting techniques. He says that none has been found in the daytime, even at known sites, and they rarely come to lights or bait. Thus, adults of this species are probably overlooked more than most *Catocala*. In fact, *Catocala grisatra* is usually collected as larvae.

Life history

What little that is known about this species comes from the unpublished observations of Rick Gillmore, Steve Roman, Jeff Slotten, Dave Baggett, and Hugo Kons The larvae can be found on small saplings, but also occur on more mature plants. The adults emerge later than other Rosaceae-feeding *Catocala* species, which matches the phenology of the host plant. The adults occur in May and June in Florida, with the larvae in April and perhaps early May. One of the two North Carolina specimens collected on 22 June was in rather fresh condition, indicating it had probably pupated in late May. The holotype was collected in June in Georgia.

Host plants

Jeff Slotten, Robert Borth, and Wayne Miller have all found larvae on yellowleaf hawthorn (*Crataegus flava*), but so far not on other *Crataegu*s species in northern Florida. Kons was able to rear one of these on *Crataegus uniflora*.

Habitat

This underwing has been found in sandhills, scrubs, and other dry, sandy pine-oak woodlands with hawthorns. The North Carolina site did not show any obvious sign of recent fire, although some Florida sites burn at least occasionally. The food plant is among the more common hawthorns in Florida (Nelson 1994), but apparently *Catocala grisatra* is more habitat-restricted than its food plant.

We do not know how fire affects habitat suitability for this species. Both sites reported in Kons and Borth (2006) contained a mix of xeric oak-pine forest and open grassland habitat. One site was a disturbed upland with a small area of degraded turkey oak scrub, whereas the other (Apalachicola Bluffs and Ravines Preserve) contains much better quality sandhill habitat. However, at Apalachicola the host occurs primarily along the edges of oak-pine forests, rather than in the burn-managed sandhill units.

Threats & management issues

In the southeastern United States, the dry upland woodlands that this species prefers are rapidly being developed or turned into pine plantations.

While there is no direct evidence, fire could be a factor in the rarity of this species. Fire may be a threat if the entire habitat is burned at one time, or if the habitat is burned too frequently. Observations on the response of populations to fires over several years are needed. In particular, it would be useful to know how quickly sprouts in burned areas can again support larvae.

Other important questions are whether unburned scrub might eventually become unsuitable as habitat, and what stage is optimal habitat. Unless females oviposit on first year sprouts, short burn intervals, such as five years or less, might not allow recovery between burns. Larvae of shrub-feeding *Catocala* are virtually absent the first spring after fires as has been reported by Borth and Barina (1991) and Metzler *et al.* (2005).

Gypsy moths could become an issue in the range of this species, although xeric sandhills and scrub might not support outbreaks. The late phenology of *Catocala grisatra* indicates exposure to *Btk* would be in early to middle instars, so mortality could be higher than for most early-flying *Catocala* species. Sensitivity to *Btk* varies greatly among species in this genus (Peacock *et al.* 1998). Late phenology increases the chance that defoliation of the hawthorns could occur before larvae mature. Gypsy moth larvae do not favor hawthorns, but readily eat them during outbreaks.

Deer could become a problem because they do heavily browse hawthorns in xeric habitats in New Jersey that resemble the more southern habitats for this moth.

References

Borth and Barina (1991), Covell (1984), Cromartie and Schweitzer (1997), Heppner (2003), Kimball (1965), Metzler *et al.* (2005), Sargent (1976).

Lincoln underwing

Catocala lincolnana Brower

Identification

At about 47 mm *Catocala lincolnana* is among the largest of the Rosaceae-feeding *Catocala*. It is similar in appearance to *Catocala pretiosa*, but tends be larger than that species. Note the heavy black shade on the inner margin which then tends to follow the antemedian line to the costa, leaving much of the basal area pale, usually with a prominent basal dash (Figure 254). Also, note that the rest of the forewing is pale with some slight darkening toward the apex.

The larvae (Figure 255) may be indistinguishable from *Catocala pretiosa*, although the fringes may be sparser.

Figure 254. *Catocala lincolnana* (Lincoln underwing) from Alachua County, Florida (Marc Minno photo).

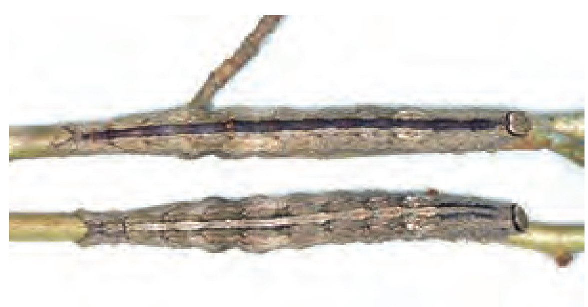

Figure 255. *Catocala lincolnana* (Lincoln underwing) larvae from Alachua County, Florida (Jeffrey R. Slotten photo).

Range

This species occurs from northern Florida, west into the lower Mississippi Valley and Texas, north into Arkansas, and along the Atlantic Coastal Plain to the Roanoke River swamps of North Carolina (Hall 1999). We have no records from the poorly collected states of Alabama or South Carolina, and it has only recently been found in Georgia (James Adams personal communication with Dale Schweitzer). Except for Arkansas and an isolated record from the Texas Panhandle on Gall's and Hawk's map, all collection sites are on the Coastal Plain.

Rarity

NatureServe global rank: G3G4. Brower (1976) named this species from only a single specimen collected in 1937. The Lincoln underwing is currently known from at least 25 sites, and is usually local and uncommon. It can be locally common in the Florida Panhandle on nights when bait is working well. However, large parts of the southeastern United States are poorly known for moths. It is likely that this underwing will be found through additional surveys at more locations in the proper habitats.

Life history

Like most hawthorn feeders, unless interrupted by cold, the eggs of this species will hatch rather synchronously within about a week (Dale Schweitzer and Larry Gall observations).

Kons and Borth (2006) report a flight season of early May to early June for the Florida Panhandle, but have subsequently found fresh individuals in late April. The flight season is similar in east Texas based on specimens collected by or known to Hugo Kons and Robert Borth. Brou (2005a) reports late April-May for the Louisiana flight. These dates imply larvae in March into early April southward. The adults fly in late May and June in North Carolina. Adults have been collected at lights, and especially at baits, in Florida Brou (2005a) reported more at bait relative to lights in Louisiana. Adults have not been found often in the daytime. Searching for larvae might be a reliable way to find the species as it is with *Catocala pretiosa*.

Host plants

In northern Florida, one host plant is parsley hawthorn (*Crataegus marshallii*) (Jeff Slotten). The same hawthorn is suspected in North Carolina (Hall 1999), but *Crataegus marshallii* is absent from all but one of the localities reported in Kons and Borth (2006), including at the site where this species is most common. According to Hugo Kons, *Crataegus spathulata* is the most common hawthorn present at one site where this moth is especially common in northern Florida, although *Crataegus viridis* also occurs there. *Crataegus spathulata* is also present at a good site for this species in Sabine County, Texas. Neither of these hawthorns occur at the Apalachicola Bluffs and Ravines where this moth is found regularly, but *Crataegus flava* and others are present. Based on the distributional data, this species must use more than one species of *Crataegus* in Florida. This species has not been found at several intensively collected sites in Alachua County where only *Crataegus uniflora* or *Crataegus aestivalis* occur. Dale Schweitzer had one cohort of eggs from Florida, nearly all of which hatched, but all of the larvae except one rejected several species of ornamental *Crataegus* and *Malus* (crabapples). The one exception was an individual that readily accepted the leaves of an ornamental crabapple and produced an adult.

Habitat

This underwing occurs in cypress-gum and hardwood swamps in North Carolina, and in both mesic and hydric hardwood forests in Florida (Kons and Borth 2006). In Sabine County, Texas Hugo Kons and Robert Borth have also found it in oak-pine uplands, and a suspected host, *Crataegus spathulata*, is present in all three habitat types at that site. At the Apalachicola Bluffs and Ravines site, adults have been found at lights and bait in the uplands as well as down in the floodplain forests. However, we note that in New Jersey, the closely related *Catocala pretiosa* often comes to bait in drier habitats than those where the larval food plants occur. Areas with *Catocala lincolnana* also often support the uncommon *Catocala orba*, which has similar phenology, and is also a hawthorn feeder, but either species may occur where the other does not (Hugo Kons and Robert Borth, personal observation). *Catocala orba* has been found at more places inland, at least in Georgia, according to James Adams.

Threats & management issues

The Roanoke River site, where Steve Hall collected *Catocala lincolnana* and *Catocala orba*, was treated a few years ago for a long-standing gypsy moth infestation. The Nature Conservancy's property was treated with pheromone flakes or Gypchek, but all of the surrounding swamps were sprayed with *Btk* (Steve Hall). We do not know if these *Catocala* still occur there.

Forest tent caterpillar (*Malacosoma disstria*) outbreaks have occurred in one *Catocala lincolnana* site in North Carolina, a cypress-tupelo swamp, but they do not appear to affect the food plant greatly, and are a natural process.

Catocala lincolnana larvae, mostly middle to late instars, would be exposed to *Btk* applications aimed at either pest. There is no basis to predict sensitivity of *Catocala lincolnana* or the others mentioned above to *Btk*, but it would be prudent to exclude core habitats from spray blocks.

Clearcutting would probably eradicate populations. Changes in hydrology could eradicate populations if the food plants were inundated during the larval, pupal, or adult seasons (March through May). *Catocala* eggs can withstand some flooding, and pupae probably can for at least a few hours. We do not know whether deer herbivory is likely to become a threat in these habitats.

References

Bordelon and Knudson (1999), Brou (2005a), Brower (1976), Covell (1984), Hall (1999), Kons and Borth (2006).

Miranda underwing

Catocala miranda H. Edwards

Identification

Although this is a fairly large moth (40 to 45 mm), it is relatively small compared to others in the genus. With its black hindwings, *Catocala miranda* (Figure 256) is similar to *Catocala orba*, but is generally smaller, and usually has some dark shading on the forewing, most often toward the inner margin. Where their ranges overlap, separation from the larger *Catocala orba* is difficult, and Covell (1984) mistakenly illustrated *Catocala orba* as *Catocala miranda*. Sargent (1976) does not illustrate *Catocala orba*. Persons not familiar with *Catocala judith* should also compare that species if shagbark hickory grows in the area. Adults of *Catocala miranda* are smaller than those of *Catocala judith*. *Catocala judith* has a dark hindwing fringe, and the basal portions of the wings are white on the underside. When seen at night around some kinds of artificial lights with the hindwings covered, *Catocala miranda* can resemble *Catocala grynea,* but under natural light they look quite different. *Catocala miranda* is paler gray and *Catocala grynea* is much more greenish. *Catocala grynea* has the hindwings banded with yellow and black-banded rather than having solid black hindwings. As first pointed out to us by Jeff Slotten, *Catocala miranda* adults from Florida are slightly different in appearance from those found in other parts of the range. Sargent (1976) has illustrations of the upper and undersides of a North Carolina specimen. The larvae are variable in color (Figure 257 and 258).

Figure 256. *Catocala miranda* (Miranda underwing) from Liberty County, Florida (Marc Minno photo).

Figure 257. *Catocala miranda* (Miranda underwing) larva from Gadsden County, Florida (Jeffrey R. Slotten photo).

Figure 258. *Catocala miranda* (Miranda underwing) larva from Gadsden County, Florida (Jeffrey R. Slotten photo).

Range

The range of *Catocala miranda* includes south-central New York and northeastern Pennsylvania (Gall and Hawks) to southern Ohio (Rings *et al.* 1992). It extends from the mountains of the Virginias (Jeff Slotten, Hugo Kons, and Robert Borth personal observation), south to southeastern Louisiana (Brou 2007), and east to the Florida Panhandle (Heppner 2003, Kons and Borth 2006).

This seems to be primarily an Appalachian species. The Gall and Hawks map shows records for only 26 counties, thirteen of which are in the mountains or foothills of northeastern Pennsylvania, the Virginias, and southwestern North Carolina, with two more in nearby southern Ohio. James Adams has recently collected several in Gordon County in northern Georgia. *Catocala miranda* has been collected in three more counties in the Florida Panhandle, and Vernon Brou gets this species occasionally in southern Louisiana, so it may occur more widely on the Gulf Coast. Other records are widely scattered.

Rarity

NatureServe global rank: G3G4. This species is a likely candidate for false rarity, because we know of very few places where this moth has ever turned up regularly. Most of the adults found at lights by Jeff Slotten, Hugo Kons and Robert Borth were after 3:30 a.m., and Miller (1977) also noted a late night collection. Collectors using lights for only part of the night probably overlook this moth. Still, it is uncommon to rare even where overnight traps are used.

Several of Gall's and Hawks' county records (including at least two from Pennsylvania) are for single specimens collected at light in two or more trap-years of overnight effort. Furthermore, except in Florida, the few records tend to be from extensively sampled localities in ordinary forests. Several specimens were collected from the 1950s to 1970s at or near Fontana Dam, North Carolina (Sargent 1976). Jeff Slotten informs us that he collected three adults at Poverty Hollow near Blacksburg, Virginia, about 20 years ago. Hugo Kons and Robert Borth collected the species in that same area in 2002.

Despite its large range, we know of only two or three places outside of the Florida Panhandle where the species has recently been found somewhat reliably. Brou (2007) reported only five specimens from St. Tammany Parish collected over 25 years. James Adams has collected three since 2005 in Gordon County in northern Georgia. It seems to be of somewhat regular occurrence around Poverty Hollow, near Blacksburg, Virginia.

Catocala miranda has not been collected during extensive sampling, mostly with lights, in Great Smoky Mountains National Park. Also, the text and shading on the phenogram of Rings *et al.* (1992) indicate only one each from the two locations in Ohio.

In addition to flying late at night, perhaps adults are not readily attracted to lights in most places. According to Jeff Slotten and Hugo Kons, some have been collected by tapping trees, but very few have been collected at bait in Florida. We are not aware of any success with these two methods elsewhere. Several persons have found larvae in Florida, so perhaps that stage is easier to collect than adults.

Life history

Adults of this underwing have been found from about mid-May into June in Florida and southern Georgia, and late June and July northward.

The eggs probably hatch in late April northward and in March in Florida. Last instars can be found in April in Florida.

Based on related species, the pupal stage should last about three weeks northward, indicating larvae maturing in June. Larvae sometimes rest near the base of small hawthorns in Florida.

According to Jeff Slotten, as with some other *Catocala*, males of this species come to light mostly after midnight until near dawn.

Host plants

In Liberty County, Florida, Rick Gillmore found larvae of *Catocala miranda* on *Crataegus spathulata* in riverine habitats. According to Hugo Kons, *Crataegus spathulata* is present at all of the Florida localities reported in Kons and Borth (2006), as well as at Torreya State Park, another known locality. .Jeff Slotten has been unable to rear the species on other hawthorns or crabapples, but this moth ranges substantially to the north of the range of *Crategus spathulata*.

Habitat

In Florida, the usual habitats of *Catocala miranda* consist of hardwood forests, often in ravines with *Crataegus spathulata*. Outside of Florida, the paucity of localities where this underwing has been found more than once makes association with any habitat questionable. However, almost all of these localities are in hardwood forest.

Threats & management issues

Based on adults appearing by late June or early July, which implies pupation around early June, the larvae would be exposed, probably in the middle instars, during a typical *Btk* application. However, there is no basis to conclude that this would, or would not, cause high mortality (Peacock *et al.* 1998).

Hawthorns are not favored by gypsy moth caterpillars, but are defoliated in severe outbreaks, although probably not until after most *Catocala miranda* larvae have matured.

Unlike several other underwings, there is no evidence that *Catocala miranda* commonly uses planted hawthorns in suburban yards. Thus, the increase in residential development in the southern mountains will probably reduce this species.

In Florida at least, prescribed burning could be an issue, because fire can top-kill small hawthorns.

The effects of selective timber harvest generally should depend on the response of the hawthorns. Clearcuts would be detrimental in the short-term, but perhaps not in the long-term if natural regeneration follows.

Loss of hawthorns to excessive deer herbivory and invasive shrubs and vines is likely to become a serious threat in some places.

References

Covell (1984, 1999), Forbes (1954), Kons and Borth (2006), Rings *et al.* (1992), Sargent (1976).

Precious underwing (Northeastern population)

Catocala pretiosa Lintner

Identification

At 45 mm, this is a large moth; however, it is relatively small for a *Catocala* species. It is usually easy to recognize in its current northern range by the extensive white in the median area of the forewing, and the details of the pattern (Figure 259). Southward it can be confused with *Catocala lincolnana*. Most *Catocala pretiosa* from North Carolina and westward have extensive dark color through the median area along the inner margin on the forewing; old northeastern specimens, modern southern New Jersey specimens, and some from the rest of the range lack this. While some *Catocala connubialis* and *Catocala micronympha* also have extensive white, the markings are very different (illustrated in Covell 1984, Sargent 1976). *Catocala blandula* has less white and much more gray on the forewings, but one Massachusetts specimen so far remains unidentified to species. Some forms of *Allotria elonympha* are patterned similarly to *Catocala pretiosa* and can be confusing in the field. However, if the hindwing is at all visible, *Allotria elonympha* is immediately separable by the lack of the median dark band. There are no other similar species normally found within the northeastern current range of *Catocala pretiosa*.

Figure 259. *Catocala pretiosa* (precious underwing) female from Cape May County, New Jersey (David Wagner photo).

Figure 260. *Catocala pretiosa* (precious underwing) larva from Cumberland County, New Jersey (David Wagner photo).

Larvae are variable (Figure 260 and 261) and similar to those of *Catocala blandula* (Muller 1981). Schweitzer (1982a) illustrated a larva with the brown dorsal stripe, a character exhibited by about 40% of larvae. Some larvae are darker than shown in our illustrations.

Figure 261. *Catocala pretiosa* (precious underwing) larva from Cumberland County, New Jersey (David Wagner photo).

Taxonomic comments

Schweitzer (1982a) suggested that *Catocala pretiosa* and *Catocala texarkana* might be the same species, but did not formally synonymize them. Gall and Hawks (2010) treat *Catocala texarkana* as a subspecies of *Catocala pretiosa*. However, there has been no detailed study of the variation of this species south of New Jersey, so application of subspecific concepts to this geographically variable species is problematic. Populations in and north of New Jersey would be included in *Catocala pretiosa pretiosa* if subspecies are recognized, but the circumscription of *Catocala pretiosa texarkana* is uncertain. In particular, the status of populations in eastern North Carolina should be investigated.

Catocala pretiosa was named from Schenectady, New York, and 19th century specimens from adjacent Albany County survive in several collections. We have also examined similar pre-1900 specimens from extreme southern Maine, New Hampshire, Massachusetts, and Philadelphia, Pennsylvania. Adults from these 19th century populations and modern ones from southern New Jersey appear to be widely disjunct from the rest of the range of the species and consistently lack the dark shading on the inner margin in the median portion of the forewings that most other specimens examined by us have. Some coastal North Carolina specimens are very similar, and specimens lacking the dark shading in the median area occur in much of the range of the species, for example Brower's (1976) "type" of the form "bridwelli" from Texas and Schweitzer's lectotype of *Catocala pretiosa* from New York are remarkably similar based on the published illustrations.

In addition to our illustrations, Schweitzer (1982a) and Sargent (1976) illustrate enough adults, including the lectotype and other 19th and 20th century specimens, to effectively capture the known variation of typical northeastern *Catocala pretiosa*. All available evidence suggests these populations from Maine to Philadelphia were disjunct by over 500 kilometers from the rest of the range. Specimens collected closest to the Philadelphia collection site are one old specimen allegedly from Blacksburg, in southwestern Virginia,[13] those collected in the 1880s in western Ohio (Rings *et al.* 1992), and current populations in New Jersey. The Ohio specimen illustrated by Rings *et al.* (1992) is faded, but apparently is not the usual northeastern phenotype. Neither are most specimens from North Carolina. For the purposes of this book we confine our discussion primarily to the northeastern populations, which ranged from the southern tip of Maine to eastern New York and Philadelphia. These are typical *Catocala pretiosa*, and are phenotypically similar to current populations in southern New Jersey. Whether any subspecies should be formally recognized farther south, and if so, how *Catocala pretiosa texarkana* should be circumscribed, we leave to others.

Range

The historical range (1833 to 1898) of *Catocala pretiosa* in the Northeast extended from extreme southern Maine to Philadelphia, Pennsylvania (Schweitzer 1982a, Titian Peale collection at Academy of Natural Sciences in Philadelphia). *Catocala pretiosa* also occurred in Ohio in the 1880s. However, a population was found at the southern tip of New Jersey in 1968 by Joseph Muller. The range expanded rapidly in the next decade or two. From 1987 to 2010, *Catocala*

[13] Schweitzer (1982a) misinterpreted the 1947 accession date of this specimen as a collection date. It is obviously much older and might well be mislabeled. Smyth (1899) did not report *C. pretiosa* from the Blacksburg area, but he might have confused it with *C. cratagei* which he did have, and which Hugo Kons also collected nearby in 2002.

pretiosa had been collected in Burlington, Ocean, Atlantic, Gloucester, Salem, Cumberland, and Cape May counties. A population was discovered in Plymouth County, Massachusetts by John Peacock in 1989, and adults were also found there in 2003 and 2004 by Mike Nelson. It is possible that *Catocala pretiosa* colonized the Plymouth area recently, but the last of the 19th century collections was also on the southern New England coast (Sargent 1976).

Populations of *Catocala pretiosa* with more varied adult phenotypes occur widely from coastal North Carolina south into Florida and west along the Gulf Coast and across the Piedmont and mountains to Missouri and Texas. Thus the two available names come from the northeast and southwest extremes of the overall range in New York and Texas.

Catocala pretiosa has not been documented from the eastern half of Ohio, West Virginia, the western half of New York, the western 80% of Pennsylvania, Maryland, Delaware, and most (if any) of Virginia. Most 19th century specimens were collected in eastern New England and in the Hudson Valley of New York. The oldest specimens, which are also the most recent records for Pennsylvania, are from Philadelphia, reared in 1833 through 1836 by Titian Peale (http://clade.ansp.org/entomology/collections/peale/peale.php).

It seems likely that the northern refugia for this species for much of the 20th century was extensive swamp forests and coastal thickets along Delaware Bay, which are not known to have been sampled for *Catocala* until 1987 (when *Catocala pretiosa* was found on the first effort), and perhaps the lower Mullica River basin located a few kilometers southeast of the 1974 and 1976 collection site at Batsto (Sargent 1976). Given the number of collectors who have baited frequently for *Catocala* in the New Jersey Pine Barrens since the 1880s, and especially from 1930 to 1970, it is unlikely that *Catocala pretiosa* was widely present in that region during that time. Decades of fire suppression in the Pine Barrens (Forman and Boerner 1981, Windisch 1999) in the 20th century lead to an increase in the mature swamp habitat that is now used by *Catocala pretiosa*.

Rarity

NatureServe global rank: G4. If the New Jersey-Massachusetts populations are treated separately, they would rank about T2. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995, but this did not include populations outside of the Northeast, which were then recognized as a separate species, *Catocala texarkana*. *Catocala pretiosa* is historical in much of its range, with last records before 1900 in Maine, New Hampshire, Connecticut, New York, Pennsylvania, Ohio, and Maryland (if it was actually present) at least, and not much later for Virginia.

We lack an explanation for the decline of *Catocala pretiosa* in the Northeast, where this moth was apparently not rare from the 1830s through the 1870s and persisted until 1898, but then later was considered possibly extinct. We know of no collections of *Catocala pretiosa* from anywhere in the Northeast after the one collected at Stonington, Connecticut, on 28 June 1898 (Sargent 1976), until Joseph Muller collected three at Cape May, New Jersey, about 100 km southeast of the documented historical range and the first record on the Coastal Plain, on 28 June 1968.

By the 1980s, *Catocala pretiosa* was found widely, and occasionally abundantly, in southern New Jersey. On 6 July 1988, over 45 adults came to a bait trail near Atsion, and two were taken at a blacklight, the highest number observed by both collecting methods. This moth has been collected since the 1980s at about 20 sites in New Jersey, mostly on state, federal, or Natural Lands Trust properties, where deer hunting is allowed. About one or two per year show up at bait in Dale Schweitzer's yard, since his township planted the crabapple *Malus X purpurea* as an ornamental street tree, compared to one in the previous decade. Two populations documented in 1986 to 1987 have been extirpated by elimination of the food plants. One of these existed in Cape May, and was extirpated by salt water storm surges. The other one was near Eldora, and it was extirpated due to the loss of *Amelanchier* and *Aronia* from several years of severe herbivory by deer, followed by repeated defoliation by gypsy moth larvae of some ancient abandoned apple trees, which *Catocala pretiosa* also used there, that killed the trees.

Life history

In New Jersey, females lay their eggs in bark crevices or cracks on the trunks of apple trees and tree-form *Amelanchier* species, usually less than one meter from the ground, and more often on or near *Aronia* bushes.

Larvae hatch over a period of about a week in April and mature in mid-May to early June, depending on the weather. Late instars are fairly easy to find from soon after dusk until about 11 p.m. as they emerge from daytime retreats and ascend the host stems to feed. When locating populations, looking for larvae has proven nearly as effective as baiting for adults. The larvae eat young leaves, flowers, and fruit mostly about 1.5 to 2 meters above the ground. If disturbed, the larvae do not drop off the host plant readily, and are easy to photograph or collect at night. The only larva found in the daytime was on the undersurface of a nearly horizontal *Aronia* stem a few centimeters off the ground. Larvae have been collected together with those of *Catocala grynea* on *Malus angustifolia*, and with *Catocala praeclara* on *Aronia arbutifolia* in New Jersey. Compared with larvae of *Catocala pretiosa*, both of these congeners tend to be in earlier instars on a given date.

The pupal period of *Catocala pretiosa* reared in captivity by Dale Schweitzer varied between 14 and 24 days. *Catocala pretiosa* adults are the first underwings to emerge in New Jersey, and this is the only *Catocala* for which Sargent gave a June date in southern New England. Dates in New Jersey range from 7 June to 26 July, with most from 20 June to 10 July. The pre-1900 dates in the cold maritime climate of Kittery, Maine, were 17 July to 24 August (Brower 1974), which is similar to current dates on the Massachusetts coast. Available dates from pre-1900 specimens are 28 June to 17 July from Massachusetts, Connecticut, and New York. While adults come to bait by dusk, they are much more likely than other *Catocala* to continue coming until midnight or later in New Jersey.

Host plants

Catocala pretiosa is among the more polyphagous species of underwings. Larvae regularly use three genera in New Jersey and a fourth farther south. The 1830s Philadelphia specimens were reared from apple (domesticated *Malus*), and females oviposited on apple at Eldora, New Jersey in the 1980s. Schweitzer (1982a) reared *Catocala pretiosa* on *Prunus maritima* in captivity, but this is not a suspected food plant in nature. The primary food plant in New Jersey is red chokeberry (*Aronia arbutifolia*). However, larvae and oviposition have also been observed several times on

Amelanchier canadensis, and several larvae have been found on southern crabapple (*Malus angustifolia*). All of these are large shrubs and small trees in the rose family (Rosaceae). Only *Aronia arbutifolia* has been documented as a host in Massachusetts (Mike Nelson).

Of about 30 wild larvae from New Jersey (collected by Dale Schweitzer, Larry Gall, and Ted Gordon), all were on plants at least 1.5 meters tall. Larvae often occur on *Aronia arbutifolia* growing in dense thickets with other tall shrubs and greenbriers (*Smilax rotundifolia*). Hawthorns, including *Crataegus sphathula* and *Crataegus flava* (Hugo Kons personal communication with Dale Schweitzer), are the primary food plants in Florida, and southern crabapple is also used there. Hawthorns are seldom available in southern New Jersey where the few *Crataegus uniflora* plants found during larval surveys never yielded any *Catocala* larvae. They are not associated with this species in Florida, either, according to Hugo Kons. Larvae of *Catocala pretiosa* from New Jersey readily accept foliage of some hawthorns, and have consistently rejected *Aronia arbutifolia* and *Amelanchier canadensis* when apple or crabapple (*Malus X purpurea*) foliage was also offered to them. Also of note is that the coloration of most larvae does not closely match *Aronia* or *Amelanchier* so perhaps these were not the original food plants.

Habitat

In the northeast part of the range, *Catocala pretiosa* now inhabits mesic to wet hardwood forests, including riparian and seepage-swamps, where the host plant grows in the dense to nearly impenetrable, two to four meter tall shrub understory. Larvae also can be found on *Amelanchier* or *Malus* in adjacent drier places, as well as on tall shrubs at the edges of bogs. However, occasional large chokeberry bushes in dry oak-pine woods almost never produce larvae. Populations historically occurred in wet thickets near the edges of the Delaware Bay salt marshes where *Aronia* was abundant 20 years ago, but these have been largely destroyed by sea level rise since 1990. Briers (*Smilax rotundifolia*), and even dense tall shrubs, provide some protection from deer for *Aronia* stems, and briers are probably an important habitat feature.

In New Jersey, adult *Catocala pretiosa* are generally encountered at bait, often in rather open dry woods, within half a kilometer of swamps or mesic hardwood forests with tall chokeberry in a dense shrub layer.

Collections from North Carolina and Florida to Missouri and Texas come from a variety of habitats that have hawthorns. These include swampy to dry upland hardwood forests, oak-pine forests, and thickets, suburban areas (twice in North Carolina), and probably occasionally pocosins. Adults from southern populations that breed in xeric uplands also rest on tree trunks in adjacent low lying hardwood forests during hot, sunny conditions (Kons and Borth 2006). Only one adult has been found in the daytime in New Jersey.

Threats & management issues

Unless the species can adapt to using primarily ornamental crabapples, the long-term fate of *Catocala pretiosa* in New Jersey could depend on deer hunters. Even where damage to larger plants is minor, or most foliage is out of their reach, deer have been observed to severely browse young stems and basal sprouts. Damage to sprouts is not limited to areas closed to hunting, but severe damage (entire loss of at least one foliage crop annually) on larger food plants is essentially limited to such areas. Even moderately high deer numbers (around 25 per square mile) can restrict suitable food plants to places avoided by deer, such as muddy areas along rivers, steep embankments around sandpit ponds, and brier patches. Because seedlings of the food plants still appear and may live as long as 2–3 years before being killed by deer, habitat could be restored by reducing the deer herd on some lands that are now closed to hunting. Coastal thickets have been lost to sea level rise, which is beginning to impact forested habitats as well. While more lands will probably be opened up to deer hunting, threats from storms and sea level rise will likely worsen.

Roadside shrub clearing and the removal of some large *Amelanchier canadensis* trees in the Turkey Point area of Downe Township resulted in the conversion of excellent occupied thicket habitat to thickets of common reed (*Phragmites australis*) within three months of the cutting. In New Jersey, *Catocala pretiosa* often occurs in swamp forests that are protected for the barred owl (*Strix varia*), a state threatened species. However, some habitat is likely to be lost to development, especially on the Cape May Peninsula.

Larvae of *Catocala pretiosa* have not been found on small stems a few years after prescribed burns, but several *Catocala praeclara* have been. *Aronia* and other shrubs resprout after most fires, but deer commonly browse them severely. Where deer do not deplete the sprouts, burned-over swamp understories recover to pre-burn height in about ten years in shaded places, and five years or less in more-open habitats.

Gypsy moth defoliation of *Catocala pretiosa* food plants, except for domestic apple, is not usually severe in New Jersey. We do not know whether larvae, all of which would be exposed in typical applications, are sensitive to *Btk*. Mortality of penultimate instar larvae of the related *Catocala praelcara* assayed on *Aronia* was 80%, but was only 16% for last instars (Peacock *et al.* 1998).

Farther south, threats could include clearcutting, site preparation, excessive fires and development.

REFERENCES

Brower (1974, 1976), Forbes (1954), Kons and Borth (2006), Rings *et al.* (1992), Sargent (1976), Schweitzer (1982a), Smith (1910), Tietz (1952).

Nutmeg hickory underwing

Catocala atocala Brou

Identification

This large (80 mm) underwing with black hindwings is easily recognized from our illustration (Figure 262). There is remarkably little variation. Until recently it was considered to be a variant of the common *Catocala agrippina*. We also illustrate the larva (Figure 263).

Figure 262. *Catocala atocala* (nutmeg hickory underwing) from Shelby County, Tennessee (Marc Minno photo).

Figure 263. *Catocala atocala* (nutmeg hickory underwing) larva from West Felliciana Parish, Louisiana (Jeffrey R. Slotten photo).

Range

This moth occurs mostly along the Mississippi River and some of its tributaries (Gall *et al.* 2002), from extreme southern Illinois to southeastern Louisiana. It probably also occurs along the lower portions of the Red River (a major stronghold for the host plant) and into eastern Oklahoma. However, so far there are few records from the latter state. There is an old specimen from the Florida Panhandle, but the documented host plant has not been recorded from Florida (Wunderlin and Hansen 2003), and the specimen is perhaps mislabeled. There is one specimen from coastal Texas, also outside this tree's limited range. It is possible that *Catocala atocala* will be found in the eastern Carolinas, where the food plant occurs, but is rare (Radford *et al.* 1968).

Rarity

NatureServe global rank: G3G4. This moth has a limited range, and is localized within it. However, Larry Gall and John Peacock found this species to be locally numerous at a few sites in Mississippi and Louisiana (Gall *et al.* 2002). Older records suggest it was slightly more widespread historically than recently.

Life history

The larvae feed on the leaves of the host tree in spring. Adults emerge in June and persist at least well into July and sometimes longer. The adults are easily flushed from tree trunks on hot afternoons. Daytime search is the best method for finding them, but they are attracted to lights and bait traps at night.

Host plants

The usual host plant is probably nutmeg hickory (*Carya myristicaeformis*), which occurs in eastern Texas, southeastern Oklahoma, Missouri, Louisiana, Alabama, Mississippi, and very locally in the coastal Carolinas (Elias 1987). However, collection sites for the moth extend beyond the known range of this tree into Illinois and supposedly Florida, suggesting that there is an alternate food plant, most likely another species in the Apocarya section of hickories such as pecan (*Carya illinoensis*) and/or water hickory (*Carya aquatica*). A larva was successfully reared in captivity on the latter plant (Gall *et al.* 2002).

Habitat

Adults usually occur in bottomland hardwood swamps with nutmeg hickory, but sometimes are found in adjacent uplands.

Threats & management issues

Severe gypsy moth outbreaks seem unlikely in the major habitats for this moth, but are possible where there are scattered oaks and many sweetgums (Schweitzer 2004). The phenology is too poorly documented for us to determine whether the larvae would be exposed to *Btk* applications against gypsy moths. Some *Catocala* species and instars are highly sensitive to *Btk*, while others are not (Peacock *et al.* 1998).

References

Brou (1985), Elias (1987), Gall *et al.* (2002), Peacock *et al.* (1998), Radford *et al.* (1968), Schweitzer (2004), Wunderlin and Hansen 2003.

Consort underwing

Catocala consors (Guenée)

Identification

This large (60 to 79 mm) underwing does not resemble any other moth in its current range (Figure 264). *Catocala badia* is somewhat similar, but has much browner forewings. This is not relevant now, but the ranges of *Catocala consors* and *Catocala badia* overlapped in New York and northern New Jersey before about 1950. If seen at rest with the hindwings covered, the closely related *Catocala epione* is similar, but it has much darker, blackish forewings. Furthermore, its hindwing are black, not orange or yellow, with some white near the apex and beneath. At present we can offer no diagnosis for the larvae (Figure 265), which resemble those of *Catocala epione*, a species that also occurs on small hickories.

Figure 264. *Catocala consors* (consort underwing) Hernando County, Florida (Marc Minno photo).

Figure 265. *Catocala consors* (consort underwing) larva from Citrus County, Florida (Jeffrey R. Slotten photo).

Range

Catocala consors is found mostly in Florida, from the Panhandle to the southern peninsula (Highlands County), and in Texas, where it is still widespread (Ed Knudson and Hugo Kons personal communication with Dale Schweitzer). *Catocala consors* historically occurred rarely, but widely, north into Iowa, and east through Ohio, Pennsylvania and somewhat widely in New Jersey and east to Long Island, New York. Collections were especially frequent in New Jersey, including the Orange Mountains (now the Watchung Hills) in the northeastern part of the state before 1950, as well as the Coastal Plain in the south.

The ancient type specimen from Maine is undoubtedly mislabeled. All known records for Pennsylvania, Indiana, and New York are from before 1950. The Kentucky record on earlier versions of the Gall and Hawks maps was in error (Larry Gall email to Dale Schweitzer in May 2008). The most recent Ohio collection was from around 1900 (Rings *et al.* 1992). There do not appear to have been any North Carolina or Virginia collections since the 1960s (Larry Gall, Bo Sullivan, Steve Hall, all personal communications with Dale Schweitzer in 2005 through 2009). Florida populations have been treated as a separate subspecies, but are not considered to be separate by Gall and Hawks (2010).

Rarity

NatureServe global rank: G4. This is because the species is not rare in Florida or Texas, although habitats are being lost to development in Florida at least. However, *Catocala consors* has become very rare or has disappeared completely, with no records in about 50 to 100 years, from about two thirds of its range. Perhaps one factor was the maturation of second growth forest in places that were clear-cut during the 1800s. *Catocala consors* recently became the fourth species of macro-moth suspected to have disappeared from the New Jersey Pine Barrens since 1900. Although there are multiple records (from before 1910 to 1989) of this moth from around the southern and western edges of the New Jersey Pine Barrens, none have been found recently.

If they were not already gone, the isolated northern New Jersey and Long Island populations would probably not have survived the spraying for gypsy moth, mostly with DDT, in the late 1950s (Doane and McManus 1981). Muller (1973) noted the drastic reduction of *Catocala* moths in northern New Jersey due to such spraying. In addition, two other hickory-feeding *Catocala* (*Catocala angusii, Catocala robinsoni*) disappeared from New Jersey at about that time. East of the Mississippi River, besides in Florida, *Catocala consors* is probably still extant in northern Georgia, with three collections there since 1990 according to James Adams. A population was still present in sandy woods in Mason County, Illinois, during the 1980s (Mo Nielsen and others), and perhaps still is.

One southern New Jersey *Catocala consors* population located in a forested residential area was eradicated by annual gypsy moth spraying during the 1970s (Schweitzer 1991). In addition, the site where Dale Schweitzer and Larry Gall collected one in 1981 was sprayed with *Btk* a few years later. However, we do not know if *Catocala consors* is sensitive to *Btk*. Overall, biocides could not have played a major role in the decline of *Catocala consors* in southern New Jersey, because very little of the overall habitat was ever sprayed.

If indeed *Catocala consors* no longer occurs in southern New Jersey, a natural extirpation from a freak weather event is suspected. The temperature extremes for 21 May 1992, were -2°C and 31°C at Pomona, New Jersey. This was the latest freeze on record, followed a few hours later by near record heat and low humidity, which probably added to the damage to young foliage from the freeze. Many unofficial morning readings were a few degrees lower. These conditions killed nearly all foliage on small hickories in xeric habitats in at least Atlantic, Cumberland, and northern Cape May counties, well before any *Catocala consors* larvae would have completed feeding. All of the hundreds of small hickory trees that Dale Schweitzer inspected in the extensive (>5,000 hectare) habitat where *Catocala consors* was seen in 1987 and collected in 1989 in Downe Township, Cumberland County, lost all of their foliage. Even the common *Catocala epione*, another specialist on small hickories, was not seen locally for three seasons. Recolonization by *Catocala consors* in Downe Township, and elsewhere, might have been impossible given the very widespread freeze impacts and absence of populations in unaffected neighboring counties and states.

Host plants

Like the closely related, common *Catocala epione, Catocala consors* appears to be a specialist on small hickories, usually saplings or sprouts. Scrub hickory (*Carya floridana*), which is endemic to peninsular Florida (Wunderlin and Hansen 2003), is the primary food plant there. *Carya texana* was the only hickory present at the sites of populations in longleaf pine sandhills in Angelina and Hardin counties, Texas, where Hugo Kons and Robert Borth found this species in numbers. An old larval specimen of *Catocala consors* from Uvalde County, Texas, and preserved in the Yale Peabody Museum is labeled as having been found on "*Juglans texana,*" presumably referring to *Carya texana*. *Carya texana* is essentially the only hickory in the southwestern part of the moth's range, and it could be a food plant in several states. Most southern New Jersey populations would have had access only to sand hickory (*Carya pallida*), which is very similar to *Carya texana* and *Carya floridana*, and mockernut hickory (*Carya alba*, formerly *Carya tomentosa*), but no food plant was ever verified there. *Carya pallida, Carya texana, and Carya floridana* do not occur in northeastern New Jersey or on Long Island, but the moth did occur in that region prior to 1950.

Habitat

This moth occurs in dry, rather open, very often sandy, wooded habitats having many small hickories. Auburn E. Brower told Dale Schweitzer that he found larvae of this species on hickory sprouts in areas of Missouri that had been logged.

Threats & management issues

Prescribed burning is likely to be a management issue with this species in some parts of its range. This species could increase after fires that result in abundant hickory sprouts. As would be expected and is reported by Borth and Barina (1991) and Metzler *et al.* (2005), *Catocala* larvae are absent on shrubs the first season after fires, but may be present again the second year. Unburned refugia would be necessary with *Catocala consors,* but this species should do well in areas subject to occasional partial burns.

Timber harvesting with natural regeneration probably could benefit this species for a decade or more, as observed by Brower (above).

There are no data to predict the impact of *Btk* applications on *Catocala consors* larvae, but given the phenology, all larvae would be exposed, probably in the middle instars. The most xeric scrub habitats usually do not support gypsy moth outbreaks in New Jersey, and defoliation in other sandy habitats is usually too late to cause mass starvation of *Catocala consors*. However, localized eradications due to starvation could occur on ridges (Gall 1991a, Schweitzer 2004) where defoliation often occurs very early. *Carya alba* (also known as *Carya tomentosa*) is much more likely than *Carya pallida* or most other hickories to be defoliated by gypsy moth caterpillars (Schweitzer 2004).

REFERENCES

Borth and Barina (1991), Covell (1984), Doane and McManus (1981), Forbes (1954), Gall and Hawks (2010), Holland (1903), Kimball (1965), Metzler *et al.* (2005), Minno (1992b), Profant (1989), Rings *et al.* (1992), Sargent (1976), Schweitzer (2004), Tietz (1952). Kons and Borth (2006).

DELILAH UNDERWING

Catocala delilah STRECKER

IDENTIFICATION

This medium sized (58 to 65 mm) underwing does not resemble any other moth found east of Texas (Figure 266). Although the combination of dark brown forewings and yellow hindwings also occurs in the common *Catocala muliercula*, there are many differences in details. Among these, the forewings of *Catocala delilah* are more mottled brown, and the heavy dark front two-thirds of the antemedian line is also distinctive. The shape of the forewings differ. The hindwing of *Catocala delilah* has more of an orange tint than most other eastern yellow underwings, but is not as red as *Catocala innubens*. The inner dark band is sharply bent and comes unusually close to the outer band at the rear of the hindwing. The forewings are darker on Florida specimens than on the specimen of unknown origin shown by Covell (1984). Sargent's (1976) illustration is a misidentified *Catocala desdemona*, a more common southwestern species. Holland (1903) illustrates both, side by side. The larva is shown in Figure 267.

Figure 266. *Catocala delilah* (Delilah underwing) from Seminole County, Florida (Marc Minno photo).

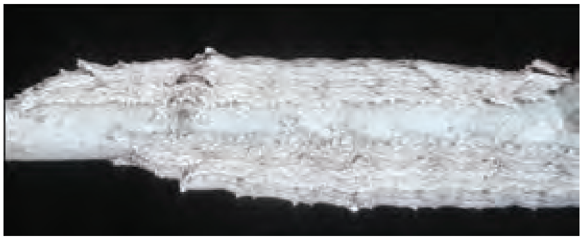

Figure 267. *Catocala delilah* (Delilah underwing) larvae from Seminole County, Florida (Jeffrey R. Slotten photo).

Range

This moth is found most regularly in the eastern half of Texas, and apparently disjunctly, from central Florida to extreme southeastern Georgia. According to Hugo Kons, *Catocala delilah* occurs in the area of transition between the Sonoran and Austral Life Zones in Texas, but he and Robert Borth failed to find it in the Austral Life Zone of east Texas (Angelina and Hardin counties) in xeric sandhill habitats. Likewise, Bordelon and Knudson (1999) do not report it from southeast Texas. There are scattered historic records in Oklahoma through Kansas and Missouri to southeastern Nebraska and along the Mississippi River in Illinois. There are truly isolated old records in northeastern Mississippi and northeastern Tennessee. Old records of this moth farther west are due to past confusion with similar species, especially *Catocala desdemona*.

Rarity

NatureServe global rank: G3G4. This rank should be reconsidered, because the moth is collected rather rarely in Texas (Bordelon and Knudson 1999, Ed Knudson email to Dale Schweitzer in June 2008), which is most of its range. Furthermore, it has long been considered uncommon or rare in Florida, although adults can be numerous where they do occur, such as in the Withlacoochee State Forest. Kons' observations suggest it may have a more limited current range in Texas than old records from Gall and Hawks' map suggest. Whether or not it is of concern in Texas and Oklahoma, *Catocala delilah* is of conservation concern in our coverage area where persistent populations appear to be confined to the northern half of Florida and perhaps adjacent Georgia. The xeric scrub habitat of this species is being rapidly lost to development.

Life history

Like almost all oak-feeding *Catocala*, eggs hatch over a brief period in spring. Larvae are probably mature before the leaves are fully hardened. In Florida, adults occur in May and June and are collected at bait and lights.

Host plants

Larvae of the Delilah underwing feed on oaks. Like virtually all oak-feeding moths we have reared, larvae can be easily reared on bear oak, which does not occur in its range. According to Larry Gall (email to Dale Schweitzer on 26 June 2008), live oak (*Quercus virginiana*) is a verified food plant in Texas. In addition, there are records for larvae on laurel oak (*Quercus laurifolia*) and Texas live oak (*Quercus fusiformis*) that could refer to either *Catocala delilah* or *Catocala desdemona*. Although the range of *Catocala delilah* overlaps all of these oaks, none come close to occurring throughout its historic range. Two of these oaks are absent from Oklahoma, and most specimens of this moth from that state were collected far from the ranges of all three oaks.

Habitat

In Florida this moth is found mostly in dry scrubby turkey oak woodland and scrub habitats. In Texas and Oklahoma, the habitat is also dry scrubby oak or oak-pine woodland. The Wichita

Mountains sites, where Hugo Kons and Robert Borth found it in 2009, are primarily a mix of xeric oak woodland and short grass prairie. At Withlacoochee State Forest in Florida, *Catocala delilah* comes to bait with *Catocala amestris, Catocala consors*, and *Catocala jair*, among others. This moth is an eastern representative of a group of small to medium-sized underwings found in the arid oak scrub of the Southwest and into Mexico.

Threats & management issues

The greatest threat in Florida is loss and fragmentation of habitat due to urban development and to pine plantations. We cannot assess most threats elsewhere. Habitat fragmentation and restriction to relatively small preserves could increase the risk of local extirpations, such as from wildfires or March freezes. For example, there was a freeze in 1986 at Withlacoochee State Forest (Dave Baggett personal communication with Dale Schweitzer) that killed most of the new growth on the oaks.

Prescribed burning is likely to be a management issue with *Catocala delilah* and any species of underwing occurring with it. Unburned refugia would be necessary in fires that scorch the oak trunks where eggs would be present, but this species should do well in areas subject to occasional partial burns.

Harvesting pines is probably not a threat if the oaks are not severely impacted.

Gypsy moth is likely to become established in Oklahoma and some other parts of the range. *Catocala delilah* grow quickly and would probably mature before the oaks are seriously defoliated. *Catocala* species that were assayed by Peacock *et al.* (1998) varied greatly in sensitivity to *Btk*, but given the phenology, *Catocala delilah* larvae would be exposed, probably in the middle instars, to applications aimed at gypsy moth larvae.

References

Bordelon and Knudson (1999), Covell (1984), Forbes (1954), Holland (1903), Kimball (1965), Heppner (2002), Kons and Borth (2006), Peacock *et al.* (1998), Profant (1989), Sargent (1976), Tietz (1972).

Pine barrens underwing

Catocala herodias gerhardi Barnes and Benjamin

Identification

This is a medium-sized (55 to 65 mm) and unusually distinctive underwing. The adult should not be confused with any other species (Figure 268). *Catocala herodias gerhardi* has a whitish costa on the forewing, whereas *Catocala herodias herodias* does not. The larva is shown in Figure 269.

Figure 268. *Catocala herodias gerhardi* (pine barrens underwing) from Montgomery County, Virginia (Marc Minno photo).

Figure 269. *Catocala herodias gerhardi* (pine barrens underwing) larva from Plymouth County, Massachusetts (David Wagner photo).

Range

Catocala herodias herodias occurs in central Texas and central-western Oklahoma, primarily along the transition area between the Austral and Sonoran Life Zones, and on the east edge of the Sonoran Life Zone (Hugo Kons). On the other hand, *C. h. gerhardi* is found in scattered places much farther east. Three major concentrations of populations occur in the coastal pitch pine-bear oak regions of the Northeast, namely in southeastern Massachusetts, including Martha's Vineyard and Nantucket islands, Long Island, New York, and the New Jersey Pine Barrens. One would expect this species to occur in the now depauperate Rhode Island pine barrens, but there was no known collecting in this area until after several applications of DDT and carbaryl for gypsy moth control from the 1950s to 1980. In the 1980s, Dale Schweitzer, Lars Crabo, and Rhode Island Natural Heritage Program staff failed to find this underwing there. The original range was probably almost contiguous from Long Island across what is now New York City, south to northern Cape May County, New Jersey. There are also poorly understood populations in the mountains of the Virginias and North Carolina. There are also isolated colonies on ridgetops and monadonocks in Orange County, New York (verified by Dale Schweitzer), Litchfield County, Connecticut (David Wagner observation), Berkshire County, Massachusetts (Larry Gall observation), and Stokes County, North Carolina (Bo Sullivan observation). The lack of records from Pennsylvania is puzzling, given the abundance of bear oak there, and the presence of populations quite nearby in New York and West Virginia.

Rarity

NatureServe global rank: G3T3.

C. herodias herodias from the southern plains was found in blackjack oak thickets in sparsely wooded barrens by Larry Gall. Hugo Kons and Robert Borth have found it in oak-juniper savanna on the Edward's Plateau in central Texas. In southwest Oklahoma, it was found in an area with mixed xeric oak woodland and short grass prairies. They also found one specimen in oak savanna in central Oklahoma. Although not imperiled in Massachusetts or the New Jersey Pine Barrens, probably much habitat for *C. herodias gerhardi* has been lost to development, fire suppression, or other factors. Much habitat loss has occurred in coastal New England and New York, and all of it has been lost in northeastern New Jersey. Probably about half of the original habitat in southern New Jersey is still occupied.

This underwing is often locally common in coastal pine barrens, and is occasionally truly abundant locally in Plymouth County, Massachusetts. Most inland pine barrens do not have populations of this moth.

Catocala herodias gerhardi has been found in about 28 counties, but is almost certainly gone from about five counties near New York City, and one or two others in New Jersey represent strays in inappropriate habitats. Populations probably occur in a few more counties in the mountains.

The area of occupancy for *Catocala herodias gerhardi* is probably between 10,000 to 15,000 hectares in southeastern Massachusetts, between 1,000 and 5,000 hectares on Long Island, and around 100,000 hectares in New Jersey. The known isolated northern ridgetop and southern monadonock populations occupy only a few thousand hectares altogether.

The status of this species in West Virginia, after extensive use of Dimilin® and *Btk* in the late 1980s and 1990s, is not known. The current status of this moth in the Appalachians is unclear, except that several new county records were documented by Virginia Natural Heritage Program staff between 2000 and 2009. Historic records cover most of the 20th century, but usually represent single adults, which could indicate sparser populations in this region or that these samples came from near, but not in, the proper habitat.

Life history

The eggs of this moth hatch near the time when the new growth of the host plant begins to expand. This is in April or early May in New Jersey. The larval and pupal stages both last about a month. Adults appear sometime in July in most places, and those from coastal Massachusetts are often fresh in late July. The flight season in New Jersey usually starts 1-5 July and lasts into early or even mid-August. Adults emerge in June in Stokes County, North Carolina. One has been taken as late as 9 September in the mountains of Virginia (Steve Roble personal communication with Dale Schweitzer).

Adults, especially males, are highly attracted to blacklights, but mostly after midnight. Few adults have been attracted to bait, and these usually are within two hours after sunset. Adults have rarely been found in the daytime, but they apparently rest on the ground under trailing pine branches or at the bases of oak bushes. The whitish costa and striated wing pattern resemble a clump of dead pitch pine needles lying on sand.

HOST PLANTS

The larvae eat soft, expanding, young leaves of bear oak (*Quercus ilicifolia*), and must mature before the leaves begin to harden. They will also eat the catkins, but do not seem to prefer these. Like all known oak-feeding *Catocala*, the eggs generally hatch over a period of only a few days (unpublished data by Larry Gall and Dale Schweitzer). Larvae can also be reared on blackjack oak (*Quercus marilandica*) and some other oaks. All four North Carolina counties mapped by Gall and Hawks are outside the range of bear oak, but a population has been found associated with bear oak in Stokes County.

HABITAT

North of New Jersey, the habitat of *Catocala herodias gerhardi* is pitch pine-bear oak barrens or sparse woodland with abundant bear oak in the understory, usually on sand, but sometimes on acidic rocky ridges. The habitat is also open pine barrens with abundant shrubby oaks in New Jersey, and either bear or blackjack oak may predominate. This moth also occurs on a monadonock with bear oak in Stokes County, North Carolina. The Virginia sites have patches of bear oak in the area, but otherwise, mountain habitats for *Catocala herodias gerhardi* are poorly known. Single adults have shown up at a few localities about 10-30 km from any likely habitat. For example, adults have been found at Eldora (Dale Schweitzer collection) and Vincetown (Howard Boyd), New Jersey, Putnam Connecticut (A. B. Klots) and several times on Cape Cod, in places with several trap-years of sampling effort.

THREATS & MANAGEMENT ISSUES

In coastal portions of the range, the main issue is a compatible fire regimen, because much of the remaining barrens habitat is on protected lands. Complete burns by wildfires of isolated barrens probably explain some absences. Excessively frequent light winter prescribed burns destroyed a historically occupied habitat just north of Batsto, New Jersey, and similar habitats have been lost elsewhere in the region. Such a regimen reduces the bear oak to weak sprouts, because the tree canopy is unaffected and shades out the understory. Long-term lack of wildfire probably also eventually eliminates habitats in New Jersey, but some occupied habitats there and in Massachusetts have not burned in over 50 years. Andrew Windisch suggests that a rotation of about 25 years between fires would be optimal for New Jersey habitats.

Both lack of fire and frequent New Jersey-style winter burns are detrimental to this species. However, winter burns might maintain existing habitats if there are few trees, or if accompanied by selective thinning. Ultimately, habitats for many coastal populations probably owe their existence to infrequent, but severe, past wild fires.

The gypsy moth is an occasional issue in *Catocala herodias* habitats. Large coastal barrens usually do not support substantial gypsy moth outbreaks (Schweitzer 2004), and most *Catocala herodias* larvae would mature before severe defoliation occurred. However, on ridgetops and in small barrens in generally oak-dominated areas, unusually early defoliation (late May in southern Connecticut) can lead to massive starvation of *Catocala* larvae (Gall 1991b, Schweitzer 2004), often before they even reach the last instar. Indeed, gypsy moth outbreaks are a very plausible explanation for some absences of *Catocala herodias*, especially from small habitats in Connecticut (Schweitzer 2004).

Sensitivity of *Catocala* larvae to *Btk* varies widely (Peacock *et al*. 1998) between species and sometimes instars of the same species. However, the closely related oak-feeding *Catocala coccinata* had 90% mortality at day five in the lab assays, and most of the survivors failed to pupate (Peacock *et al*. 1998). *Catocala herodias* larvae would be present at spray time. *Catocala herodias* is often associated with other rare species, and if severe defoliation is expected it would be prudent to consider the use of Gypchek, which is nearly specific to gypsy moth caterpillars.

References

Covell (1984), Forbes (1954), Pague and Schweitzer (1991), Sargent (1976), Tietz (1972).

Marbled underwing

Catocala marmorata W. H. Edwards

Identification

This huge (90 to 95 mm) moth is among the two or three largest *Catocala* species in its range. Note the prominent, slightly curved dark subapical marking and the otherwise subdued pattern on the forewing (Figure 270). The huge size and often lazy flight of flushed adults is distinctive.

Photographs of worn females can be confused with related species, but actual specimens are easily identified by size. The forewing pattern and size are similar to that of the black hindwinged *Catocala maestosa*, but identification of undisturbed resting adults is usually easy. *Catocala marmorata*, like many of the Salicaceae feeders (Sargent 1976), rests head up. *Catocala maestosa*, like most other underwings, rests head down.

Figure 270. *Catocala marmorata* (marbled underwing) from Virginia (Marc Minno photo).

Peacock and Gall (2000) also illustrate the larva (Figure 271 and 272), which should be reared to adult to verify identity if it comes from within the range of *Catocala parta*, but it should be easily identifiable southward. Holland (1903), Covell (1984), and Sargent (1976) also illustrate the adult. Peacock and Gall (2000) recently described the larva.

Range

Over 90% of post-1950 records of this species (mostly from the Gall and Hawks maps) can be grouped into four regions:

1) the lower Ohio Valley from southern Indiana into the mid-Mississippi Valley;

2) the Atlantic Coastal Plain and eastern Piedmont from Delaware to South Carolina;

3) the Appalachian Mountains along the West Virginia/Virginia border;

Figure 271. *Catocala marmorata* (marbled underwing) larva from Posey County, Indiana (Valerie Giles photo).

Figure 272. *Catocala marmorata* (marbled underwing) larva from Posey County, Indiana (Valerie Giles photo).

4) from about Charlotte, North Carolina west to eastern Tennessee and south in the Chattahoochee River basin to about Atlanta, and James Adams reports one recent specimen from substantially farther south at Broxton Rocks in Coffee or Jeff Davis County, Georgia.

About 75–100 years ago, *Catocala marmorata* occurred from northeastern New Jersey (e.g., Bayonne, Bloomfield) to Long Island and coastal Connecticut (Sargent 1976, Peacock and Gall 2000). Old (mostly 19th century) records extend farther up the Ohio Valley to near Pittsburgh. Pre-1900 specimens from the Chicago area and Vermont, plus three recent collections from southeastern Louisiana in October, were probably strays, and occasional Piedmont collections from Pennsylvania and Virginia may have been as well. Darryl Willis found adults of this moth to be locally common in Gastonia County, North Carolina, and elsewhere on the upper Piedmont during July 2006 and 2007, which suggests that historical records from that region were probably not strays.

RARITY

NatureServe global rank: G3G4. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

Catocala marmorata is fairly rare in most of its range and is extirpated from the tri-state New York City area and probably Ohio. Eastward, we know of ten adults that were collected between 1994 and 2007 on the Coastal Plain of Delaware (3), Maryland (1), Virginia (2), and North Carolina (4), and another on the Delaware Piedmont. However, adults have recently been found commonly in a few places in Posey County, Indiana (Peacock and Gall 1990, Hugo Kons personal communication with Dale Schweitzer) and in Gastonia County, North Carolina (Darryl Willis personal communication with Dale Schweitzer), mostly by daytime search.

Draining of wetlands, channelization, and dams have altered much or most of the marbled underwing's habitat along the major inland river valleys and in the Appalachian part of the range. The ability of the adults to move large distances between summer habitats and breeding areas complicates interpretation of collection records. Many recent collections and observations are either singletons or summer adults, well away from breeding habitats. Since the food plants are mostly confined to riparian areas, there are probably substantially fewer places where significant breeding occurs, compared to habitats (Willis 1991) where adults are found in summer.

This species is likely to be overlooked in summer sampling using lights and bait. For example, Hugo Kons and Robert Borth obtained none in nine overnight mercury vapor light, 18 black light, and 16 bait trap samples in August in 2002 and 2008 at a site in Posey County, Indiana where adults are readily found in the daytime. However, most serious *Catocala* collectors know that during the southern summer, the larger species are best found in the daytime in hot weather. About 80% of recent eastern records from Delaware to coastal North Carolina have been collected at 15-watt blacklights from September to early November, which is unusual for a large *Catocala*. Adults were not taken at light in the same places in summer. Daytime search has produced a population associated with swamp cottonwood in Delaware, as undoubtedly similar efforts would in other coastal regions.

Life history

Like many large southern *Catocala* species, adults of *Catocala marmorata* live for several months and reproduce late in the season. Freshly emerged adults have been collected from late June to about mid-July in most of the range, but they may eclose earlier in June on the Carolina Coastal Plain, and probably do in Georgia.

The observations of Willis (1991 and personal communication with Dale Schweitzer) and Peacock and Gall (2000) indicate that females oviposit in September. Mating probably also takes place in late summer, because both sexes are found near the food plants in September, and females collected in July or August by Darryl Willis and maintained alive did not produce viable eggs. However, none were checked for spermatophores. Apparently the adults are most active after the heat of summer wanes. In southeastern North Carolina, four were collected at blacklight traps between 4 October and 8 November in 1994 to 1996, but not at other times, despite extensive trapping from spring to fall (Hall 1999, Hall *et al.* 1999). Four of five recent Delaware and Maryland records were in September. Adults are easy to find and catch in the daytime (Willis 1991, Peacock and Gall 2000) in the summer.

John Peacock and Larry Gall secured eggs from three females, which hatched over four, six, and 12 days indoors. Dale Schweitzer observed eclosion over an eight-day period of eggs from one of the females that were kept outdoors. The larval stage was reported to average 27 days under captive conditions, and was no more than 29 days for Dale Schweitzer's larvae. Duration might be more like 30–35 days outdoors with cool spring nights.

The pupal stage was reported to last 26 days (Peacock and Gall 2000). This should apply outdoors in June as well, but Dale Schweitzer had one undersized male eclose after only 19 days outdoors. These observations indicate that egg hatching begins slightly less than two months before the first adults appear, or about early to mid-May in much of the range, and probably mid- to late April in the warmest regions.

Host plants

The primary food plant is almost certainly swamp cottonwood (*Populus heterophylla*) in the Ohio Valley (Peacock and Gall 2000), on the Coastal Plain of Delaware, Maryland, and in North Carolina. This tree is uncommon or local over much of its range. On the Coastal Plain and in Ohio Valley, the range of the swamp cottonwood is remarkably coincident with the range of the moth. Even the old collections from northern New Jersey to coastal Connecticut were within a disjunct part of the swamp cottonwood's distribution.

However, there must be another food plant if *Catocala marmorata* breeds in the Appalachian region, because that region is hundreds of kilometers outside the range of swamp cottonwood (see Peacock and Gall 2000). More than 100 specimens have been collected (Gall and Hawks maps), and many others observed (Willis, 1991) in the southern Appalachians. Larvae from southern Indiana were easily reared on eastern cottonwood, *Populus deltoides*, which is also largely absent in the mountain region. They also readily ate willows, including black willow (*Salix nigra*), although some of Dale Schweitzer's larvae refused to switch to it, at least the first night.

The relatively short spread of egg hatch is more consistent with other *Catocala* species that feed on poplars (including cottonwoods) that leaf out fairly synchronously, rather than willow feeders, which are often staggered over several weeks (Dale Schweitzer and Larry Gall unpublished data).

HABITAT

In both the Ohio Valley and on the Coastal Plain, breeding habitats of *Catocala marmorata* apparently are mainly bottomland forests with swamp cottonwoods along rivers. Coastal Plain populations also utilize forest depressions or seepage areas that contain swamp cottonwoods. Both sexes have been found around swamp cottonwoods in September in coastal areas of Delaware (Dale Schweitzer and Chris Heckscher), Maryland (specimen at National Museum of Natural History), Virginia (Steve Roble), and Indiana (Peacock and Gall 2000). The specimens caught in blacklight traps in October and November (1994–1996) in North Carolina were along brownwater rivers where these trees grow (Steve Hall).

A very fresh individual was photographed on 12 July 2005, in an upland forest near Blackbird, Delaware (Delaware Natural Heritage Program), having already moved a few kilometers from known swamp cottonwoods. James Adams collected one at Purchase Knob, high in the Smokies in June, which probably had dispersed from elsewhere. In the mountains and western Piedmont, this moth has been found very commonly in summer habitats that are well separated from the breeding areas. Of modern observers and collectors, Darryl Willis has by far the most experience (hundreds of observations) with this spectacular moth. Based on his observations (Willis 1991 and personal communication with Dale Schweitzer in 2006 and2007), adults are most easily found in their summer habitats in mesic hardwood forests where no potential food plants exist. Adults were not found particularly near the food plants in July and August, but occurred in substantial numbers (often several dozen seen) in favorable habitats up to 8 km from habitats with willows or perhaps a few cottonwoods.

Essentially all observers agree that a good predictor of adult summer habitat is an abundance of large, light-barked trees, such as white oak (*Quercus alba*), tulip tree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and others that match the pale color of the forewings. The adults also rest on large trees with pale-colored bark, such as red maples, in the breeding habitats. Observations of Hugo Kons and Robert Borth in Posey County, Indiana indicate similar habits and habitats, but in this areas adults were closer to the breeding areas in summer. In swampy places, the moths seem to concentrate in areas with the largest trees.

THREATS & MANAGEMENT ISSUES

Water level fluctuation due to releases from impoundments is a potential issue in some riparian habitats. It is very unlikely that occasional flooding would harm eggs. Pupae would probably survive some inundation, and young larvae would be mostly high in the trees with the foliage, but we have little basis to suggest impacts, or lack of impacts, to older larvae or adults.

Gypsy moth spraying in adult summer habitats might affect female fecundity if Dimilin® or other persistent chitin inhibitors were used, because adults could be exposed by contact for two months. This chemical is known to affect egg production in exposed females of some insects, and it can act as a contact poison. Furthermore, it persists for several months (references in Schweitzer 2004). Gypsy moth spraying is a potential threat to larvae where breeding occurs in wet areas of forest types with oaks, for example in Delaware. Depressions or seeps with swamp cottonwoods might not be excluded from spray blocks with *Btk*, but riparian habitats and areas near estuaries would generally be spared from Dimilin® applications out of concern for aquatic invertebrates.

If our estimate of phenology, based on Peacock and Gall (2000) and Dale Schweitzer's rearings in southern New Jersey is correct, then eggs hatch around the time a single *Btk* application would usually be made. With one application, most first or second instars would be exposed, although a few might hatch late enough to avoid exposure. All larvae would probably be exposed in multiple applications. However, during gypsy moth outbreaks in southern New Jersey willows (mostly *Salix nigra*), which are likely food plants where cottonwoods are not available, are among the first trees to be severely defoliated in May, several weeks before *Catocala marmorata* could complete feeding. *Catocala* larvae can survive only a few days without food, so mortality would approach 100% from starvation if their food plants were completely defoliated—as willows often are. See Gall (1991b) and Schweitzer (2004) for similar observations with other *Catocala* on oaks and hickories. Cottonwoods are less likely than willow to be seriously defoliated, but at least eastern cottonwoods are not immune.

Sensitivity of *Catocala* to *Btk* varies substantially by species and instar. Peacock *et al.* (1998) report mortality of 100% in three laboratory assays with *Btk* using first and second instar *Catocala vidua* and *Catocala ilia*, but only 80% with first and second instar *Catocala lineella*, and 70% with *Catocala obscura* first instars. Mortality might (or might not) decline significantly by the third instar (Peacock *et al.* 1998). For example, mortality to *Catocala vidua* declined from 100% with first instars to only 47% for a mixture of second and third instars. However, mortality was 100% for firsts and seconds, and 95% for a mixture of third and fourth instar *Catocala ilia*. While the sensitivity of *Catocala marmorata* larvae to *Btk* has not been determined, for some *Catocala* species mortality from a *Btk* application would be much less than mortality caused by severe defoliation of their food plants.

REFERENCES

Covell (1984, 1999), Forbes (1954), Gall (1991b), Hall, 1999, Hall *et al.* (1999b), Holland (1903), Peacock *et al.* (1998), Peacock and Gall (2000), Rings *et al.* (1992), Sargent (1976), Shuey (1996a), Tietz (1952), Willis (1991).

Wiregrass Doryodes

Doryodes species (not formally described)

Identification

This medium-sized (30 to 35 mm) moth is more richly colored than other *Doryodes* species (Figure 273). Identification is usually easy, because the other species in its general range occur only in or near tidal marshes. While there are genitalia differences (Hugo Kons personal communication with Dale Schweitzer), we know of no reliable color or pattern characters. Any *Doryodes* specimen found in wiregrass savannas is almost certainly this species.

Figure 273. *Doryodes* species (wiregrass Doryodes) from Brunswick County, North Carolina (David Wagner photo).

Taxonomic notes

This genus is in need of taxonomic study. It is possible that the name *Doryodes bistrialis* was based on this species, rather than the salt marsh species to which it is generally applied (Forbes 1954, Covell 1984). This moth is referred to as *Doryodes* species 1 by NatureServe.

Range

The wiregrass *Doryodes* is found from North Carolina to Florida as far west as Liberty County. Hugo Kons and Robert Borth have looked for it in suitable habitats from the western Panhandle to eastern Texas, but did not collect any.

Rarity

NatureServe global rank: G3G4.

Wiregrass habitats have been reduced by more than 95%. Except that it is not imminently imperiled or demonstrably secure, the status of this moth is unclear. It apparently has a rather limited range. A high percentage of the remnant wiregrass areas that have been sampled still have this species at least in North Carolina. However, relatively few (<20) occurrences are actually documented (Hall and Schweitzer 1993; Hall *et al.* 1999, Hall 2003). Nevertheless, at least five occurrences in North Carolina are clusters of several colonies within relatively large habitats.

Life history

Adults occur from April into October in North Carolina, suggesting three or four broods. It has been found from late March to late November in northern Florida (Kons and Borth 2006, under the name "*Doryodes bistrialis*").

Pupae of this genus overwinter as a cocoon, probably at the base of the grasses at or near the soil surface, but not underground.

Host plants

Probably wiregrass (*Aristida stricta*).

Habitat

This species is characteristic of wiregrass savannas, ranging from boggy to xeric uplands, most often with longleaf pine as the main tree.

Threats & management issues

Populations seem to persist with most prescribed burning regimens. This moth has several generations annually, so populations probably can recover quickly after fires, as long as a few individuals survive. Nevertheless, burning the entire habitat presents some risk to populations, especially in small habitats, and should be avoided. Most habitats would probably be lost to succession without fires, and once lost, wiregrass is very difficult to restore. Lack of fires nearly eliminated the grass and the moth at Weymouth Woods in North Carolina, and the status of the moth there may be precarious even with improved management.

References

Hall and Schweitzer (1993), Hall *et al.* 1999, Hall (2003), Kons and Borth (2006).

Okefenokee Zale

Zale perculta Franclemont

Identification

This large moth (60 mm, forewing length 27 to 28 mm) is the largest species of *Zale*. Adults are dark brown with black markings and patches of green, the color of lichens (Figure 274), and are somewhat similar to, but much larger than, *Zale aeruginosa*. Kutis and Heppner (1995) illustrate a typical male with extensive green, as well as one with almost no green.

Wagner (2005) also illustrates the larva, which is unmistakable, with its bold black and white bands (Figure 275). The diagnostic feature of the larvae of the Okefenokee Zale is the bright red dorsal patch on each segment.

Figure 274. *Zale perculta* (Okefenokee Zale) from Osceola National Forest, Baker County, Florida (Marc Minno photo).

Figure 275. *Zale perculta* (Okefenokee Zale) larva from Charlton County, Georgia (Douglas C. Ferguson photo).

Range

This species is best known from the Okefenokee Swamp (Okefenokee National Wildlife Refuge and Stephen Foster State Park) in southeastern Georgia. It has been collected just to the south in Baker County, Florida (Kutis and Heppner 1995). It has also been found by Dave Baggett in Liberty and Jefferson counties in the Florida Panhandle region. Kons and Borth (2006) report it from sites Baker and Liberty counties.

The food plant extends into Alabama, and *Zale perculta* may occur there as well.

Rarity

NatureServe global rank: G2.

Both the Okefenokee Zale and its food plant have a limited range in the southeastern United States, and there are specimens of the moth in collections from less than ten places. This species is not imminently imperiled, and some populations occur on protected public lands. Two of the known locations have large populations. Surveys for the moth are difficult, because it occurs in swamps where biting flies, alligators, and poisonous snakes commonly reside. Undiscovered populations very likely exist.

Life history

The adults occur mostly in March, but in some years they start to emerge in February, or extend into April. Hugo Kons and Robert Borth have taken one specimen in good condition as late as 29 April (2005), a year with the phenology delayed from normal.

The larvae mature in May, and at least occasionally, in early June. Most *Zale* species require four to six weeks as larvae. The rest of the year is spent as a pupa in a weak cocoon, probably in the surface soil or duff. There is only one generation per year. Adults will come to lights and bait, and the larvae are not difficult to find.

Host plants

The larvae feed on the new growth of the evergreen ericaceous vine, fetterbush (*Pieris phillyreifolia*). This nonparasitic plant roots at the bases of bald cypress (*Taxodium distichum*), pond cypress (*Taxodium ascendens*), Atlantic white cedar (*Chamaecyparis thyoides*), large titi (*Cyrilla racemiflora*), and sometimes pines and oaks. It grows as a vine upward under the bark of the host tree, sprouting leafy branches at intervals from the trunk (Nelson 1996).

Habitat

This moth is found in cypress swamps and other wetlands where the host plant occurs.

Threats & management issues

Logging, hydrological changes, or other impacts to the food plant and the trees it grows on are major concerns.

Gypsy moth might become established in the range of *Zale perculta*, but should not be an issue in swamps.

Swamps are typically only seasonally wet in the Southeast, and sometimes burn during exceptionally dry periods. Under such conditions fire-caused mortality to pupae could be very high. Although cypress is resistant, white cedar trees incur very high mortality from fires.

Prolonged droughts, flooding, and severe storms are expected to become more common in the southeastern United States in coming decades, and could threaten some populations.

References

Franclemont (1964), Heppner (2003), Kons and Borth (2006), Kutis and Heppner (1995), Wagner (2005).

Family Noctuidae[14]

Subfamily Plusiinae

Ridings' pitcherplant moth

Exyra ridingsii (Riley)

Identification

The three species of this genus are easily recognized by wing color and pattern (Jones 1921, Lafontaine and Poole 1991).

This small to medium-sized (22 to 32 mm) moth is variable in appearance. However, it always has a dark band near the base of the forewing (Figure 276), with some yellow before it, and a yellowish outer band (described as ivory by Folkerts and Folkerts 1996). In some specimens, the outer three quarters of the forewing is basically dark brown with a vague yellowish median band, but the antemedian is still conspicuously yellowish. Jones (1921) shows additional variants. First brood adults of *Exyra ridingsii* (mostly late May and June) are larger and more heavily marked than later generations. Even so, most show conspicuous yellow bands. In most summer specimens, the forewing is predominantly yellowish with prominent dark bands, and the terminal part is solidly dark brown.

Figure 276. *Exyra ridingsii* (Ridings' pitcherplant moth) from Screven County, Georgia (David Wagner photo).

The basal half of the forewing of *Exyra semicrocea* is yellow with no dark markings, and the outer portion is dark, sometimes with vague yellow bands, or the entire forewing may be essentially unmarked yellow.

Tarachidia semiflava, which is illustrated by Covell (1984), has been confused with *Exyra*

[14] In this book we follow the classification of Schmidt and Lafontaine (2010). Their arrangement separates some groups that were traditionally included in Noctuidae into other families, such as Erebidae.

semicrocea, leading to false reports that *Tarachidia semiflava* feeds on pitcherplants and that *Exyra ridingsii* occurs in New Jersey. *Tarachidia semiflava* feeds on golden aster foliage (*Chrysopis* species).

Larvae of *Exyra ridingsii* would be difficult to separate from *Exyra semicrocea*, but the lateral lappets are more prominent in the former (Jones 1921, Folkerts and Folkerts 1996).

The egg of *Exyra ridingsii* is much larger than that of its congeners according to Jones.

It is possible to identify this species in any stage, except perhaps pupal, and often just from larval damage to the food plant. See Folkerts and Folkerts (1996) for details and keys to adults, larvae, and larval damage.

RANGE

This pretty moth occurs in the Coastal Plain and Sand Hills regions from North Carolina to the Florida Panhandle, and immediately adjacent Alabama. Disjunct occurrences are found in western North Carolina and northeastern Florida (Folkerts and Folkerts 1996). It apparently does not range west along the Gulf Coast.

RARITY

NatureServe Rank: G2G4.

All species of *Exyra*, as well as their hosts, are declining in the Southeast, although none are imminently threatened with extinction according to Folkerts and Folkerts (1996). Folkerts and Folkerts (1996) report that *Exyra ridingsii* is generally less abundant than *Exyra semicrocea*. Furthermore, it is absent from many sites where *Sarracenia flava* occurs with other species of pitcherplants, apparently in part because of competition from *Exyra semicrocea*. Steve Hall has found the situation in North Carolina to be quite the opposite, and Hugo Kons observed that both species are numerous at two bogs in close proximity in Liberty County, Florida, during late May. Hall supplies the following observations (email to Dale Schweitzer on 5 August 2008).

> *E. ridingsii* is usually common to abundant at almost all sites that have *S. flava*, whereas *E. semicrocea* is much less commonly collected at these same sites. From my database, we have collected 112 specimens of *E. fax*, 72 of *E. ridingsii*, and only 41 of *E. semicrocea*. I suspect that *semicrocea* cannot compete with the specialists where they are present. However, for many years it was the only species recorded at Weymouth Woods, which had lost many of its pitcher plants due to fire suppression, but where there was a least enough of a mixture of *S. flava, S. purpurea,* and *S. rubra* to support a generalist.

While they made little effort to document known localities, Lafontaine and Poole (1991) examined specimens of *Exyra ridingsii* from only seven places compared to 16 for *Exyra semicrocea* and 32 for *Exyra fax*. Both southern species of *Exyra* are local and declining enough to be ranked G3G4 by NatureServe. *Exyra fax* (G4) is also uncommon to rare south of New Jersey, but is much more widespread farther north.

LIFE HISTORY

The larvae of *Exyra ridingsii* live and feed inside the leaves of yellow pitcherplant, for the most part. The pitcherplant leaves die back to the ground in the fall. Second, third, or fourth instars overwinter inside in a chamber made from frass and debris accumulated at the bottom of the pitcher (Jones 1921, Folkerts and Folkerts 1996).

In April in South Carolina, the larvae break diapause and either feed on the flower buds, or bore into the new leaves (Jones 1921). The next generation of larvae enter young pitchers.

Except sometimes for early spring larvae, pupation is in a watertight cell in the corky refuse from the larval feeding that accumulates at the bottom of the pitcher.

In smaller pitchers, the larva first closes off the opening of the pitcher with silk when it is feeding. It then cuts a drainage hole below the pupation site, and a larger exit hole above it.

Both Jones (1921) and Lafontaine and Poole (1991), but not Folkerts and Folkerts (1996), indicate that adults appear later in spring than *Exyra semicrocea*, because most larvae of that species overwinter in later instars. Jones (1921) provides detailed descriptions and illustrations of the biology of all three species of *Exyra*. He reports that overwintered larvae, especially of *Exyra ridingsii*, produce larger, more-heavily-marked adults, compared with later generations, a fact that he attributes to their diet.

Based on Jones (1921) and available collection dates (Lafontaine and Poole 1991), there are probably three broods annually in most places, and not less than two. LaFontaine and Poole (1991) indicate that *Exyra* adults are mostly diurnal, but Folkerts and Folkerts (1996) report they can be observed at dusk. All three *Exyra* species come to blacklights at night, but, like most Plusiinae, do not appear to be strongly attracted to them. The adults hide in the pitcherplant leaves, especially the females, during the daytime. Marc Minno has collected *Exyra* simply by searching inside pitcherplant leaves for resting adults.

At a good site in Liberty County, Florida, Hugo Kons and Robert Borth found *Exyra ridingsii* numerous (and flying with *Exyra semicrocea*) in mid and late May surveys, but did not find it in surveys conducted in mid March, late April, early May, late August, and early October. *Exyra fax* was the only *Exyr*a found on the late August and early October surveys. Kons also reports collecting dispersing individuals of *Exyra semicrocea* and *Exyra ridingsii* more than two kilometers away from their habitats.

Host plants

The main host of *Exyra ridingsii* is yellow pitcherplant (*Sarracenia flava*), in the family Sarraceniaceae. The larvae will eat other species of pitcherplants if they have to (Jones 1921), but the life history of this species, especially its overwintering and pupation habits, is intimately adapted to *Sarracenia flava*.

Habitat

This moth occurs in open pine savannas, seeps, low pocosins, and other moist pineland openings having an abundance of yellow pitcherplant. It occurs in herb bogs in Florida (Kons and Borth (2006). As Jones (1921) points out, *Sarracenia flava* often grows in drier habitats than do other pitcherplants. These savannas are normally maintained by fires.

Threats & management issues

The largest threat is loss of pitcherplant savannas due to development, agriculture and pine plantations.

Based on the detailed observations of their overwintering habits by Jones (1921), it is likely that *Exyra ridingsii* would incur higher mortality in prescribed burns than *Exyra fax* or *Exyra semicrocea*. Populations could be eliminated by complete winter or early spring burning. All stages of *Exyra ridingsii* appear well adapted to surviving inside the succulent to wet pitchers during light fires in the late spring and summer fire season, but could be killed in hot fires. However, in winter, larvae are in dead pitchers that are often still standing. If these dead pitchers are dry, they are vulnerable to prescribed burns through most of April. Steve Hall has studied pitcherplant moths at Black Ankle Bog and elsewhere in North Carolina, and reports that typically there is no sign of larval feeding after prescribed burns. However, where unburned refugia are left, burned areas are usually recolonized the first season. Entire habitats should not be burned at once, but without fires, pitcherplant savannas will be crowded out by dense shrubs.

Folkerts and Folkerts (1996) believe that exotic fire ants and armadillos are probably contributing significantly to the decline of *Exrya* species. However, Steve Hall notes that *Exyra ridingsii* larvae are common at a North Carolina savanna with exceptionally high numbers of fire ants. He suggests that *Exyra* webs offer substantial protection, and the ability of the larvae to move deeper into the pitcher may allow them to escape, when necessary. Folkerts and Folkerts also point out that *Exyra semicrocea* and *Exyra ridingsii* sometimes displace each other in *Sarracenia flava* populations.

Gypsy moth issues are not likely to be a concern in these habitats, and spraying would not likely affect the larvae, since they would be protected inside the pitcherplant leaves.

References

Folkerts and Folkerts (1996), Jones (1921), Kons and Borth (2006), Lafontaine and Poole (1991).

Subfamily Xyleninae

Tribe Apameini

As currently defined, the Apameini is mostly a northern temperate zone group. The larvae are borers in stems, rhizomes and roots, or live among the root crowns of mostly herbaceous plants and grasses. Diversity of Apameini drops off in the southeastern United States with one notable exception. The exception is a multi-genus assemblage of about 15 cane associates, alluded to in our discussion of canebrakes in the introduction.

Some of these moths are associated primarily with only one of the three species of canes (Quinter in Mikkola *et al.* 2009). Cane feeders in the tribe Apameini include three unnamed species of *Papaipema,* as well as *Franclemontia interrogans, Acrapex relicta, Mesapamea trigona* (called *Luperina trigona* in Forbes 1954), the two species of the newly described genus *Protapamea*, and about half a dozen other unnamed species, some in unnamed genera. *Protapamea* larvae feed on developing axillary shoots of the culms in spring; most other *Apameini* are borers.

Like the cane-feeding *Amblyscirtes* skippers, some of these Apameini have much more limited ranges than their food plants. While *Protapamea danieli* occupies much of the range of canes, the rarely encountered *Protapamea louisae* is known only from a few places in western North Carolina, Tennessee, Kentucky and Illinois. The related *Loscopia roblei* from a small area in coastal Virginia and North Carolina is suspected to be a cane feeder as well. Two of the three unnamed cane-boring *Papaipema* (see Georgia Lepidoptera website) are relatively widespread, one in the southeast Coastal Plain and the other farther west. The third is known from only a few places in the Mississippi Valley. *Acrapex relicta* is apparently widespread in the Southeast. *Apamea wikeri* is another rarity found in a few canebrakes in Kentucky, Missouri and Illinois. Females of this species oviposit on flowering stems of the grass *Diarrhena americana* growing among canes, but it is uncertain which the larvae actually eat (see Quinter in Mikkola *et al.* 2009).

Adults of most of the species occur in late spring or early summer, indicating that it is the eggs (definitely in *Protapamea*) or partially grown larvae that overwinter. However, all of the *Papaipema* species fly primarily in October, and definitely overwinter as eggs. *Franclemontia interrogans* is usually collected in April, and overwinters as nearly mature larvae.

All of these cane borers have one generation annually. Since nearly all of what is known about these cane moths is based on the work of Eric Quinter, we are not providing individual accounts for these species, most of which are unnamed or recently described by him in Mikkola *et al.* (2009), and some of which are unfamiliar to us.

The unnamed species of cane borer that we illustrate in Figures 277 and 278 is otherwise known from a few counties in eastern North Carolina and southeastern Virginia, but somehow colonized a patch of Asiatic bamboo (*Pseudosasa japonica*) in Dale Schweitzer's yard in New Jersey. Over five years, a few hundred adults emerged from the patch of this bamboo covering about five square meters. Deliberate "overcollecting" of most adults in at least two years failed to control the infestation, and the larvae riddled the lower stems and rhizomes with borings, killing the mature stems. Mating was never observed and must have occurred late at night. A few calling females were seen around 2:00 a.m. Both sexes were easily found starting about an

Figure 277. The pale form of an undescribed cane-feeding noctuid from a colony using the exotic arrow bamboo (*Pseudosasa japonica*) at Port Norris, New Jersey reared by Dale F. Schweitzer (David Wagner photo).

Figure 278. The dark form of an undescribed cane-feeding noctuid from a colony using the exotic arrow bamboo (*Pseudosasa japonica*) at Port Norris, New Jersey reared by Dale F. Schweitzer (David Wagner photo).

hour after dark. They were discovered resting or flying very slowly among or within a meter of the stems, and never more than about 1.5 meters off the ground. A blacklight that was set up one night seemed to suppress all activity in this species. Some of the other cane borers do come to lights, notably *Protapamea danieli, Acrapex relicta*, and at least two of the *Papaipema*. The moths did occasionally come to sugar baits as far as about 15 meters away. Eggs were laid on new shoots in July and hatched in March, when the larvae were often seen "ballooning" on sunny days. Last-instar larvae occasionally left their burrows and tunneled high into new shoots. This colony ultimately died out when all mature bamboo stems died by December 2009, after the severely damaged bamboo flowered profusely in 2005 to 2007.

Searching among the canes with a flashlight is a very effective way of finding adults of some related species.

Fire is obviously a management issue with these cane borers (see Special Habitat: Canebrakes section), at least in the Coastal Plain. Quinter has discussed this issue with Dale Schweitzer on several occasions. At least *Acrapex relicta* and one of the *Papaipema* species occur in places in North Carolina that are subject to frequent partial burns.

Gypsy moth spraying could be an issue for forest Apameini, since Dimilin® poses a threat to hatchlings for several days. Caterpillars can be poisoned either by contact with the spray as they crawl among litter or vegetation looking for food plants, or by ingestion if they chew into contaminated stems. However, larvae that bore into a food plant without receiving a lethal dose probably would not be further exposed. With the precise phenologies poorly known, risk is difficult to assess and would probably be minimal for larvae already inside the food plants. *Papaipema inquaesita* is among the handful of forest moths with spring larvae that Dale Schweitzer has seen in light trap samples the same season as Dimilin® applications in Delaware. Furthermore, the *Amianthium* borer we discuss has survived at least one application at one site. *Btk* is quite toxic to first instars of most of the species of Lepidoptera that have been evaluated (Peacock *et al.* 1998), but it must be ingested to be harmful. Exposure would be plausible only for young larvae as they first chew into stems and ingest *Btk* in the process. Although there is some potential risk if application occurs as the eggs are hatching, we doubt that mortality from *Btk* would be high to *Papaipema*.

The genus *Papaipema* is endemic to North America. It is notable for having an exceptionally large number of globally rare species. About 53 species of *Papaipema* are known, including at least six unnamed ones. At least 48 occur, or did so historically, in the United States east of the Mississippi River. Substantial declines of *Papaipema* were reported as early as Bird (1934), and in Latham (1953), and Muller (1965). One eastern species (*Papaipema aerata*) and one western species (*Papaipema dribi*) are ranked as globally historic (GH) by NatureServe, and *Papaipema aweme* (G1) has been collected recently at only one site in Ontario. As of 2009, we know of no *Papaipema aweme* collected in the United States in the past 60 years. Three additional *Papaipema* species are ranked G1 or G2, two are ranked G2G3 or G3, and six are ranked G2G4 or G3G4, including four declining forest species treated here. Several *Papaipema* species have very small ranges compared to those of their food plants. Both Massachusetts and Pennsylvania have an endemic *Papaipema*, representing the only endemic species of Lepidoptera known in either state.

Papaipema species are often thought of as prairie moths, but they were slightly more diverse farther east. For example, at least 32 species were collected in the 20th century from northern New Jersey through southeastern New York to Litchfield County, Connecticut, with 31 species in the northern third of New Jersey, alone. About nine of these have not been collected in New Jersey for 30 years or more. Ohio and Wisconsin, which collectively contain most of the prairie species, have only 28 species each (Rings *et al.* 1992, Ferge and Balogh 2000). The total is about 30 for Illinois, which probably still has all of the prairie species. Covell (1999) records 27 species of *Papaipema* in Kentucky. As of August 2008, 26 species are known from North Carolina (Steve Hall). The large number of species known from the Chicago and northern New Jersey/New York City areas in part reflects the concentration of early 20th century *Papaipema* collectors in those regions.

All *Papaipema* species have life histories similar to that described in detail for *Papaipema nebris* by Decker (1931), except that most others feed on a single plant genus or species. However, a few are oligophagous, and *Papaipema cataphracta* and *Papaipema nebris* are widely polyphagous. Adults occur primarily in late summer or fall, mostly in September through mid-October at 37° to 42° North and in the southern mountains.

The eggs are laid in groups near the base of the food plant, but their exact placement is not well documented. Winter or early spring mowing seem to be quite compatible with *Papaipema baptisiae* and *Papaipema nebris* (Dale Schweitzer observation), suggesting that their eggs are on or near the ground. The eggs hatch in spring, but Decker (1931) concluded that most hatchlings perish before they find a food plant. If a host is found, the larvae bore into the stems or root crowns. Hessel (1954) and Winter (2000) provide details on the location and habits of older larvae and location of the pupae of various species of *Papaipema*. Late instar larvae of most species can be reared by transferring them to carrots or potatoes.

The larvae mature in the summer and often aestivate for several weeks before pupating. Prepupal aestivation is generally longer southward, and adults emerge a bit later there, even though feeding is completed earlier than farther north.

Some *Papaipema* species of forest and moist meadow habitats have declined substantially since the 1970s, from at least Connecticut through northern Delaware. More recent efforts (2004 to 2010), mostly by Anthony McBride and Joseph Garris in northern New Jersey, and by Dale Schweitzer and Chris Heckscher in northern Delaware, produced very similar results. Muller (1965) mentioned *Papaipema cerina* as having become very scarce in New Jersey. At least in New Jersey, deer are among the main factors in this decline, although there may be other factors. Even where deer are subsequently controlled, and the flora recovers, *Papaipema* and other fauna may not recover after severe herbivory. For example, Great Swamp National Wildlife Refuge in Morris County, New Jersey, has made much progress in reducing deer damage and restoring their flora which had been devastated by overly abundant deer. Several *Papaipema* species were collected there (labeled Green Village) by Otto Buchholz, Charles Rummel, Joseph Muller and others in the early and mid-20th century. However, some can no longer be found there (Anthony McBride), and *Papaipema sciata*, and *Papaipema maritima*, among others, probably no longer occur in northern New Jersey.

There are *Papaipema* species whose larvae bore in trees, ferns, and even in pitcherplants, or in plants that commonly grow in old fields, such as dogbane (*Apocynum* species) or thistles (*Cirsium* species). In northern New Jersey and New Castle County, Delaware, all nine of these *Papaipema* species have usually been found (2004–2009) where they would be expected (Anthony McBride, Dale Schweitzer, and Chris Heckscher observations), some of them very commonly. Other species of *Papaipema* have larvae that bore into herbaceous plant stems (other than ferns) that typically occur in wet meadows, riparian habitats, or forest understories. Despite substantial effort in the past six years, many of these moths have not been seen in those states in 22 to nearly 100 years, including all of three or four forest understory forb specialists in Delaware, and three of six such species in northern New Jersey.

Because the food plants of *Papaipema* species are mostly patchy herbs, impacts from non-native plants, deer, and fragmentation are likely to directly affect members of this genus more than most other forest-dwelling moths that feed on trees.

One of the rarest *Papaipema* collected in our region is *Papaipema eryngii,* which is among the very few moths ranked G1. One adult was found in a North Carolina pine savanna by Bo Sullivan in 1994. The entire habitat in this area was subjected to a prescribed burn soon thereafter. An intensive effort by Steve Hall and Eric Quinter produced only one larva the next summer. Other occurrences of *Papaipema eryngii* in the Midwest (Covell 1999) are considered to be in prairie habitats, so we do not provide a full account for this moth, but list it in Appendix 2.

Prescribed fire is a well-known and sometimes controversial land management issue with this genus, because it can eradicate populations (Bird 1917, 1934, Latham 1953, Hessel 1954). Burning the stubble and immediately surrounding vegetation provided good control of *Papaipema nebris*, a pest species, based on data provided by Decker (1931). Panzer (1988) demonstrated that prescribed burning is quite compatible with maintaining populations of *Papaipema*, including *Papaipema eryngii*, if adequate refugia are left unburned. Both Decker and Panzer documented that larvae will be heavily reduced or absent from the burned area during the first season after a fire, but females from the unburned areas move in and numbers rebound within a year or two.

Many species of *Papaipema* are attracted to lights placed in patches of their food plants during the flight season, but this is sometimes only true several hours after sunset so overnight effort should be considered. In this regard, 15-watt blacklights are about as productive as 175-watt mercury vapor lights, and a lot more convenient. Adults of *Papaipema* species, especially older females, sometimes wander, and can be taken at lights two kilometers or more away from larval habitats.

Disruption of dispersal by artificial lights is considered a likely cause of population declines among moth species for which dispersal between small habitats is important (Eisenbeis 2006, Frank 2006), and we do not rule out this possibility with some of our *Papaipema* species.

ARALIA BORER MOTH

Papaipema araliae BIRD AND JONES

IDENTIFICATION

This medium-sized (40 mm) moth is among the larger *Papaipema*. It is similar to the generally smaller *Papaipema arctivorens* and *Papaipema rutila*, but the dark portions of the wings are at least redder than *Papaipema rutila*. Other than by size, locality, and probably genitalia (Forbes 1954), some *Papaipema araliae* would be difficult to separate from *Papaipema arctivorens*. The satellite spots surrounding the reniform may contain one or two white anterior spots (Figure 279). There is a yellow basal patch, and the orbicular and claviform spots are white. The orbicular patch does not contain a dark spot. We illustrate the larva in Figure 280.

Figure 279. *Papaipema araliae* (Aralia borer moth) from Pope County, Illinois (David Wagner photo).

Figure 280. *Papaipema araliae* (Aralia borer moth) larva from Alexander County, Illinois (David Wagner photo).

RANGE

Like many *Papaipema* species, this one's known range is far more restricted than that of its food plant. *Papaipema araliae* is known only from two disjunct, limited areas. These are the Delmarva Peninsula and south along the coast through Virginia to eastern North Carolina, and also in central Tennessee, western Kentucky and southern Illinois (Eric Quinter personal communication with Dale Schweitzer in 1999). *Papaipema araliae* probably does not occur with any similar species eastward, but occurs with *Papaipema rutila, Papaipema arctivorens* and the closely related *Papaipema polymniae* in Kentucky and Tennessee. An old report from Pennsylvania (Forbes 1954) is an error.

RARITY

NatureServe Global Rank: G3G4.

This moth is rare in both parts of its limited range, and probably has been found in fewer than 20 places. However, the rank reflects the assumption that more populations are likely to occur, especially in Virginia and North Carolina. It is possibly extirpated from Delaware and Maryland.

Life history

The eggs probably hatch in April. The larvae bore into and kill the new growth of the host tree, and then burrow about a foot into the twig. Fresh borings are very easy to locate.

When mature, the larvae enter the soil to pupate. Dale Schweitzer found several larval burrows in York County, Virginia, in late June. They were already empty, and the frass piles were not fresh, indicating the larvae had probably already matured. Hessel (1954) gives the pupation date as 10 August and eclosion as 1 October. This is undoubtedly based on Jones' observations, although Jones (1928-1932) indicated emergence dates as 19-30 September for the three Delmarva states. Adult collections in North Carolina are from 29 August to 16 October (Bo Sullivan, Steve Hall) and 18 August to 15 October in Kentucky (Covell 1999).

Host plants

The food plant is devil's walking stick, *Aralia spinosa*, a small, very spiny understory tree in the ginseng family (Araliaceae).

Habitat

The food plant is perhaps most typically found in the understory of mesic to swampy hardwood or mixed pine-hardwood forests, but can be numerous in drier oak-hickory-pine forests from Delaware to North Carolina. *Papaipema araliae* can probably occur in a variety of habitats. We know it can be found in swamps on the Coastal Plain.

Threats & management issues

Prescribed burning is a potential issue in the eastern range, and any activities that reduce forest understory will impact or eradicate populations in the treated areas. Gypsy moth occupies the eastern range already, and will occupy the entire range, but probably will not be an issue with this species. The greatest long-term threat to *Papaipema araliae* might be habitat fragmentation, especially eastward where the habitats are suitable for conversion to pine plantations.

References

Covell (1999), Forbes (1954), Jones (1928-32).

Yellow stoneroot borer moth

Papaipema astuta Bird

Identification

This medium-sized moth (35 mm) is relatively small for a *Papaipema*, is mostly yellow with brown dusting, the outer portion of the forewing is dark grayish (Figure 281). The spot ring around the reniform is yellow (not white), with the two inner spots angulate; the orbicular and claviform may be yellow or white. This species is smaller and more yellow than the common *Papaipema cataphracta*, and far more frosted than *Papaipema rigida*.

Field-collected larvae (Figure 282) should be reared to adults for identification.

Figure 281. *Papaipema astuta* (yellow stoneroot borer moth) from Sussex County, New Jersey (Marc Minno photo).

Figure 282. *Papaipema astuta* (yellow stoneroot borer moth) larva from Warren County, New Jersey (David Wagner photo).

Range

Papaipema astuta was historically found from Connecticut, southeastern New York, and northern New Jersey westward through Pennsylvania, northern Delaware, and Ohio to southern Michigan, the Virginias, western North Carolina, and northeastern Kentucky. This moth probably still occurs at a few places in Ohio (Rings *et al.* 1992), where it has been found quite commonly at one site. This moth is found in western North Carolina in and near Great Smoky Mountains National Park (Steve Hall personal communication with Dale Schweitzer), including the east end of the Park where James Adams found several in the Purchase between 3,500 (1,067 m) and 4,500 feet (1,372 m) in September 2009. It has also been collected at several places in northwestern New Jersey from 2006–2010 (Anthony McBride and Dale Schweitzer observations). Since 2003, there have been collections of *Papaipema astuta* in Bath County, Virginia (Steve Roble personal communication with Dale Schweitzer), Cass County Michigan, and Boone County West Virginia (Steve Johnson personal communication with Dale Schweitzer).

This species has the same food plant as *Papaipema duplicata*, and their ranges overlap broadly. However, *Papaipema astuta* seems to be more of a Northeastern and Midwestern species and less of an Appalachian species. Although the host plant was locally common in parts of Connecticut where Dale Schweitzer lived from 1975 to 1983, the many plants examined showed no signs of *Papaipema* damage.

Rarity

NatureServe global rank: G2G3.

This moth is rare, local, and declining at least eastward of Virginia. It has so far been collected at only one locality in the mountains of Virginia (Steve Roble). About ten colonies are known extant in Sussex and Warren counties in New Jersey (Anthony McBride personal communication with Dale Schweitzer), which may be a current stronghold. Robust metapopulations might still occur in southern Ohio, the Virginias, and western North Carolina where there are extensive forest lands with active deer hunting, but we have no confirmation of this. However, we know of no evidence that *Papaipema astuta* ever was common and widespread in the southern Appalachians. This species appears to be historic in Connecticut, New York, Delaware, and Pennsylvania.

Assessment of status is especially difficult with species such as this one, whose food plants are fairly common. However, the food plant is often found in fragmented woodlands, or may be subject to substantial browsing by deer, so the plants are now seldom occupied by *Papaipema* larvae. Only places with large numbers (probably at least 100s) of robust plants are potential habitat. In poor (e.g. dry) site conditions, or where they are often browsed, *Collinsonia* plants are too small to support *Papaipema* larvae. With the growing deer and invasive-species problems in the eastern United States, we doubt this species is secure, but there are probably more populations than are now documented.

Life history

The life histories of all species of *Papaipema* are similar and discussed in the generic account. Adults of this species fly somewhat earlier than those of *Papaipema duplicata*, from about the end of August through September, and rarely into October. The larvae bore in the lower stem and root of the host, and sometimes form a cell (or small chamber) in the root. The larvae pupate in the soil. Anthony McBride has also found *Papaipema cataphracta* larvae in *Collinsonia*, so vouchering requires a specimen.

Host plants

The food plant is stoneroot (also called richweed or horse balm) (*Collinsonia canadensis*), a large, perennial herb in the mint family (Lamiaceae).

Habitat

This moth lives in rich deciduous forest where the food plant is abundant in the understory. In New Jersey, *Papaipema astuta* primarily occurs in wildlife management areas and other public and private lands open to deer hunting (Anthony McBride and Dale Schweitzer observations). Suitable un-browsed food plants are seldom seen on lands that have been closed to hunting.

Threats & management issues

Deer and habitat fragmentation are the major known threats to this moth. Excessive browsing by deer has destroyed most undeveloped potential habitat in New Jersey. While the food plant is not highly favored by deer when their densities are moderate, it is eaten at least in summer.

Where deer densities are very high, repeated browsing kills many of the plants, and it reduces others to ankle-high sprigs with very few leaves.

Invasive exotic plants are also very probable threats to *Papaipema astuta*. Even if the food plants are not killed, browsing by deer or competition from invasives can cause them to be too small for *Papaipema* larvae to mature on. If the host plant is only moderately stunted, larvae might be able to compensate by moving into the root.

Observations by Dale Schweitzer, especially in Delaware, suggest that exotic earthworms, which now consume most leaf litter in these habitats, could be important egg predators, but this has not been documented. This hypothesis needs to be investigated.

References

Covell (1999), Forbes (1954), Goldstein (1999), Hessel (1954), Jones (1928-32), Rings *et al.* (1992), Tietz (1952, 1972).

Bottlebrush borer moth

Papaipema cerina (Grote)

Identification

This medium-sized (50 mm), distinctive moth is easily recognized from our picture (Figure 283). Note the lemon yellow color, and that the spots on the forewing are dark, not ringed with white.

Taxonomic notes

According to Eric Quinter, along with the three unnamed cane feeders, *Papaipema cerina* forms a clade of four relatively primitive grass feeders within *Papaipema*. These four species share some details of pattern.

Range

This species has been found from extreme southern Maine and New Hampshire west through New York and southern Ontario, to Wisconsin and south into Kansas, southeastern Pennsylvania, and northern New Jersey. *Papaipema cerina* has not been reported from Delaware, Vermont, Ohio, or Kentucky.

Figure 283. *Papaipema cerina* (bottlebrush borer moth) from Cook County, Illinois (Marc Minno photo).

Rarity

NatureServe global rank: G2G4.

This moth was apparently never very common. It is historic, with no known records for 30 to 100 or more years in Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, and as far as we know, in Kansas. Muller (1965) noted an apparent decline of this moth in New Jersey, but there are later specimens in the Rutgers University collection. Efforts by Dale Schweitzer and Anthony McBride in 2007 to 2010 to locate this moth in New Jersey have been unsuccessful, even with multiple efforts in places where the primary food plant is common (although larger alternate hosts are nearly absent).

Papaipema cerina occurs regularly at light in mesic woodlands and forests in eastern Connecticut (Brooklyn, Hampton, and Pomfret). In Michigan, where *Papaipema* have been well-studied by James Bess, Mo Nielsen, and others, *Papaipema cerina* is ranked S1S2. In Indiana it is ranked S1. This moth is extant but unranked in Wisconsin. In Wisconsin, six localities were documented by Hugo Kons and Robert Borth in the early and mid 1990s. Five of the six localities contained native prairie. All five prairie sites surveyed in the fall contained *Papaipema cerina*.

Life history

The life history of *Papaipema cerina* is similar to the rest of the genus. The larvae bore in the stems, not the roots, of the food plants. Adults come to lights and most specimens are collected from mid-September to early October.

Host plants

The primary food plant of *Papaipema cerina* is believed to be bottlebrush grass, *Elymus hystrix* (better known as *Hystrix patula*), a large grass (Poaceae). Older larvae have been found as borers in other plants, including Turk's cap lily (*Lilium superbum*), starry campion (*Silene stellata*), and mayapple (*Podophyllum peltatum*). We do not know whether availability of a larger alternate food plant for the late instars is critical. If large forbs are essential, a lack of them could explain the apparent decline of *Papaipema cerina* in New Jersey and probably other places where bottlebrush grass still occurs frequently.

Habitat

Like its usual food plant, this moth occurs in forest and woodland understories, openings, edges, and apparently sometimes in prairies.

Threats & management issues

Habitat loss and fragmentation due to development, and probably deer and invasive plants are the main threats.

We are uncertain of the severity of the threat posed by deer to this species, because grasses tend to be more tolerant of browsing than many plants. However, in areas such as most New Jersey forests, where deer occur in very high numbers, bottlebrush grass is sometimes stunted.

If this moth had declined in New Jersey as early as Muller (1965) indicated, the decline would pre-date deer overpopulation by a few decades; however, Muller did not know the correct food plant, and so might have overlooked this species.

References

Forbes (1954), Goldstein (1999), Hessel (1954), Muller (1965), Rings *et al.* (1992), Tietz (1952, 1972).

DARK STONEROOT BORER MOTH

Papaipema duplicata BIRD

IDENTIFICATION

This medium-sized (45 mm) moth is rather large for a *Papaipema* species, and dark gray-brown (Figure 284). Forbes (1954) described this moth as:

> Similar to the plainer forms of *nebris*; fore wing irrorated [sprinkled] with white; st. [subterminal] line indicated by vague whitish lunules; am. and pm. [antemedian and postmedian] lines typically with their two brown lines more nearly equal and the filling pale.

When seen together, the color of *Papaipema duplicata* is slightly different from *Papaipema nebris*. There are also several other plain dark brown *Papaipema* species without the usual white spots. An expert may need to verify specimens of these, although, except for *Papaipema necopina* and *Papaipema eupatorii*, they are not likely to occur with *Papaipema duplicata*.

Figure 284. *Papaipema duplicata* (dark stoneroot borer moth) from Bedford County, Virginia (Marc Minno photo).

RANGE

This moth occurred historically from the vicinity of New York City across northern New Jersey, eastern Pennsylvania, and northern Delaware to the mountains of Virginia and North Carolina, and along the Ohio River in Kentucky.

RARITY

NatureServe global rank: G2G4.

Jones (1928-1932) regarded *Papaipema duplicata* as "rather abundant" in northern Delaware. Eric Quinter found a population in Somerset County, New Jersey in 1980. This population has since been destroyed by deer (Anthony McBride site visit in 2006). Since then, we know of only one population of this species north or east of southwestern Virginia and Kentucky. Steve Johnson and Sam Smith found a population in Lebanon County, Pennsylvania in September 2009, and as far as we know, these are the first records from that state since 1967 (Dale Schweitzer observation). Repeated efforts in the early 1970s, a few attempts in 1988 to 1990, and multiple annual efforts from 2004–2007 (Dale Schweitzer and Chris Heckscher) failed to produce any adults or larvae of this moth in northern Delaware or adjacent Pennsylvania. Some of Jones' collecting sites still exist in northern Delaware. Despite substantial efforts to find this moth, *Papaipema duplicata* is considered historic in New York, New Jersey, and Delaware. North Carolina records are also old. *Papaipema duplicata* was locally abundant at blacklights in the Virginia mountains in the 1990s (Steve Roble and others), and was still numerous as larvae in 2008 (A. McBride).

LIFE HISTORY

The larvae start in the lower stem. As late instars they enter the root, where they excavate a large cell in which they feed and pupate. Adults emerge mostly in September in Virginia, where collections dates have been 1 September to 15 October (Steve Roble). Jones (1928-32) gave emergence dates as 28 August and 10-24 September. Hessel (1954) gives much later emergence dates, 30 September to 28 October. These later dates may be based on the observations of Henry Bird from the New York City area, or perhaps they are in error.

HOST PLANTS

The food plant is *Collinsonia canadensis*, a large, perennial herb in the mint family (Lamiaceae), which is also the food plant for *Papaipema astuta*.

HABITAT

This moth lives in rich deciduous forest where the food plant is abundant in the understory.

THREATS & MANAGEMENT ISSUES

Threats for *Papaipema astuta* also apply to *Papaipema duplicata*.

Deer have nearly eradicated the host plant from the most recent New Jersey site, and from numerous similar forests. Even if *Collinsonia* plants survive, damage from deer and probably competition from exotics can reduce the host plants' size sufficiently to make them unsuitable for *Papaipema*.

Papaipema duplicata was common in Delaware less than a century ago, but is no longer found there. If its absence reflects current, rather than past conditions, then loss of food plant to invasive plants and deer do not seem to be fully adequate explanations for the loss of this moth from the White Clay and Brandywine Valleys. The possibility that abundant (several per square meter), large exotic earthworms could be eating most *Papaipema* eggs in the forest litter there needs to be investigated.

REFERENCES

Covell (1999), Forbes (1954), Goldstein (1999), Hessel (1954), Jones (1928-32), Rings *et al.* (1992), Tietz (1952, 1972).

Flypoison borer moth

Papaipema species (not formally described)

Identification

This medium-sized (45 to 50 mm), distinctive moth is intermediate in appearance between the *Papaipema birdi* group and *Papaipema appassionata* (illustrated by Covell 1984). All of the forewing spots are white (Figure 285). The median area and postmedian line are not yellow. The white reniform spot ring is proportionately larger than that of other species, except not quite equal in size to that of most *Papaipema appassionata*. Habitat and numbers will usually be strong identification clues too, because one typically gets several–occasionally more than 50—per night, at lights in acid forest or barrens with the food plant. Often no other *Papaipema* occurs in these habitats, but *Papaipema pterisii* is the most common associate. We illustrate the larva in Figure 286.

Figure 285. Flypoison borer moth (*Papaipema* species) from Carbon County, Pennsylvania (Marc Minno photo).

Figure 286. Flypoison borer moth (*Papaipema* species) larva (David Wagner photo).

Range

This species is found on the Pocono Plateau of northeastern Pennsylvania, extending slightly to the south and west. Specimens have been collected in Luzerne, Lycoming, Dauphin, Carbon, Clinton, Monroe, Berks, and Schuylkill counties. The flypoison borer has been sought but not found at a number of sites in the Virginia mountains (especially Shenandoah National Park) where the food plant is abundant (Steve Roble). Very few other *Papaipema* species are as easy to find as this one. This is Pennsylvania's only known endemic moth.

Rarity

NatureServe global rank: G2G3 (listed as *Papaipema* species 1.

This undescribed *Papaipema* species was discovered by Eric Quinter in the early 1970s. It can be very numerous at light. In fact, it may reach the highest larval and adult densities of any species in the genus other than the crop pest *Papaipema nebris*.

Aside from where its habitat has been obliterated by development, the flypoison borer seems to occupy much of its original range. It is of concern due to its small total range, habitat loss, and fragmentation due to residential development.

Life history

The larvae bore into the bulb of the host causing considerable damage to the plant for that season. Larvae are very easy to find.

Pupation occurs in the bulb of the food plant, making this a very convenient stage for finding the species.

The adults fly in much of September into early October and come readily to lights, sometimes dozens at a time. Dale Schweitzer has also taken two at bait. Ironically, this was on an early October night when none came to two blacklight stations.

Host plants

The host is flypoison, *Amianthium muscaetoxicum*, an herb in the Melanthium family (Melanthiaceae).

Habitat

The habitats where this species is found are acidic oak or mixed forests, woodlands, and pine barrens, generally above 800 feet (250 meters). Although this moth seems to be more abundant in relatively open habitats, it also finds places where the host plant grows in more dense forest to be suitable.

Threats & management issues

The main threats are habitat loss and fragmentation due to development. Gypsy moth spraying is a potential issue. Deer probably benefit the flypoison borer, because they will not eat the toxic host plant. Where deer are excessively abundant, this plant is sometimes virtually the only non-woody greenery in spring. The host plants are likely to respond favorably to removal of competing species.

Invasive plants have not been widespread problems in these acidic habitats, so far.

References

Goldstein (1999).

REEDGRASS BORER MOTH

Spartiniphaga[15] *carterae* SCHWEITZER

IDENTIFICATION

At 25 to 31 mm (forewing length 11.7 to 15.2 mm) this medium-sized moth is among the smaller Apameini. The moth has light ochreous forewings and virtually unmarked white hindwings (Figure 287). On the forewings, the postmedian line is usually reduced to a series of dots, and the antemedian line is sometimes reduced to a series of dots. The reniform and orbicular spots are usually dark rings, with the lower portion of the reniform spot being dark. In New Jersey there is a form with fully developed prominent antemedian and postmedian lines that closely resembles *Spartiniphaga inops* (illustrated by Rings *et al.* 1992). In North Carolina there is a rare dark brown form.

Figure 287. *Spartiniphaga carterae* (reedgrass borer moth), from Fort Dix Military Reservation, Burlington County, New Jersey (David Wagner photo).

This moth could be confused with *Platysenta videns*, which sometimes occurs with it in New Jersey, and is similar in size, shape, and color. However, the details of the markings are different (see illustration in Covell 1984), and *Papaipema videns* usually has a prominent white spot on the forewing.

RANGE

Spartiniphaga carterae occupies all three major portions of the range of its host plant, pine barrens reedgrass (*Calamovilfa brevipilis*). Most reedgrass stands in the core of the New Jersey Pine Barrens, Fort Bragg, North Carolina, and southeastern North Carolina, have *Spartiniphaga carterae*. A few colonies might also exist in South Carolina. Isolated patches to the north and south of the main range in New Jersey and in Virginia appear to lack the moth. In November of 2005 and October of the following year, James Adams collected many specimens that appear to be this species in a moist pine savanna in Colquitt County, Georgia, which is far outside the range of the known food plant. The specific identity of Georgia specimens needs to be verified, and associated grasses need to be identified.

RARITY

NatureServe global rank: G2G3. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

This moth has a small known range, which is nearly the same as its known food plant. Furthermore, there are probably less than 100 viable metapopulations (clusters of interacting colonies). In New Jersey, most populations are precarious in the long-term due to dependence on wildfires and military activities to maintain the moth's habitat. On the other hand, some

[15] Lafontaine and Schmidt transferred all species of this genus to *Photedes*.

are stable due to a hydrology which promotes long-term persistence of the food plant. Some North Carolina populations are probably well-managed by prescribed burning. This species is not imminently imperiled in either state.

Life history

This moth has not been reared, but more than 20 ovipositions have been observed in the field. As far as is known, the eggs are laid in the fall on standing grass stems. They are slipped under the sheaths or otherwise hidden. It's likely that females also oviposit among old stems and blades near the base of the plant. In New Jersey, females always oviposit in patches of *Calamovilfa brevipilis*, but the eggs are often placed on the stems of other grasses.

Eggs kept outdoors in the shade hatched in November, indicating that young larvae overwinter. They are active upon hatching and probably enter the base of the food plant within a day or two. Dale Schweitzer and William J. Cromartie have found the remains of pupae that almost certainly were this species in the root crowns of pine barrens reedgrass. The larvae probably start feeding in the thickened, succulent leaf bases and then work their way into the rhizomes. The larvae seem to be very well protected from fires, because the adults occur in normal numbers during the fall following late spring or summer fires. Populations of this moth have even survived intense fires in New Jersey.

The adults emerge around 10-20 September in New Jersey, and persist into late October. Most collections have been in September. Adults are found mostly in October in North Carolina. Adults do not come to bait or flowers, but are easily found by searching patches of pine barrens reedgrass with a flashlight about one to three hours after dark. They also come readily to ultraviolet lights placed in, not merely near, reedgrass patches.

Host plants

The food plant is pine barrens reedgrass (*Calamovilfa brevipilis*) in New Jersey and North Carolina.

Habitat

The habitat for *Spartiniphaga carterae* is essentially the same as for the known food plant. This is moist pine savannas, swales, edges of bogs and pocosins, and other relatively open moist habitats in Coastal Plain and sandhill pinelands. The substrate where the host plant grows varies from white sand, which is moist below, but at times dry at the surface, to permanently saturated peat with sphagnum moss. The habitats are fire-dependent in North Carolina, but in New Jersey some are constantly wet and burn only rarely. Fire frequencies at highly productive New Jersey sites vary from about ten per decade (on military lands) to only about two per century. The optimum habitat in New Jersey is on active military base impact areas where soldiers practice firing weapons. On Fort Dix, the extreme fire frequency maintains hundreds of hectares of reedgrass and many additional hectares of mixed shrubs and reedgrass, all of which are occupied by *S. carterae* in most years. An ultraviolet light at this location will often attract 20 or more adults in an evening.

The most extensive and most intense fires tend to occur in spring and summer, and *Spartiniphaga carterae* is often abundant in the burned places in September. In less frequently burned habitats at Fort Dix, *Spartiniphaga carterae* shares its food plant with *Atrytone arogos*. In the most frequently burned areas, larvae of *Dichagyris reliqua* feed on developing seeds at about the time that *Spartiniphaga carterae* are ovipositing on the same stems. Both of these species are included in this book.

Other rare species included in this book will almost always co-occur in or around the edges of *Spartiniphaga carterae* habitats in New Jersey and North Carolina. For example, *Crambus daeckellus*, *Cyclophora* species near *culicaria*, *Agrotis buchholzi*, *Agrotis carolina* and even *Hemipachnobia subporphyrea* may co-occur with *Spartiniphaga carterae*.

While the food plant flowers and fruits vigorously after fires, and declines to a suppressed vegetative condition within several years, *Spartiniphaga carterae* will persist in these vegetative plants, providing some of them maintain a bunchgrass form. On drier sites, succession can eliminate the habitat in ten to 15 years, as observed in New Jersey.

Threats & management issues

This species can reach very high densities in places with extreme fire frequencies. The greatest threat to many remaining populations is the elimination of fire. This will cause the food plants to become very small, as shrubs shade them out. Essentially any practice other than frequent fall fires, as long as it improves abundance or vigor of the grasses, should benefit this species, including tree or shrub thinning as well as burning. Mortality could be extremely high in fall fires, when the eggs are exposed on dry grass, and possibly into winter and early spring. Summer fires are definitely safe, and April and May burns appear to be fine in New Jersey.

Lack of fire in most of the habitat since the July 1983 inferno reduced *Spartiniphaga carterae* habitat in the Atsion-Batsto Natural Area just north of the type locality by 1996. North Carolina habitats require more frequent fires, and none are thought to be hydrologically maintained.

References

Schweitzer (1984), Schweitzer and McCabe (2004).

TRIBE XYLENINI

Xylenini are a diverse group with about 80 species in our area. Most forests northward and in the mountains have 25 to 35 species. This tribe includes some of our most abundant forest moths, such as *Sunira bicolorago* and *Eupsilia vinulenta*. These species are commonly seen by the hundreds at sugar baits,[16] and occasionally by the thousands.

Xylenini are the winter noctuids, with adults of nearly all of the species active in the cooler months. Larvae feed in spring, and prepupae or pupae aestivate through the summer. Some species complete their adult life in the fall. Many others overwinter then mate and lay eggs in the spring. Most have one generation per year, and larvae of nearly all feed on new spring growth.

The genus *Lithophane* includes some notorious examples of false rarity. *Lithophane joannis* and southern populations of *Lithophane patefacta* are good examples. Adults of these species are not attracted to most kinds of collecting lights, and sometimes not even to baits. Similarly, in a lifetime, a persistent and lucky collector might manage to take a series of *Lithophane lepida adipel* at bait on a few good nights, but otherwise will encounter only one or two at bait or lights now and then.

Between about 1978 and 1988, some species of Xylenini, most notably *Lithophane patefacta*, *Lithophane querquera*, and *Eupsilia cirripalea*, experienced marked increases in distribution and abundance from New Jersey to southern New England. Around 1988, an unnamed southern species near *Lithophane disposita*[17] suddenly became common in southern New Jersey, where there were no prior collections, and had reached Bethany Connecticut by October, 1999 (Dale Schweitzer observation). Others in this genus are in decline. *Lithophane scottae* has declined substantially at least northeastward. *Lithophane lepida lepida* is possibly now restricted to two sites (although this depends on the taxonomy applied). Between 1900 and 1940, *Pyreferra ceromatica* appears to have disappeared from 99% of its range.

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16 An easy and effective bait mix for Xylenini is approximately 12 fluid ounces of beer, 10 ounces of white sugar, a quarter cup of molasses, about four rotting bananas, and a tablespoon of corn meal, run through a blender. Never store in a sealed glass container. Paint on tree trunks with a clean brush during the day, retouch around the edges shortly before dusk. Check at deep dusk and as long as productive—typically 20–40 minutes. Works best if the temperature is 8º–16ºC at dusk.

17 This previously, little-known, now widespread, southern moth was mentioned by Franclemont in Forbes (1954) from Virginia as *L. disposita*. There are also a few old specimens from Arkansas. Color, wing pattern, size, and food plants differ.

Lemmer's pinyon moth

Lithophane lemmeri (Barnes & Benjamin)

Identification

This medium-sized (about 40 mm), brownish-gray moth (Figure 288) is similar to *Lithophane fagina*, but the forewings of that species are a smooth slate gray with a whitish costa. The genitalia are distinctive compared to other eastern *Lithophane* species. It should be easily recognized from our illustration. Note the color, fragmented pattern, wing shape, and prominent thoracic crest.

There are several similar species elsewhere in North America and Europe, including an unidentified species with very different genitalia in Missouri. The related *Lithophane thujae*, which is known from Canada, northern Michigan, and Wisconsin, does not occur near the range of *Lithophane lemmeri*. Webster and Thomas (1999) illustrate the adults and compare the male and female genitalia of *Lithophane lemmeri* and *Lithophane thujae*. The larva is colored like cedar foliage, green with white markings (Figure 289), and is also illustrated by Maier *et al.* (2011).

Figure 288. *Lithophane lemmeri* (Lemmer's pinyon moth) from Atlantic County, New Jersey, reared Dale F. Schweitzer from female in Figure 47.

Figure 289. *Lithophane lemmeri* (Lemmer's pinyon moth) larva from Atlantic County, New Jersey, reared Dale F. Schweitzer from female in Figure 47 (David Wagner photo).

Range

This is a Coastal Plain and Piedmont species. Most older specimens of *Lithophane lemmeri* in collections are from Lakehurst, Ocean County, New Jersey, and were taken in the 1930s and 1940s in the swamps within walking distance of Eisenhower's Tavern, the usual starting point and refreshment stop for the collectors, at the route 70 traffic circle. There are specimens from Burlington, Atlantic, Salem, Cumberland, and Cape May counties from 1997 to 2009. This moth has been locally common in Burlington and Atlantic counties from 2001 to 2007. Dale Schweitzer has examined single specimens from Talbott County, Maryland, and Prince William County, Virginia, and he has looked at about a dozen from the Piedmont and Coastal Plain of North and South Carolina, Whitfield County, Georgia (James Adams), Jackson County, Alabama (H. Grisom), and the Florida Panhandle.

There are old specimens in collections labeled "Ivoryton, Connecticut," but among other reasons, similarly labeled specimens of *Lithophane viridipallens* suggest they might have come from Lakehurst, New Jersey. A male *Lithophane lemmeri* was collected at mercury vapor light in Bristol County, Massachusetts on 11 April 2011 by Mark Mello.

We are not sure whether Texas populations are *Lithophane lemmeri*, but suspect larval images we have seen are not. Dale Schweitzer has seen one photograph of a larva that appears to be *Lithophane lemmeri* from Arkansas.

Rarity

NatureServe global rank: G3G4.

The G3 part of this rank may be due to false rarity, but this moth is rarely collected outside of New Jersey. Even there it seems to have been rare in some decades, such as the 1950s, 1960s, and 1980s, when no adults were collected despite continued efforts. Muller (1965) noted its apparent disappearance at that time.

Although *Lithophane lemmeri* does come better to lights than some of its congeners, no *Lithophane* is common at lights. *Lithophane lemmeri* does not come reliably to bait in many areas or in many years. Thus, it is unclear how uncommon this species really is.

In New Jersey, the habitat has declined due to fires, flooding, deer browsing of regenerating stands, sea level rise, and other factors. By the early 1950s, this species could no longer be found at the Lakehurst bait trail (Muller 1965, John W. Cadbury III and Joseph Muller personal communications with Dale Schweitzer in the 1970s). However, that does not necessarily mean the population was greatly reduced. John G. Franclemont found a larva elsewhere in Lakehurst in the 1950s. White cedars in the traditional area have mostly been killed by fires, and to some extent by logging and development. So far, collection records suggest that this species is rare where it is using red cedars, but false rarity is a confounding factor for *Lithophane* species that do not come reliably to bait.

Life history

The adults eclose in late autumn, overwinter, and mate early in spring (about early March in New Jersey). Adult collection dates in New Jersey range from 16 October to 12 May, including all intervening months. Most specimens from the 1930s and 1940s were taken mid-November to early December. From 1970 through spring 2006, over 90% (n < 20) were from 7 March to 16 April. More than 25 were collected or observed at bait on 18 December 2006 and 3-15 January 2007, near Chatsworth, New Jersey, by William J. Cromartie and Dale Schweitzer. However, none came to bait there the following winter or spring. This probably reflects local and annual differences in the seasonal response to sugar baits, rather than changes in numbers.

Persistence into May is probably very unusual, but was documented in 1940 by John W. Cadbury III and in 2005 by Steve Johnson. Farther south, the flight season starts in November or December and goes through March, or occasionally into April. While the above observations in New Jersey were almost all at bait, all seven adults that Dale Schweitzer has collected slightly further south in Cumberland and Cape May counties have been at lights. Five of these were off building walls, and one each was taken at blacklight and mercury vapor light. By contrast, observations on building walls and blacklights do not approach 1% of total *Lithophane* adults observed in those counties from 1988 to 2010. Mercury vapor collecting lights or blacklights, as well as bait, are recommended when looking for this species. Most adults of *Lithophane lemmeri* that come to light or bait do so within the first hour or two after sunset.

The eggs are laid singly on the foliage of the host trees, and are very large for the size of the moth. Although this species lays over 220 eggs, the number of eggs laid is less than one-third of the typical clutch size for the genus, even from well-fed captive females. Most eggs hatch in late April to early May in New Jersey.

Young larvae eat the new growth at the tips of branchlets and gradually consume older foliage along the branch. Both the larvae and adults (when seen in resting position, Figure 47) blend in well with cedar foliage and bark, respectively. The larvae of *Lithophane thujae* (Webster and Thomas 1999), *Lithophane subtilis* (Comstock and Henne 1969), and *Lithophane lemmeri* are the only Xylenini known to mature in only five instars. However, *Lithophane lemmeri* larvae grow slowly and complete feeding from mid-June to mid-July. The larval stage of the very similar *Lithophane subtilis* in California is reportedly much longer (Comstock and Henne 1969).

When mature, *Lithophane lemmeri* larvae descend the host tree and make a tough cocoon on the bark of the lower trunk near the base of the tree, among old cedar needles, or in the soil. The summer is spent as larvae within the cocoons in a prepupal condition. Pupation occurs in autumn, and the adults eclose mostly in November. Prepupal larvae are amazingly adept at escaping from rearing sleeves, usually without chewing any holes, and Dale Schweitzer recovered about half of over a dozen escapees in cocoons partially excavated into the red cedar bark, and one among dried cedar litter at the base of the tree. Larvae will also burrow into and spin cocoons in peat if this is provided.

The odd habit (for a xylenine noctuid) of spinning cocoons on the tree or in the leaf litter rather than consistently in the soil may be an adaptation to very wet habitats. Also, it is likely that the adults hibernate under loose cedar bark rather than in the leaf litter.

The fact that this species rarely comes to bait suggests either that adult foods are usually plentiful, or that adults seldom need to feed. They may have some unusual nutritional needs. Several females that were overwintered in captivity and fed solutions of maple syrup, honey, and over-ripe fruit, did not attempt to mate. A mated female collected on 15 January 2007, and similarly treated, began ovipositing at the end of March, but over 90% of the eggs were not viable.

Host plants

Red cedar (*Juniperus virginiana*) is present in all counties where this moth occurs. The larvae have been found in the wild on Atlantic white cedar (*Chamaecyparis thyoides*) in New Jersey by Chris Maier and Anthony McBride, and in Liberty County, Florida, by Dave Baggett (reared adult determined by Dale Schweitzer) and Jeff Slotten. However, no counties where the moth has been collected from Maryland to Georgia are reported to have Atlantic white cedar. Larvae from white cedar habitats are easily reared in captivity entirely on red cedar. Newly eclosed larvae from New Jersey seem to prefer eating red cedar when given a choice. There is no difference in wing color, pattern or genitalia of adults, whether they are from a population where the larvae feed on red cedar or Atlantic white cedar.

Habitat

Most collections of this moth from New Jersey and the few from Florida have been in or near Atlantic white cedar swamps, although some New Jersey sites also have red cedar nearby. Generally, specimens from the Carolinas, Georgia, Alabama, Maryland and Virginia have been single individuals not associated with any noteworthy habitats, but are in the general vicinity of red cedars. The only obvious need seems to be sufficient cedar stands in reasonable proximity to each other, or simply numerous scattered patches of cedars over a large area. In southern New Jersey, the moths are usually found in or within a kilometer of cedar swamps of several dozen hectares or larger. At least a few Atlantic white cedars grow along nearly every stream in this area, which may explain why the moth has been primarily known from southern New Jersey. This moth does not require old growth. All of the Atlantic white cedar swamps in New Jersey have been cut over and/or burned, usually several times, but many are composed mostly of relatively mature trees.

Threats & management issues

Atlantic white cedar has declined in New Jersey and elsewhere. Excessive numbers of deer in the Northeast now reduce or preclude regeneration of this tree in many places, because winter browsing is very destructive to small Atlantic white cedars.

In the last decade or two, rising sea level has taken a large toll of Atlantic white cedars along Delaware Bay and in the lower Mullica basin. This process will accelerate as the climate warms.

Highway construction and other projects that slightly raise water levels (whether salt water or fresh) also can eliminate Atlantic white cedar stands. Most Atlantic white cedar swamps in North Carolina, which presumably were inhabited by *Lithophane lemmeri*, have been cutover, and in some cases converted to other uses. Development and succession are more likely threats to red cedar-associated populations, because they grow in upland areas as opposed to swamps.

Fire can be important in the long-term dynamics of Atlantic white cedar swamps and red cedar stands, but in the short-term, fire kills most of the trees. Prescribed burning is usually not carried out in cedar swamps.

The early instars of this species were remarkably tolerant of *Btk* in laboratory assays, with most treated second instars producing normal adults after some initial slowing of growth (Peacock *et al.* 1998). A healthy population would survive a field application of *Btk*. However, spraying Dimilin® for gypsy moth suppression could be a threat, because early or middle instars would be present at the time applications most likely would be made.

References

Comstock and Henne (1969), Forbes (1954), Maier *et al.* (2004), Peacock *et al.* (1998), Schweitzer (1974), Tietz (1972), Webster and Thomas (1999).

Acadian pine pinyon moth

Lithophane lepida lepida Grote

Identification

This is a medium-sized (about 40 mm), gray, boreal noctuid with somewhat pinkish hindwings (Figure 290) that flies in autumn and early spring. The "*lepida* complex" can be recognized from our image, but this subspecies needs to be verified by an expert. A 1903 Ottawa specimen is illustrated by Handfield (1999); Ferguson (1955) illustrated the Nova Scotia specimen. Note the powdery looking gray forewing with the normal lines and spots complete, or nearly so. Specimens collected at the Albany Pine Bush (which was historically known as Centre), New York, are in several collections. All of the above specimens and perhaps 20 others collected since 1900 in eastern Canada and the far northeastern United States are much more powdery and strongly marked than populations from either west of the Ottawa district of Canada or from southern New Jersey to Georgia. These more-western and southerly populations have the forewings smoother gray (illustrated by Rockburne and Lafontaine 1976), with the markings less distinct and often incomplete (Forbes, 1954). We illustrate the larva in Figure 291.

Figure 290. *Lithophane lepida lepida*, one of few modern specimens, from Clinton County, New York, reared from the larva in Figure 291 found by D. L. Wagner. Adult emerged in Sept. 2008 (David Wagner photo).

Figure 291. *Lithophane lepida lepida* larva, same individual as the moth in Figure 290, from Clinton County, New York, found on pitch pine in June 2008 (David Wagner photo).

Taxonomic notes

Don Lafontaine has studied this complex and co-authored two new western species (Troubridge and Lafontaine 2003). He has since concluded that the well-marked northeastern populations represent a separate species. Furthermore, Lafontaine concluded that the name *Lithophane adipel*, described from Lakehurst, New Jersey, should also be applied to populations from Clinton County, New York, central Ontario (illustrated as *Lithophane lepida* by Rockburne and Lafontaine 1976) west to Saskatchewan, and from southern New Jersey to Georgia. Franclemont and Forbes (in Forbes 1954) also describe specimens from central and western Canada as "rather plain, though powdery, leaning toward *adipel*." We agree they approach, but are not identical in appearance to, typical *adipel*. In this strict sense, *Lithophane lepida* may also differ in the valve tips of the male genitalia (Don Lafontaine), which would support species status, but a larger sample size is needed.

Both the *lepida*- and *adipel*-like phenotypes occur among specimens collected from 1985 to 2004 at the Ossipee pine barrens in Carroll County, New Hampshire (mostly by Jeff Lougee since 2002), with most being of the *adipel*-like phenotype. Apparently at least one specimen of the *lepida* phenotype has been collected recently from Clintonville, New York (Tim L. McCabe, not examined by us), where the *adipel*-like phenotype also occurs. We illustrate a second one. We are uncertain if these two northern entities are separate species that occur together in a few places, or if they represent eastern and western subspecies with a few populations containing both phenotypes. We also point out that while the three specimens known from Maine, two from New Brunswick, and one from Nova Scotia are typical *Lithophane lepida lepida*, we cannot exclude the possibility that the *adipel*-like phenotype also occurs in those areas and in Quebec. DNA comparisons from all three entities—typical *Lithophane lepida lepida*, typical southeastern *Lithophane lepida adipel*, and the central Canadian *adipel*-like populations—might help to resolve the taxonomy.

We accept Troubridge and Lafontaine's circumscription and restrict our concept of *L. l. lepida* to populations from the Ottawa and Albany areas eastward, characterized by well-marked powdery adults. However, for now we retain the traditional subspecies status for *L. l. adipel*, including most Canadian populations. According to Don Lafontaine, the larva of *L. l. lepida* has not been previously illustrated. A larva, presumably a Canadian *L. l. adipel*, is illustrated (as *L. lepida*) at the Canadian Biodiversity Information Facility (http://www.cbif.gc.ca/noctuoidea/lithophane_larvae_e.php). Larvae of the *adipel*-like phenotype from Clintonville, New York (Tim L. McCabe) are apparently not separable from those of New Jersey *L. l. adipel*.

Range

As discussed above, this moth's range and rarity depends greatly on the circumscription of the taxon. As defined here, *Lithophane lepida lepida* has been collected in Nova Scotia (one specimen, Ferguson 1955), New Brunswick (two recently at Charters Settlement, by Reginald Webster), southern Quebec (two localities, Handfield, 1999), Maine (one each from three places, Brower 1974), the Ottawa area (a few 1903 to the 1950s), and Albany, (which was historically known as Centre as well as Karner, New York. It no longer occurs in the Albany, New York area, but was apparently not rare in the 1870s. Both typical *Lithophane lepida lepida* and *adipel*-like phenotypes occur in the pitch pine barrens near Ossipee, New Hampshire, and near Clintonville, New York.

Populations leaning toward *Lithophane lepida adipel* occur from central Ontario to Saskatchewan. Typical *Lithophane lepida adipel* is much more southern. *Lithophane lepida adipel* is known from southern New Jersey, and is locally distributed in the southern mountains, including Virginia (one specimen at ultraviolet light from U.S. Forest Service samples in Rockbridge County), Kentucky (one specimen in Covell 1999), Tennessee (two larvae collected by David Wagner in Blount County), and northern Georgia (five specimens found at lights by James Adams and Irving Finkelstein). It has also been found on the Coastal Plain of both Carolinas (collections of Bo Sullivan and John G. Franclemont), where it is known from only three counties, but is probably more widespread than in New Jersey. The *Lithophane lepida lepida* complex is unknown from anywhere in southern New England or northeastern Pennsylvania, despite substantial efforts to find it. The absence of this complex in the extensive pinelands of southeastern Massachusetts and apparently on Long Island, New York, is baffling. Populations may yet turn up in Pennsylvania, and should be looked for in the nearby Shawangunk Mountains of New York.

Rarity

NatureServe global rank: G4T1.

Lithophane l. lepida has a limited range and is rarely collected within it, but there probably is an element of false rarity involved. Taxa in the complex are difficult to collect, even where they are known to be present, largely because they do not often come to bait. However, considering the advent of modern collecting lights and continued use of baits, the lack of records of *Lithophane lepida lepida* in most of its range over the last 50 to 130 years suggests a decline. Northeastern collections of the *Lithophane lepida* complex rarely involve more than one adult. Exceptions are in the Ossipee region pine barrens of New Hampshire, where many adults have been taken at bait or lights in mid-April a few times during the present century, and in Albany, New York in the 1870s, where adults were taken in the fall.

Regarding *Lithophane lepida adipel,* the proportion of captures since 1970 at lights compared to bait is unusually high for a *Lithophane* (about 15%) in New Jersey. Specimens of this complex have been collected at both light and bait in New York and New Brunswick. Yet nothing of this sort has been collected at blacklight or mercury vapor lights that were operated at Ossipee on most nights when the moths came to bait. In regularly sampled places in New Jersey, where populations are known to occur, most otherwise productive nights for *Lithophane* collecting produce no *Lithophane lepida adipel* at bait. In other words, this species (or species complex) is unlikely to be attracted to bait even if adults are present.

Lithophane l. adipel is probably not globally rare. This moth has turned up at least once at nearly every locality in six southern New Jersey counties where there have been persistent efforts from late November through March. It is almost certainly rather generally distributed over hundreds of thousands of hectares within much of Ocean, Burlington, Atlantic, Cumberland, and the pinelands portions of Salem, Cape May and several other counties. It is also probably not really rare farther south. One would not expect many encounters with a *Lithophane* species, even a common one, that seldom comes to bait. There are only scattered collections south of New Jersey. As far as we know, the populations leaning toward *Lithophanele lepida adipel* from central Ontario to Saskatchewan and are mostly still extant.

Life history

Lithophane lepida lepida and *Lithophane lepida adipel* larvae feed on pines in the spring, starting on new growth, but eating older needles as well in the late instars. Larvae probably complete feeding in late June or early July northward. They then enter the duff or soil, where they spin a cocoon and spend the summer as a prepupa.

Pupation is in August or September northward, and adults appeared in late September at Albany and in Ontario, and have been collected into mid-October at Ottawa. The two recent New Brunswick specimens were in early October, one at light, one at bait.

Adults hibernate. At the current New Hampshire site, all collections (about 20 of both taxa or phenotypes) have been at bait in mid-April. At least two efforts to bait for them there in autumn have produced very few moths of any kind. Lincoln Paul Grey told Dale Schweitzer he collected the Enfield Maine specimen at light. The Pownal specimen was found alive by Auburn E. Brower on a snow drift after a thaw on 25 January 1952, when the air temperature was below -15°C.

Host plants

Known food plants for this complex include red pine (also called Norway pine)(*Pinus resinosa*) in Ontario (Don LaFontaine), and Virginia pine (*Pinus virginiana*) in the Virginia mountains (David Wagner observation) for what Lafontaine is calling *Lithophane lepida adipel*. In many of its New Jersey habitats, only pitch pine is available. Larvae are easily reared on pitch pine (Dale Schweitzer observation). *Lithophane lepida lepida* uses pitch pine in New York (for example, the larva we illustrate), and jack pine (*Pinus banksiana*) (Don Lafontaine) in Canada. Red and white pine were present at the Enfield, Maine, and New Brunswick sites for *Lithophane lepida lepida*. Only pitch pine and white pine (*Pinus strobus*) are readily available at the New Hampshire site. White pine is not suspected as a food plant for either taxon.

Habitat

This moth is found mostly in sandy pitch and jack pine forests and barrens. The Enfield, Maine, and New Brunswick specimens were from the collector's yard after many years of effort. At Enfield, a small red-pine plantation was nearby.

Threats & management issues

Logging, wild fire, and other threats to the pine trees would severely impact populations. However, some habitats are to some degree fire-generated or fire dependent. Generally, fires during July to mid-September should cause little mortality to individuals aestivating in the soil. However, David Wagner observed a captive larva spin its cocoon among dead pine needles at the surface of the sand, where they would be vulnerable to fire. We do not know whether fall and early spring prescribed burns would kill adults, because we do not know where they rest. Fires during May and June would cause little mortality to larvae if flames stay below the pine foliage.

Chemical applications against spruce budworm are a potential threat. Peacock *et al.* (1998) found sensitivity to *Btk* be variable within *Lithophane*; thus, we have no basis to predict what the impact of *Btk* would be.

If *Lithophane lepida lepida* has disappeared from much of its range, we cannot offer any explanation. Housing developments threaten portions of both known current United States habitats.

References

Brower (1974), Ferguson (1955), Forbes (1954), Peacock *et al.* (1998), Rockburne and Lafontaine (1976), Handfield (1999), Troubridge and Lafontaine (2003), Wagner *et al.* (in press).

CONNECTICUT PINYON MOTH

Lithophane scottae TROUBRIDGE

IDENTIFICATION

This medium-sized (38 mm) moth is similar to *Lithophane tepida, Lithophane baileyi,* and one of the common color forms of *Lithophane querquera*. *Lithophane scottae* is very close to *Lithophane querquera* in the shape of the male genitalia, notably the terminal spine. Both Dale Schweitzer and John G. Franclemont dissected several males more than 20 year ago, and believed that the purported genitalia differences in the description of this species are not reliable. The wing pattern (Figure 292) is distinctive from *Lithophane querquera*. The wings of *Lithophane scottae* are not shiny or glossy like most *Lithophane querquera*, and there is more cream-white associated with the basal dash. In addition, the reniform spot of *Lithophane scottae* has more extensive brown, and the forewings are slightly more pointed.

Figure 292. *Lithophane scottae* (Connecticut pinyon moth) from Frontenac County, Ontario, Canada (David Wagner photo).

Worn specimens of *Lithophane scottae* and *Lithophane baileyi* can be difficult to distinguish from one another except by genitalia. The wings of fresh *Lithophane baileyi* are very shiny and often somewhat greenish.

Dissection is not necessary to examine male genitalia of *Lithophane scottae*, *Lithophane baileyi* and *Lithophane tepida*. One can moisten the tip of the abdomen with alcohol, brush scales from the tip, and compare the valve tips to the drawings in Forbes (1954). *Lithophane scottae* will match that of *Lithophane querquera* closely.

TAXONOMIC NOTES

Although *Lithophane scottae* is in fact a widespread species and has been known for at least 50 years, it was described only recently from two places in Ontario (Troubridge 2006). John G. Franclemont distributed specimens in the 1950s or 1960s, under a manuscript name that he never published. For over 20 years, this species has been listed on NatureServe Explorer and its predecessors as *Lithophane* species 1 near *querquera*. *Lithophane scottae* is also the species identified as "9904.1" in Ferge and Balogh (2000) based on a specimen verified by Dale Schweitzer. There are probably 100 specimens of *Lithophane scottae* from Connecticut, mostly collected before 1965 by Hermann Wilhelm. Wilhelm's specimens are available in multiple collections, but Troubridge (2006) was apparently unaware of this.

RANGE

Based on specimens of *Lithophane scottae* examined by one of us (usually Dale Schweitzer) early specimens were collected from the vicinity of Boston, Massachusetts, to Washington, D.C. (8 April 1885, National Museum of Natural History). All post-1940 specimens in this region are from Tolland, Windham, and New London counties in eastern Connecticut. Some Massachusetts records of *Lithophane tepida* and/or *Lithophane baileyi* reported by Farquhar (1934) are presumably *Lithophane scottae*. Dale Schweitzer has a specimen from Newton collected by Roland Thaxter (labeled 12 November [no year]). The National Museum of Natural History has specimens from Concord (19 May 1919) and Bedford (4 October 1884). Farquhar reports both *Lithophane tepida* and *Lithophane baileyi* from Newton and Concord.

Between 50 and 100 specimens of *Lithophane scottae* were collected by Herman Wilhelm at Mansfield, in Tolland County, Connecticut, and most of these are in the Yale Peabody Museum. In 1979 and 1980, Dale Schweitzer used bait to attract moths on what had been Wilhelm's property in Mansfield. On 1 November 1979 he collected a male *Lithophane scottae* at bait, which is the last specimen that we know of from New England. Since the 1970s, *Lithophane scottae* has been collected at other widely scattered sites near Ottawa, Ontario, to northern Georgia. One specimen from Perth Road, Frontenac County, Ontario, is listed as a paratype (Troubridge 2006), but others were collected there in the 1970s, some of which are in the Eric Quinter and Dale Schweitzer collections.

In the Appalachians there are a few specimens (collected 1971–1978) from Pocahontas County, West Virginia, and Menifee County, Kentucky (vouchers in Dale Schweitzer's collection). Six were taken from 1991 to 1998 in the vicinity of Dalton, Whitfield County, in northern Georgia (James Adams). There was at least one collection in Grant County in southern Wisconsin in 1982 (Ferge and Balogh 2000).

Rarity

NatureServe rank: G2G4.

This moth was much more widespread 70–120 years ago than it is now in the Northeast, especially in southeastern New England. Outside of New England, this moth has been collected occasionally at widely scattered localities. It has been collected regularly at one site each in Georgia and Ontario. This moth represents another case of an unexplained decline in the northeastern United States. The timing and locations suggest *Compsilura* as a cause, but because no other Xylenini or spring caterpillars in any family appear to have been widely affected by *Compsilura*, it is very unlikely that the parasitoid was a major factor. Besides, *Lithophane scottae* outlasted suspected *Compsilura* casualties such as *Citheronia* and *Eacles* species in Connecticut by more than 20 years. The granite hills and other habitats among them in Medford, Melrose, and Boston, Massachusetts are essentially the introduction area for both *Compsilura* (1906) and gypsy moth (soon after 1869). These areas had at least 16 species of *Lithophane* in the 1980s in seemingly normal abundance; *Lithophane scottae* was the only plausible species that was not still found there (Dale Schweitzer observation). As noted above, several species of *Lithophane* had increases in abundance and range expansions in the late 20th century. This is the only widespread species that declined substantially.

Life history

Nothing is known about the biology of *Lithophane scottae*, but it is undoubtedly similar to that of other *Lithophane* species. Oddly, the larva of the closely related *Lithophane querquera* (Schweitzer 1979b, Wagner 2005) is more-similar in appearance to most *Pyreferra* species than to other species of *Lithophane*, including the closely related *Lithophane viridipallens*, *Lithophane baileyi*, and *Litho-*

phane tepida (Wagner 2005). Capture dates for *Lithophane scottae* adults in Connecticut range from mid-October into November, with lesser numbers in March and April. These dates are similar to other *Lithophane* species collected by Herman Wilhelm in that area. Georgia collection dates are from 21 October to 25 November (four specimens), and one each in January and February.

The Georgia specimens, the holotype, and some others were taken at lights. Most Connecticut specimens and one from Menifee County, Kentucky, were taken at bait or in bait traps.

Host plant

The host plant is not known, and there are no obvious candidates at the sites that we are familiar with in Connecticut and Georgia. Other *Lithophane* species feed on trees or shrubs, and some are carnivorous and eat other caterpillars. Many species are highly specialized, others feed on multiple genera of trees. The four closest relatives of this species are polyphagous. *Lithophane viridipallens* and *Lithophane tepida* possibly feed mostly on shrubs.

Habitat

This species lives in hardwood forests, but which specific types of hardwood forest is unknown. The Mansfield-Willimantic, Connecticut, site was in a residential area just above the Willimantic River floodplain. The floodplain was disturbed and had abundant silver maple (*Acer saccharinum*). Patches of hardwood forest and small areas of pitch pine/bear oak barrens were also nearby. The Georgia locality is mixed upland deciduous forest.

Threats & management issues

Too little is known about *Lithophane scottae* to determine threats. The larvae would likely be in the third or fourth instars about the time *Btk* applications would be made to control gypsy moth caterpillars. Sensitivity to *Btk* varies greatly among *Lithophane* species, and also between instars (Peacock *et al.* 1998). It is unlikely that defoliation by gypsy moth larvae would occur early enough to cause large-scale mortality of *Lithophane* larvae, but quite likely subsequent fecundity would be moderately reduced for one generation among moths from larvae maturing in severe outbreak conditions (Schweitzer 2004).

References

Farquhar (1934), Ferge and Balogh (2000), Forbes (1954), Peacock *et al.* (1998), Schweitzer (1979b), Troubridge (2006), Wagner (2005).

Pink sallow

Psectraglaea carnosa (Grote)

Identification

This is one of the most distinctive noctuids in our region. Some individuals are spectacularly handsome. This medium-sized moth (38 to 45 mm) is relatively large for a noctuid. Normal adults are unmistakable due to their unique pink coloration (Figure 293), largely obsolete pattern, and autumn flight season. Occasional specimens of *Psectraglaea carnosa* are more or less olive-gray. The feathery antennae of the males are also a nearly unique characteristic among the Xylenini.

Psectraglaea carnosa larvae are plain reddish brown with no distinct pattern (Figure 294). Crumb (1956) briefly described the larva, which is illustrated by Wagner *et al.* (in press) and here. We cannot separate the larva of *Psectraglaea carnosa* from that of *Eucirroedia pampina*.

Figure 293. *Psectraglaea carnosa* (pink sallow) from Myles Standish State Forest, Plymouth County, Massachusetts (David Wagner photo).

Figure 294. *Psectraglaea carnosa* (pink sallow) larva from Atlantic County, New Jersey (David Wagner photo).

Taxonomic notes

As defined now (2010), this is one of the few noctuid genera in our region with only one species worldwide. The larva and resting posture of the adult suggest a close relationship to *Eucirroedia*, which also has only one species.

Range

This moth originally occurred from southern Maine westward very locally through southern Quebec and Ontario to Michigan and northern Wisconsin (Marinette, Douglas and Bayfield counties). Its range extends southward in the mountains to Pennsylvania and Garrett County, Maryland. The species occurs along the coast to southern New Jersey, mainly in the core of the Pine Barrens, and Worcester County, Maryland. There are no records for Vermont, Rhode Island, western New York, Ohio, Indiana, Illinois, Kentucky, or in the mountains south of Maryland. However, there are seemingly suitable habitats in those mountains (e.g. Panther Knob, West Virginia).

RARITY

NatureServe global rank: G3.

This moth is historical to rare in parts of its range. However, it is still fairly common in the pitch pine or jack pine barrens and oak scrub of southern New Jersey, southeastern Massachusetts, northeastern Pennsylvania, northern Lower Michigan, and parts of Wisconsin. This species still occurs locally elsewhere, such as in Ontario. Populations are extant at Concord, New Hampshire (very precarious), and on Long Island, New York. In Massachusetts, David Winter collected one adult in the 1970s during about ten trap-years of effort at his residence in Norfolk County. Ted Sargent collected only one in over a decade of effort in Franklin County, Massachusetts. Winter's site is near Boston, so *Psectraglaea carnosa* may occur in the granite hills around Boston, for example, at Blue Hills and Middlesex Fells reservations. There is one 1966 specimen from Poughkeepsie, New York, at North Carolina State University.

Psectraglaea carnosa is very rare in Quebec, according to Handfield (1999), who illustrates a 1964 specimen from Terrebonne High. In Ontario, Don Lafontaine (email to Dale Schweitzer on 4 July 2008) states that *Psectraglaea carnosa* can still be found "in barren rocky balds among blueberry with scattered pine and oak."

Although clearly not now imperiled range-wide, *Psectraglaea carnosa* is historic in Maine (Brower 1974). However, there are unchecked potential habitats in Maine, as well as in Connecticut, western Pennsylvania, and the mainland of New York. The Connecticut record represents only one individual captured in Litchfield County during twelve years of almost nightly effort by Sidney Hessel. Nevertheless, we are now aware of habitat in that county and in nearby parts of New England and southeastern New York where *Psectraglaea carnosa* may occur.

Psectraglaea carnosa is largely restricted to uncommon habitats, and is absent from many seemingly suitable places. This is one of the few nocturnal Noctuidae that is frequently found in the daytime. Adults also come to blacklights. In places in Massachusetts, New Jersey, and Pennsylvania where populations were known or suspected to occur, over 80% of efforts have produced this species either in the daytime or within an hour or two after dark. Virtually anyone collecting moths in a barrens area in autumn would be aware of this species and would run lights for it. *Psectraglaea carnosa* is unlikely to go undetected except on nights when activity occurs late. Repeated failures to detect it on some large barrens, especially Shapleigh and Waterboro, Maine and Ossipee, New Hampshire, are perplexing.

LIFE HISTORY

The biology of this species is known only from captive rearings. Dale Schweitzer has reared several broods. The larvae were difficult to rear, because the late instars were of unusually long duration, but this may be indicative of a poorly timed egg hatch in captivity. Small larvae seem to prefer to feed inside the flowers of blueberries. Crumb (1956) described a field-collected larva, but did not give a food plant.

The eggs are not glued to a substrate, but are laid loosely, probably as the moth crawls among the heaths. The eggs overwinter and hatch in spring. The larvae probably mature mostly in

June southward, and July northward. As in most Xylenini, the larvae aestivate in the soil and pupate in late summer. Adults occur mostly in October in the Cape Cod region, Long Island, and southern New Jersey, but they start in mid- or late September in most of the range.

The adults very rarely come to bait, almost never have access to flowers, and aside from taking moisture, they probably do not often feed. As was first pointed out by Forbes (1954), adults often rest on red autumn leaves of low heaths and occasionally on small bear oaks. They can often be found perched on the upper leaf surfaces in cool sunny weather. They sometimes flush readily from daytime roosts on hot fall days. Lasting only about three weeks, this moth has by far the shortest flight season of any Xylenini in New Jersey and Massachusetts. The adults are easily attracted to blacklights and mercury vapor lights, often soon after dusk (Dale Schweitzer observation). Steve Johnson observed activity only after midnight on some nights in New Jersey. Whether early or late at night, the temperature is sometimes below 10°C and rarely above 15°C, and the species may fly late on some warm nights. Adults can be somewhat localized, and Don Lafontaine states that in Ontario they are collected reliably in traps placed in the middle of, not on the edge of, large blueberry patches.

Host plants

We know of no food plant records from the wild. In many habitats where *Psectraglaea carnosa* has been collected, only pines, lowbush blueberries (*Vaccinium* species), and other Ericaceae are readily available. In captivity, the larvae refused to eat pines. In most places one or more species of scrubby oaks (usually at least *Quercus ilicifolia* eastward) also can be abundant. Several species of blueberries and oaks are readily eaten by larvae in captivity, as are flowers and foliage of black chokeberry (*Aronia melanocarpa*) in the Rosaceae family, which are available in some habitats. They will also feed on leaves of wild black cherry, which usually are not available in their preferred habitats. Lowbush blueberries appear to be the only potential food plants in common among all of the documented habitats of this moth.

Habitat

Although occasional individuals turn up in ordinary oak forests and in collectors' yards, this species has been found regularly in jack pine and pitch pine barrens and the maritime heathlands of Massachusetts. Eastward, bear oak is usually the dominant plant, but in New Jersey adults can be numerous in moist pitch pine lowlands, which lack oaks but have a diversity of heaths. While most sites have sandy soils, this species also occurs on rocky ridgetops and glacial till, especially in Pennsylvania. Habitats include both rocky and sandy places in Quebec, as well (Handfield, 1999). It often co-occurs with *Chaetaglaea cerata* (not covered in this book) in Pennsylvania, New York, Michigan, New England, and Wisconsin.

Threats & management issues

Many habitats for *Psectraglaea carnosa* are maintained by fires at frequencies of one to perhaps ten per century. The underground summer aestivation pre-adapts this species to survive natural (lightning) summer fires, but all other life stages are fully exposed. Because adults are sometimes found 10–20 km or more out of the expected habitat, it can be inferred that females are excellent colonizers.

Nevertheless, this species is not being found in some places where it is expected. It has not been found in about six sampling efforts in the Shapleigh-Waterboro, Maine, area. It is also apparently absent from the greater Ossipee, New Hampshire barrens. Each of these sites contains thousands of hectares of seemingly ideal habitat, and *Psectraglaea carnosa* was historically widespread in southern Maine (Brower 1974). It may not be a coincidence that these barrens were burned in the wildfires of October 1947. Furthermore, *Psectraglaea carnosa* and *Chaetaglaea cerata* are not the only missing species that would be vulnerable to massive fall fires.

Most pine barrens habitats would probably not be sprayed for gypsy moths now, but some occasionally have been in New Jersey. Peacock *et al.* (1998) found two other "glaeas" to be insensitive to *Btk,* as are several other Xylenini. We are not certain, but doubt that *Btk* applications would be as detrimental to *Psectraglaea carnosa* as would a severe gypsy moth outbreak. Ridge-top barrens and a few others with abundant oaks could support outbreaks.

References

Crumb (1956), Brower (1974), Farquhar (1934), Ferge and Balogh (2000), Forbes (1954), Handfield (1999), Metzler *et al.* (2005), Peacock *et al.* (1998), Rockburne and Lafontaine (1976), Schweitzer (1974), Tietz (1952), Wagner *et al.* (in press).

Anointed sallow

Pyreferra ceromatica (Grote)

Identification

This medium-sized (35 mm) moth (Figure 295) occasionally has been confused with *Pyreferra pettiti*, which is smaller (30 mm) and more orange. As a larva, *Pyreferra ceromatica* is perhaps indistinguishable from *Pyreferra hesperidago* and *Pyreferra citrombra,* both of which also feed on witch hazel. David Wagner's few examples of *Pyreferra ceromatica* larvae had brighter yellow markings (Figure 296) than either of the other species. Field-collected larvae should be reared to the adult stage to verify the identification (Wagner 2005). Brou (2004) provides very good illustrations of *Pyreferra ceromatic*a, *Pyreferra pettiti*, and *Pyreferra hesperidago*, which should easily allow for identification of specimens.

Figure 295. *Pyreferra ceromatica* (annointed sallow) from Croatan national Forest, Craven County, North Carolina, reared from a larva found by J. B. Sullivan (David Wagner photo).

Figure 296. *Pyreferra ceromatica* (annointed sallow) larva from Croatan National Forest, Craven County, North Carolina (David Wagner photo).

Range

Aside from an ancient (probably pre-1900) specimen at National Museum of Natural History labeled "Harris County, Texas," specimens examined by or known to us that were collected from 1877 to the 1930s were all from north of the 40° North Latitude line. The pre-1940 range included the Montreal, Quebec area to southern Connecticut, northern New Jersey, New York, and Pennsylvania (Scranton and Pittsburgh). It extended from Hamilton to Toronto, Ontario, into southern Michigan (Moore 1955, one confirmed by Dale Schweitzer), northwestern Indiana, and adjacent Illinois. According to Crumb (1956), it was also found in Massachusetts. There were no known collections in Vermont, Rhode Island, Wisconsin, Ohio, or Kentucky, and a Maine record (Forbes 1954, Crumb, 1956) is unsubstantiated (Brower 1974). John G. Franclemont collected a series near Ozark, Alabama, in March 1943 (Forbes 1954). If accurate, the report from Indiana, Pennsylvania, in Tietz (1952) may have been from after 1940.

All collections of *Pyreferra ceromatica* made after 1950 have been along the southern Atlantic and Gulf coasts. One was reportedly collected in Escambia County, Florida on 30 January 1962 (Kimball 1965), but the identity of this has not been recently verified. More recent Florida records by Kons and Borth (2006) refer to *Pyreferra pettiti* or possibly an unnamed species. Two *Pyreferra ceromatica* adults were collected at the Wedge Plantation near McClellanville, South Carolina. One of these specimens was taken on 29 March 1969 by John G. Franclemont, and the other in late February 1977 (specimen in the Yale Peabody Museum examined by Dale Schweitzer).

Since 1990, about 24 adults and several larvae have been collected in Jones and Craven counties, North Carolina by Bo Sullivan, with sometimes three or four individuals per night. Also, about 12 have been collected in 22 years of massive effort at Abita Springs, St. Tammany Parish, Louisiana by Vernon Brou. Ed Knudson has collected one *Pyreferra ceromatica* in Sabine County, Texas.

The Houston area is apparently the only place with both old (Harris County) and modern records (Sabine County) of *Pyreferra ceromatica*. We do not know whether populations south of 40º North Latitude were always restricted to the Coastal Plain, or whether *Pyreferra ceromatica* also occurred widely inland in the Southeast, as it did in the Northeast and Great Lakes regions. We have no idea whether the southern Coastal Plain part of the range, where the species is still present, was ever connected with the pre-1940 northern range.

Rarity

NatureServe global rank: GU. This species seems to be extirpated from most of its range.

Pyreferra ceromatica is historic with no records in anywhere from 65 to over 100 years in Quebec, Ontario, Connecticut, New York, New Jersey, Pennsylvania, Michigan, Indiana, Illinois, and Massachusetts. It has not been collected in Florida or Alabama for over 45 years. *Pyreferra ceromatica* has been recently collected at only at a few places on the North Carolina coast, in southern Louisiana (but pre-Hurricane Katrina), and in Sabine County, Texas. It was collected as recently as 1977 in South Carolina. To date, collectors in Georgia and Alabama, who have documented most of the other expected and many unexpected species of Xylenini in their northern counties, have not found *Pyreferra ceromatica*. However, sampling effort near the coast has been limited.

This species should not be widely overlooked where collectors survey in season, because the adults are attracted to lights and bait.

Pyreferra ceromatica declined widely in the early and mid-20th century. Although the food plant was harvested commercially, other witch hazel specialists, including two congeneric species, did not decline. Perhaps more than any other American moth or butterfly covered in this book, the decline of this species seems inexplicable.

None of the other three or four *Pyreferra* species are now rare, and neither was *Pyreferra ceromatica* a century ago. The host plant remains common over a vast portion of eastern North America. Major habitat loss or food plant decline simply have not happened. Massive gypsy moth spraying came decades after its decline. The last known New England specimen was collected at Waterbury, Connecticut, on 12 May 1900, before *Compsilura* was introduced. The last collections in New York, New Jersey, and Pennsylvania were made decades before the decline of Saturniidae and other likely *Compsilura*-impacted species. The only collections in Quebec were before 1912. Ontario specimens are also pre-1900. *Pyreferra ceromatica* survived into the 1930s in Indiana and New York. The last northeastern specimens were collected at Horseheads, New York. This final collection of *Pyreferra ceromatica* happened at about the same time as collection of the only specimens of *Lambdina canitiaria* (see Appendix 2), and occurred with *Acronicta dolli, Glaucopsyche lygdamus nittanyensis,* and *Erastria coloraria* (Dirig 1986), but we cannot argue for any connection.

LIFE HISTORY

The life history of *Pyreferra ceromatica* is similar to other species of Xylenini. Adults of this genus overwinter in the leaf litter, and mate and oviposit in spring. Female *Pyreferra* species lay several hundred eggs, mostly one at a time, on the food plant.

The eggs hatch soon after bud-break. *Pyreferra* larvae are easy to find in late spring on the undersides of the host leaves. They are easily reared to adults if kept moist during aestivation. The larvae curl when disturbed, as do those of sawflies (Hymenoptera), and they are considered to be sawfly mimics (Wagner 2005). When mature, about 4–6 weeks after bud-break, the larvae burrow about an inch or two into the soil, spin a weak cocoon, and aestivate over the summer in a prepupal condition. Field-collected *Pyreferra ceromatica* larvae matured in June northward (Crumb 1954).

The adults come to sugar baits and lights from fall to spring. The earliest adult collection date is 28 August in Lewis County, New York, but most were in October and late March to early May northward. All captures are from December to early March in Louisiana (Brou 2003), and the Texas specimens were taken in March and April. Bo Sullivan's specimens from both bait and blacklights in North Carolina are from November, January, February, and April, but he cautions that the scarcity of fall records is at least in part due to reduced collecting during deer hunting season. The females apparently persist rather late in the spring for a xylenine noctuid. Adults were collected in April in North Carolina and Texas (National Museum of Natural History) and as late as 28 April and 12 May in Connecticut (National Museum of Natural History, Connecticut Agricultural Experiment Station Collection) This is similar to *Pyreferra hesperidago*.

We know nothing about the dispersal tendencies of *Pyreferra ceromatica*, but the related *Pyreferra hesperidago* is somewhat migratory. Adults sometimes appear suddenly in large numbers in November in southern New Jersey, and remain into March in places where there are almost no food plants.

Host plants

The only verified food plant for *Pyreferra ceromatica* in New York, Indiana, and North Carolina is witch hazel (*Hamamelis virginiana*). All collections have been within the range of this common shrub. Witch hazel is also the food plant for *Pyreferra hesperidago*. In many areas, witch hazel is also the food plant for some populations considered to be *Pyreferra citrombra* (Schweitzer 1979a, Wagner 2005, Wagner *et al.* in press). Species of *Fothergilla*, also in the witch hazel family (Hamamelidaceae), may serve as food plants southward, as well.

Habitat

Bo Sullivan describes the habitat for this moth in North Carolina as "invariably where mesic woodlands meet swampy bottomland." Ravines and other wooded habitats with witch hazel could support populations of the anointed sallow moth. At least in the past *Pyreferra ceromatica* obviously occurred mostly in dry to mesic mixed hardwood and oak-hickory forests in the northern parts of the former range, because those are the habitats where the food plant is common.

Threats & management issues

We have no explanation for why this species declined so drastically in the early 20th century. Where it still occurs, activities that damage or kill the host plant would harm populations of this moth. Examples would be logging, site preparation for silviculture, or fire.

Prescribed burning seems unlikely to be an issue in most places, but fires that burn the leaf litter would kill most adults during fall, winter, and spring.

Virtually all larvae would be exposed as early or middle instars to gypsy moth spraying. Although no species of *Pyreferra* were assayed, Peacock *et al.* (1998) found that sensitivity to *Btk* varies among Xylenine caterpillars. Gypsy moth caterpillars do eat witch hazel, and sub-lethal impacts would be likely (Sample *et al.* 1996, Schweitzer 2004). However, large-scale starvation during gypsy moth outbreaks would be unlikely. In New England, most other *Pyreferra* larvae mature before defoliation becomes severe.

In its present range, the main management issues for *Pyreferra ceromatica* may be prescribed burning, silviculture, and other activities that suppress or eradicate understory shrubs like witch hazel.

References

Brower (1974), Dirig (1986), Forbes (1954), Handfield (1999), Holland (1903), Kimball (1965), Kons and Borth (2006), Rockburne and Lafontaine (1976), Sample *et al.* (1996), Schweitzer (2004), Tietz (1952), Wagner (2005).

Subfamily Acronictinae (dagger moths)

Barrens dagger moth

Acronicta albarufa Grote

Identification

This medium-sized (30 to 35 mm) moth has a rather dark, slatey, blue-gray ground color on the forewings. There is a conspicuously brown to slightly orange reniform spot, and a prominent, rounded orbicular containing a darker spot. The hindwing is dark brownish on females (Figure 297), and almost white with dark veins on most males (Figure 298). A few males have the outer portion of the hindwing somewhat rust tinted, and this is distinctive.

A larva of *Acronicta albarufa* is illustrated in Figure 299. As with most species in the *Acronicta ovata* group, suspected larvae should be reared to adults and a specimen kept as a voucher for identification.

Figure 297. *Acronicta albarufa* (barrens dagger moth) female from Cumberland County, New Jersey (Douglas C. Ferguson photo).

Figure 298. *Acronicta albarufa* (barrens dagger moth) male from Cumberland County, New Jersey (Douglas C. Ferguson photo).

Holland (1903), Rings *et al.* (1992), and Rockburne and Lafontaine (1976) also illustrate the adult. Adults of this species should be confirmed by an expert. Persons who are reasonably familiar with the *Acronicta ovata* complex (see Rings *et al.* 1992) should have little difficulty recognizing *Acronicta albarufa*.

Figure 299. *Acronicta albarufa* (barrens dagger moth) larva from Cumberland County, New Jersey (David Wagner photo).

Range

Acronicta albarufa has an unusually fragmented range. In Canada, it is reported from southern Manitoba (Forbes 1954), and on Lake Huron in Ontario, at Grand Bend (Rockburne and Lafontaine 1976, Dale Schweitzer collection) and adjacent Port Franks (Hardwick and Stead 1999).

In the eastern United States, *Acronicta albarufa* is known from less than 20 places, including Albany, New York (Tim L. McCabe and old specimens), and Scranton, Pennsylvania (at the Peabody Museum of Natural History at Yale University),[18] inland. Based mostly on specimens we have examined or that were verified by Steve Hall, records are a bit more continuous from eastern Massachusetts (including the type locality of Newton), Connecticut, and Long Island, New York, to the New Jersey Pine Barrens. *Acronicta albarufa* is found in the Piedmont in Virginia (one specimen Hanover County, Ludwig 2000), and both the Piedmont (old specimens from Raleigh) and the Sand Hills of North Carolina (Steve Hall personal communication with Dale Schweitzer). We have not seen the specimens, but Albu and Metzler (2004) report *Acronicta albarufa* from southern West Virginia. Covell (1999) reports *Acronicta albarufa* in Kentucky. Farther west, this species was widespread in the Ozarks into at least the 1980s, according to Richard Heitzman, and it probably still is. Rings *et al.* (1992) illustrate specimens of *Acronicta albarufa* from two counties in the Ozarks, but have no valid Ohio records. Ferge and Balogh (2000) do not report *Acronicta albarufa* from Wisconsin, nor have we seen specimens from Minnesota, Michigan, Illinois, Indiana, or Tennessee. This moth is also known from Oklahoma, Colorado, and New Mexico (Forbes 1954, Schweitzer 1989, National Museum of Natural History). *Acronicta albarufa* has been collected since 1990 in coastal Massachusetts, in Virginia, on Long Island, New York, in southern New Jersey, and in the North Carolina Sand Hills.

Rarity

NatureServe global rank: G3G4. *Acronicata albarufa* was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

Although believed still to be widespread in the Ozarks of Missouri (Richard Heitzman), the barrens dagger moth is rare and very locally distributed farther east, and its status farther west is unknown. It is unrecorded from vast areas within its disjunct overall range, and is historical in others. New Jersey and Massachusetts, with three known current sites each, are the apparent strongholds for this species east of the Ozarks. The ecological requirements of this species are poorly understood, and it is unclear why it is absent from so many seemingly suitable places.

Compsilura might have been a factor in the decline of *Acronicata albarufa*. This is evidenced in the timing of the decline of this species in the northeastern United States, its larval phenology, and especially (see Elkington *et al.* 2006) its current refugia in the coastal pine barrens of Plymouth, Cape Cod, and on Martha's Vineyard island. In Connecticut, the last three adults were collected in Litchfield and Tolland counties from 1949 to 1954. This is about the time when *Eacles imperialis, Citheronia regalis* and certain other summer moths disappeared (Ferguson 1972, Morrell, 1979). However, this is also about the time that scrubby open habitats were rapidly being converted to other cover types such as farms and cemeteries, or becoming reforested. The last known Boston-area specimen was collected at Wilmington on 10 July 1910 (Yale Peabody Museum) at an arc light, along with the last *Citheronia sepulcralis* from that area, four years after *Compsilura* was introduced. Suitable habitat is still abundant at that site.

[18] Tietz (1952) reports other localities, but these specimens, supposedly at the National Museum of Natural History, were not located by Dale Schweitzer in March 1999.

Acronicta hamamelis also disappeared from eastern New York and New England at about the same time, or possibly earlier. If *Compsilura* was a factor, questions arise regarding several similar, synchronic oak-feeding *Acronicta* that either did not decline, or recovered quickly. Why would *Acronicta albarufa* have been eliminated, while *Acronicta ovata*, *Acronicta increta*, *Acronicta modica*, *Acronicta tristis*, and *Acronicta haesitata*, which are all similar and feed on oaks at the same time, either not decline, or recover quickly? Perhaps *Acronicta albarufa* was exceptionally vulnerable because it was already much rarer (Farquhar 1934) than the others. *Compsilura* certainly does not explain the enormous gaps in the range of *Acronicta albarufa*.

We do not know the extent to which this moth declined in southern New Jersey, or if it actually did decline. Muller (1965) only had records of *Acronicta albarufa* at Lakehurst from Otto Buchholz, who collected there in the 1940s and early 1950s. Muller collected regularly at Lakehurst from the 1950s into the 1970s, but never found the moth. There seem to have been only two specimens collected in New Jersey from 1960 to 1990, which cannot be explained by changes in sampling effort. Only two substantial populations are known to be extant in New Jersey now. However, in North Carolina, loss of habitat is a likely factor in its decline.

Life history

There is only one brood of this moth northward, with at least a partial second brood southward. The first brood flies from the end of May well into August in New Jersey. In this area, Dale Schweitzer has documented eclosion from overwintered pupae spread over as much as 60 days in a given year. Adults peak there from mid-July to early August, and the second brood, mostly in late August, is very small.

Larvae occur in New Jersey from June to late October. The egg stage lasts about six days. The larval stage is typically 29 to 35 days in duration, but due to cooler weather is much longer for larvae hatching in late August or September.

Pupation occurs in a cocoon partially excavated in soft dead wood or bark, probably usually in contact with soil or humus.

Adults are usually taken at light before midnight, and they have been collected at bait in Massachusetts and New Jersey. At some sites in these two states, this is the most common *Acronicta* species at blacklights.

Host plants

Barrens dagger moth larvae feed on oaks. Bear oak is the usual food plant in Massachusetts, probably New York, and almost certainly at one New Jersey site. Larvae have been collected on post oak (*Quercus stellata*) and dwarf chinkapin oak (*Quercus prinoides*) in Cumberland County, New Jersey. Bur oak (*Quercus macrocarpa*) is the only oak in the Manitoba range. Larvae are easily reared on black oak (*Quercus velutina*) in captivity, and this is a likely food plant in New Jersey and Ontario. Larvae reared on black oak take a few days longer to mature than those fed on post oak. Young larvae rejected blackjack oak (*Quercus marilandica*). The two current North Carolina sites have a lot of post oak.

Habitat

The barrens dagger moth occurs in dry oak forests in the Ozarks, in sandy oak woodland or savanna in Ontario, in bear oak barrens in Massachusetts and New York, and in turkey oak (*Quercus laevis*) sandhills in North Carolina. The two currently reliable New Jersey sites consist of ultraxeric sandy oak-pine woodland (probably too xeric for bear oak), and a mowed airport approach zone dominated by bear oak. There have also been other collections in the New Jersey Pine Barrens, including one specimen from a burned bear oak area on Fort Dix. This species historically occurred occasionally in non-pine barrens areas, such as the type locality and Wilmington, both near Boston. Both of these sites probably had a lot of bear oak at that time, and there are no specimens from that area after 1910. *Acronicta albarufa* was collected in the early 1950s at Washington, Connecticut (Sidney Hessel), which is not close to any barrens. The Mansfield, Connecticut site had bear oak nearby.

Threats & management issues

Some habitats for this moth require occasional fire, but probably not all of them. Unburned refugia should always be provided, because the eggs, larvae, and perhaps most pupae would be killed by fire. It is quite possible that sprout regeneration of oaks after fires or cutting provides optimal habitat, but observations are lacking.

While both Dale Schweitzer and Tim L. McCabe have anecdotally noticed some decline of *Acronicta* species for a season or two after gypsy moth outbreaks, it is not likely that this species would be seriously affected, unless the larvae cannot develop as well as related species on refoliated oaks.

Dimilin® residue would kill most larvae, but it is very unlikely that *Btk* would have any impact, because newly hatched larvae do not appear until June through mid-August.

References

Farquhar (1934), Forbes (1954), Hardwick and Stead (1999), Holland (1903), Ludwig (2000), Rings *et al.* (1992), Rockburne and Lafontaine (1976), Tietz (1952, 1972), Wagner *et al.* in press.

Doll's Daggermoth

Acronicta dolli (Barnes & McDunnough)

Identification

This medium-sized (37 mm) spring moth has medium to dark gray forewings, whitish hindwings with darker frosting terminally, and a very hairy body (Figure 300 and 301). The forewing lines, to the extent that they are distinct, are whitish. The postmedian line is zigzag. There is usually a whitish patch between the orbicular and reniform spots and some whitish coloring in the terminal area. Northeastern specimens, at least males, are usually darker than the Wisconsin and Georgia females shown by Ferge and Balogh (2000) and on the Georgia Lepidoptera website (http://www.daltonstate.edu/galeps/).

The larvae are black with tufts of white hairs, a cream-colored spiracular line, and a large red-orange lateral patch on most segments (Figure 302). The similar *Acronicta longa* (Wagner *et al.*, in press) can occur with this species. *Acronicta oblinita* larvae (Wagner 2005) may have substantial orange, or more often none, but the lateral patches are yellow, and this species probably would not be in most *Acronicta dolli* habitats.

Excellent images of adults, showing variation, and a larva of *Acronicta dolli*, are also available on the Georgia Lepidoptera website. This species was known as *Merolonche dolli* prior to the Lafontaine and Schmidt (2010) checklist, and since its description.

Figure 300. *Acronicta dolli* male from Whitfield County, Georgia (James K. Adams photo).

Figure 301. *Acronicta dolli* female from Whitfield County, Georgia (James K. Adams photo).

Figure 302. *Acronicta dolli* larva from Rockridge County, Virginia (David Wagner photo).

Range

The range appears to be in several disjunct areas. It is found in the Appalachian region from Horseheads, New York, and Buttzville, New Jersey (Rutgers collection), to Walker and Whitfield counties in northern Georgia. It has been found in the Great Lakes Region in parts of Michigan (Mo Nielsen) and Wisconsin (Ferge and Balogh 2000). It occurs on Long Island, New York, and in the New Jersey Pine Barrens (north of the Mullica River).

Larvae should be looked for on dry scrubby ridges in southern New York and adjacent Connecticut where *Catocala herodias gerhardi* has been collected.

No specimens are known from Canada, Ohio, Indiana, or Illinois.

Rarity

NatureServe global rank: G3G4. This species was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995.

To some degree, this species is an example of false rarity, because adults are difficult to collect. Doll's daggermoth is not imperiled, but we include it because of the dearth of collection sites, and the fact that we know of none collected in the past 20 years in Pennsylvania or West Virginia. As far as we know, *Acronicta dolli* is only documented from one site each in Virginia (Rockbridge County, U.S. Forest Service samples), West Virginia (Hampshire County, Dale Schweitzer collection), Kentucky (Covell 1999), and western North Carolina (James Adams) It has been found at three sites in northern Georgia (James Adams). It is documented in at least three oak-pine barrens sites in Wisconsin, according to Hugo Kons. These include Burnett County (Hugo Kons and Robert Borth), Adams County (Kyle Johnson), and Jackson County (Tom Rochealeau). Populations are probably widespread on acid ridgetops in the mountains from Pennsylvania to northern Georgia, and in the New Jersey Pine Barrens. Despite the paucity of records, we doubt that *Acronicta dolli* is rare in the mountains, where larvae often occur in oak woodland.

Life history

There is one brood, with adults flying briefly in April or early May in most places, but as early as late March southward. Most *Acronicta dolli* fly in May in Michigan and Wisconsin.

Larvae probably mature in about mid-June in New Jersey. Most of the year is spent as a pupa in a cocoon in the leaf litter. While larvae can often be found there if sought, only about a dozen adults have been collected in the New Jersey Pine Barrens, none by us. These include seven taken by James Madenjian at four blacklight traps in Burlington County on the night of 12 April 1977, after a record high of 88ºF (31ºC) was recorded that day at nearby Mt. Holly.

Dale Schweitzer's only collections of adults were in similarly hot weather on 19 and 20 April 1986 in Hampshire County, West Virginia, and Centre County, Pennsylvania, respectively. The only upstate New York collection of *Acronicta dolli* (Dirig, 1986) was under similarly hot conditions. A Walker County, Georgia collection was also in a spring heat wave (James Adams personal communication with Dale Schweitzer). Collections in Whitfield County, Georgia, and the 2007 Long Island collection of several specimens by Hugh McGuinness were in more normal weather.

Young larvae of *Acronicta dolli* are rather conspicuous when resting on the upper side of leaves on small oaks. All instars remain on the food plant when not feeding. *Acronicta dolli*, and the related *Acronicta lanceolaria* are most readily found as larvae by beating shrubs or small oaks in late spring.

Host plants

Larval food plants include various oaks (John G. Franclemont in addition to us), ash (observed once by David Wagner), beach plum (*Prunus maritima*) (Dale Schweitzer observation), blueberry (*Vaccinium pallidum*) (Wagner *et al.* 1995) and cranberry (*Vaccinium macrocarpon*) (Forbes, 1954, John W. Cadbury III). Considering the habitats, oaks and various heaths are probably the usual food plants.

Habitat

This is a species of open oak woodland and pine barrens, typically with blueberry in the understory. It also occasionally occurs in bogs. Habitats range from ordinary mountain oak forest to dwarf pine plains. The presence of bear oak or blackjack oak is a clue to possible habitats northeastward. The Rockbridge County, Virginia, site, where several larvae and at least one adult were collected, also produced several barrens species, but the *Acronicta dolli* larvae were in dry oak woodland. Some New Jersey sites were in dry oak woodland, as well. The larval collection from beach plum was in a sandy field adjacent to dry oak-pine woodland.

Threats & management issues

Gypsy moth is the number one management issue for *Acronicta dolli*. There is no way to guess what the impact of *Btk* applications would be, however. The entire *Acronicta dolli* population—early to middle-instar larvae—would be exposed in the typical single applications of suppression programs, and mortality would probably be high to first and second instars. Mortality to third and later instar noctuid caterpillars varies greatly among species (Peacock *et al.* 1998). In New Jersey, *Acronicta dolli* larvae mature about the same time gypsy moth larvae are in the last instar, so severe defoliation by gypsy moth caterpillars could cause high mortality of larvae on oaks, especially if understory blueberries were also stripped or were not present. There would probably be low viability of aestivating pupae from nutritionally stressed, last-instar larvae.

Survival of any stage would probably be low in fires, so unburned refugia are needed in prescribed burns. Regenerating burned areas might result in superior habitat for the larvae. According to Hugo Kons (personal communication with Dale Schweitzer in September 2010) "overburning practices on Wisconsin barrens that eliminate scrub forest/barrens mosaic and convert all of the habitat to open treeless barrens are probably reducing and destroying habitat for this species."

Impacts of selective logging or even clear-cuts with natural regeneration might benefit this species. While *Acronicta dolli* might merit sensitive species status in some National Forests, collecting restrictions are not only unjustified, but could very well be detrimental to this species. The only likely impact of collecting restrictions would be to prevent the discovery (or at least reporting) of new occurrences.

References

Covell (1999), Dirig (1986), Ferge and Balogh (2000), Forbes (1954), Peacock *et al.* (1998), Wagner *et al.* (1995), Wagner *et al.* (in press).

Acronicta sinescripta Ferguson[19]

Identification

This is among the most easily recognized *Acronicta* species, especially for those with some experience with moths in this genus. The most similar species are *Acronicta longa*, *Acronicta lanceolaria,* and *Acronicta oblinata*. *Acronicta longa* has a more strongly contrasting white forewing postmedial line, and has a basal dash, but lacks the long transverse thin black forewing streak present in *Acronicta sinescripta* (Figure 303). *Acronicta lanceolaria* has more elongated wings, and the pattern is even more reduced. Other differences and a detailed description is provided in Ferguson (1988). *Acronicta oblinata* has conspicuous black dots present at the end of the veins along the forewing margin, which are lacking in *Acronicta sinescripta*. The larva has not been described.

Range

Ferguson (1988) reported *Acronicta sinescripta* to range from McClellanville, South Carolina south to Highlands County in south peninsular Florida, and west to Abita Springs in southeast Louisiana. A few have been collected in southeastern North Carolina. Surveys by Knudson and Bordelon and Hugo Kons and Robert Borth have failed to find this species in east Texas.

Figure 303. *Acronicta sinescripta* from Liberty County, Florida (Hugo Kons photo).

Rarity

Brou (2005b) reported collecting 162 specimens of *Acronicta sinescripta* at the type locality of Abita Springs, Louisiana. However, this results from decades of running multiple mercury vapor light traps almost nightly. Records elsewhere are few. Only two recent specimens were found in the north Florida survey results reported in Kons and Borth (2006). These came from two herb bogs in close proximity in Liberty County in the Apalachicola National Forest. Ferguson (1988) reported eleven specimens in addition to those from Abita Springs, from locations including the Archbold Biological Station in Highlands County, Florida (4 males), Gainesville in Alachua County, Florida (one female), the Wedge Plantation in McClellanville, South Carolina (four females), and the Mississippi Test Facility in Hancock County, Mississippi (one female). If this species is dependent on southeast herb bogs (a possibility discussed below), it would be a localized species, since it would be dependent on a specialized habitat. It is difficult to assess its status, because, like *Acronicta dolli* and especially *Acronicta lanceolaria*, this species appears to be very difficult to collect at lights. Furthermore, we are not aware that it has been found at bait. Only Vernon Brou's home base operation of regularly running multiple mercury vapor light traps has produced numbers of adults on a consistent basis. The odds of finding this species on a short trip to a colony using mercury vapor sheets or blacklight traps are probably quite low. This introduces an element of false rarity.

19 This account was written by Hugo Kons Jr.

Like *Acronicta dolli* and *Acronicta lanceolaria*, larvae probably will be more easily located, once their food plants become known.

Life history

Ferguson (1988) describes but does not illustrate the larvae. He reports that larvae he reared pupated in late September and produced adults the next spring, after pupal diapause. Brou (1995) presents detailed phenology data in the form of a graph of the number of specimens collected at the type locality at different times of the year. Records range from mid March to mid September, with peaks in early-mid April, mid June, and late August. There are few records during May, and this is the time of year Kons and Borth have concentrated survey effort in the Florida Panhandle. The Kons and Borth Florida Panhandle specimens are from late May and late August. Other dates provided in Ferguson (1988) are within the range of dates recorded for Louisiana in Brou (2005).

Species of this section of *Acronicta* spin silk cocoons in leaf litter on the ground.

Host plants

Ferguson (1988) reported that the larvae of *Acronicta sinescripta* had been reared on a plant "tentatively identified by R. O. Kendall as *Froelichia arizonica* Thornber (Amaranthaceae)." He also reported larvae had been found feeding on another unidentified plant with long succulent stems and peltate leaves. Like *Acronicta oblinita, Acronicta sinescripta* might feed largely on herbs rather than trees or shrubs.

Habitat

Kons and Borth found two specimens in Liberty County in herb bogs with pitcherplants, the same habitats where *Exyra* species occur. They considered *Acronicta sinescripta* to be a preliminary candidate for herb bog dependency in northern Florida, as no specimens were found in other habitats among these surveys. The habitat at the Abita Springs site contains pitcherplant bog as well. Two moths that feed upon the pitcherplants, *Exyra semicrocea* and *Papaipema appassionata*, have been collected at the same site by Brou. Hugo Kons found a specimen of *Acronicta sinescripta* from Mississippi in the Milwaukee Public Museum back log that was labeled as having been collected in a pitcherplant bog. Ferguson (1988) did not report any information about habitat for the collection localities, but the Archbold Biological Station is mostly upland scrub habitat. Pitcherplants do occur in the same county as the Archbold Biological Station, in Highlands Hammock State Park.

Threats and management issues

If this species is herb bog dependent, succession and fire regimes, would be management concerns even where the habitat is protected.

Burning only a fraction of the habitat at a time, and having plots with variable lengths of time between burns, are recommended strategies for maximizing the chance of preserving herb bog dependent Lepidoptera species where little is known about their response to fire, or what stage of succession is optimal for their survival. Collecting activities that could discover new populations or provide recent records for known sites should be strongly encouraged. Studies of the life history, and response of populations to fire and succession, are needed.

REFERENCES

Brou (2005b), Ferguson (1988), Kons and Borth (2006).

CORA MOTH

Cerma cora HÜBNER

IDENTIFICATION

This medium-sized (27 to 30 mm), pretty moth has a distinctive color pattern (Figure 304). The larva has long black setae, prominent tubercles, and the general shape of *Cerma cerintha* (Wagner 2005, Wagner *et al.*, in press), but it is blackish dorsally, with a narrow white mid-dorsal line. The caterpillar also has a variable mix of white, yellow, and sometimes orange on the sides, especially on the abdominal segments (Figure 305). Rings *et al.* (1992) and Rockburne and Lafontaine (1976) also illustrate the adult.

Figure 304. *Cerma cora* (Cora moth) from St. Tammany Parish, Louisiana (Marc Minno photo).

Figure 305. *Cerma cora* (Cora moth) larva from Frontenac County, Ontario, Canada (David Wagner photo).

TAXONOMIC NOTES

Wagner (2007a, b) presents evidence supporting the transfer of genus *Cerma* to the Acronictinae.

RANGE

The historical range of this moth is from Nova Scotia across Maine to southern Quebec and Ontario, westward to Iowa, and southward to central Florida and Texas. However, there are very few or no records from some states within this range.

RARITY

NatureServe global rank: G3G4.

It is not clear why this moth has such a spotty distribution and is found so rarely or not at all in so much of its vast overall range. The species is historical in New Jersey (pre-1910), Pennsylvania (pre-1950), New Hampshire (1983, habitat mostly destroyed since [Dale Schweitzer observation]), Massachusetts (pre-1934), and Ohio (around 1900). It not rare in Florida, where it is found regularly with hawthorns from Ocala to the Panhandle. Several populations are also known in North Carolina, where it is ranked as S2S3, as well as Wisconsin. Besides Florida, North Carolina, and Wisconsin, it is likely that no state or province in our primary coverage areas has five or more recently verified occurrences, although Maine has several historical sites. The cora moth is known from several places in Louisiana and Texas.

Cerma cora is among the few uncommon species still found regularly in the degraded Albany, New York, pine barrens (Tim L. McCabe). There are two recent specimens from Virginia, including one collected in the mountains (Butler *et al.* 2001) and another along the Atlantic Coast (Steve Roble, unpublished). Butler *et al.* (2001) also recorded this species from northern West Virginia, but Albu and Metzler (2004) do not report it farther south in that state.

Life history

There is a single brood with adults flying from mid February to early April in Florida (Kons and Borth 2006, Hugo Kons personal communication with Dale Schweitzer in 2010); 13-28 April in eastern North Carolina; 8 May to 3 June in Augusta County, Virginia (Butler *et al.* 2001); mid-May to mid-June in Wisconsin (Ferge and Balogh 2000) and Albany, New York (Tim L. McCabe); and mid-June to late July in Maine and Nova Scotia (Brower 1974, Ferguson 1955). Records from Jefferson County, Kentucky, indicate two broods from 9 May to 12 June, and then from 8-30 July (Covell 1999), but the accuracy of these records is suspect, because all records elsewhere indicate one brood.

Northern larvae eat the new growth of the host. When mature, about early July in New York and southern New Hampshire, the caterpillars excavate a cell in soft dead wood and spin a cocoon where the pupae overwinter (Wagner 2007a).

The adults come to mercury vapor lamps and blacklights. The larvae have been found by beating them off the food plants.

Host plants

The larvae of the cora moth feed on pin cherry (*Prunus pensylvanica)*, at least in New York (Tim McCabe) and New Hampshire (Dale Schweitzer). This plant is also reported by Forbes (1954), and is probably the main food plant northward. Northern larvae will not accept the leaves of black cherry (*Prunus serotina)* in captivity. In the Roanoke River basin of North Carolina, hawthorns such as *Crataegus marshalii* are essentially the only possible food plant (Steve Hall). Hawthorns have recently been verified as food plants in Florida by David Wagner and others. Wild plums, crabapples or other small trees and shrubs in the Rosaceae might also be used.

Habitat

Recent northern collections are mostly from sandy places, often oak, jack pine or pitch pine barrens, in Wisconsin (Ferge and Balogh 2000, Hugo Kons personal communication with Dale Schweitzer in 2010), Quebec (Handfield 1999), New York (Tim McCabe collection), and New Hampshire (Dale Schweitzer collection). Maine (Brower 1974) and Nova Scotia collections

(Ferguson 1955) were not in barrens areas, but most could have been on sandy soils. This moth is much more habitat-restricted northward than its common food plant.

Farther south populations may prove to be associated with certain species of hawthorns. Recent collections have included the Roanoke River swamps in North Carolina (Steve Hall), relatively ordinary hardwood forests in Gordon and Whitfield counties, and Ohoopee Dunes in Emanuel County in Georgia (James Adams), and coastal dunes in Virginia (Steve Roble). Kons and Borth (2006) reported the species to be a habitat generalist in Florida, where habitats range from hardwood swamps to xeric pinelands.

Threats & management issues

Gypsy moth spraying with *Btk* could be a threat (Peacock *et al.* 1998), especially southward, since young larvae could be present at application time. Hall *et al.* (1999) listed the susceptibility of this species to *Btk* spraying as high in North Carolina. There is little chance of impact from *Btk* applied against gypsy moth larvae northward, where *Cerma cora* adults appear after the normal season for such applications.

The larvae mature earlier than any of the species which are suspected to have been impacted by *Compsilura*. However, eastern Massachusetts, where this fly was introduced in 1906, is among the few places with only pre-1950 records.

Fire is an issue in drier habitats, such as northern barrens, because no stage is underground, but some pupae should survive light fires. Very frequent prescribed burns could cause a scarcity of pupation sites and host plants. The food plants could take several years to be acceptable to ovipositing females following fires.

Hugo Kons and Robert Borth (Hugo Kons personal communication with Dale Schweitzer in 2010) consider habitat changes resulting from excessive burning of barrens habitats to be a significant threat to this species and several other barrens species in Marinette County, Wisconsin. Lack of fires could also be an issue in the Northeast where the food plant is a mid successional species.

Thinning, roller chopping, or herbiciding of understory shrubs would be incompatible with this species.

In wetland habitats, regulating water levels could be a threat if the host plants are harmed, and might also directly kill larvae or pupae.

References

Brower (1974), Butler *et al.* (2001) Ferge and Balogh (2000), Ferguson (1955), Forbes (1954), Handfield (1999), Hall (1999), Hall *et al.* (1999b), Holland (1903), Kimball (1965), Kons and Borth (2006), Landau and Prowell (1999), Metzler *et al.* (2005), Rings *et al.* (1992), Rockburne and Lafontaine (1976), Tietz (1952), Wagner (2005, 2007a, b), Wagner *et al.* (in press).

SUBFAMILY AMPHIPYRINAE

TRIBE PSAPHIDINI

Brachionycha borealis J. B. SMITH

IDENTIFICATION

This is a medium-sized (50 mm) gray moth with a distinctive pattern (Figure 306). There are no other similar species in North America, and there is no apparent difference in appearance among moths from the various portions of the disjunct range. Handfield (1999) mentions a melanic form, which we have not seen. Handfield (1999) also illustrates an adult.

Figure 306. *Brachionycha borealis* from Grant County, West Virginia (David Wagner photo).

The larva is green without distinct lines, but has a spiracular stripe indicated by tiny spots and yellowish tubercles (photograph supplied by Les Ferge to Dale Schweitzer). Three characteristics of the larva appear diagnostic. The true legs are mostly red. The end of the abdomen forms a slight hump suggestive of, but not as prominent as, that on *Amphipyra pyramidoides* larvae. There is a yellow diagonal stripe across the top of the last proleg.

RANGE

Specimens from State College (Centre County) and Luzerne County, Pennsylvania, were the only ones known to Forbes (1954) from east of Manitoba, but this species is now also known from northern Minnesota (Kyle Johnson), central and northern Wisconsin, Michigan, Ontario, Quebec, and the Virginias. This moth occurs in sandy parts of eight counties in Wisconsin (Les Ferge), including Portage, Jackson, Marathon, Wood, Burnett, and Douglas counties according to Hugo Kons, as well as Otsego County in northern Michigan (Mo Nielsen). Populations have also been found in the mountains of northeastern Pennsylvania and adjacent Sussex County, New Jersey, several counties in northeastern West Virginia (Linda Butler and others) and in Rockbridge County, Virginia. The Virginia specimen was taken in the 1990s in U.S. Forest Service samples from Goshen Wildlife Management Area, but this individual probably was a stray from a higher ridge.

East of Wisconsin, the range is somewhat suggestive of the composite ranges of two grasshoppers. The Michigan bog grasshopper (*Appalachia arcana*) is endemic to, but fairly widespread in, slightly more southern Michigan pine barrens. The globally historical (GH) Appalachian grasshopper (*Appalachia hebardi*) ranges from the mountains of northeastern Pennsylvania to Virginia (NatureServe 2008). Eastern populations of *Brachionycha borealis* and *Appalachia* grasshoppers may be ice age relicts from similar refugia.

The scarcity of old records relative to recent ones probably reflects the advent of better collecting equipment, such as blacklights and mercury vapor lamps, which sometimes attract males in large numbers. Only in Pennsylvania are there more old (1932 and older) records than recent (post-1980) records. This easily collected species has proven to be spottily distributed, but ranges much more widely eastward in both Canada and the United States than was known 50 years ago.

Rarity

NatureServe global rank: G4.

Brachionycha borealis might be better described as local and poorly understood than as rare. This moth is apparently secure in central Canada and Wisconsin, but it is local in eastern Canada and the rest of its range in the United States. However, we include *Brachionycha borealis* because of the disjunct Appalachian populations and its apparent rarity and/or decline in Pennsylvania. Furthermore, the U.S. Forest Service has been treating this as a species of special concern in West Virginia (http://iz.carnegiemnh.org/inverts/nathist.html and http://www.wvhighlands.org/mnf_fp/Final_EIS_Appendices_A-H.pdf), with gypsy moth spraying the main issue.

A specimen collected from State College, Pennsylvania on 22 April 1932 (Tietz 1952) seems to have been the most recent for that state until a collection in Monroe County in 2007 (information from Anthony McBride). On 11 April 2008, Joseph Garris collected one in adjacent Stillwater Township, Sussex County, New Jersey. It has not been found at Moosic Mountain (which seems likely to have been the "Scranton" locality) or other places in northeastern Pennsylvania, which have been sampled repeatedly in early spring by Steve Johnson, Anthony Wilkinson, Dale Schweitzer, and others since 1985. However, efforts in those places were usually concentrated in bear oak areas, which may not be the proper habitat.

Except for the collection in 2007, Pennsylvania collections took place prior to large-scale gypsy moth spraying with DDT and Sevin® (from the 1950s to 1970s). However, other spring moths are now easily found in northeastern Pennsylvania. Under suitable conditions this moth is easy to find. Mo Nielsen reports success on eight of nine attempts between 19 April and 6 May in four different years, with the only failure being a cold night (45°F at dusk).

Life history

The larvae occur in the spring and feed on new growth. They pupate in the soil, probably about mid-June. It is not known if this species sometimes overwinters for more than one year. One of the two European *Brachionycha* species (Young 1997) and four of six eastern United States Psaphidinae that Dale Schweitzer has reared overwinter for more than one year.

Adults occur in early spring, with dates from 19 April to 1 May in Michigan, April and early May in Quebec, and April in Pennsylvania and West Virginia. One adult from Scranton, Pennsylvania (American Museum of Natural History collection) is dated 12 March 1905, and is so perfect as to suggest an unflown, reared specimen. However, mid-March is not impossible as a collection date. Two others from adjacent Luzerne County are dated simply "April" in the same handwriting (apparently Max Rothke's).

Timing would be important to anyone trying to look for this moth. Based on field notes from Mo Nielsen (letter to Dale Schweitzer dated 23 February 1986) and observations from Les Ferge (letter to Dale Schweitzer dated 1 March 1986), adults will come to lights in temperatures at least as low as 49° F (9.5°C) Like other Psaphidinae, this one comes most abundantly to lights on very warm (≥21°C) evenings. Their observations that *Brachionycha borealis* flies in Wisconsin and Michigan with *Orthosia rubsecens, Cerastis* species, *Feralia major, Feralia jocosa, Psaphida styracis, Psaphida rolandi, Psaphida resumens*, *Gluphisia lintneri*, and with the first *Orthosia revicta* of the season should aid in timing searches. Ferge notes that the flight season is before red maples and aspens flower, and most years it lasts for 14 or fewer nights. Adults, almost always males, are usually collected at lights, but also in Malaise traps (Handfield 1999).

Host plants

Larvae of this moth feed on spring foliage of oaks (Les Ferge), paper birch (*Betula papyrifera*) (Handfield 1999), blueberry (*Vaccinium* sp.) (Handfield 1999), and probably other plants. They also readily eat other caterpillars (Les Ferge). This is the only species of its subfamily in North America known to feed on plants from more than one family, and as far as we know, the only one that eats other caterpillars.

Habitat

The species is locally common in Wisconsin and Michigan pine barren habitats, and also occurs to some extent in dry sandy pine-oak woodlands or forests in both states. In West Virginia, populations occur mostly in oak forests above 2,500 feet (758 meters). Adults were often abundant when found in the 1980s. The specimen from State College, Pennsylvania mentioned in the "Range" section above, may have come from the nearby Scotia Barrens. However, from the 1980s to 2000s, collectors including Steve Johnson, Dale Schweitzer, and Pennsylvania Natural Diversity Inventory staff, have not found it there. The 2007 and 2008 collections in that state and New Jersey were not in barrens. Known *Brachionycha borealis* habitats in the Virginias that we have seen did not seem unusual except for their high elevation, although chestnut oak (*Quercus prinus*) seemed unusually prevalent at one site. Habitats from New Jersey to the Virginias appear to be more or less cold mountain oak forests.

Threats & management issues

The management needs of this moth would vary with habitat. Global warming is a threat to this boreal species in most of its United States range.

Pine barrens sites require occasional fires to maintain the habitat, but because the pupae of this moth are underground most of the year, mortality should approach zero in most fires. Oak sprouts should be suitable within one or two seasons after a fire, except in areas where excessively abundant deer eat most of them. Other stages of this moth could be killed in spring fires.

The sensitivity of the larvae to *Btk* is unknown. Although the two species of Psaphidinae assayed by Peacock *et al.* (1998) were sensitive, related species would not necessarily be. In Pennsylvania and the Virginias, mountain and ridgetop oak forests are at high risk for gypsy moth outbreaks. The U.S. Forest Service has funded inventory work for this species in West Virginia due to concern about possible impacts from gypsy moth spraying. If pupae of this species commonly overwinter more than once, there would be little risk of eradication from a single *Btk* application, even if nearly all larvae would be killed.

The ridge above the New Jersey collection site was severely defoliated by gypsy moth larvae in the previous year, and was moderately defoliated two months after the moth was collected. Other psaphidine larvae can often mature in less than a month and occur at the same time of year, so the larvae of *Brachionycha borealis* probably would also mature before defoliation becomes severe.

References

Ferge and Balogh (2000), Forbes (1954), Handfield (1999), Peacock *et al.* (1998), Poole (1995), Rockburne and Lafontaine (1976), Tietz (1952), Wagner *et al.* (in press).

Subfamily Hadeninae

Hadena ectypa Morrison

Identification

This medium sized (about 34 mm) dark moth is similar in size and color to *Orthodes detracta*. However, it is easily recognized by the pale, wavy subterminal line which contrasts with the general coloration and is sometimes more conspicuous than on the specimen we illustrate (Figure 307).

We illustrate the larvae (Figure 308). Its association with the food plant will also be a clue to its identity, although the occurrence of generalized noctuid cutworms on these plants is possible.

Figure 307. *Hadena ectypa* from Haywood County, North Carolina (David Wagner photo).

Figure 308. *Hadena ectypa* larva from Greenbrier State Forest, Greenbrier County, West Virginia (David Wagner photo).

Range

The known range of this moth is western Massachusetts (Mike Nelson) and southeastern New York, westward to Minnesota and Iowa, and southward in the mountains to North Carolina, Tennessee and Whitfield County, Georgia (James Adams). It seems to turn up most often from southern Ohio and the mountains of the Virginias southward. We note that Albu and Metzler (2004) report it from Kanawha County, West Virginia.

Rarity

NatureServe global rank: G3G4, which seems likely to change to G4 or G5 if use of nonnative food plants becomes widespread.

Forbes (1954) called this moth very rare—a term he rarely used. Dale Schweitzer has collected the moth only once, in 1972, in Graham County, North Carolina. Rings *et al.* (1992) report the species as uncommon in five nearly contiguous southern Ohio counties. Covell (1999) also considered it uncommon, and had records from three widely separated counties in Kentucky. Steve Roble reports there have been at least three recent collection sites in the Virginia mountains.

There could be an element of false rarity with *Hadena ectypa*, because despite the apparent scarcity of adults, David Wagner has found larvae to be common along roads in the West Virginia mountains. Several adults have turned up in recent inventories in Great Smoky Mountains National Park in Tennessee, and in Haywood County, North Carolina. On the other hand, Dale Schweitzer has seen no signs of larvae the few times he has encountered the food plant in Pennsylvania. *Hadena ectypa* was still present in the 1970s in northern New Jersey (Rutgers University collection), but has not been found there since. Presumably due to the current over abundance of deer, the moth's natural food plant is seldom seen now. However, this moth may yet adapt to introduced species of *Silene* that are more common there.

Life history

Larvae of this mainly European genus feed on flowers and seed capsules of plants in the pink family.

Most of the year is spent as a pupa, almost certainly in the soil.

The flight season may vary regionally, but adults are most frequently collected in July. Jones (1928-1932) found adults in Delaware from 22 June to 2 August. He noted that they were best sought at flowers of the food plant. Adults are also attracted to blacklights. Eight available New Jersey dates are from 22 June to 20 August. Most Ohio records are from late June to late July, with one in April (Rings *et al.* 1992). Kentucky dates are 25 May, 20 June, and 11 July (Covell 1999). Five recent specimens from higher elevations in Virginia were collected from 28 July to 20 August.

The larvae of *Hadena ectypa* probably mature from July to September. We suspect the species is partially double brooded.

Host plants

The only previously reported (many sources) food plant was *Silene stellata*, a woodland wildflower in the pink family (Caryophyllaceae) that has an overall range similar to this moth. Reports of adults in April and May in Ohio and Kentucky (if correct) suggest another, earlier flowering food plant. Recently David Wagner and Mike Nelson have been finding larvae on the introduced *Silene vulgaris* in New England, where this moth is probably increasing in numbers.

Habitat

This moth occurs in close association with the food plant in somewhat open woodlands and forests. The three recent Virginia collections were in ridge-top habitats at around 1,300 m, but most collections elsewhere have been much lower. Regardless of elevation and other details, this species is usually found in forest openings.

Threats & management issues

Aside from outright loss of habitat to residential and second home development, the most serious threats to this species are probably deer, which eat the flowers of the food plant, and non-native plants that are displacing native forest herbs in general.

Species, such as *Hadena ectypa*, that depend completely on flowers and ripening seed pods could be rapidly eradicated (potentially in one season) if the food plant is favored by overly abundant deer.

The host plant sometimes grows along roads in wooded areas, and mowing in July or August would kill many larvae.

References

Covell (1999), Crumb (1956), Forbes 1954), Godfrey (1972), Jones (1928-1932), Metzler *et al.* (2005), Rings *et al.* (1992), Tietz (1952, 1972), Robinson *et al.* (2002), Troubridge and Crabo (2002), Wagner (2005), Wagner et al. (in press).

Subfamily Noctuinae

Buchholz's dart

Agrotis buchholzi (Barnes and Benjamin)

Identification

This medium-sized (28 to 32 mm) moth is very small for an *Agrotis* species (Figure 309). It superficially resembles species in the *Agrotis volubilis* group. Of this group, *Agrotis stigmosa* overlaps with *Agrotis buchholzi* in range, but Buchholz's dart is much smaller.

The larva of *Agrotis buchholzi* is a typical cutworm, but more darkly colored than most. Schweitzer and McCabe (2004) illustrate the adult and larva. Lafontaine (2004) also illustrates the adult.

Figure 309. *Agrotis buchholzi* female, Fort Dix Military Reservation, Ocean County, New Jersey (David Wagner photo).

Range

Agrotis buchholzi is found only in the core of the New Jersey Pine Barrens. It is somewhat widespread in the eastern parts of Ocean and Burlington counties, and extends about a kilometer into Atlantic County and probably into eastern Camden County. A small, disjunct population also occurs near the Atlantic City Airport. There is very little potential habitat elsewhere in New Jersey, and none in any nearby states.

Rarity

NatureServe global rank: G2. The former U.S. Fish and Wildlife Service Category 2 listing for *Agrotis buchholzi* also included *Agrotis carolina*, as indicated by the stated range.

Populations of *Agrotis buchholzi* are stable only where its habitat is maintained by military use, or rarely other factors. *Agrotis buchholzi* is presently very common and widespread over thousands of hectares at the Fort Dix military reservation in New Jersey, where wildfires occur frequently due to military training activities. It was common at least in 1988 and 1989 after a 1987 fire on an adjacent Naval property at Lakehurst. *Agrotis buchholzi* is also extant, but its habitat is deteriorating in the West Pine Plains east of Chatsworth and the East Pine Plains near Warren Grove. The food plant has been declining at the periphery of its range, and is being increasingly overtopped by tall shrubs in core areas. This species is not immediately threatened, primarily because fires are common on military lands. Elsewhere, most of its habitat is protected from development. Unfortunately, virtually none of its habitat is managed in such a way that this and numerous associated rarities are likely to persist. If present management practices and wildfire suppression continue, *Agrotis buchholzi* will likely continue to decline, and could disappear in most of its range in the next few decades. It remains to be seen whether the 2007 wildfire will benefit this species, or whether the habitat had already deteriorated beyond the point of rapid recovery.

Life history

The life history of *Agrotis buchholzi* was recently determined and the larva described by Schweitzer and McCabe (2004). There are two broods per year. The egg stage lasts about a week. The larvae feed on the foliage of the host plant. When they are not feeding, small larvae hide among the sand grains or litter around the host, but older larvae are nocturnal and hide in short burrows in the sand during the daytime. Larvae from the second brood mature in October and then hibernate underground. In April, they re-emerge from the soil and pupate in a cell at or just beneath the surface, without any further feeding.

Adults are well adapted to their very cold nocturnal microhabitat. They will fly readily even on nights with air temperatures between 5 and 10°C when very few other summer moths are active. Adults of *Agrotis buchholzi* occur over a 2 to 3 week period between about 15 May and 15 June, depending on the year, and again about two months later. The adults seem to be very reliably present around 1 June and 1 August. Almost all collections of adults at lights in both broods have been made before 2300 hours.

Host plants

The larvae feed exclusively on the leaves of the mat-forming succulent plant, *Pyxidanthera barbulata* (pixie moss) in the family Diapensiaceae.

Habitat

This moth occurs in frequently burned, rather open, pitch pine-oak scrub or pitch pine lowlands. The mat-forming food plant grows in openings between shrubs on xeric to mesic, very nutrient-poor soils. Some habitats, notably on the dwarf pine plains, were formerly more grassy. The soil where the food plant grows is typically dry at the surface, but often wet just beneath, especially in pitch pine lowlands that are generally considered to be wetlands. Wetland shrubs commonly occur near the food plant, but blackjack oak (*Quercus marilandica*), which is a xerophyte, can also occur nearby. Populations of the moth can persist for a decade or more without fire, but eventually the litter accumulates sufficiently to smother the food plants. In most cases, the habitat becomes suboptimal beginning about five years after a fire. It is probably unsuitable by the 20th season. *Agrotis buchholzi* does not occur where the food plant has been relegated to paths and sand roads in otherwise shaded forest. This tends to be the last stage before final extirpation of the food plant once fires are suppressed for a few decades.

Threats & management issues

The main threat to this moth is lack of fire and consequent loss of habitat. However, another threat can be the intensity of wildfires once they finally do occur. With heavy fuel loads, fires may be hot enough to completely kill the food plant and destroy its seeds. On the other hand, where fuel load is lower, for example at Fort Dix, summer ground fires sometimes fail to burn beyond the edges of the succulent food plant mats.

Survival of this species will become tenuous if its habitat is reduced to small remnant sites, as has happened in most of its range. Habitat is currently deteriorating due to fire suppression, but probably also due to the preference for light winter burns in New Jersey. Light winter burns do not prevent canopy closure, but do prevent the hot fires that open the canopy. Thinning trees before winter burns would be likely to increase the food plant in areas where it still exists.

It is possible to maintain populations of *Agrotis buchholzi* without fire. One very small, occupied habitat has been maintained by over 50 years of annual mowing. At least in the last 20 years, mowing has occurred during the winter. However, this management regimen would be impractical and undesirable in most habitats. Some sort of prescribed burn program is the preferred management technique for nearly all habitats.

Gypsy moth suppression is not an issue in most habitats, but defoliation of oaks occasionally occurs in drier ones. New Jersey does not allow aerial application of Dimilin® for gypsy moth control, and due to the timing of application and based on phenology, the risk from *Btk* should be minimal. However, the occasional use of *Btk* against the pine looper (*Lambdina pellucidaria)* in late summer would pose a risk. The instars exposed would depend on the application date, and it is unknown how sensitive any instar would be, although mortality probably would be high at least for the first two instars (Peacock *et al.* 1998).

References

Forbes (1954), Lafontaine (2004), Peacock *et al.* (1998), Schweitzer and McCabe (2004).

Carolina dart

Agrotis carolina Schweitzer and McCabe

Identification

This medium-sized (35 mm) moth is larger, paler, and more sharply marked (Figure 310) than the similar *Agrotis buchholzi*. There are also genitalia differences between the two species. The larva is probably very similar to *Agrotis buchholzi*, which is described by Schweitzer and McCabe (2004).

Figure 310. *Agrotis carolina* male (paratype) from Brunswick County, North Carolina (Bo Sullivan photo).

Taxonomic notes

Schmidt and Lafontaine (2010) consider this to be the same species as *Agrotis buchholzi*. However, several generally recognized species in this genus do not differ at all in genitalia characters, while *Agrotis carolina* and *Agrotis buchholzi* have minor differences in both sexes. Their note 639 states that the shape of the male valve does not differ. However, valve shape was not used as a character for separating this species by Schweitzer and McCabe (2004) in their description. Schmidt and Lafontaine point out the vesica illustrated is slightly damaged, and this might affect its apparent length. However, length of the vesica was also not used as a diagnostic character in the description. Since they do not discuss any genitalia characters that actually were used in the diagnosis and description of this species, their evidence of conspecificity of these taxa is minimal. Given the large separation of their ranges and that most adults are easily separated, treatment of *Agrotis carolina* as a subspecies is recommended if further research shows this to be conspecific with *Agrotis buchholzi*.

Range

Agrotis carolina is known only from eastern North Carolina, including Carteret, Onslow, Pender, and Brunswick counties on the southeastern outer Coastal Plain, and Hoke and Harnett counties in the interior Sand Hills region. This moth is likely to be found somewhat more widely in the Sand Hills. Based on the range of the food plant, *Agrotis carolina* may extend into South Carolina.

Although a few populations of the food plant still exist in Virginia, neither *Agrotis buchholzi* nor *Agrotis carolina* have been found there.

Rarity

NatureServe global rank: G2G3.

Agrotis carolina has a limited, highly fragmented range and specialized habitat requirements. Probably well over 90% of its original habitat has been destroyed. Depending on how populations are defined, 10 to 20 are known. Some of these are substantial, with subpopulations (Hall and Schweitzer 1993, Hall *et al.* 1999, Hall 2003).

Although the habitat has been reduced to isolated parcels, some are several hundred hectares or larger and are somewhat protected. As with *Agrotis buchholzi*, the best areas for this species include military lands where weapons practice causes a high incidence of wildfires. It is probably still abundant in the Green Swamp area where very frequent prescribed fires create good habitat for it. Unlike *Agrotis buchholzi*, current prescribed burning practices in its range can maintain occurrences of *Agrotis carolina*.

Life history

Agrotis carolina uses the same food plant as *Agrotis buchholzi*, but not much else is known. It is assumed that their life histories are similar, but at least a few details differ. For example, adults of *Agrotis carolina* emerge in late March or early April when the food plant is in flower, while those of *Agrotis buchholzi* start a few weeks after flowering. *Agrotis carolina* broods seem to be more protracted and there is a substantial third brood. The broods occur roughly in late March-April, June, and from August to mid-September.

Host plants

Based on observations by Bo Sullivan of captive specimens, the larvae feed on the leaves of *Pyxidanthera barbulata*.

Habitat

Agrotis carolina occurs in open pine or pine-oak savanna or woodland with a lot of the host plant. Most sites have a low density of trees, but longleaf pine is usually dominant. These habitats require fire every few years to persist.

Threats & management issues

The Carolina dart occurs on Croatan National Forest, and research into the effects of management there would be very useful. In general, this species seems to do well in areas managed by frequent light fires (Schweitzer and McCabe 2004). Due to much sparser pine cover, light winter fires seem to maintain *Agrotis carolina* habitats better than those of *Agrotis buchholzi*, although the food plants may be top-killed where there is a lot of dry wiregrass. However, any management practice that maintains good quality, abundant, healthy food plant patches should suffice for either species. Complete burns of the habitat should be avoided, although adults have been collected commonly from winter-burned sites in North Carolina.

Precautions were taken to minimize exposure of this species to *Btk* during the Asian gypsy moth eradication project in southeastern North Carolina, and known populations survived. More routine suppression programs are unlikely to target the habitats of *Agrotis carolina*. Unlike *Agrotis buchholzi,* early instar larvae occur early enough that they would probably incur high mortality from *Btk* applications against gypsy moth larvae, but there is no basis to predict whether third-to-last instar or older larvae would be killed.

References

Hall and Schweitzer (1993), Hall *et al.* (1999b), Hall (2003), Lafontaine and Schmidt (2010), Schweitzer and McCabe (2004).

Dichagyris reliqua Lafontaine and Schweitzer (New Jersey and Florida populations)

Identification

This small (23 to 26 mm) moth has largely white hindwings (especially males), a contrastingly tan costal area, and shadings on the forewings (Figure 311). *Dichagyris acclivis* is somewhat similar, but is larger and much less contrasty, with a somewhat striated look to the forewings, and the hindwings are not as white. It is also similar to *Ochropleura implecta* (formerly *Ochropleura plecta*), a common species illustrated by Covell (1984), Rockburne and Lafontaine (1976), and Holland (1903), among others. Note the more rounded spots and more evenly colored forewings of *Dichagyris reliqua*. The larva is shown in Figure 312. Adults from New Jersey and elsewhere and a larva are illustrated in Lafontaine (2004).

Figure 311. *Dichargyris reliqua* from Fort Dix (Impact Area), Ocean County, New Jersey (David Wagner photo).

Figure 312. *Dichargyris reliqua* larva, midwestern prairie population (David Wagner photo).

Taxonomic notes

The New Jersey population differs slightly in coloration from Midwestern specimens, and uses a different food plant, but has not been formally described as a subspecies. According to Tim McCabe, there is an undescribed species from the southeastern United States with distinctive females and males similar to *Dichagyris reliqua*.

As defined by Lafontaine (2004), *Dichagyris* is a large genus with about 46 species in North America including Mexico and an unstated number of species in Eurasia. We know nothing about *Dichagyris broui*, other than what is in its original description (Lafontaine 2004), except that it is known only from three localities in Louisiana and Mississippi.

Range

Dichagyris reliqua is known from southern Manitoba and the Great Lakes region southward to southwestern Missouri and westward to eastern Wyoming. A disjunct population cluster occurs in the northern part of the New Jersey Pine Barrens. Lafontaine (2004) shows a record in the Florida Panhandle. This species should be sought in North Carolina, especially at Fort Bragg where the artillery-impact area harbors some of the largest reedgrass areas outside of Fort Dix, New Jersey.

Rarity

NatureServe global rank (New Jersey populations): G3T1.

Dichagyris reliqua is known from about 15 scattered prairie remnants in the Midwest, where we presume a few additional populations will be discovered. Biologically distinctive populations, equivalent to a subspecies, are known historically at about four sites in the New Jersey Pine Barrens, one of which still supported a population in the 1990s. More than 99% of the prairie habitat of this moth has been destroyed, mostly for agriculture, and most remaining prairies lack *Dichagyris reliqua*. About 15 New Jersey specimens (adults taken at lights and larvae found at night on reedgrass seed heads) were collected in a very limited portion of the firing range impact area of Fort Dix during in the 1990s. Two others were collected near New Lisbon, New Jersey, in 1937. Dale Schweitzer collected singletons near Chatsworth in 1993, and at Atsion New Jersey in 1985 (after the intense July 1983 wildfire). It has not been found at Fort Dix since 1995, but survey efforts there have been brief and limited to the one known location.

The New Jersey food plant was a U.S. Fish and Wildlife Service Category 2 species, but the agency subsequently determined that it did not merit listing.

Life history

Very little is known about the biology of *Dichagyris* species (at least in North America). *Dichagyris reliqua* and *Dichagyris acclivis* are locally monophagous grass-seed feeders in New Jersey. Two other species in the genus *Dichagyris* feed on the flowers of plants in the Asteraceae (Crumb 1956, Lafontaine 2004, Tim McCabe larval specimen).

New Jersey *Dichagyris reliqua* larvae mature from mid- to late September and then burrow in the soil, where they make a very strong cell in which they overwinter without pupating. Some individuals remain in diapause through at least two winters, and probably longer.

There is a short adult flight season, with collection dates from 28 July to 12 August. Collection dates from Ontario and the upper Midwest are from 30 July to 26 August. This moth has been collected at blacklights. None have been seen at bait in New Jersey, and flowers would not usually be available to adults there. Dependence on seeds of *Calamovilfa brevipilis*, which produces few or no flowers and seeds except for a season or two after fires, begs the question of how this species could possibly have persisted in New Jersey where natural (lightning) ignitions are quite rare. Perhaps for thousands of years the survival of these populations has depended on human-caused fires.

It seems unlikely that prepupae can simply remain dormant until a fire occurs, because the maximum diapause documented for a noctuid is only seven years (for *Psaphida rolandi* and *Psaphida resumens*, Dale Schweitzer observation), and fire intervals are typically longer than that. However, the maximum documented dormancy for any moth is 30 years for a desert yucca moth (Powell 2001).

Host plants

In Ontario, first-instar larvae of *Dichagyris* reliqua have been found in late July feeding on the developing seeds of prairie dropseed (*Sporobolus heterolepis*) (Don Lafontaine). Dale Schweitzer found last instars in late September in New Jersey feeding on maturing seeds of pine barrens reedgrass (*Calamovilfa brevipilis*). In captivity, these larvae fed very reluctantly on seeds of purple-top (*Tridens flavus*), which does not occur in the habitat, and they would not eat the foliage of either grass. The larvae did not accept seeds of *Andropogon glomeratus*, *Schizachyrium scoparium*, or *Panicum virgatum*. Florida larvae might use a species of *Calamovilfa* as well, but have not been sought.

Habitat

This moth occurs in recently burned pitch pine-reedgrass savannas in New Jersey, and dry prairies or alvar grasslands in most of the range. We have no details regarding habitat in Florida. At Fort Dix, both blacklight sampling and larval searches indicate that most reedgrass savanna habitat is unoccupied, even just after fires. Most of the occupied habitat burns in most years. Unoccupied habitat a few kilometers to the west burns several times per decade. All Fort Dix collections and the Atsion collection were within two years after large fires. Although it is not known how closely these fires approached the site of the 1937 New Lisbon collections, there were several large wildfires a few kilometers to the east from 1930 to 1935, not counting the then-undocumented fires on nearby Fort Dix.

The 1993 Chatsworth collection was about 100 m from a small vegetative reedgrass population, which had not burned in many years. According to Andrew Windsich, a pitch pine lowland (which probably contains some reedgrass) less than 4 km distant burned on 3 May of the previous year, and there are four known reedgrass savannas 1–9 km away, of which two had burned from 1986–1989.

At Fort Dix, savanna patches occupied by *Dichagyris reliqua* tend to be drier than most and are not occupied by the rare skipper *Atrytone arogos*, which eats the leaves of pine barrens reedgrass in less frequently burned places a few kilometers away.

Threats & management issues

The New Jersey version of *Dichagyris reliqua* requires a very high incidence of spring or summer fires. Relatively intense fires that occur from spring to mid-summer seem to stimulate flowering of the food plant reliably. Fire may provide the larvae with cues as to when to terminate diapause, although four of five reared from New Jersey eclosed the first summer.

Such a fire regimen would not persist in the climate of the recent past, or probably in the new warmer one, without human-caused ignitions, and would be incompatible with current winter burning practices. Prospects for the continued existence of *Dichagyris reliqua* in New Jersey look poor, except perhaps on Fort Dix. Even there it is perplexing that this moth remains very localized, leaving most burned reedgrass patches unoccupied, at least in seasons when they have been surveyed.

Prairie and alvar populations of typical *Dichagyris reliqua* probably need no special management beyond normal practices, such as prescribed burning sufficient to maintain healthy populations of *Sporobolis heterolepis*.

References

Crumb (1956), Lafontaine and Schweitzer in Lafontaine (2004), Metzler *et al.* (2005), Powell (2001).

Venus flytrap cutworm moth

Hemipachnobia subporphyrea (Guenée)[20]

Identification

This medium-sized (34 mm, forewing length 17 to 20 mm) moth is reddish (Figure 313). The terminal area of the forewing usually has a frosted appearance. *Hemipachnobia monochromatea* is similar, but smaller than at least southern *Hemipachnobia subporphyrea*, and with little or none of the terminal frosting. Most in New Jersey, and probably all of them from farther north, are a bit paler and less purplish than *Hemipachnobia subporphyrea*. Lafontaine (1998) does not illustrate *Hemipachnobia subpophyrea* on his color plates, but does have a black and white image and good images of the genitalia of both species. Specimens from north of southeastern North Carolina should be verified by genitalia, especially if any turn up in Virginia or Delaware.

The genitalia of *Hemipachnobia subporphyrea* are diagnostic (Lafontaine 1998). Males of *Hemipachnobia subporphyrea* have three projections near the tip of the valve, while the valve of *Hemipachnobia monochromatea* is more rounded and has only one projection (also illustrated by McDunnough 1929). Also *Hemipachnobia subporphyrea* has a large triangular projection off the juxta, while that of *Hemipachnobia monochromatea* is much thinner, and perhaps more erect. Females of *Hemipachnobia subporphyrea* have the bursa more heavily sclerotized.

The variation in the color of the larvae is shown in Figure 314.

Figure 313. *Hemipachnobia subporphyrea* (Venus flytrap cutworm moth) from Pender County, North Carolina (David Wagner photo).

Figure 314. *Hemipachnobia subporphyrea* (Venus flytrap cutworm moth) larvae from Carteret County, North Carolina (David Wagner photo).

Taxonomic notes

A population in Anne Arundel County, Maryland is very similar to typical *Hemipachnobia subporphyrea* in male genitalia. Don Lafontaine compared specimens, and concluded the genitalia and genetic bar codes of this population and *Hemipachnobia subporphyrea* are not distinguishable. Superficially, however, these Maryland specimens appear inseparable from southern New Jersey specimens of *Hemipachnobia monochromatea*, of which the dozen or so checked by Dale Schweitzer and others are normal *Hemipachnobia monochromatea* based on genitalia. The few known

[20] Steve Hall of the North Carolina Natural Heritage Program contributed to this account.

specimens of *Hemipachnobia monochromatea* from northeastern North Carolina are not unusual looking, and their genitalia match New Jersey and northern specimens. The genitalia differences are much greater than would be expected within a moth species and males of the Maryland population clearly do not match *Hemipachnobia monchromatea*.

Range

This moth is currently known from Brunswick, Pender, Carteret and Bladen counties in North Carolina, where nearly all of the remaining populations of its known food plant occur. It has also been collected from a single bog in Anne Arundel County on Maryland's western shore. Lafontaine and Schmidt (2010) explicitly include eastern Maryland in the range.

The type locality of "Georgia" may be an error.

It is possible that if more specimens from southern New Jersey were dissected, especially more of the purplish phenotype, some would prove to be *Hemipachnobia subpophyrea*.

Rarity

NatureServe global rank: G1, but this does not include the Maryland population.

The food plant used in North Carolina is itself globally uncommon (G3). Historically, the food plant was not found to grow naturally more than about 170 kilometers from Wilmington, North Carolina. The moth, moreover, is rarer than its host plant, probably due to changes in the fire regime, and possibly ant predation or other factors. Apparently, the great majority of populations of the food plant, including the largest one we know of, no longer support this moth. There is evidence of continuing loss of populations and serious threats in most remaining sites. North Carolina populations of this species are probably in danger of extinction in the short term as discussed below. If inappropriate prescribed burning is the primary threat, there is some possibility for recovery.

The authors of this book suspect that *Hemipachnobia subporphyrea* warrants listing under the U.S. Endangered Species Act, but the Maryland population obviously complicates assessment of conservation status.

Life history

The adults fly from late March to early May in North Carolina. Maryland dates known to us are 5 and 15 May. Early-instar larvae in North Carolina appear to feed only on Venus flytrap (*Dionaea muscipula*) leaves, and late instars also eat this plant. We do not know whether later instars sometimes switch to secondary hosts in the summer. Larvae are fully grown by fall, and hibernate in that state, before pupating in early spring.

There is only one brood. The life history of this species first became known from larvae feeding on flytrap plants cultivated by the late Aubrey M. Shaw. Two specimens from his plants were reared out by David Stephan (North Carolina State University Extension Service) in 1986, and are in the North Carolina State University collection.

Host plants

The larva eats the leaves of the Venus flytrap (*Dionaea muscipula*), a small insectivorous plant in the sundew family (Droseraceae), found in North Carolina.

The Maryland population presumably feeds on one or more species of sundews (*Drosera* species), which are the primary food plants of *Hemipachnobia monochromatea*. Older larvae of *Hemipachnobia monochromatea* often switch to cranberry or other Ericaceae, but the few late instars of *Hemipachnobia subpophyrea* that have been found have been on Venus flytraps.

Habitat

In North Carolina, this moth is restricted to high-quality, wet, pine savannas where the food plant is abundant. The Maryland population occurs in a bog.

Threats & management issues

This species is sensitive to both too-frequent and too-infrequent fire. Field surveys indicate numbers appear to be strongly reduced following a fire, and populations may become extirpated under conditions of annual to semiannual burning. Apparently, due to an artificially high fire frequency, the largest known populations of flytraps in the artillery-impact areas of the Camp Jejune Marine Corps Base do not support *Hemipachnobia subporphyrea*. Conversely, a formerly vigorous population located on a Nature Conservancy preserve has nearly vanished due to prolonged fire suppression. Venus flytraps themselves survive for only a few years under conditions of deep thatch build up, and stop producing leaves after an even shorter period.

In order to provide good conditions for this species, habitat should be divided into at least three burn units, with only one unit burned per year in an orderly rotation. The largest known population of the moth was located at a site where these conditions prevailed, with individuals being captured at multiple sites across this metapopulation over a multi-year period. However, with a change to a two-year fire rotation, the Venus flytrap cutworm moth has declined markedly, and the population at this site is no longer regarded as the globally best example.

Poaching of the host plant is a well-known problem, and has lead to the extirpation of several populations of the plant, and likely also of the moth.

Establishment of a high density of fire ant colonies is believed to be responsible for the loss of at least one population of the moth previously occupying an isolated area of semi-natural habitat. However, where fire ants are more dispersed, populations of the moth coexist with them. It is unknown whether fire ant densities will remain low in the North Carolina savannas, or increase dramatically as they have in the Gulf Coast states. Preserves containing this moth should be monitored regularly to detect any change in fire ant density.

References

Lafontaine (1998), Hall and Sullivan (2000, 2004, 2005).

Subfamily Heliothinae

Much of the information in the accounts for Florida species is from Jeff Slotten.

This subfamily is very diverse in western North America, where it includes over 100 species in the genus *Schinia* alone. As Hardwick (1996) points out, there is also a concentration of heliothines in Florida, with 42 species recorded (32 species of *Schinia*). Some 14 species of *Schinia* occur at Archbold Biological Station in Highlands County (Minno 1992b). Kons has collected 22 to 24 species of heliothines, with up to 18 species of *Schinia*, depending on the taxonomy, at the Katharine Ordway Preserve in Putnam County, Florida (Kons and Borth 2006).

Most species are specialized flower and seed feeders. They use only a few related plants, often a single genus, and sometimes even just one species. Most species have one brood, with adults flying when the food plants are flowering.

The heliothines discussed here typically occur in dry sandy oak or pine savannas or woodlands or disturbed areas within them, and in prairies. Some *Schinia* species can be found in almost any situation where the food plant is present. Examples of this in New Jersey are *Schinia nubila, Schinia lynx, Schinia saturata, Schinia arcigera,* and *Schinia rivulosa*. Others have more specialized habitat requirements, such as *Schinia septentrionalis*. Kons and Borth (2006) consider *Schinia nundina* to be a habitat specialist in Florida. Panzer *et al.* (1995) consider *Schinia arcifera* to be dependent on prairie remnants in the Chicago area. Both *Schinia nundina and Schinia arcifera* occur in a variety of disturbed habitats in New Jersey.

Although the rare species occur in very localized colonies, *Schinia* are fast fliers, and the females disperse, thus, many species are good colonizers.

Typically, eggs are laid on or in the flowers of herbaceous plants, which are often late flowering Asteraceae (although *Heliocheilus* species eat the flowers and developing seeds of grasses). Eggs of most heliothine moths hatch in less than a week, sometimes in as little as three days.

The larvae feed on the flowers or developing seeds of the host. Some are further specialized in terms of exactly what part of the plant they eat. Larvae of most Heliothinae are cannibalistic, so generally only one can mature in a given flower or cluster of flowers. Some heliothine larvae hide in the flowers or among the seed capsules, others rest on the outside but are very cryptic. Yet others hide in the soil or litter at the base of the host when not feeding. The larval stages are usually brief, about 13–20 days unless protracted by cool weather in the fall.

Heliothinae species have pupal diapause, which is obligate in most North American species. The pupae of most *Schinia* species and some other heliothines spend at least ten months underground. Many of the species commonly overwinter for two or three years before eclosing. This phenomenon is not limited to arid regions (Hardwick 1996); *Schinia arcigera* and *Schinia Schinia nubila* do so in New Jersey (Dale Schweitzer observation).

The adult flight periods of widespread species typically occur later in the year in the southern parts of their range. The exact phenology is adapted to the local flowering season of the food plant. Kons and Borth (2006), however, report a few examples of single individuals being collected much earlier in the season than normal.

Adults visit flowers for nectar, often those of the larval food plant. Dale Schweitzer has noted that female *Schinia arcigera* often appear to feed as they oviposit. Adults of some *Schinia* species are colored to match buds or flowers of the food plant. With a little practice, searchers can find resting singles or even mating pairs on the host flowers. Others resemble dried basal leaves or, like most species in related genera, have more generalized patterns.

Most heliothines are nocturnal, but some are diurnal, and some are active at night as well as during the day. Hardwick (1996) lists food plants and larval feeding habits, and provides illustrations of adults of almost all North American species of heliothines, and the larvae of most.

Management issues of rare heliothines vary according to the food plant and habitat, but many species use fire-maintained habitats. Substantial direct mortality in fires would generally be possible only during the month or two when eggs, larvae, and adults occur. Survival of these stages would be unlikely, so a population could be eliminated if the entire habitat was burned. Because the pupae are underground, their survival should be high.

The main issues concerning fires, or lack thereof, would be both long-term and short-term effects on the larval food plants. If the food plants or nectar plants (if these are different) do not bloom, reproduction cannot occur that season. Some species have a reservoir of pupae overwintering for more than one year, so would not be eradicated by a single reproductive failure. However, it should not be assumed this is true of all species.

Gypsy moth and related issues should not affect heliothine moths. Few, if any, of their food plants are likely to be eaten by gypsy moth larvae, and virtually none during their flowering periods. Very few species would be larvae early enough to be affected by applications of *Btk*. Furthermore, females of most species insert the eggs into flowers where hatchlings would have no exposure to *Btk* or chemical applications, and most feed on plant tissues not present during the spring spraying periods. Therefore, the risk of mortality even with Dimilin® spraying should be low. Because *Schinia* and other Heliothinae larvae feed on herbs and grasses in open habitats, they should not be very vulnerable to parasitism by *Compsilura*.

Mowing shortly before or during the period when the food plant flowers and the seeds mature could displace or eradicate a colony, because all food would be destroyed. It is probably irrelevant whether the larvae are in the flowers or hiding at the base of the plant, thus left to starve. Mowing appears to explain most absences of *Heliocheilus lupatus* from food plant patches in New Jersey. The extent to which mowed roadsides become ecological sinks for rare *Schinia* may need investigation.

The main threat to most of the southeastern *Schinia* and other Heliothinae is the rapid conversion of their upland habitats to agricultural and urban land uses.

Heliocheilus turbatus (Walker)

Identification

Heliocheilus turbatus is similar to *Heliocheilus lupatus*, but *Heliocheilus lupatus* is distinctly lighter basal to the median line, as well as a more contrasting median band (Figure 315). *Heliocheilus lupatus* has a warmer orange-brown (versus dull brown of *Heliocheilus turbatus*) hindwing, and is a univoltine fall species in Florida. *Heliocheilus turbatus* has been found from late March to early April. The larva has not been observed.

Figure 315. *Heliocheilus turbatus* from Putnam County, Florida (Hugo Kons photo).

Taxonomic notes

Hardwick (1996) and Kons and Borth (2006) concluded that *Heliocheilus turbatus* is likely to be a separate species from *Heliocheilus lupatus*. Hardwick illustrates one of the three specimens known at that time. Other authors were unfamiliar with it. *Heliocheilus lupatus* is a univoltine fall species in Florida and a mid to late summer species farther north, whereas both of the specimens of *Heliocheilus turbatus* with dates on the labels were collected in the spring. *Heliocheilus turbatus* is known only from peninsular Florida (Hardwick 1996, Kons and Borth 2006) where its range overlaps that of *Heliocheilus lupatus*. *Heliocheilus turbatus* has not been found in southwest Gainesville where *Heliocheilus lupatus* occurs (Kons and Borth 2006). *Heliocheilus lupatus* has not been found in sandhill habitats such as the site where *Heliocheilus turbatus* was found.

There is no known geographic variation among specimens of *Heliocheilus lupatus* examined by us or Hugo Kons from Indiana, New Jersey, Florida, and east Texas, including some from within the range of *Heliocheilus turbatus* (Kons and Borth 2006).

Range

The only known recent locality for *Heliocheilus turbatus* is the Katharine Ordway Preserve in Putnam County, Florida, where Hugo Kons collected specimens on 3 April 1999 and 31 March 2000. However, the first specimen is not listed in Kons and Borth (2006). Hardwick (1996) knew of three specimens from peninsular Florida collected prior to 1863, but none had a precise locality or collection dates.

Rarity

Heliocheilus turbatus was not collected at all in the 20th century, and only five specimens are known. While this species has long been sought by Heliothinae collectors, these collectors typically visit habitats in the fall when a large variety of beautiful Schinia species are present. Nonetheless, there is no reason to believe *Heliocheilus turbatus* would be overlooked in general light trap surveys in spring, because the closely related *Heliocheilus lupatus* comes readily to lights in New Jersey. Furthermore, *Heliocheilus lupatus* is easily flushed and occasionally seen at flowers during the daytime in New Jersey. The specimen of *Heliocheilus turbatus* reported by Kons and

Borth (2006) came to a mercury vapor light at 4:13 a.m. (Kons and Borth 2006), but there is no way to know if this flight time is typical. The other specimen was taken in a light trap.

Surveys of sandhill and scrub habitats in peninsular Florida, and perhaps elsewhere where similar habitats occur, are badly needed to determine the status of this species. Although the habitat association with sandhills cannot be confirmed until more specimens are collected and/or something is learned about the host plant, searching in this habitat would be a good place to start. Assuming *Heliocheilus turbatus* feed on the seed heads of spring flowering grasses, compiling a species list of spring flowering grasses where it occurs would help with efforts to identify the host plants.

Life history

The life history of *Heliocheilus turbatus* is unknown. Adults have been collected on 31 March and 3 April.

Larvae of this genus feed on flowers and developing seeds of grasses (Wagner *et al.* in press). Based on the adult collection dates, larvae would occur in April and perhaps into May. Species of this genus spend most of the year as pupae, and there probably is only one brood.

Larvae of *Heliocheilus lupatus* are easy to locate in New Jersey on the flowering and fruiting stems of its food plant, especially at night. Thus, looking for larvae in April might prove to be an effective way of finding *Heliocheilus turbatus*.

Host plants

The host plant of *Heliocheilus turbatus* is unknown, but is almost certainly a spring-flowering grass. Larvae of this genus feed on grass flowers and developing seeds.

Habitat

The two recent specimens of *Heliocheilus turbatus* were collected in longleaf pine/turkey oak sandhill scrub savanna.

Threats and management issues

Too little is known about *Heliocheilus turbatus* to make an assessment of threats. If the species is an obligate of sandhill habitats, succession and fire management regimes would be issues. Burning only a fraction of the habitat at a time, and having plots with variable lengths of time between burns, are recommended strategies for maximizing the chance of preserving sandhill dependent Lepidoptera in general. Without knowing what grasses the larvae feed on, we cannot be more specific. The Ordway Preserve does conduct burns, but according to Hugo Kons, the collection site did not appear to have burned recently when he collected the two specimens.

Loss of sandhill habitats to development is a likely threat if this is the breeding habitat. Regulations that prevent or discourage collecting on public lands have undermined efforts to study this and other sandhill species in Florida.

Surveys to document new populations of *Heliocheilus turbatus* may be more urgent than for most moths. This species may really be extremely rare and possibly management dependent. It is quite possible that fires or lack of fires affect the availability of the larval food plant. Some grasses flower and produce seeds mostly following fires. For now, a significant hindrance to further work on this species is that Hugo Kons was denied permission to continue his inventory work at the Ordway Preserve after 2000 (Kons and Borth 2006), so the larval food plant and any management needs are likely to remain unknown. A person familiar with the spring flowering grasses that grow on the Ordway Preserve might be able to locate a population elsewhere, where its life history could be studied.

References

Hardwick (1996), Kons and Borth (2006).

Melaporphyria immortua Grote

Identification

This small (22 mm) moth has an unmistakable color pattern (Figure 316). Hardwick (1996), Kimball (1965), and Metzler *et al.* (2005) also illustrate the adult.

Range

The main range of *Melaporphyria immortua* is the Canadian prairie region from Alberta and British Columbia to Manitoba, southward to western North Dakota and Colorado (Forbes 1954). It once occurred disjunctly from eastern Connecticut into New Hampshire and at Albany, New York. More generalized eastern ranges implied by Forbes (1954) and Hardwick (1996) appear to be unsubstantiated by any specimens.

Figure 316. *Melaporphyria immortua* from northeastern Connecticut [either Mansfield or Willimantic] (Marc Minno photo).

This species was named in 1874 from specimens collected at Albany, New York, and Cambridge, Massachusetts. We know of no more recent collections in New York. Farquhar (1934) lists specimens from Sherborn, Newton, and Berlin, Massachusetts, with the most recent in 1919. Forbes (1954) also mentions New Hampshire. There are specimens in collections collected from 1955 to 1958 at Mansfield, or possibly at immediately adjacent Willimantic, Connecticut (including Yale University's Peabody Museum and Harvard University's Museum of Comparative Zoology).

We doubt the accuracy of the Orlando, Florida, record in Kimball (1965), because this is more than 1,000 km out of the known range. Kons and Borth (2006) likewise doubt the Orlando record, yet this information was repeated by Heppner (2003), but notably not mentioned by Hardwick (1996). If the species did occur in Florida, it is very unlikely that the flight season there would be in June, the same time as much farther north.

Mansfield or Willimantic, Connecticut is the likely place of origin of the "Orlando" specimen. Kimball (1965) provides a figure of a specimen from Connecticut.

Rarity

NatureServe global rank: GU.

This moth has disappeared from the northeastern United States and is rare elsewhere in its range. There are specimens from eastern New England and adjacent New York, collected mostly before 1920. It persisted in Connecticut until at least 1958. Its status in the western part of its range is not known to us, but Hugo Kons informs us that Kyle Johnson recently collected one in northern Minnesota.

Life history

In the northeastern United States, adults have been collected from 10 May to 13 June. Based on other heliothines, the egg and larval stage are probably brief, with pupation underground by early July.

Host plants

This species has been rumored to feed on lupine (*Lupinus* species), but we cannot find a source for this. Evidence that is consistent with a lupine host includes the late spring phenology, the Cambridge, Massachusetts, and Albany, New York, localities, its persistence into the mid-20th century in or near the Mansfield-Willimantic sandplain in Connecticut (Yale Peabody Museum), and its apparent extirpation east of the prairie region.

However, there is a specimen in the Yale Peabody Museum taken by Sidney Hessel, a reliable source, labeled Willimantic, Connecticut "bred 1959 *Thalictrum*." *Thalictrum* (meadowrue) species are plants in the Ranunculaceae family and several species are common in New England and much of the northern United States and eastern Canada. Such a common plant seems odd as the food plant for such a rare, disjunct moth. But additionally, Herman Wilhelm found *Melaporphyria immortua* in Connecticut "by alders" with the "moths on *Thalictrum*." This observation was communicated by Auburn E. Brower to Dale Schweitzer on 18 October 1975, based on notes from a visit Schweitzer made to Auburn E. Brower. Both Sidney Hessel and Auburn E. Brower knew Herman Wilhelm. The description of the collection location suggests areas along the Willimantic River just downhill from Wilhelm's house. Hessel collected at least three adults (at the Yale Peabody Museum) at this site on 3 June 1958, and additional specimens should be present at Harvard's Museum of Comparative Zoology. This was the last collection in our coverage area that is known to us.

Tim McCabe has suggested to us that other Ranunculaceae might be the primary food plants. For example, *Ranunculus rhomboideus* would be plausible in the North Dakota Badlands where Tim McCabe collected specimens in 1974, and *Ranunculus abortiva* occurs on the Albany, New York pine barrens. Tim McCabe noted that the adult flight period of *Melaporphyria immortua* fits the flowering times of these plants as well as of lupine. Several other genera of Ranunculaceae, such as some columbines (*Aquilegia* species), also have suitable phenology. It is also possible that Sidney Hessel reared the *Melaporphyria immortua* larvae in captivity on a plant unrelated to any that they use in nature. Brower's note of "moths on *Thalictrum*" could refer to nectaring adults.

Habitat

This seems to be primarily a prairie species. We do not know if eastern habitats where this species was found were wooded. We include this species in this book primarily to make available what little information we have. The habitat where Herman Wilhelm probably collected specimens was at the edge of a partially wooded sand plain along the Willimantic River, where he lived.

Threats & management issues

Given the documented flight period, and assuming the basic life history is similar to all other temperate Heliothinae, first instar larvae could be present in some years during *Btk* applications aimed at gypsy moth larvae. They would probably be killed if they ingested any of the spray.

The underground pupae should survive fires well.

Without knowing the food plant, we cannot assess the threat from deer, but lupine flowers are highly favored, and *Thalictrum* species are also eaten.

References

Forbes (1954), Kimball (1965), Kons and Borth (2006), Hardwick (1996), Metzler *et al.* (2005).

Stoneroot flower moth

Psectrotarsia hebardi Skinner

Identification

The color pattern of this medium-sized (30 mm) moth is unique (Figure 317). There are no remotely similar species in its range. Rings *et al.* (1992) and Hardwick (1996) also illustrate the adult. Images of an adult and two larvae are available at John Snyder's website (http://facweb.furman.edu/~snyderjohn/leplist/e-hebardi.htm). The larva is shown in Figure 318.

Figure 317. *Psectrotarsia hebardi* from Warren County, New Jersey, reared from a larva (David Wagner photo).

Figure 318. *Psectrotarsia hebardi* larva from Warren County, New Jersey (David Wagner photo).

taxonomic notes

Lafontaine and Schmidt (2010) transferred *Erythroecia hebardi* to the genus *Psectrotarsia*.

Range

Psectrotarsia hebardi is known from only a few sites. These include Scioto County in southern Ohio, two sites in Greenup County, Kentucky, four sites (two current) in the northwestern New Jersey limestone region (Warren and Morris counties), and one recent site in Bath County, Virginia. Collections at Hot Springs, Virginia, were on 15 August 1916 (Skinner 1917, 1921), and the Hopatcong, New Jersey, collection (Forbes 1954) probably dates to around that time.

Rarity

NatureServe global rank: GU.

Psectrotarsia hebardi was included on the U.S. Fish and Wildlife Service Category 2 list prior to 19 July 1995. The food plant and potential habitats are common in much of the eastern United States, yet this moth is known historically or recently from fewer than a dozen localities in five states.

In our experience, the adults do not come readily to lights at night, as was also pointed out to Dale Schweitzer by Eric Metzler. Furthermore, none has been found at bait. As a result, this moth could easily be overlooked even where it is common.

The best survey technique might be to search for the larvae on the host at night in forested tracts where the food plant is still abundant. Such efforts in 2006 and 2007 verified that this species is still extant in New Jersey, but apparently is quite scarce.

While this species could be, to some extent, an example of false rarity, it seems likely that most seemingly suitable habitats do not have populations.

Life history

This is apparently the only species of the genus for which any biological information is known. Steve Hooper discovered larvae in southern Ohio where they eat the flowers and developing seeds of stoneroot (*Collinsonia canadensis*), a large forest herb in the mint family (Lamiaceae). This is also the food plant in New Jersey.

There is one brood per year, with the adults occurring mostly in August. The larvae mature in late August or September.

Although substantial suspected feeding damage was found, only one larva of this moth was found during a two-hour search of *Collinsonia* plants in New Jersey by Joseph Garris, Anthony McBride, and Dale Schweitzer on 7 September 2006. This suggests that most larvae had already completed feeding. The one larva collected became prepupal the next day, and the moth eclosed before dawn on 23 August 2007. Older larvae probably rest in the litter or soil and ascend the plants at night to feed. Pupae spend most of the year underground. Anthony McBride has had several pupae overwinter twice before producing adults.

Host plants

The larvae of *Psectrotarsia hebardi* eat the flowers and developing seeds of stoneroot, also known as horse balm and richweed (*Collinsonia canadensis*). This large forest herb in the mint family (Lamiaceae) is also host to two somewhat rare *Papaipema* species, which are stem and root borers (see our separate accounts for *Papaipema astuta* and *Papaipema duplicata*). *Psectrotarsia hebardi* has occurred with *Papaipema astuta* at two known sites in New Jersey.

Habitat

This moth is found in rich deciduous forests, with abundant flowering food plants in vigorous condition in the understory. One current New Jersey site, in a well-hunted wildlife Management Area, supports some enormous (1.5 m tall) examples of the food plant.

Threats & management issues

Much of this moth's potential habitat has been lost to development, especially in and near northern New Jersey.

Overly abundant deer have obliterated the native understory flora in much of northern New Jersey and some other areas, resulting in further loss and fragmentation of habitats. *Collinsonia canadensis* survives occasional herbivory by deer, but flower production is reduced. Where such herbivory is more frequent, the few remaining plants have only a few small leaves and do not flower. We are not certain of the extent to which deer eat the flowers and seeds, but they would be potential direct predators of *Psectrotarsia hebardi* larvae at night.

In addition, rich forest understories in the northeastern United States are becoming increasingly dominated by invasive exotic plants. The invasive plants can potentially out compete the native herbaceous flora, such as *Collinsonia canadensis*, and therefore make the native flora unavailable to specialized herbivores that depend on these plants. While the food plants often seem to survive among these exotics, they tend to be stunted and produce few flowers.

Gypsy moth damage and control efforts, as well as *Compsilura*, are unlikely to impact *Psectrotarsia hebardi*, due to its phenology and habits.

References

Covell (1999), Forbes (1954), Hardwick (1996), Rings *et al.* (1992), Skinner (1917,1921).

False foxglove seed caterpillar[21]

Pyrrhia aurantiago

Identification

A medium sized (25–33 mm) orange moth, with the spots, basal and subterminal areas, and outer portion of the hindwing variably purplish (Figure 319). The lines, especially the postmedian, are jagged and blackish. Very fresh specimens may be so heavily overlaid with reddish scales as to obscure the markings. The lines become more obvious as the scales wear off. The only similar species in our area is *Pyrrhia cilisca* (known as *Pyrrhia adela* of authors), on which the postmedian line is not jagged and the spots are not purplish.

The larva is shown in Figure 320. Usually the larva will be identifiable by its close association with the food plants, and from our image. Kimball (1965), Rockburne and Lafontaine (1976), and Covell (1984) also illustrate adults.

Figure 319. *Pyrrhia aurantiago* from New Haven County, Connecticut (David Wagner photo).

Figure 320. *Pyrrhia aurantiago* larva from Hampden County, Massachusetts (Michael W. Nelson photo).

[21] We consider the common name of "orange sallow" used by Covell (1985) to be inappropriate. The term "sallow" originated in England and is usually applied to early spring moths such as Xylenini that visit sallow (*Salix* spp.) flowers.

Taxonomic Notes

Until recently, this moth was called *Rhodoecia aurantiago*.

Range

This species is spottily distributed in sandy or rocky places from southern Maine and the hills around Boston, Massachusetts, west across southern Ontario to southwestern Wisconsin and Missouri, and south into Florida and Texas.

Rarity

NatureServe Rank: G3G4.

With such a large range, one would think this moth must be common someplace. If so we do not know where. It is apparently uncommon to rare from Connecticut through the Ohio Valley region, in the mountains south to north Georgia, and in the Coastal Plain of New Jersey and North Carolina (Bo Sullivan and Steve Hall personal communications with Dale Schweitzer), as well as in Texas and Louisiana. *Pyrrhia aurantiago* is very localized with few known occurrences in most of its range. For example, only one has been found recently in Wisconsin, in Grant County (Hugo Kons). Closer to the core of the range, the species is considered uncommon in Kentucky where Covell (1999) reported only three localities, and in Ohio where Rings *et al.* (1992) report it from only six southern counties. Albu and Metzler (2004) do not report it from adjacent southern West Virginia, although Steve Johnson collected two in Boone County in 2003. Ed Knudson (email to Dale Schweitzer on 10 January 2009) reports only two recent specimens from Texas (Tyler and Travis counties). Steve Roble (personal communication with Dale Schweitzer in January 2009) reports only one recent locality for Virginia, in Nottoway County, and an old record for Montgomery County. Nine specimens have been collected in the last two decades in five counties in eastern North Carolina. Only one *Pyrrhia aurantiago* was found during recent intensive inventory in Great Smoky Mountains National Park (James Adams email to Dale Schweitzer on January 2009). Adams reports it as rare in Gordon and Whitfield counties in northern Georgia, but it may be more regular in the Ohoopee Dunes farther south in Emanuel and Tattnal counties. Even with intensive nightly effort, Vernon Brou (as of January 2009) has only 27 Louisiana records, most at Abita Springs, which would be an average of about one per year. Furthermore, he notes that none has been seen since the post-Hurricane Katrina deer explosion on and near his property. *Pyrrhia aurantiago* is apparently less rare in Massachusetts, where it is considered a threatened species. However, to some extent this reflects the persistent well-targeted efforts of the state's Natural Heritage and Endangered Species Program.

One or two of the known food plants are reported from every mainland county in or contiguous to Massachusetts (U.S. Department of Agriculture PLANTS database profiles). Notably, Farquhar (1934) reported this moth from three places near Boston even before the local food plants were known. *Pyrrhia aurantiago* has been found at over 20 places from the coast to the edge of the Berkshires between 2003 and 2008, so Massachusetts may really be a stronghold.

Pyrrhia aurantiago is still found regularly in northern Florida (Jeff Slotten) where Kons and Borth (2006) indicate the habitat is xeric oak-pine scrub, typically with turkey oak and longleaf pine.

This moth was also extant between 1992 and 1994 in the Indiana Dunes near Gary (Dale Schweitzer observation), in southern New Jersey (rare, Dale Schweitzer observation), in Virginia (Chris Ludwig observation), and in Texas (Ed Knudson observation). It is considered extant (2009) in North Carolina (Steve Hall observation) and on Long Island, New York (Hugh McGuinness observation).

As far as we know, the species is historic, but not presumed extirpated, in Maine, New Hampshire, Connecticut, mainland New York, and Maryland. Tietz (1952) did not report any Pennsylvania records, and Steve Johnson and Dale Schweitzer have not collected it there. The U.S. Department of Agriculture PLANTS database profile maps show the food plants to be spottily distributed in most of those states other than in New England.

Based on continuous county-level distribution for the three documented food plants, this moth might be concentrated along the Gulf coast from Florida to southeastern Louisiana, and from northern Indiana and southern Wisconsin through Missouri and northern Arkansas. The species could turn up more widely in the Carolina Sand Hills, especially if *Aureolaria pectinata* is a food plant. If *Aureolaria laevigata* is also a food plant, then *Pyrrhia aurantiago* could be widespread in the mountains from Pennsylvania to the Smokies, but there is no evidence that it is. However, many of these *Aureolaria* records are old, and *Aureolaria* species often occur as widely scattered small patches in many parts of their ranges, such as from Pennsylvania to Rhode Island.

Life history

Like most Heliothinae, this one is single-brooded with adults in late July to early September northward, September in North Carolina and Texas, and in September through October in Florida.

The eggs are probably laid in the flowers of the food plant. The larvae mature over several weeks in September and October northward, sometimes after the first frost, with stragglers into November near Boston.

Young larvae live inside the developing seed pods. Older larvae become too big for the seed pods and must leave. They bore a hole in the side of the pod and reach inside to feed, mostly at night. These holes are easily found in fall and winter as long as the stems remain standing. Older larvae are easy to find during the day, because they either remain on the pods or rest in litter at the base of the plants.

Pupation is in the soil. Dale Schweitzer has never had any pupae (n=27) overwinter more than once, although reared pupae are usually small. Perhaps better provisioned individuals occasionally remain in diapause for an extra year or two. Comparably under-sized, reared *Schinia nubilia* and *Schinia arcigera* pupae often overwintered two or three times before the moths eclosed.

Host plants

Larvae eat developing seeds of false foxgloves (*Aureolaria* species). *Aureolaria pedicularia* is widely used, along with *Aureolaria grandiflora* in Illinois (Crumb, 1956, crediting A. K. Wyatt) and *Aureolaria flava* in New England (Dale Schweitzer observation). A report of *Dasistoma macrophylla* (formerly known as *Afzelia macrophylla*) being used as a food plant goes back to at least Farquhar (1934), and is repeated by Forbes (1954) and Kimball (1965) but is not repeated by Crumb (1956) or Hardwick (1996), and should be verified. All of these are tall, yellow-flowered woodland herbs in the snapdragon family (Scrophulariaceae), and *Aureolaria* are hemiparasites on oak roots.

Larvae do not occur on *Aureolaria virginica* even where it is common in the habitat. Other food plant records in Robinson *et al.* (2002) are either incorrectly attributed to Forbes (1954) and Kimball (1965), or cannot be readily traced to their original sources. *Agalinis*, attributed to both, is an incorrect interpretation of Wyatt's and Forbes' *Gerardia*. *Agalinis* and *Aureolaria* were both formerly in *Gerardia*. Similarly, *Seymeria*, attributed to Forbes, is a misinterpretation of his *Afzelia* (see http://plants.usda.gov/java/profile?symbol=SECA4).

Adults are nocturnal and visit flowers, including *Aureolaria* species, for nectar. They also come to bait and blacklights.

Habitat

Populations occur in dry sparsely wooded terrain or in openings in dry oak forest. They are often found on rock outcrops, ledges, powerlines through oak woods, edges of openings in oak savannas, sand hill oak scrub, or in the understory of frequently burned oak or oak-pine woodland. In other words, they live in dry, rocky or sandy wooded places where any of the food plants are common, or at least widely distributed. Hill top colonies of the butterfly *Euphydryas phaeton* utilizing *Aureolaria*, are probably good indicators for the presence of this moth, even if they are transient, as they are in New England.

Threats & management issues

Threats to the false foxglove seed caterpillar include fire suppression in much of the range. Deer are a threat in the Northeast, Texas (Ed Knudson), and Louisiana (Vernon Brou). Rapid development of upland habitats threatens this species in Florida.

Allowing deer hunting may be the most important issue, and Steve Hall notes that the recent North Carolina records are all from well-hunted areas, as were those in the 1980s and 1990s in southern New Jersey.

An aggravating factor is that *Aureolaria pedicularia*, which is possibly the most commonly used food plant, and *Dasistoma macrophylla*, another alleged food plant, are annuals. *Aureolaria pedicularia*, at least, is strongly associated with recent disturbances, such as fires. Thus these food plants may be absent some years. If pupae always eclose the first summer, then populations inhabiting isolated habitats would be vulnerable even to short-term failure in their food supply. If a perennial food plant like *Aureolaria flava* is also present, and some stems escape herbivory long enough to produce seed pods, the moth could survive. However, repeated browsing by deer can kill *Aureolaria flava* (Dale Schweitzer observation).

From late fall to spring, frequent prescribed burning, such as at Lebanon State Forest, New Jersey in the 1980s and at Indiana Dunes National Lakeshore in the 1980s through the1990s, or fires due to carelessness or vandalism, such as near Boston and Worcester, Massachusetts from the 1980s to the present (Mike Nelson and Dale Schweitzer observation), appear to greatly benefit *Pyrrhia aurantiago* where *Aureolaria pedicularia* is the main food plant. The Virginia site also burns frequently. Except in late summer or early fall when adults and larvae occur, mortality in fires is unlikely.

Some populations may need little management other than deer control. One such population was located on the trap rock outcrops above New Haven, Connecticut in the 1970s, where the moths relied mostly on the perennial *Aureolaria flava*. In such places, some food plants on ledges and cliffs are often out of reach of deer.

While most habitats are vulnerable to gypsy moth outbreaks, neither defoliation nor control efforts are likely to impact *Pyrrhia aurantiago* directly.

References

Covell (1984), Covell (1984,1999), Crumb (1956), Farquhar (1934), Ferge and Balogh (2000), Forbes (1954), Hardwick (1996), Kimball (1965), Kons and Borth (2006), Rings *et al.* (1992), Robinson *et al.* (2002), Rockburne and Lafontaine (1976).

Schinia arefacta (Henry Edwards)

Identification

This small (26 mm) moth has brown forewings with a thick blackish median line, white antemedian and postmedian lines, and a pale terminal area (Figure 321). Hardwick (1996) and Kimball (1965) also illustrate the adult.

Range

Schinia arefacta occurs in northern and central peninsular Florida. It has also been found in the Ohoopee Dunes of Emanuel County, Georgia, where Irving Finklestein and James Adams collected eight specimens on 4-5 September 2010.

Figure 321. *Schinia arefacta* from Putnam County, Florida (Marc Minno photo).

Rarity

NatureServe global rank: None, but G2G3 seems appropriate.

This moth has a limited range and is rapidly losing habitat as uplands are developed for housing and other uses. Kons and Borth (2006) report only two localities.

The host plant has been documented from 21 counties in Florida (http://plants.usda.gov/java/profile?symbol=CHRYS7). It is not rare (G4G5), but is not necessarily still found in all of these counties. The moth is probably less persistent than the plant in degraded, fragmented habitats. We do not even know if the moth's range is as large as that of the food plant. We doubt the *Schinia arefacta* is imperiled now, but it is unlikely it could be considered secure.

Life history

Schinia arefacta larvae are green. They feed exposed on the outside of the flower heads of the host (Jeff Slotten). In Florida, this species often occurs together with *Schinia petulans*, which has the same food plant.

Host plants

The larvae eat the flowers of scrubland golden aster (*Chrysopsis subulata*), a wildflower stated to be endemic to Florida (Wunderlin and Hansen 2003). It is unclear whether it uses the same plant in Georgia.

Habitat

This moth is found in dry pinelands, such as long leaf pine/turkey oak woodland, where the food plant grows in Florida. The habitat is similar, or perhaps a bit less wooded, in Georgia.

Threats & management issues

The threats to *Schinia arefacta*, if any, are unknown, but general issues are covered in our discussion in the Subfamily Heliothinae section.

References

Hardwick (1996), Kimball (1965), Kons and Borth (2006).

Schinia petulans (Henry Edwards)

Identification

This is a medium-sized (26 mm) and variable moth (Figure 322), similar to several other *Schinia* species. Hardwick (1996) illustrates the adult and larva, but provides almost no descriptive notes or diagnostic characters for the moth.

Range

Northern and central Florida apparently into southern Georgia. Specimens of *Schinia petulans* or a similar unnamed species occur as far west as east Texas (Bordelon and Knutson (1999) and north to Ohoopee Dunes in central Georgia.

Figure 322. *Schinia petulans* from Putnam County, Florida (Marc Minno photo).

Rarity

NatureServe global rank: None, but G2G3 seems appropriate.

Schinia arefacta has the same food plant in Florida. Kons and Borth (2006) found this species at only one locality in northern Florida. Jeff Slotten has found both species at other places.

Life history

The larva of *Schinia petulans* is brown with mottling, similar to *Schinia fulleri*, and has been reared by David Wagner and Jeff Slotten. The larvae hide inside the host flower heads tied with silk. Unless there are two sibling species, dates given by Hardwick indicate two flights, July and September–October, although this would not necessarily be two broods.

Host plants

The larvae eat the flowers of scrubland golden aster (*Chrysopsis subulata*), a wildflower stated to be endemic to Florida (Wunderlin and Hansen 2003). It is unclear whether the same plant is used in Georgia.

Habitat

This moth is found in sandy long leaf pine/turkey oak woodland or other places with the food plant. This moth sometimes occurs in the same places as *Schinia arefacta* in Florida.

Threats & management issues

The threats to *Schinia petulans*, if any, are unknown, but general issues are covered in our discussion in the Subfamily Heliothinae section.

References

Bordelon and Knudson (1999). Hardwick (1996), Kimball (1965), Kons and Borth (2006).

Schinia carolinensis (Barnes and McDunnough)

Identification

The forewings of this small (22 to 24 mm) moth are immaculate straw yellow (Figure 323). The hindwings are dark grayish with a darker discal spot. Kimball (1965) and Hardwick (1996) also illustrate the adult.

Range

Schinia carolinensis occurs in the Sand Hills and Coastal Plain of North Carolina, south to Florida and probably west along the Gulf coast.

Rarity

NatureServe global rank: G3.

This species is very local and thought to be declining.

Figure 323. *Schinia carolinensis* from Ocala National Forest, Marion County, Florida (Marc Minno photo).

Life history

Nothing is known about the biology of this species. The adults occur as early as 1 August northward, and as late as late September southward. Adults come readily to light traps and can also be flushed from pine savannas during the day according to Bo Sullivan.

Host plants

The food plant is still unknown (Jeff Slotten).

Habitat

According to Steve Hall, *Schinia carolinensis* is associated with wet pine savannas and sandhill seepage bogs in North Carolina. These would probably be fire-maintained habitats. One recent Florida specimen was found in dry long leaf pine/turkey oak sandhill at the Ordway Preserve. Another was not associated with any discernable habitat.

Threats & management issues

The threats to *Schinia carolinensis*, if any, are unknown, but general issues are covered in our discussion in the Subfamily Heliothinae section.

References

Hardwick (1996), Kons and Borth (2006).

Phlox flower moth

Schinia indiana (J. B. Smith)

Identification

This pretty moth is among the smallest of heliothines (16 to 19.5 mm), and among the few that fly early in the season. The crimson and violet forewings, olive thorax, and yellow tip on a black abdomen are very distinctive (Figure 324). Hardwick (1996) also illustrates the adult and the larva. Ferge and Balogh (2000) and Bordelon and Knudson (1999) show adults. Any heliothine larva on phlox in late spring will almost certainly be this species.

Figure 324. *Schinia indiana* (phlox flower moth) from Montcalm County, Michigan (Marc Minno photo).

Range

This moth occurs or is historical in central and northeast Wisconsin, near Chicago, Illinois into nearby northwestern Indiana, Minnesota, and Michigan (Forbes 1954, Schweitzer 1989, Hardwick 1996). Because Hardwick had not seen any southern specimens, those from Nebraska (no date) and College Station Texas (4-8-18), which were identified as *Schinia indiana* at the National

Museum of Natural History as of March 1987, and accepted as this species by Schweitzer (1989) and in part by Forbes (1954), should be re-verified. However, James Adams reports an authentic specimen collected by Fattig at Atlanta, Georgia in 1944. A specimen from central Texas (Mason County) is illustrated by Bordelon and Knudson (1999). The North Carolina specimen cited by Forbes (1954) in the State Department of Agriculture Collection in Raleigh does not appear to be this species (Dale Schweitzer observation).

Rarity

NatureServe global rank: G2G4.

There are fewer than twenty documented recent sites for this moth, and some of these may no longer be extant. There is a chance that this moth has been widely overlooked, due to its small size and especially its habits. The moths are diurnal and do not come to lights. Hugo Kons reports that sweeping the flowers of the food plant can be an effective search technique. Adults are most easily found when they are sitting on the flowers of the food plant during cool cloudy weather (Swengel and Swengel 1999a), but not on warm sunny days when searches are often conducted. Similarly, Hugo Kons reported that an effort at a Menominee County site during hot and sunny conditions yielded no individuals, although some had been found at other sites earlier in the day when it was cooler. At the same site the following day, under sunny but cooler conditions, they found 21 individuals in 35 minutes. This species seems more likely than many moths to be overlooked where it is actually present. On the other hand, very few modern sites are known, and most are near the northern limit of its range.

Loss of habitat seems to be an adequate explanation for the decline of this moth, but it can persist in degraded habitats. Hardwick (1996) found a good population in a small scrap of habitat in industrial Hammond, Indiana.

Life history

Adults of this moth occur when the food plant flowers. This is in April and May in Texas and from late May into mid-June northward. The specimen from Texas at the National Museum of Natural History was collected in April.

The egg stage is undoubtedly less than a week in duration, and the larval stage lasts about two weeks. This is according to Hardwick (1996), although Crumb (1956) stated that the larvae persist into August, which seems unlikely. Hardwick (1996) considered the moths to be inactive. He suggested they spend most of their time resting on the food plant flowers, but this is apparently not the case during hot weather.

This species apparently does not fly at night, which might be a good time to find them at rest, although we are not aware of any such efforts.

Host plants

The larvae feed on the flowers of downy phlox (*Phlox pilosa*) in the family Polemoniaceae.

Habitat

Ferge and Balogh (2000) considered this moth to be a pine barrens species in Wisconsin, which is consistent with Swengel and Swengel (1999a). Metzler *et al.* (2005) concluded that *Schinia indiana* is not dependent on remnant native grasslands, which is consistent with Hardwick (1996). However, the species seems restricted to regions of former savannas or barrens. Hugo Kons reports finding the species in oak-pine barrens and roadsides through dry oak pine forests. The known habitats are dry and sandy, but the food plant occurs in other habitats, as might the moth, especially southward where it is very poorly known.

Threats & management issues

The threats are essentially the same as for other heliothines, except that the larvae are present earlier in the season and possibly could be exposed to gypsy moth spraying, especially when two applications are made. Presumably the early instars could be killed by *Btk* if they ate it, but they would probably largely escape exposure, since they are inside the flowers. Older larvae would not likely be exposed.

We do not know if deer abundance is an issue with this food plant.

Hugo Kons reports much of the Menominee County barrens habitat was being converted to lawns by cottage owners in the early 1990s. Extensive habitat still remained along the edges of oak forest along roadsides. Populations in such places would be very vulnerable to roadside mowing during the larval stage.

References

Bordelon and Knudson (1999), Balogh (1987), Ferge and Balogh (2000), Forbes (1954), Hardwick (1996), Metzler *et al.* (2005), Swengel and Swengel (1999a).

Schinia rufipenna Hardwick

Identification

This small (21.5 to 24 mm) moth (Figure 325) is very similar to *Schinia tuberculum*, which shares its food plant, and less so to *Schinia septentrionalis,* with which it occasionally hybridizes in Louisiana, according to Hardwick (1996). While specimens can be tentatively identified from our illustration, and those of Hardwick (1996), we suggest getting expert confirmation.

Figure 325. *Schinia rufipenna* from Blackwater River State Forest, Santa Rosa County, Florida (Marc Minno photo).

Range

This moth occurs in scattered sites in Florida and southeastern Louisiana. The types were collected by Hardwick (1983) at Lake Placid near the Archbold Biological Station in Highlands County, in south-central Florida. He also had an old specimen from Orlando. Jeff Slotten has collected specimens at Blackter River State Forest in Okaloosa and Santa Rosa counties in the Panhandle. Hardwick (1996) also knew of specimens from Abita Springs, Louisiana.

Schinia rufipenna probably does not range northward along the Atlantic coast like *Schinia tuberculum*, which extends disjunctly as far as Massachusetts.

Rarity

NatureServe global rank: G2G4.

So far this moth is known from only four counties and one parish. Notably it was not found in extensive efforts by Kons and Borth (2006) in northern Florida. Hardwick collected the type series in 1979 at the Archbold Biological Station in Lake Placid, Florida. Although the Archbold Biological Station is a well-maintained natural area, *Schinia rufipenna* has apparently not been found again in central Florida since then. There is no known reason why *Schinia rufipenna* would be overlooked more than other *Schinia* species. More populations will likely be found, but this species is apparently much less abundant than *Schinia tuberculum*, which feeds on plants in the same genus.

Life history

Hardwick (1996) substantially revised his discussion of the biology of this moth from the original description (Hardwick 1983). Properly fed larvae would probably mature in about half the 37 days reported originally. The larvae eat the florets and developing seeds of the host.

Adults occur in November, and occasionally in late October, in central Florida. Probably all larvae pupate by mid-December. Adults probably occur mostly in October northward, and are diurnal and nocturnal. Mating takes place on the flower head of the food plant, apparently mostly in the daytime.

Host plants

The food plant is narrowleaf silkgrass (*Pityopsis graminifolia*), a wildflower in the aster family (Asteraceae).

Habitat

The habitat is grassy, longleaf-pine sandhills. The food plant is common throughout Florida in pine flatwoods and sandhill habitats.

Threats & management issues

The habitats of *Schinia rufipenna* are rapidly being converted to agricultural and urban land uses. Other general issues are covered in our discussion in the Subfamily Heliothinae section.

References

Hardwick (1983, 1996).

Aster flower moth[22]

Schinia septentrionalis (Walker) (formerly *Schinia brevis* Grote)

Identification

Although it is a relatively small to medium-sized moth (23 to 26 mm), *Schinia septentrionalis* is one of the more robust species in its genus. As noted by Forbes (1954), this is a thicker-winged, heavier-bodied moth than most eastern *Schinia* species. Adults are variable in the amount of red-brown and black on the forewing (Figure 326). The hindwing pattern is more diagnostic. It will be either solid black with a yellow fringe, or, as Forbes (1954) describes it, mainly black with 2–3 yellow spots at the center, somewhat like our illustration of *Schinia rufipenna* but more yellow. The spotted effect results from the unusually extensive black margin and discal spot largely obscuring the median whitish yellow area. The hindwings typically have a median whitish yellow area bisected by a dark black discal patch and a broad black border producing this spotted effect. The base of the hindwing is dusky gray to black. Holland (1903 as *Schinia brevis*), Kimball (1965), Hardwick (1996), Handfield (1999), Ferge and Balogh (2000), and Metzler *et al.* (2005) also illustrate adults.

Figure 326. *Schinia septentrionalis* (aster flower moth) from Mt. Holly, Burlington County, New Jersey [1906] (David Wagner photo).

Range

This species is, or was, very widespread in the western United States Its range extended eastward, mostly in the prairies, to northwestern Indiana, the Chicago area, and perhaps western Michigan (one locality). East of the prairies, *Schinia septentrionalis* has been found mostly within 100 kilometers of the coast, but not necessarily on the Coastal Plain, from southern Maine to southern Delaware (Metzler *et al.* 2005), and near the coast or in the Sand Hills from North Carolina to Louisiana. Extant populations can be found in sand plain or coastal areas near Concord, New Hampshire (Mark Mello), widely in southeastern Massachusetts (Mello and others) and eastern Connecticut (David Wagner observations), near Montauk, Long Island, New York (The Nature Conservancy, identified by Dale Schweitzer), and in southeastern North Carolina. We presume it can also still be found in its Gulf Coast range. Otherwise, this is now a species of the Chicago area (Panzer *et al.* 1995) and southern Wisconsin (Ferge and Balogh 2000) prairies and regions to the south and west, where, in the past, it ranged as far as Texas and Arizona (Forbes 1954, Crumb 1956). A concentration of records near the coast from New England to New Jersey, then a disjunction to eastern North Carolina, is a familiar pattern. The disjunction suggests this species is a prairie or savanna relict eastward. The gap through northeastern Massachusetts shown by Metzler *et al.* (2005) is not real, because Farquhar (1934) had records in the Boston area. Metzler *et al.* (2005) map two

[22] We do not use Covell's (1984) common name of northern flower moth which, although derived from the scientific name, is inappropriate given the actual distribution.

peninsular Florida localities, but these may be misidentifications. One of these, the Winter Park record in central Florida, is very dubious based on the date given as 1 September by Kimball (1965). Hardwick (1996) does not mention *Schinia septentrionalis* from Florida, nor can Jeff Slotten or Hugo Kons vouch for its occurrence there. Kimball's record from Escambia County in the Panhandle is plausible, but unverified.

Between the coasts and the mid-continent prairie region, there are also widely scattered eastern inland records, summarized here. Among inland records mapped by Metzler *et al.* (2005) or otherwise known to us, east of western Michigan and western Indiana, only seven localities are more than 100 km from the coast or Carolina Sand Hills. Two of these seven were single specimens captured by Tim McCabe in very well-collected places in New York, who collected one adult on New England aster (formerly known as *Aster novangliae*) near Ithaca in 1974, apparently the only one for this region. He collected another in 1991 at Albany at blacklight (where he has over 25 years of nearly nightly samples). The other five such localities include one near Montreal, Canada before 1912 (Handfield 1999), and Metzler *et al.* (2005) map locations in or near Lewis County, New York, and in southwestern Pennsylvania, western North Carolina, and Kentucky.

We know of only two specimens of *Schinia septentrionalis* from the entire Piedmont, both near its northeastern end. One of these was collected by F. M. Jones in 1934 in New Castle County, Delaware, and the other by Dale Schweitzer in 1964 in adjacent Delaware County, Pennsylvania. Both of these sites are within 100 km of the coast, as is one near Allentown, Pennsylvania (Metzler *et al.* 2005), just northwest of the Piedmont. These authors show only one locality from Kentucky (Covell 1999 had no records). Metzler *et al.* (2005), Ferge and Balogh (2000), and Kons and Borth (2006) conclude that several species of *Schinia* stray significant distances, and because *Schinia septentrionalis* is a larger, more powerful moth than almost all of its congeners, these widely scattered records away from coastal or prairie regions could have been strays, or may represent ephemeral populations. From the above sources and Tietz (1952), it appears that the species was taken several times in the Pittsburgh area before 1950, so there probably were populations in western Pennsylvania. We know of no records for Ontario, Ohio, Maryland, the Virginias, Tennessee, or Georgia.

Rarity

NatureServe global rank: G3G4.

Schinia septentrionalis has a disjunct, spotty, and reduced range eastward, and is not common westward, where the range may also be discontinuous. The G4 part of this combination reflects lack of information on the status westward. Collection records (e.g. the many states listed by Crumb 1956) suggest that this species was much more common before the 1950s than it is now. While this moth has declined greatly in the Northeast, and is dependent on prairie remnants in the Midwest, we are less certain of its status elsewhere. The fact that Hardwick (1996) collected only a single female in his many years of field work suggests this species had become rare. *Schinia septentrionalis* is historic and quite possibly extirpated from Quebec to New Jersey or Delaware, and Pennsylvania, with last-known collections being from the 1920s to 1964. It is also historic and possibly extirpated in mainland New York, with single collections in 1974 and 1991. The most noticeable decline seems to have been from southwestern Connecticut and mainland southern New York through New Jersey to Delaware, where records in Metzler *et al.* (2005) and Smith (1910) indicate that the species was widespread, but apparently no longer occurs.

This moth should not be widely overlooked, because it can be readily found flying, nectaring, or resting in the daytime and comes to blacklights. Dale Schweitzer looked for this moth around New England aster (a known food plant) nearly annually through the 16 autumns he lived in New England. He found it only once, in the Plymouth, Massachusetts pine barrens, where this aster does not grow. Two of the known food plants have declined in the Northeast; *Aster concolor* is now a very rare plant, and *Aster spectabilis* is noticeably less common now than it was in the 1970s in New Jersey, although it is not considered rare. To some extent the history of this moth in the eastern United States is reminiscent of the regal fritillary butterfly (*Speyeria idalia*), which disappeared almost completely from the East in the second half of the 20th century. Both are fundamentally prairie species that must have been negatively impacted by loss of habitat. Many other shrubland and grassland species have declined due to loss of prairie habitat (Wagner *et al.* 2003b). The regal fritillary thrived for a time in pastures, hayfields, and meadows, and *Schinia septentrionalis* may have as well. Many of the historic records in the east are not from places that would have had natural grasslands.

Life history

Schinia septentrionalis flies in September, starting in late August northward, and probably mostly in October on the Gulf coast. Adults appear to be mostly diurnal, but they do come to lights at night.

The eggs hatch in about five days. The larvae mature in October in New York and Massachusetts and probably as far south as North Carolina. The larvae feed on the flowers and developing seeds of certain blue-flowered asters, which are now placed in three different genera by some authors. Larvae must feed on the achenes prior to pupation (Hardwick 1996).

Host plants

The larvae of *Schinia septentrionalis* eat several blue-flowered asters, and these are also the usual nectar plants for the adults. Recently, many familiar names for these plants have been changed, so we give both the traditional and current scientific names. Specimens from near Chicago, New York City (Forbes 1954), Dale Schweitzer's Pennsylvania male, and Tim McCabe's Ithaca specimen were collected from *Symphyotrichum novangliae*, which Forbes considered to be a food plant. Other food plants include *Symphyotrichum oolentangiense* (formerly *Aster azureus*) in the Chicago area (Panzer *et al.* 1995); *Symphyotrichum laeve* (formerly *Aster laevis*) at Rye, New York (Crumb 1956); *Ionactis linariifolius* in eastern Connecticut (David Wagner observation); and *Symphyotrichum concolor* on Nantucket in Massachusetts (*fide* Mark Mello). Both Dale Schweitzer and Hardwick (1996) found the species in close association with *Eurybia spectabilis* in southeastern Massachusetts, which Hardwick found to be an acceptable food plant in captivity. *Eurybia spectabilis* is also reported to be a food plant by Metzler *et al.* (2005). *Symphyotrichum concolor* and *Eurybia spectabilis* are small, usually under half a meter tall, and are virtually restricted to sandy pine barren or heathland areas in the Northeast. *Symphyotrichum concolor* is more widespread southward. *Ionactis linariifolius* is an even shorter species that occurs on both rocky and sandy substrates, and is often found with *Eurybia spectabilis*. Tietz (1952) also lists *Symphyotrichum puniceus*, a common wetland aster, but we do not know the details. Formerly all of these food plants were in the genus *Aster*.

Habitat

We agree with Panzer *et al.* (1995), Ferge and Balogh (2000), and Metzler *et al.* (2005) that *Schinia septentrionalis* is fundamentally a species of xeric to mesic prairies, often on sand or limestone substrates. Metzler *et al.* also note that it occurs along forest edges in the Ozarks. Other than "high plains" (Harwick 1996), we have no habitat information from the far western parts of the range. From Maine to New Jersey, this moth apparently inhabited a variety of dry, grassy, often successional habitats. This included heathlands and shrublands, which were much more prevalent on sandy soils in the past than they are now (Wagner *et al.* 2003b, Windisch 1999). In New England, *Schinia septentrionalis* is now found mostly on dry, sandy, grassy, powerline right-of-ways through wooded landscapes, often in pine-barren areas. Populations also occur in more natural sandy grasslands and heathlands on the off-shore islands including on eastern Long Island, New York. The use of *Aster novangliae* as a food plant suggests that this moth was not always restricted to dry sandy places.

While there are many old New Jersey specimens (e.g. Smith 1910, Metzler *et al.* 2005), one of which we illustrate, the habitat there is unclear. Few records were from the Pine Barrens region. Dry, sandy, right-of-way habitats similar to those used in New England are common now, but the moth has not been found in decades. (On 19 September, 2011 Dale Schweitzer collected one male nectaring on *Liatris graminifolia* that was growing with *Eurybia spectabilis* in a large sandy airport right of way in Atlantic County.)

Populations of *Schinia septentrionalis* in the Southeast also occur on dry, grassy, Coastal Plain and sandhill pinelands or disturbed areas associated with these habitats.

Threats & management issues

To persist, some of the habitats of *Schinia septentrionalis* require fires or other disturbance. As long as the food plants flower every year, any reasonable fire regimen not involving extensive fall fires should be beneficial to the moth in prairies and in pinelands. Dormant-season mowing is a suitable management regimen for right-of-ways and similar places.

Deer browsing would probably not be a major issue except in extreme situations, because other flowers of many kinds tend to be abundant when asters bloom.

Gypsy moth and its control are not issues, since this *Schinia* species occurs in the autumn.

The larvae are present after *Compsilura* activity has ended for the year. Other general issues are covered in our discussion in the Subfamily Heliothinae section.

References

Brower (1974), Covell (1984, 1999), Crumb (1956), Farquhar (1934), Ferge and Balogh (2000), Forbes (1954), Handfield (1999), Hardwick (1996), Holland (1903), Kimball (1965), Metzler *et al.* (2005).

Appendix 1: Butterflies and macromoths found in the eastern United States, whose caterpillars feed on forest understory plants

An asterisk (*) indicates that we provide a species account above.

Butterflies

Hesperiidae (skippers)

*Autochton cellus** (Boisduval and Le Conte) (gold-banded skipper) G4

Host Plants: Primarily American hogpeanut (*Amphicarpa bracteata*).

Status: Declining. Uncommon to extirpated in its eastern range, but not rare in Arizona and Mexico.

Erynnis lucilius (Scudder and Burgess) (columbine duskywing) G4

Host Plants: *Aquilegia* spp. (columbine), both native and occasionally cultivated.

Status: Declining and now rare over most of New England, Pennsylvania, Ohio, and West Virginia; historical in New Jersey. It is not rare northward and westward.

*Euphyes dukesi** (Lindsey) (Duke's skipper) G3

Host Plants: *Carex lacustris*, *Carex hyalinolepis*, and other large sedges.

Status: Uncommon and local, but often present in the right habitat.

Amblyscirtes vialis (W. H. Edwards) (common roadside-skipper) G4

Host Plants: Grasses.

Status: Rare and declining in much of the northeastern United States, but not in Quebec, Virginia, and western states. This skipper uses more open habitats westward.

Amblyscirtes hegon (Scudder) (pepper and salt skipper) G4

Host Plants: Grasses.

Status: Uncommon to rare, but not obviously declining.

*Amblyscirtes belli** H. A Freeman (Bell's roadside-skipper) G3G4

Host Plants: River oats (*Chasmanthium latifolium*).

Status: Uncommon.

Papilionidae (swallowtails)

*Papilio joanae** J. R. Heitzman (Ozark swallowtail) G3

Host Plants: *Taenidia integerrima*, *Thaspium barbinode*, and *Zizia aurea* in the carrot family.

Status: This species has a limited range, but there has not been any obvious decline.

Pieridae (whites, sulphurs, orange-tips)

*Pieris virginiensis** W. H. Edwards (West Virginia white) G3G4

Host Plants: Toothwort (*Dentaria*) and occasionally rockcress (*Arabis*).

Status: Declining in some areas. Habitat invasion by garlic mustard[23] and parasitoid wasps (*Cotesia glomerata*) are potential threats.

Anthocharis midea (Hübner) (falcate orange-tip) G4G5

Host Plants: The flowers and young fruit of plants in the cabbage family, especially rock-cress (*Arabis* species) and bittercress (*Cardamine* species).

Status: This butterfly is locally common over much of its range.

Lycaenidae (blues, hairstreaks, etc.)

Celastrina neglectamajor Tutt. (Appalachian azure) G4

Host Plants: Black cohosh (*Actaea racemosa*) flowers and young fruit.

Status: This butterfly is not in serious trouble range-wide, but the food plant is harvested and sold as a medicinal herb. Black cohosh persists in areas with moderately abundant deer.

Celastrina nigra (W. H. Edwards) (dusky azure) G4

Host Plants: Bride's feathers (*Aruncus dioicus*) flowers.

Status: Based on limited information, this blue is uncommon in most of its range and rare northward. The G4 rank needs to be re-evaluated.

Glaucopsyche lygdamus nittanyensis F. H. Chermock (silvery blue) G5T3T4

Host Plants: Carolina vetch (*Vicia caroliniana*).

Status: Probably extirpated in New York and rare in Pennsylvania and Maryland, but not as rare southward.

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23 Females oviposit on this increasingly abundant exotic plant, which is lethal to their larvae (e.g., Gochfeld and Burger 1996).

Riodinidae (metalmarks)

*Calephelis borealis** (Grote and Robinson) (northern metalmark) G3

Host Plants: Roundleaf ragwort (*Packera obovata*).

Status: Very local, fragmented, and much reduced from historical times in most areas. This butterfly is limited to forest openings, outcrops, and barrens. Deer eliminate nectar plants but not food plant.

Nymphalidae (brushfooted butterflies)

*Speyeria diana** (Cramer) (Diana fritillary) G3G4

Host Plants: Violets (*Viola* species).

Status: The range of this species has become reduced from historical times. It is most common in the southern Appalachians and Ozarks, and is increasing in some places.

Chlosyne nycteis nycteis (Doubleday and Hewitson) (silvery checkerspot) G5

Host Plants: Varies regionally. Uses woodland sunflowers (*Helianthus* spp.), crownbeard (*Verbesina* species), and some others in the eastern United States.

Status: The univoltine, woodland sunflower-feeding strain disappeared in New Jersey in the 1970s, and from Connecticut in 1986. Other biotypes are fairly common from central Pennsylvania and Virginia westward and southward.

*Phyciodes batesii maconensis** Gatrelle (tawny crescent) G4T2T3

Host Plants: Asters, apparently *Symphyotrichum undulatum*.

Status: Uncommon but not rare. There is no evidence of a major decline. This butterfly has a very limited range.

Phyciodes cocyta incognitus Gatrelle

Host Plants: Asters, but actual species are unknown.

Status: Although Gatrelle (2004) named it as a full species, we suspect this butterfly is just an Appalachian variant of the common northern pearl crescent (*Phyciodes cocyta*), which follows Pelham (2008). This butterfly occurs on U.S. Forest Service land, and is of local conservation concern in Georgia and probably in North Carolina.

Hermeuptychia sosybius (Fabricius) (Carolina satyr) G5

Host Plants: Grasses.

Status: A southern species that is very common in many areas and tolerant of disturbance.

Cyllopsis gemma (Hübner) (gemmed satyr) G4

Host Plants: Grasses.

Status: Uncommon but no obvious decline.

Megisto cymela complex G4G5

Host Plants: Grasses.

Status: Needs taxonomic work to determine if this is one or two species. A second emergence is common from Connecticut westward and southward. This could perhaps represent a second (bimodal) flight of the same species that flies about a month earlier in the same areas. However, the flights are too close phenologically for this to be a second brood.

Lethe anthedon A. H. Clark (northern pearly-eye) G4

Host Plants: Grasses.

Status: Local, and uncommon in some areas, but not in trouble except in peripheral areas. This butterfly now oviposits on, and is associated with, the invasive grass *Microstegium vimineum* in New Jersey.

Moths

Geometridae (inchworm moths)

Gueneria similaria (Walker) G5

Host Plants: Ferns (*Dryopteris, Thelypteris*, and *Dennsteadtia* species).

Status: Generally fairly common where *Dryopteris* ferns grow.

Petrophora subaequaria (Walker) G4G5

Host Plants: Bracken fern (*Pteridium aquilinum*), and perhaps other ferns.

Status: Generally not rare, especially around bracken fern.

Homochlodes fritillaria (Guenée) G5

Host Plants: Bracken fern (*Pteridium aquilinum*) and other ferns.

Status: Common in many places, and often associated with bracken fern.

Homochlodes lactispargaria (Walker) GNR (probably would be G5)

Host Plants: Ferns.

Status: Common to the north and in the mountains.

Homochlodes disconventa (Walker) G4

Host Plants: Ferns. Usually not associated with bracken fern.

Status: Common to the north and in the mountains.

Stamnodes gibbicostata (Walker) G4

Host Plants: Eastern waterleaf (*Hydrophyllum virginianum*) according to Tim McCabe.

Status: Local and rare in the northeastern United States. Its status elsewhere is not well known.

Heterophleps refusaria (Walker) G4

Host Plants: Woodnettle (*Laportea canadensis*) (Wagner *et al.* 2001).

Status: This moth is widespread from Maine to Wisconsin, and is locally common in the mountains. Its status is not well known in some areas.

Heterophleps triguttaria (Herrich-Shäffer) G5

Host Plants: Clearweed (*Pilea pumila*).

Status: Generally this moth is still common, and clearweed persists well in degraded, wet forest understories.

Trichodezia albovittata (Guenée) G4G5

Host Plants: Jewelweed (*Impatiens* species).

Status: Fairly common. The food plants are apparently not favored by deer.

Eupithecia cimicifugata Pearson GNR

Host Plants: The flowers and young fruit of black cohosh (*Actaea racemosa*) and related species.

Status: Its status is unknown. The host plant seems fairly persistent even with deer, but browsing of flowers would eliminate the larvae. Black cohosh is also harvested and sold as a medicinal herb.

Eupithecia indistincta Taylor GNR

Host Plants: False hellebore (*Veratrum viride*) seeds.[24]

Status: The status of this moth is largely unknown, but several were collected in Sussex County, New Jersey in 2010. Deer can severely damage false hellebore in spring.

Eupithecia cretaceata (Packard) GNR

Host Plants: False hellebore (*Veratrum viride*) and death camas (*Zigadenus* species), mostly flowers and seeds, but also leaves.

Status: Fairly common northward. Deer can severely damage false hellebore in spring.

Scopula ordinata (Walker) GU

Host Plants: Reportedly *Trillium catesbaei* (Robinson *et al.* 2002).

Status: Little is known of this species and its larva might be a generalist.

Erebidae (owlet moths in part)

Hypena (or *Bomolocha*) *edictalis* (Walker) G4

Host Plants: Canadian woodnettle (*Laportea canadensis*) (Wagner 2005, Wagner *et al.* in press).

Status: This moth is not known to be in decline and is common at some places in the mountains and Midwest.

[24] This long-suspected food plant has been confirmed by George Balogh.

Bomolocha sordidula (Grote) G4?

Host Plants: Canadian woodnettle (*Laportea canadensis*) (Wagner 2005, Wagner *et al.* in press).

Status: An uncommon species that is often misidentified and falsely reported. There are three recent Virginia records (Chris Ludwig collections), and a few localities in Pennsylvania in 2007 (Betsy Leppo collections determined by Dale Schweitzer), and it is common in Great Smoky Mountains National Park. Hugo Kons indicates that it has been collected recently in Wisconsin, Indiana, and Kentucky.

Bomolocha manalis (Walker) G5

Host Plants: False nettle (*Boehmeria cylindrica*) and probably related genera.

Status: Generally widespread and rather common in moist forests and wetlands.

NOCTUIDAE (OWLET MOTHS IN PART)

Abrostola ovalis Guenée G4?

Host Plants: Stinging nettle (*Urtica dioica*) and undoubtedly native *Urtica* spp. and maybe woodnettle (*Laportea* species).

Status: Historically rare or more likely just rarely collected. This seems to be more of a forest species than the more common *Abrostola urentis*.

Eosophoropteryx thyatyroides (Guenée) G4

Host Plants: Meadowrue (*Thalictrum* species) and wild columbine (*Aquilegia canadensis*).

Status: Uncommonly encountered. There has not been an obvious decline. Adults are found at dusk on flowers of *Collinsonia canadensis* in forests (Rings *et al.* 1992 and Dale Schweitzer observation), and do not come readily to lights. This moth appears to be mainly a forest dweller.

Polychrysia morigera (Fabricius) G4

Host Plants: Larkspur (*Delphinium* species).

Status: This moth is rarely collected eastward, but six recent sites have been found in Virginia (S. Roble). It is also extant in Great Smoky Mountains National Park, and is probably secure in the West.

Papaipema cerina (Grote)* G3G4

Host Plants: Primarily in eastern bottlebrush grass (*Hystrix patula*), but older larvae use, and possibly require, other hosts.

Status: This species is declining in at least the eastern part of its range. In its historical range, none have been found in 30-100+ years in Maine, New Hampshire, Pennsylvania, New York, and New Jersey. There are no records from Vermont, Massachusetts, Ohio, Kentucky, or Virginia. It has recently been found in Connecticut, Michigan, Indiana, Minnesota, and Wisconsin.

Papaipema species* (flypoison borer moth) G2G3

Host Plants: Flypoison (*Amianthium muscaetoxicum*).

Status: Endemic to the Pocono Mountains and vicinity of Pennsylvania, where it is locally very common. Deer shun the food plant.

Papaipema pterisii Bird (bracken borer moth) G5

Host Plants: Bracken fern (*Pteridium aquilinum*).

Status: Common north of 42º N latitude and in northeastern Pennsylvania; naturally rare in New Jersey, Ohio, and Delaware; local in the Virginia mountains. Deer occasionally eat the food plant.

Papaipema species (near *pterisii*) (ostrich fern borer moth) G3G4

Host Plants: Ostrich fern (*Matteuccia struthiopteris*).

Status: Not rare in Vermont, but otherwise local and uncommon in Massachusetts, Connecticut, New York, and Ontario.

Papaipema inquaesita (Grote and Robinson) (sensitive fern borer moth) G5

Host Plants: Sensitive fern (*Onoclea sensibilis*) and occasionally ostrich fern (*Matteuccia struthiopteris*).

Status: Possibly the most common *Papaipema* species in several states. Food plant persists well in wet areas, especially in northern forests.

Papaipema speciosissima (Grote and Robinson) (osmunda borer moth) G4

Host Plants: Ferns (*Osmunda* species).

Status: This moth is easily overlooked, but there is no evidence of serious decline. Deer eat the young fronds of the host plants in spring, but do not seem to cause any major damage.

Papaipema circumlucens (Smith) (hops borer moth) G3G4

Host Plants: Hops, possibly only the native *Humulus lupulus*.

Status: Declining. This moth is uncommon in Ohio, but is probably less rare westward. There are no modern records from Connecticut, New York, New Jersey, or Delaware.

Papaipema rutila (Guenée) (mayapple borer moth) G4

Host Plants: Mayapple (*Podophyllum peltatum*).

Status: This moth was locally common in Ohio and Kentucky (as of 1992 and 1999, respectively). It is extant since 2000 in Pennsylvania, Virginia, Maryland, North Carolina, Indiana, Wisconsin, and New Jersey (scarce). It is historical in Delaware (last specimen was taken in 1988 by Dale Schweitzer) and Connecticut. The food plant is not favored by deer.

Papaipema necopina (Grote) (sunflower borer moth) G4?

Host Plants: Woodland sunflowers (*Helianthus* species).

Status: This moth is declining eastward, but is believed to be secure in its core range. It is very rare east of Ohio. At least in New Jersey, deer have probably been a leading cause of its decline.

Papaipema polymniae Bird (leafcup borer moth) G4

Host Plants: Hairy leafcup (*Smallanthus uvedalius*).

Status: Little is known of this southern moth.

*Papaipema astuta** Bird (yellow stoneroot borer moth) G2G3

Host Plants: Stoneroot (*Collinsonia canadensis*).

Status: Declining. This moth is historical in Pennsylvania, Delaware, Connecticut, and New York, but still occurs in New Jersey, West Virginia, Virginia, Michigan, and North Carolina. It was documented in Ohio in the 1980s.

*Papaipema duplicata** Bird (dark stoneroot borer moth) G2G4

Host Plants: Stoneroot (*Collinsonia canadensis*).

Status: Declining. This moth is historical in Delaware, New Jersey, New York, and North Carolina, but is extant in Pennsylvania and locally abundant in Virginia. Also has been collected in Kentucky.

Papaipema leucostigma (Harris) (columbine borer moth) G4

Host Plants: Columbines (*Aquilegia* species).

Status: Declining southward. Now rare south of about 44º North latitude, but common in Quebec.

Papaipema lysimachiae Bird (loosestrife borer moth) G4

Host Plants: Yellow loosestrife (*Lysimachia quadrifolia*) and related species.

Status: It is still of regular occurrence in much of New England and Virginia, and undoubtedly elsewhere. In New England, populations occur especially in dry woods and barrens where *Lysimachia quadrifolia* is abundant, but in some places this is mostly a wetland species. Deer do not seem to favor the host plants.

Papaipema rigida (Grote) (rigid sunflower borer moth) G5

Host Plants: *Helianthus* species and *Heliopsis* species in the aster family, and *Zizia aurea* (carrot family) in prairie habitats.

Status: This moth is locally common in some places in Connecticut, Ohio, Vermont, Wisconsin, and Virginia, but now seems rare in New Jersey. Its status in Massachusetts, where *Helianthus* is probably the main food plant, is uncertain, but it is expected to decline there and in Connecticut due to abundant deer populations.

Parapamea buffaloensis (Grote) G4

Host Plants: Lizard's tail (*Saururus cernuus*).

Status: This moth is very rare in New Jersey, but extant in 2007 in Sussex and Morris counties. It is locally common in swamps in southern Delaware, Virginia, and Kentucky southward.

Hydraecia[25] *stramentosa* Guenée G4

Host Plants: The larva is a borer in lanceleaf figwort (*Scrophularia lanceolata*).

Status: Historical in New Jersey. Extant in the Virginia mountains, and uncommon in Ohio, Kentucky, and Wisconsin. This species should be monitored.

Basilodes pepita Guenée (gold moth) G4

Host Plants: Crownbeard *(Verbesina* species).

Status: Naturally absent in the northeastern United States, but widespread in the southeast and Midwest. The host plant has become increasingly common in Virginia and is tolerant of grazing and disturbance (Chris Ludwig).

Callopistria cordata (Ljungh) (silver-spotted fern moth) G5

Host Plants: Bracken Fern (*Pteridium aquilinum*), and maybe other ferns.

Status: Generally not rare, but uncommon in Ohio. Often in open woodland and barrens, less so in forests (but widely so in southern New Jersey).

Callopistria mollissima (Guenée) (pink-shaded fern moth) G5

Host Plants: Ferns including *Thelypteris and Dennsteadtia* spp.

Status: Generally not rare. Common on the Atlantic Coastal Plain.

Sympistis species (formerly *Adita* species) GU

Host Plants: Feverwort (*Triosteum perfoliatum*).

Status: This species is undescribed. Its status and range are unknown due to confusion with *Adita chionanthi*. Historic eastward, extant in upper Midwest.

*Hadena ectypa** Morrison G3G4

Host Plants: Widowsfrill (*Silene stellata*) flowers and developing seeds.

Status: This moth is of regular occurrence in the mountains, and is extant in Massachusetts, Connecticut, Ohio, Virginia, West Virginia, and Great Smoky Mountains National Park, and undoubtedly elsewhere, but is historical at least in New Jersey and Delaware.

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25 It is not clear whether *Hydraecia immanis* was part of the original fauna of eastern forests or an adventive pest of hops starting in the late 1800s. A major original food plant seems to have been *Silphium* spp., which grow in prairies. *H. immanis* is probably extirpated in the Northeast. It is a pest in corn, westward.

*Psectrotarsia hebardi** Skinner GU

Host Plants: Stoneroot (*Collinsonia canadensis*) flowers and seeds.

Status: This moth is recently known only from about ten sites in New Jersey (extant in 2009), Ohio, and Kentucky. There are two specimens (types) from 1916 from Virginia. It is probably both rather rare and overlooked.

*Pyrrhia aurantiago** (Guenée) G4?

Host Plants: Yellow false foxgloves (*Aureolaria flava and Aureolaria pedicularis*, but not *Aureolaria virginica*) flowers and developing seeds.

Status: Uncommon to historical in much of its large range. The food plants are heavily browsed by deer.

Appendix 2: Other poorly known species of Lepidoptera found in the eastern United States of possible conservation concern

This list includes uncommon species, or least localized habitat specialists, for which we do not supply a full account. This list is not considered by us to be complete. We are sure there are omissions. See also Kons and Borth (2006) for more information on these and other possible rarities in northern Florida. We have very little current information on South Florida moths, in large part because of restrictions on insect collecting there since the 1990s. Since several butterflies have declined drastically or disappeared there during this time, we suspect some nocturnal moths have as well. For some species on this list, the ecology, and often the food plants, are too poorly known for us to write a useful account at this time.

We could prepare an account for most of the Florida scrub and dry pineland taxa (see Kons and Borth 2006), but we are unsure how uncommon most of them actually are. We selected a few (e.g. *Catocala delilah*, *Hyparpax perophoroides*) for full accounts in the text, and note others here.

Probably some additional species of the numerous cane-feeding Noctuidae, named or otherwise, are of conservation concern. However, with most of the species undescribed and some not well known to us, we include only two that are both named and very rarely encountered.

Lycaenidae

Glaucopsyche lygdamus lygdamus (Hübner). If this is distinct from the widespread but uncommon *Glaucopsyche lygdamus nittanyensis* (see Harris 1972), it would rank as TH, and it may well be extinct. Two specimens were taken before 1842 in Screven or Burke County, Georgia, one of which still exists at the National Museum of Natural History and was illustrated by Clark and Clark (1951). Ron Gatrelle located another one collected in 1985 (emails to Dale Schweitzer in March 2005 with electronic image) almost directly across the river in Allendale County, South Carolina. These specimens differ from *Glaucopsyche lygdamus nittanyensis* in hindwing shape, larger size (the modern specimen is 32 mm), and apparently color pattern details (Harris 1972).

Nymphalidae

Neonympha helicta (Hübner). G3G4. Gatrelle (1999b) recognized *Neonympha helicta* as a species. This butterfly is found in the New Jersey Pine Barrens, southeastern Virginia to most of Florida, probably west into Texas. Mostly wet pine savannas, sometimes bogs in New Jersey or drier savannas southward. Adults stay close to trees. Possibly two or more taxa involved northward.

Limacodidae

Slossonella tenebrosa Dyar. This species appears likely to be globally rare according to James Adams (personal communication with Dale Schweitzer in 2006). Kons and Borth (2006) records are all from sandhills, and it is known from only a few dozen specimens, mostly from Florida. Its biology is unknown, but most Limacodidae are generalists on woody plants.

Geometridae

Eusarca packardaria (McDunnough). This species occurs from Illinois southward into east Texas. One colony has recently been discovered in northern Georgia (Gordon County), where James Adams found it locally numerous at times.

Heliomata infulata (Grote). G3G4. This species has always been considered rare. It is found from about western Pennsylvania to northern Georgia, mostly in the mountains. It apparently feeds on *Robinia hispida* (specifically var. *nana*) in North Carolina (Bo Sullivan). Deer may be a threat. Use of Dimilin® would be a threat.

Hydriomena exculpata Barnes and McDunnough. In our coverage area, this species is known from Mt. Mitchell, North Carolina, but apparently not recently.

Hypomecis luridula (Hulst). Northern and central Florida in scrub habitats. Minno (1992b) recorded it from the Archbold Biological Station in Highlands County. The habitat is probably some sort of scrub. The known range is similar to that given by Kimball (1965) and Rindge (1973). Heppner (2003) included Georgia in its distribution, but the Georgia Lepidoptera website (http://www.daltonstate.edu/galeps/) indicates that no specimens from that state have been located.

Itame ribearia Fitch. G4. Currant spanworm moth. This species was a collateral damage victim of the *Ribes* eradication efforts of the 1920s to 1960s. However, it survives in enough places, especially northward, that it should be secure (Wagner *et al.* 2001, Handfield 1999). It was formerly a minor pest on cultivated currants.

Lambdina canitiaria (Rupert). GHQ. This species was described from five specimens collected at Horseheads, New York in the 1930s. See Dirig (1986) and Cryan and Dirig

(1991) for details of the location and habitat, which resembles more southern shale barrens. We question the validity of this taxon, and it is exceedingly unlikely that any moth would be endemic to the Horseheads area. Muller's (1965) application of this name to spring specimens of the oak feeder that Covell (1984) illustrates as *Lambdina fervidaria athasaria* may have been correct. Dale Schweitzer found this oak feeder abundantly in shale regions of Pennsylvania in the springs of 1985 and 1986.

Nemoria outina Ferguson. Unranked, but G3G4 seems about right. Feeds on *Ceratiola ericoides* (G4), which is widespread in Florida scrub habitats, extending into Georgia and Alabama. As Hugo Kons suggested, this species probably should have had a full account in this book.

Nemoria tuscarora Ferguson. GU. This is an Appalachian species recently found to feed on *Hypericum perfoliatum* (David Wagner observation). It is not seriously imperiled.

Saturniidae

Anisota consularis Dyar. Ranked G4 based mainly on Tuskes *et al.* (1996). Its oak scrub habitat is rapidly being developed in Florida and elsewhere.

Sphingidae

Sphinx franckii Neumoegen. G4. This species ranges through Central New Jersey (historically) to northern Florida and westward to Missouri and Mississippi. For now, this species is considered an example of false rarity, and the males seem to come to lights late at night most of the time. Larvae feed on ash (*Fraxinus* species), which are now common forest trees, but are seriously threatened by the emerald ash borer. Larvae can also be reared on the invasive *Ligustrum sinense*.

Eumorpha intermedia B. P. Clark. G3G4. This species has been found in eastern Texas into northern Florida and northward to northern Mississippi and along the Coastal Plain to North Carolina. Recently several were also found in western Kentucky, according to James Adams. This species has a relatively limited range in a generally under-collected region of the southeastern United States, and this genus tends to be difficult to collect as adults. Tuttle (2007) does not regard this moth as particularly rare, but it does appear to be less common than most resident sphingids in its core range, and it may be historical (no records since before 1980) in some states. The only known food plant is peppervine (*Ampelopsis arborea*).

Proserpinus gaurae J. E. Smith. GU. This moth occurred from South Carolina to northern Florida and westward into Texas, Kansas, and Missouri, but we know of no recent records from much of its range, especially eastward. This species apparently occurs in generally wooded terrain, but the food plants occur in openings and disturbed areas. We know too little about this species to provide a useful account, and could do little more than paraphrase Tuttle's (2007) discussion.

Notodontidae

Datana robusta Strecker. This G2G4 moth of the southeastern Coastal Plain was not included in this book due to the lack of important information, including reliable food plant records. It is a late summer/early fall species that occurs in sandhills/scrubs (Kons and Borth 2006).

Datana modesta Beutenmuller is probably not a separate species, but see our account of *Datana ranaeceps*. Heppner (2003) omits it, and we have seen the name applied to *Datana major* and *Daana ranaeceps* in collections, and probably to a third species which could be the true *Datana ranaeceps*.

Heterocampa cubana Grote. G2G4, but GU would be more appropriate. It is reported from a substantial number of places in peninsular Florida from Sarasota and Volusia counties southward through the Florida Keys. This species also occurs in Cuba. We do not know its food plants and habitat. Its current status is unknown due largely to lack of moth collecting in South Florida.

Heterocampa zayasi (Torre and Alayo). G2G3. This species occurs in the Keys and coastal areas of the southern peninsula of Florida (Kimball 1965, Heppner 2003) as well as in Cuba (Torre and Alayo 1959). We do not know its current status, especially outside of Florida, nor its food plants and habitat. As with many South Florida moths, collecting restrictions since about 1990 have lead to a lack of current information on this species.

Nystalea indiana Grote. GU. Status in Florida and Cuba (Todd 1973), and maybe elsewhere, is unknown. This moth feeds on planted, and presumably, the native Myrtaceae (Torre and Alayo 1959).

Rifargia bichorda (Hampson). GU. This species is native to peninsular Florida and the Keys (Kimball 1965, Heppner 2003). It is also found in the Bahamas (Draudt 1940) and Cuba, where it is said to be rare (Torre and Alayo 1959). We do not know its current status, especially outside of Florida, nor its food plants and habitat. There is another unnamed species of this genus in the Coastal Plains from North Carolina to at least Louisiana.

Erebidae

Bleptina sangamonia Barnes and McDunnough. GU. This species has been found rarely from southern Illinois, Kentucky, and North Carolina southward to Texas and northern Florida. It is probably overlooked, and poorly known.

Catocala jair Strecker. G4. This species is found in oak scrub habitat of peninsular Florida and southeastern Georgia (E. Quinter), and in pine barrens and other xeric scrubby oak habitats elsewhere from Long Island, New York and west to Texas. *Catocala jair* seems to have declined substantially in the New Jersey Pine Barrens, and we know of no collections there since the mid 1990s. It was common in the dwarf pine plains section of the Barrens and widespread from Batsto northward as recently as 1980. *Catocala jair* was locally common in the Dwarf Pine Plains of Long Island New York in the 1990s. It has not been collected in several states in its range. Most specimens we have seen come from New Jersey, North Carolina, Florida, and Texas. Hugo Kons makes a good case that we underestimated the rarity of this underwing, especially westward, and that it should have had a full account in this book. Florida peninsula populations, which are typical *Catocala jair*, are yet another example of a species that maintains a distinctive phenotype there. Specimens from outside of peninsular Florida and southeast Georgia are much blacker than most typical *Catocala jair*, with the post median line somewhat more dentate. For example, specimens from along the coast from New York to North Carolina, as well as Texas, and at least some from the Florida Panhandle would be different from those in Florida and southeast Georgia. Dale Schweitzer reared Florida and New Jersey larvae together, and could not tell them apart. Gall and Hawks' maps indicate that this species is widespread in Texas and Oklahoma, but a lot of their county records are now rather old. Larvae eat oaks, including *Quercus ilicifolia* and *Quercus marilandica* in New Jersey. In both New Jersey and Florida, the adults appear slightly later than those of other oak-feeding underwings, and the main flight season is about a month, typically between 10 July and 10 August in New Jersey.

Catocala messalina Guenée. G4. An oak scrub species that is rare in Florida and up the coast to North Carolina. It is supposed to be more common in Texas and Oklahoma. It seems to be associated with live oak (*Quercus virginiana*) northeastward.

Catocala species (?). GUQ. This is a mystery underwing (Figure 327) that has been collected in about a dozen counties near the coasts ranging from the Boston suburbs to the Houston area. Recent Kons and Borth surveys have produced four recent records from the Florida Panhandle and three recent records from east Texas. This moth has also been collected several times near Boston, where it occurs in ordinary habitats in or near a collector's yard. We suspect it is either a rare variant of *Catocala andromedae* (which differs mostly in its all black hindwings), or a hybrid of that species.

Figure 327. A *Catocala* moth from Gadsden County, Florida, ex. Jeffrey R. Slotten, J. R. Slotten collection (photo, M. C. Minno). This and a few similar specimens from along the coast from Massachusetts to Texas are of unknown taxonomic status, and are perhaps hybrids.

Dasychira matheri Ferguson. GU. This species is described from Bovina Mississippi, and similar specimens have been collected east to Florida. It apparently has one brood. This may prove to be a synonym of either *Dasychira basiflava* or *Dasychira meridionalis*, according to Hugo Kons.

Crambidia species 1 and species 2 of Franclemont (in Forbes 1960). The NatureServe ranks for these are G2G3 and G3G4, respectively. The only published records appear to be those for Lakehurst, New Jersey. Douglas Ferguson, who had intended to publish on this group, found no specimens that he considered to be these species from elsewhere. One species appears to be a rare localized endemic in the core of the New Jersey Pine Barrens. The other is common to abundant in dry habitats in the greater Pinelands region. There are also unrecognized species farther south, and this genus is in need of revision.

Grammia placentia (J. E. Smith). G4, but should be re-evaluated. This is essentially a sandhill/scrub and pine barrens specialist. It is local, but can be abundant where it does occur in Georgia and Florida. It is considered to be of conservation concern in North Carolina (Steve Hall observation), and has become very rare in New Jersey (Dale Schweitzer has collected two in 43 years) where it was formerly not uncommon (Muller 1965). This species also occurs in South Carolina and Georgia. Hugo Kons notes that he has not seen specimens from Louisiana or Texas. Records from West Virginia and Kentucky need verification. Males are similar to those of *Grammia phyllira*. Succession due to lack of fires, as well as development and silviculture, are likely causes of decline.

Prosoparia floridana Lafontaine and Dickel. Florida.

Pseudanthracia coracias (Guenee). A poorly known southeastern oak feeder probably found mostly in sandhills and scrub. A few were collected in the New Jersey Pine Barrens (Forbes, 1954), but the normal range is more southern.

Ptichodis pacalis (Walker). This moth is found in Georgia and Florida, at least. It is quite rare, according to James Adams. It may be a species of dry pinelands or scrub (Kons and Borth (2006).

Litoprosopus bahamensis Hampson. This moth is found in the Bahamas and the Florida Keys, in pine rockland and perhaps other habitats. It presumably feeds on palms. Since much of its range has been generally off limits to collectors for the past 20 years, we do not know the current status of this moth in Florida.

Zale smithi Haimbach. This species is apparently endemic to the Florida Keys and southern Florida mainland. Its current status is unknown due largely to collecting restrictions.

Noctuidae

Abagrotis cryptica. This is a recently described species known only from a few places in the New Jersey Pine Barrens and one in Michigan. *Arctostaphylos uva-ursi* would be a plausible food plant in New Jersey. So far, this species is not identifiable except by genitalia, so if this is a valid species, it could be easily overlooked.

Acronicta perblanda Ferguson. G3G4. This is a species of the Southeast. It may be a cypress swamp species, and is found from eastern North Carolina to southern Louisiana, mostly in April.

Anicla cemolia Franclemont. This moth is known from the Florida Keys, Cuba, and the Bahamas (Lafontaine 2004). The larva probably feeds on grasses. At least some collections were in pine rocklands. Due to restrictions leading to a lack of moth collecting in southern Florida in recent decades, we do not know the status of this species.

Apamea smythi (Franclemont). GH. This species is known only from near Blacksburg, Virginia and Putnam County, Illinois. These localities are just north of the range of canes, but the larva probably feeds on some large grass.

Aoamea wikeri Quinter. This is a cane associate known from a few places in the Midwest.

Caularis lunata Hampson. This moth is known only from the Florida Keys and the Bahamas. Most specimens were taken at lights during the summer (H. D. Baggett), and this species was apparently not rare in the 1970s. Its current status is unknown due largely to lack of moth collecting in South Florida.

Chaetaglaea fergusoni Brou. G3G4. Brou (2008) collected less than three dozen specimens in 26 consecutive years of year-round light trapping and many nights of baiting in Louisiana. This probably means he sampled near but not in a good habitat. It is also known to occur in southern Mississippi, the North Carolina Sandhills, and coastal South Carolina. Dale Schweitzer has reared larvae, but was unable to find a good food plant, and none matured. Other *Chaetaglaea* are oligophagous with oaks, blueberries, and *Aronia* among the documented food plants in nature. The habitat is unclear. We suspect this species will be found in more states, and that it is not as rare as records now indicate. Adults are present from November to February.

Loscpia roblei Quinter and Lafontaine. This is cane-associated moth, known from a few places in Virginia and North Carolina.

Papaipema eryngii Bird. G1G2. This rare moth is found primarily in prairies, but did occur in a pine savanna in North Carolina, and would have been given a full account if it were more characteristic of wooded places. Larvae are found in *Eryngium yuccifolium*.

Protapamea louisae Quinter. This is apparently among the rarest of the unnamed or recently named cane feeders known from a few places from North Carolina to Illinois (Quinter in Mikkola *et al*. 2009).

Ponometia parvula. A Southeastern species. See Kons and Borth (2006).

Sideridis (or *Trichoclea*) *ruisa* Forbes. This species is known from Georgia and Florida, at least. The habitat appears to be dry sandy places. See Kons and Borth (2006).

Sideridis (or *Trichoclea*) *vindemialis* (Guenee). This species occurs in xeric oak-pine scrub in Florida (Kons and Borth 2006) and reportedly, in Georgia.

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