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The Moths of Neal Smith National Wildlife Refuge: A Preliminary Assessment

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North American prairie systems are believed to have supported substantial insect biodiversity. Loss of prairie and oak savanna habitats, however, has been severe in many Midwestern states, including Iowa. An unanswered question facing land managers interested in restoring tallgrass prairies to the Iowan landscape is the degree to which restored habitats contain native insect species that are dependent upon prairie habitat. This study reports data from a preliminary survey of the moths of Neal Smith National Wildlife Refuge, a 2,292-ha prairie and oak savanna restoration site in central Iowa. We identified and cataloged a total of 426 species of moths from woodlands and savanna sites throughout the refuge but few species appeared to be remnant-dependent. Of the 31 moth families observed from Neal Smith, the Noctuidae, Geometridae, Tortricidae, Crambidae, and Pyralidae contributed 75% of the species in our checklist. Slightly over half of the species we were able to identify were previously recorded from Iowa by a larger scale inventory of the states Lepidoptera by A. W. Lindsey. We estimated that < 150 species remained to be sampled from our study sites, but a far greater number of species likely reside on the unsampled prairie reconstructions of the Refuge.

INDEX DESCRIPTORS: Iowa, Lepidoptera, moths, prairie restoration, remnant-dependent species, tallgrass prairie, species accumulation.

Tallgrass prairie and oak savanna originally represented the dominant plant associations of the Midwestern landscape. In addition to supporting a great diversity of vegetation, North American prairies and savannas also are hypothesized to have comprised a hotspot of insect diversity (Metzler 1998, Smith 1998, Rosburg 2001). For example, Panzer et al. (1995) identified more than 1,100 species of insects from prairie remnants in northern Illinois. Hamilton (1993), Brown (2003), and Metzler and Zebold (1995), however, argue that, in general, the insect fauna of prairie ecosystems remains poorly known, particularly for smaller-bodied species that may also be restricted to a single habitat type. Lack of awareness for prairie and savanna insect diversity is further exacerbated by the massive scale of habitat loss in tallgrass prairie ecoregions. Less than 1% of original prairie habitat currently remains in states such as Iowa; the amount of remnant savanna may be considerably lower (Smith 1998). Some of the largest prairies in Iowa are reconstructions, and the diversity of insects returning to such habitats is among the least understood aspects of grassland restorations in Iowa (Rosburg 2001; Summerville et al. 2005).

The most extensive insect surveys in Iowa focus primarily on butterflies. Larsen and Bovee (2001) conducted butterfly surveys in Winneshiek County, Iowa in 1998 and found 55 species present in grassland habitats. The majority of these species, however, are common throughout the Iowan landscape. In addition, Schlicht and Orwig (1998) documented a total of 122 species of butterflies for the entire state. Of these, 50–60 species appeared restricted to high quality prairie remnants and 33–50% of those appeared to be limited to prairie habitats. Thus, perhaps upwards of half of the butterfly diversity in Iowa appears to be restricted to less than 1% of the habitat remaining within the state.

The current state of the moth fauna of Iowa is not nearly as well known (Schlicht and Orwig 1998). In the most extensive study of Lepidoptera in Iowa, Lindsey (1920, 1922) described greater than 500 species of moths from across the state, but his papers only contain general information regarding the localities in which he collected. Furthermore, a greater proportion of moths may be restricted to specific habitat types compared to butterflies because of their limited vagility, yet data that can be used to test this hypothesis is scant. Interest continues to grow for using moths as indicators of habitat quality within some prairie systems, so it is becoming increasingly imperative that ecologists have accurate data detailing lepidopteran species' habitat preferences, dispersal potential, and geographic distribution. In a multi-year study, Panzer et al. (1995) and Panzer et al. (1997) proposed that certain species, termed remnant-dependent species, are generally restricted in distribution to high quality prairie habitats. In addition, a list of hypothesized prairie and savanna remnant-dependent Lepidoptera continues to be compiled for the Chicago area (Panzer et al. 1995; Panzer, pers. comm.). The general applicability of this list for prairie habitats outside of the Chicago region, however, remains poorly known.

This paper describes a preliminary inventory of the moths (Lepidoptera) of Neal Smith National Wildlife Refuge, a large-scale prairie and oak savanna restoration in south central Iowa. The goals of this study were to document current moth species diversity within the refuge, to conditionally assess the number of remnant-dependent Lepidoptera within savanna and woodland habitats within the restoration area, and to analyze patterns of species accumulation in our inventory to suggest how sampling strategies can be developed for more closely monitoring lepidopteran biodiversity of Iowan landscapes. Finally, we make preliminary recommendations for management of prairie and savanna restorations that will potentially make such habitats more attractive for moth species.

MATERIALS AND METHODS

Site Description

Trapping sites were located within Neal Smith Wildlife Refuge in Jasper County, Iowa (41°34′53″N, 93°14′24″W, Figure 1). A

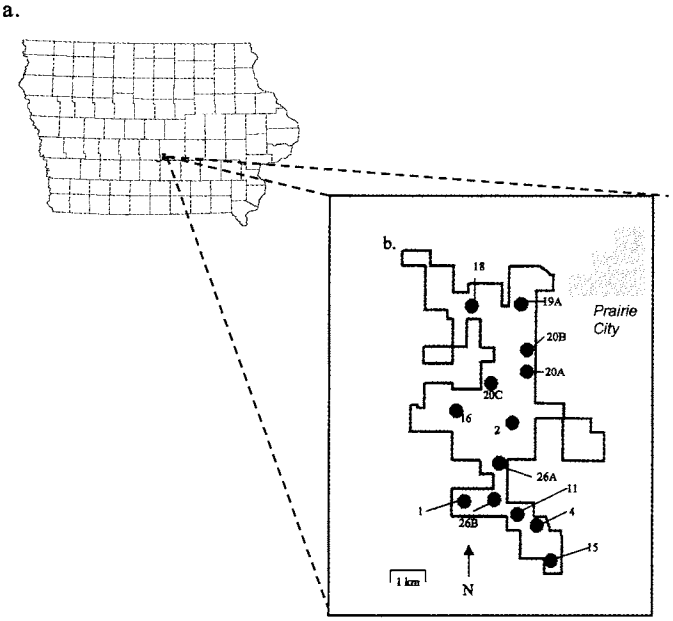

Fig. 1. a) Map of Iowa and its counties. Neal Smith National Wildlife Refuge is located in the southwestern portion of Jasper County. b) Administrative boundaries of Neal Smith National Wildlife Refuge (41°34′53″N, 93°14′24″W). Prairie City is shown as an additional reference point. In 2003, moths were sampled from 13 prairie, savanna, and woodland habitats throughout the refuge (●). Site codes follow Table 1.

post-settlement history of intensive agricultural land use left this portion of central Iowa with few scattered remnants of native vegetation interspersed within a matrix of row crops and pastures. In 1991, the U.S. Fish and Wildlife Service purchased the 2292-ha refuge to restore continuity to the oak savannas and tallgrass prairies that once dominated the landscape. Currently, Neal Smith is a mosaic of prairie plantings seeded over the last 12 y. Savanna habitat has also been recreated by experimental thinning of undesirable trees and prescribed burning within select woodlots.

Thus, the refuge is gradually being restored to the original vegetation characteristic of the Northern tallgrass prairie ecoregion (Ricketts et al. 1999). Common herbaceous species include big bluestem (*Andropogon gerardii* Vitman), little bluestem (*Andropogon scoparius* Michx.), indian grass (*Sorphastrum nutans* Nash), compass plant (*Silphium laciniatum* L.), purple coneflower (*Echinacea pallida* Nutt), white wild indigo (*Baptisia leucantha* T. & G.), and partridge pea (*Cassia fasciculate* Michaux). Savannas are being managed primarily for oak species (*Quercus* spp.). Some early successional woodland also occurs on mesic soils and around gullies, with species such as boxelder (*Acer negundo* L.), prairie apple (*Pyrus ioensis* Bailey), and silver maple (*Acer saccharinum* Marsh.) dominant. Invasive species such as Canada thistle (*Cirsum arvense* L.) and honey locust (*Gleditschia triacanthus* L.) attain high abundance in many areas.

Moth Sampling

We sampled moths from 13 degraded savanna and woodland sites within Neal Smith National Wildlife Refuge (Figure 1, Table 1). Moths were collected using a single Universal blacklight trap per site (12-watt, BioQuip Products, Inc.) powered by 12-V, 26 Amp-

Table 1. Spatial location of 13 woodland and savanna remnants used for Lepidoptera sampling at Neal Smith National Wildlife Refuge in 2003. Latitude and longitude were measured using a Magellan SportPro Global Positioning Unit. Dominant canopy species were determined using importance values and the method of Summerville and Crist (2004).

Site Code	Latitude	Longitude	Dominant Canopy Species	Habitat Type
1	41°32.547	93°17.448	*Ulmus rubra* Muhl., *Quercus macrocarpa* Michx.	Remnant savanna
2	41°33.354	93°16.093	*Quercus macrocarpa* Michx., *Gleditsia triacanthos* L.	Remnant savanna
4	41°32.199	93°15.802	*Tilia Americana* L., *Quercus rubra* L.	Remnant savanna
11	41°32.332	93°16.201	*Ulmus rubra* Muhl., *Quercus macrocarpa* Michx.	Remnant savanna
15	41°31.547	93°15.475	*Ulmus rubra* Muhl., *Prunus serotina* Ehrh.	Remnant savanna
16	41°33.689	93°16.534	*Quercus macrocarpa* Michx., *Gleditsia triacanthos* L.	Remnant savanna
18	41°34.984	93°16.920	*Morus alba* L., *Ulmus rubra* Muhl.	Woodland
19A	41°35.752	93°16.179	*Acer negundo* L., *Prunus serotina* Ehrh.	Woodland
20A	41°34.508	93°15.909	*Ulmus rubra* Muhl., *Juglans nigra* L	Woodland
20B	41°34.801	93°16.174	*Acer saccharinum* L., *Acer negundo* L.	Woodland
20C	41°33.955	93°16.308	*Acer saccharinum* L., *Acer negundo* L.	Woodland
26A	41°32.417	93°16.593	*Ulmus rubra* Muhl., *Celtis occidentalis* L.	Remnant savanna
26B	41°32.302	93°16.708	*Acer saccharinum* L., *Gleditsia triacanthos* L.	Woodland

hr batteries. Traps were operated about every 10 d from May 15, 2003–September 15, 2003, producing 91 total samples. On nights of operation, traps were placed on platforms 2 m above the ground and remained lit from 20:00–7:00 CDT. Because weather and moon intensity affect sampling efficiency of blacklight traps, we trapped only on nights that had a minimum temperature of 16°C, no precipitation, and low levels of ambient moonlight (½ to new moon phases) (Yela and Holyoak 1997). Moths were killed inside the traps with ethyl acetate and dichlorvos. Collected specimens were frozen immediately following trap processing to facilitate curation and identification. Specimens requiring particular taxonomic expertise were forwarded to recognized experts: R. Brown, M. Sabourin, and W. Miller (Tortricidae), R. Hodges (Gelechioidea), G. Balogh (Pyralidae and selected Geometridae), and E. Metzler (selected Noctuidae). Voucher specimens have been deposited in the insect collections of Drake University and the United States Fish and Wildlife Service (Neal Smith National Wildlife Refuge).

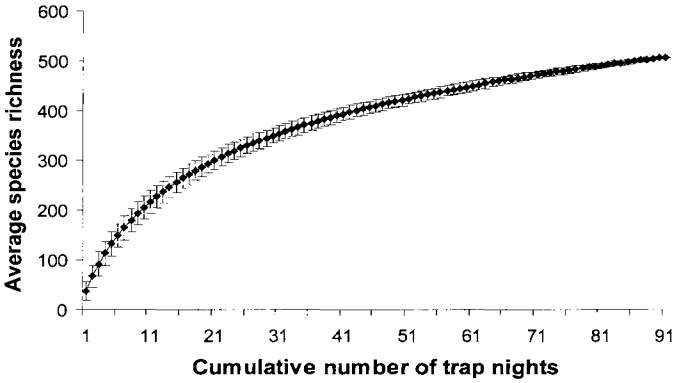

Fig. 2. Species accumulation curve for moths sampled from 13 woodland patches in Neal Smith National Wildlife Refuge. A total of 91 samples were collected June–August 2003. Error bars represent a single standard deviation about the mean.

Checklist Compilation and Data Analyses

Identified species collected from Neal Smith National Wildlife Refuge were compiled in a checklist and arranged by family, genus, and species following the classification presented in Hodges et al. (1983). Since the publication of Hodges et al. (1983), a number of modifications to the higher-level taxonomy of the Lepidoptera have occurred (e.g., Adamski and Brown 1983, Solis 1997). Such additions have been relatively simple to rectify with Hodges et al. (1983) and we retain them here. However, we follow Covell (1999) in neglecting to accommodate the phylogenetic or nomenclatural changes of Poole (1988), Scoble (1995), and Hodges (1998) because such revisions substantially disrupt the organization of the fauna presented in Hodges et al. (1983). Thus, we intend our checklist to serve as a tool to communicate with non-taxonomists, and direct advanced lepidopterists to the previously cited literature for changes in systematics.

Blacklight traps are considered to be a standard technique for sampling nocturnal Lepidoptera, but the technique is biased toward phototactic species (Southwood 1978). Because some moths are primarily diurnal and some nocturnal moths are not readily collected at lights (e.g., Sessiidae), our method is not well-suited to producing a complete inventory of all lepidopteran species. Winter moths (e.g., *Lithophane* spp., *Eupsilia* spp., *Metaxaglaea* spp.) are also not represented, as our sampling interval did not include the appropriate time intervals. Future studies will emphasize a greater diversity of sampling techniques as we attempt to expand our inventory (e.g., sugar-baiting and pheromone trapping). Finally, the checklist is also weighted toward larger-bodied moth species, as the taxonomy of many families of microlepidoptera is poorly known and species identifications are not considered reliable.

In addition to providing a list of described species from Neal Smith National Wildlife Refuge, we also tallied total abundance and months of collection to provide a coarse estimate of species dominance and variation in phenology. Moth species that were previously described from Iowa in Lindsey (1920, 1922) are acknowledged, and we cross-referenced our species list with a list of remnant-dependent prairie species from northern Illinois (Panzer et al. 1995, Panzer pers. comm.). Finally, we used EstimateS *{Ver. 6.0b1}* to generate a species accumulation curve for our total sampling effort, including named species and unnamed morphotypes. EstimateS calculates a final species accumulation curve as the average of 1000 randomized species accumulation curves based on our original species-by-sample abundance matrix (Colwell 2000). In addition, EstimateS was used to calculate the species incidence coverage estimator (ICE; Lee and Chao 1994) and the Chao2 richness estimator (Chao 1987). These two non-parametric statistics provided estimates for total moth species richness at Neal Smith National Wildlife Refuge. Of all the non-parametric statistics commonly used to estimate total species richness from an observed species-by-sample matrix, ICE and Chao2 are widely recognized as being the most reliable when sampling effort is low to moderate and a large number of species are represented by one or two individuals (Colwell and Coddington 1994, Chazdon et al. 1998).

RESULTS

A total of 508 morphospecies and 9,416 individuals of moths were collected from Neal Smith National Wildlife Refuge in 2003. We were able to identify 426 species or roughly 80% of the total number of morphospecies we recognized (Appendix 1). Of the 31 moth families observed from Neal Smith, the Noctuidae, Geometridae, Tortricidae, Crambidae, and Pyralidae contributed 75% of the species in our checklist. The five most abundant species, *Mellilla xanthometata* (Geometridae), *Hypoprepia fucosa* (Acrtiidae), *Anavitrinella pampinaria* (Geometridae), *Udea rubigalis* (Crambidae), and *Lithacodia carneola* (Noctuiidae), represented approximately 20% of the total number of individuals collected. All of these species are widespread throughout North America, and none are restricted to savanna habitat. In contrast, 101 of the identified species were recorded as a single individual (Appendix 1). Our sampling effort was inadequate to document the total number of species present in the woodlands of Neal Smith during the months of June–August (Figure 2). The ICE and Chao2 species richness estimators predicted that 128 or 143 species remained to be sampled, respectively. Therefore, total species richness of Neal Smith woodlands is likely to fall within the range of 636 (ICE)–651 (Chao2) species.

Slightly over half (ca. 56%) of the species we were able to identify were previously recorded from Iowa by Lindsey (1920, 1922). Correcting for changes in nomenclature since Lindsey's publications, our list is most similar to his for species of large-bodied moths in the families Arctiidae, Noctuidae, Geometridae, and Notodontidae. Lindsey recorded a far greater number of sphingid and saturnid moths from Iowa, while our inventory collected a much higher richness of microlepidoptera at Neal Smith National Wildlife Refuge (especially Gelechiidae, Tortricidae, Pyraloidea).

Seven species of moths recorded from Neal Smith were considered remnant-dependent by Panzer et al. (1995), although his list was generated for habitats near Chicago, IL. The vast majority of these species were graminoid and forb feeding Noctuidae and Tortricidae,

and few species of oak-feeding *Catocala* or forb-feeding *Schinia* (Noctuidae, underwing & flower moths) were collected in the savanna remnants or woodlands. The most abundant of the remnant-dependent species was *Agriopodes teratophora* (Noctuidae), which comprised 262 individuals (Appendix 1). All other remnant-dependent species were less abundant by at least one order of magnitude. Indeed, most of the remnant-dependent species we cataloged were represented by < 5 individuals.

DISCUSSION

Our preliminary analysis of the moth biodiversity of Neal Smith National Wildlife Refuge revealed a fauna that contained a large number of species, most of which are not widely regarded as restricted to undisturbed prairie habitats (Panzer et al. 1995). Our species accumulation curve did not saturate, however, and estimates of total species richness suggest about 150 species remain to be collected. It is important to note that this estimate is calculated only with reference to the number of species already discovered within the sites sampled in 2003. Increasing sampling extent is also likely to increase the proportion of new moth species collected (Summerville et al. 2003). For example, expanded sampling extent to include additional prairie and sedge meadow sites at Neal Smith will likely significantly increase the numbers of Tortricidae, Crambidae, and Gelechiidae—all families that reach high diversity in grassland ecosystems (Scoble 1995). Thus, future inventories should also concentrate on the scattered tallgrass prairie remnants and widespread prairie plantings that comprise the dominant components of the habitat mosaic at Neal Smith. For land managers concerned with establishing baseline data on lepidopteran diversity within restored grassland habitats, we recommend a more spatially extensive survey than performed here. Even when sampling intensity is limited within any particular site, extensive surveys reveal important patterns in species-abundance distributions and species dominance that allow land managers to "characterize" a community (Gaston 1996). Of course, remnants of native vegetation deserve more intensive sampling, as they are likely to contain a biological legacy more conducive to conservative moth species (Panzer 1988).

Few of the lepidopteran species we sampled are regarded as restricted in distribution to tallgrass prairie or oak savanna habitat (Panzer et al. 1995). Because Neal Smith National Wildlife Refuge has only been actively managed for tallgrass prairie and savanna habitat since 1992, we suggest two potential explanations for lack of conservative or remnant-dependent moth species. First, restored habitats may sample species from the regional species pool in proportion to their abundance; the most common species should be expected to colonize a newly restored habitat first (Lockwood and Pimm 1999). If this is true, rare species of higher conservation value should begin to colonize the refuge in a sequence that corresponds to their relative abundance in the surrounding landscape (Nichols and Nichols 2003). Secondly, the nearest native prairie remnant > 25 ha in size is approximately 70 km from Neal Smith National Wildlife Refuge (Rosburg 2001), suggesting that only common, generalist species may remain within the species pool likely to generate potential colonists for newly created habitats within the region. This pattern is also suspected to characterize lepidopteran faunas in some European agricultural landscapes and may explain why even old restorations lack a substantial number of native insect species (Saarinen 2002). Differentiating between these two explanations will be important if prairie and savanna restoration is to succeed as a tool for insect conservation (e.g., Summerville et al. 2005). If landscapes are found to have a species pool largely bereft of remnant-dependent insect species, they should be considered low priority for allocation of future management efforts if the goals of restoration include regaining more complete faunal communities (Lockwood and Pimm 1999). An understanding of how diversity is partitioned at local and regional scales will facilitate the identification of meaningful scales where management activities can be directed across preserve boundaries to facilitate local faunal recovery (Ouin and Burel 2002, Chase 2003, Summerville et al. 2003).

In conclusion, continued ecological restoration at Neal Smith National Wildlife Refuge will contribute to changes in the structure of the lepidopteran community. Importantly, some species turnover (gain and loss of moths) is inevitable as undesirable floristic assemblages are managed against and others are encouraged. In some grassland and savanna systems, habitat restoration that promoted an increase in native vegetation increased the diversity of native Lepidoptera in as few as two years (Waltz and Covington 2004, see also Ries et al. 2001). Encouraging an abundance of forbs has also been recommended as a strategy for attracting numerous adult lepidopterans into restored grassland habitats (e.g., Ries et al. 2001, Summerville and Crist 2001, Schneider et al. 2003), however, other studies suggest that many lepidopterans prefer narrow and non-overlapping ranges of nectar plants and management of grassland habitats should rather be focused on increasing the density of larval host plants (e.g., Fleischman et al. 2002, Tooker et al. 2002). Because host plant information is lacking for most species of grassland microlepidoptera (e.g., Gelechioidea), land managers concerned with managing habitats of moths will find themselves operating with some degree of uncertainty. With regards to establishing regimes for prescribed burning, however, the conclusions of Panzer (1988) and Panzer (2002 and citations within) deserve attention and may serve as a general guideline for management of tallgrass prairies in the Midwestern United States. In particular, Panzer (2002) noted that insects restricted in distribution to tallgrass prairie remnants and lacking significant mobility were negatively affected by prescribed burning. Despite significant negative post-fire responses for many species, 100% of the populations studied by Panzer (2002) neared recovery after approximately two years.

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LITERATURE CITED

ADAMSKI, D. and R. L. BROWN. 1989. Morphology and systematics of North American Blastobasidae (Lepidoptera: Gelechioidea). Mississippi Agricultural and Forestry Experiment Station Technical Bulletin #165. Starkville, Mississippi.

BROWN, R. L. 2003. Paleoenvironment and biogeography of the Mississippi black belt: evidence from insects. Pages 11–26. *In* Blackland prairies of the gulf coastal plain. E. Peacock and T. Schauwecker (eds.). University of Alabama Press, Tuscaloosa, Alabama.

CHAO, A. 1987. Estimating the population size for capture-recapture data with unequal catchability. Biometrics 43:783–791.

CHASE, J. M. 2003. Community assembly: when should history matter? Oecologia 136:489–498.

CHAZDON, R. L., R. K. COLWELL, J. S. DENSLOW, and M. K. GUAR-

IGUATA. 1998. Statistical methods for estimating species richness of woody regeneration in primary and secondary rain forests of northeastern Costa Rica. Pages 285–309. *In*: Forest biodiversity research, monitoring, and modeling: conceptual background and Old World case studies. F. Dallmeier and J. A. Comisky (eds.). Parthenon Publishing, Paris.

COLWELL, R. K. 2000. EstimateS: statistical estimation of species richness and shared species from samples. Version 6.0b1. User's guide and application published at: http://viceroy.eeb.uconn.edu/estimates.

COLWELL, R. K. and J. A. CODDINGTON. 1994. Estimating terrestrial biodiversity through extrapolation. Philosophical Transactions of the Royal Society B. 345:101–118.

COVELL, C. V. O. 1999. The butterflies and moths of Kentucky. Kentucky state natural preserves commission scientific and technical series #6. Frankfort, Kentucky.

FLEISHMAN, E., C. RAY, P. SJOGREN-GULVE, C. L. BOGGS, and D. D. MURPHY. 2002. Assessing the roles of patch quality, area, and isolation in predicting metapopulation dynamics. Conservation Biology 16: 706–716.

GASTON, K. J. 1996. Biodiversity: a biology of numbers of difference. Blackwell Science, Inc., London.

HAMILTON, K. G. A. 1993. Leafhopper evidence for origins of northeastern relict prairies (Insecta: Homoptera: *Cicadellidae*). Proceeding of the thirteenth North American Prairie Conference 13:61–70.

HODGES, R. W., T. DOMINICK, D. R. DAVIS, D. C. FERGUSON, J. G. FRANCLEMONT, E. G. MONROE, and J. A. POWELL. 1983. Checklist of the Lepidoptera of America north of Mexico. E. W. Classey and the Wedge Entomological Research Foundation, London.

HODGES, R. 1998. Gelechioidea. Pages 127–201. *In*: Niels Kristensen (ed.). Handbook of Zoology: Volume IV, Insecta: part 35 Lepidoptera. Walter de Gruyter, Inc. Copenhagen.

LARSEN, K. J. and J. A BOVEE. 2001. Changes in the butterflies (Lepidoptera) of Winneshiek County, Iowa after 90 years. The Great Lakes Entomologist 34:43–54.

LEE, S.-M. and CHAO, A. 1994. Estimating population size via sample coverage for closed capture-recapture models. Biometrics 50:88–97.

LINDSEY, A. W. 1920. Some Iowa records of Lepidoptera. Proceedings of the Iowa Academy of Science 27:319–335.

LINDSEY, A. W. 1922. Iowa microlepidoptera. Proceedings of the Iowa Academy of Science 29:157–161.

LOCKWOOD, J. L. and S. L. PIMM. 1999. When does restoration succeed? Pages 363–392. *In*: E. Weiher and P. Keddy (eds.). Ecological assembly rules: perspectives, advances, retreats. Cambridge University Press, London.

METZLER, E. H. 1998. Status of lepidopterans associated with prairies in Ohio. Proceedings of the fifteenth North American prairie conference. 15:185–191.

METZLER, E. H. and R. A. ZEBOLD. 1995. Twenty-eight species of moths new to Ohio from Huffman prairie, Greene county (Lepidoptera). Ohio Journal of Science 95:240–242.

NICHOLS, O. G. and F. M. NICHOLS. 2003. Long-term trends in faunal recolonization after mining in Jerrah forest of southwestern Australia. Restoration Ecology 11:261–272.

OUIN, A and F. BUREL. 2002. Influence of herbaceous elements on butterfly diversity in hedgerow agricultural landscapes. Agriculture, Ecosystems, and Environment 93:45–53.

PANZER, R. 1988. Management of prairie remnants for insect conservation. Natural Areas Journal 8:83–90.

PANZER, R. 2002. Compatibility of prescribed burning with the conservation of insects in small, isolated prairie reserves. Conservation Biology 16:1296–1307.

PANZER, R. D., J. SHUEY, and D. STILLWAUGH. 1997. Characterizing insects within fragmented landscapes. Natural Areas Journal 17:53–55.

PANZER, R., D. STILLWAUGH, R. GNAEDINGER, and G. DERKOVIOTZ. 1995. Prevalence of remnant dependence among the prairie and savanna inhabiting insects of the Chicago region. Nature Areas Journal 15:101–116.

POOLE, R. W. 1988. Lepidopterorum catalogus, part 118: Noctuidae. E. J. Brill Publishers, London.

RICKETTS, T. H., E. DINERSTEIN, D. M. OLSON, C. J. LOUCKS, W. EICHBAUM, D. DELLASALA, K. KAVANAGH, P. HEDAO, P. T. HURLEY, K. M. CARNEY, R. ABELL, and S. WALTERS. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press, Covelo, California.

RIES, L., D. M. DEBINSKI, and M. L. WEILAND. 2001. Conservation value of roadside prairie restoration to butterfly communities. Conservation Biology 15:401–411.

ROSBURG, T. 2001. Iowa's prairie heritage: From the past, through the present, and into the future. Proceedings of the seventeenth North American prairie conference: 17:1–14.

SAARINEN, K. 2002. A comparison of butterfly communities along field margins under traditional and intensive management in SE Finland. Agriculture, Ecosystems, and Environment 90:59–65.

SCHLICHT, D. W. and T. T. ORWIG. 1998. The status of Iowa's Lepidoptera. Journal of the Iowa Academy of Science 105:82–88.

SCHNEIDER, C., J. DOVER, and G. L. A. FRY. 2003. Movement of two grassland butterflies in the same habitat network: the role of adult resources and size of the study area. Ecological Entomology 28:219–227.

SCOBLE, M. J. 1995. The Lepidoptera: form, function, and diversity. Oxford University Press, Oxford.

SMITH, D. D. Iowa prairie: Original extent and loss, preservation and recovery attempts. Journal of the Iowa Academy of Science 105:94–108.

SOLIS, M. A. 1997. Snout moths: unraveling the taxonomic diversity of a speciose group in the neotropics. Pages 231–242 *In*: M. L. Reaka-Kundla, D. Wilson, and E. O. Wilson (eds.). Biodiversity II. Joseph Henry Press, Washington, DC.

SOUTHWOOD, T. R. E. 1978. Ecological methods. Chapman and Hall, London.

SUMMERVILLE, K. S. and T. O. CRIST. 2001. Effects of experimental habitat fragmentation on patch use by butterflies and skippers (Lepidoptera). Ecology 82:1360–1370.

SUMMERVILLE, K. S. and T. O. CRIST. 2004. Contrasting effects of habitat quantity and quality on moth communities in fragmented landscapes. Ecography 27:3–12.

SUMMERVILLE, K. S., M. J. BOULWARE, J. A. VEECH, and T. O. CRIST. 2003. Spatial variation in species diversity and composition of forest Lepidoptera in eastern deciduous forests of North America. Conservation Biology 17:1045–1057.

SUMMERVILLE, K. S., M. N. LEWIS, and R. M. STEICHEN. 2005. Restoring lepidopteran communities to savanna remnants: contrasting effects of habitat quantity and quality. Restoration Ecology 13:120–128.

TOOKER, J. F., P. F. REAGEL, and L. M. HANKS. 2002. Nectar sources of day-flying Lepidoptera of Central Illinois. Annals of the Entomological Society of America 95:84–96.

WALTZ, A. E. M. and W. W. COVINGTON. 2004. Ecological restoration treatments increase butterfly richness and abundance: mechanisms and response. Restoration Ecology 12:85–96.

YELA, J. L. and M. HOLYOAK. 1997. Effects of moonlight and meteorological factors on light and bait trap catches of noctuid moths. Environmental Entomology 2:1283–1290.

APPENDIX 1. Preliminary checklist of the moths (Lepidoptera) of Neal Smith National Wildlife Refuge. Species are arranged in the order they appear in Hodges et al. (1983).

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
Opostegidae	*Pseudospostege quadristrigella* Clem.	122		Jl	3
Adelidae	*Adela ridingsella* Clem.	228		M	1
Tineidae	*Nemapogon angulifasciella* Dietz	262		Jl	1
	Xylesthia pruniramiella Clem.	317	×	Jl, Au	5
	Kearfottia albifasciella Fern.	319		Jl	2
Acrolophidae	*Acrolophus plumifrontella* Clem.	372	×	Jl	10
	Acrolophus popeanella Clem.	373		Jl	8
	Monopis dorsistrigella Clem.	416		Ju, Jl, Au	34
Gracillariidae	*Caloptilia violacella* Clem.	644		Au	2
Oecophoridae	*Agonopteryx curvilineella* Beutenmüller	859	×	Jl, Au	12
	Agonopteryx clemensella Cham.	862	×	M, J	5
	Agonopteryx pulvipennella Clem.	867	×	M, Ju, Jl, Au	8
	Agonopteryx flavicomella Engel	880		Ju	1
	Depressaria pastinacella Dup.	922		Jl	7
	Psilocorsis reflexella Clem.	957	×	Au	1
	Antaeotricha leucillana Zell.	1014		M, J, Au	15
	Callima argenticinctella Clem.	1046		Jl	16
Elachistidae	*Cosmiotes illectella* Clem.	1129		Jl, Au	2
	Gerdana caritella Bsk.	1144		Jl	1
Coleophoridae	*Blastobasis glandulella* Riley	1162	×	Ju, Jl, Au	19
	Coleophora spissicornis Haw.	1387		Jl	1
	Coleophora apiciabella Braun	1389		Ju, Jl	4
Momphidae	*Mompha circumscriptella* Zell.	1434	×	Ju, Jl, Au	5
	Mompha eliosella Clem.	1443	×	Jl, Au	5
Cosmopterigidae	*Euclemensia bassettella* Clem.	1467		Jl	1
	Cosmopterix pulchrimella Cham.	1472	×	Ju, Jl, Au	14
	Cosmopterix clemensella Staint.	1493		Jl	1
	Limnacea phragmitella Staint.	1515		Jl	1
	Triclonella determinatella Zell.	1527		Au	1
	Walshia miscecolorella Cham.	1615		Au	3
Gelechiidae	*Theisoa constrictella* Zell.	1722		M, Ju, Au	7
	Deltaphora sella Cham.	1928		Ju, Jl, Au	3
	Gnorimoschema gallaesolidaginis Riley	1986	×	Au	1
	Chionodes mediofuscella Clem.	2093		M, Ju, Jl, Au	53
	Brachmia hystricella Braun	2268	×	Ju, Au	21
	Dichomeris ligulella Hbn.	2281	×	M, Ju, Au	27
	Dichomeris ochripalpella Clem.	2289		Jl, Au	21
	Dichomeris citrifoliella Cham.	2292		Au	1
	Dichomeris juncidella Clem.	2298	×	M, Ju	6
	Dichomeris setosella Clem.	2302	×	Au	1
Epermeniidae	*Epermenia imperialella* Bsk.	2325		Ju	2
Plutellidae	*Plutella xylostella* L.	2366		M, Ju, Jl	46
Yponmeutidae	*Atteva punctella* Cram.	2401	×	M, Au	3
	Yponomeuta multipunctella Clem.	2420		Jl	1
Cossidae	*Prionoxystus robinae* Peck	2693	×	Ju	1
Tortricidae	*Episimus argutanus* Clem.	2701	×	M, Au	5
	Endothenia microptera Clarke	2741		Jl, Au	8
	Endothenia nubilana Clem.	2743a		Au	4
	Olethreutes exoletus Zell.	2791	×	Ju, Au	55
	Olethreutes malana Fern.	2820		Au	1
	Olethreutes coruscana Clem.	2838	×	Ju	6
	Olethreutes cespitana Hbn.	2859		Ju, Jl, Au	16
	Hedya separatana Kft.	2860		Jl	1
	Hedya chionosema Zell.	2863		Jl	2
	Eucosma matutina Grt.	3091	×	Au	26
	Eucosma giganteana Riley	3098		Au	2
	Eucosma dorsisignatana Clem.	3116	×	Au	1
	Eucosma similana Clem.	3116b	×	Au	2
	Eucosma derelecta Heinr.	3120		Au	6
	Eucosma sombreana Kft.	3127	×	Au	17

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
	Pelochrista scintillana Clem.	3151		Jl, Au	8
	Epiblema strenuana Wlk.	3172	×	Ju, Jl, Au	73
	Epiblema walshinghami Kft.	3196		Jl, Au	12
	Epiblema otiosana Clem.	3202	×	Jl, Au	5
	Epiblema brightonana Kft.	3203		Jl, Au	19
	Ancylis metamelana Wlk.	3359		Au	1
	Ancylis burgessiana Zell.	3367	×	M, J, Jl	9
	Dichrorampha bittana Bsk.	3406		Ju	1
	Grapholita packardi Zell.	3428	×	M, Ju, Au	6
	Grapholita prunivora Walsh	3429		M	1
	Grapholita interstinctana Clem.	3439		M	1
	Ecdytolopha insiticiana Zell.	3497	×	Au	1
	Pseudogalleria inimicella Zell.	3500		Ju	1
	Phaneta ambodaidaleia Miller	—		Au	2
	Acleris robinsoniana Fbs.	3536		Jl	1
	Acleris chalybeana Fern.	3539		Jl, Au	4
	Acleris maculidorsana Clem.	3543		Au	1
	Pandemis lamprosana Rob.	3593		Ju	1
	Argyrotaenia velutinana Wlk.	3597	×	M, Ju, Jl, Au	63
	Argyrotaenia quadrifasciana Wlk.	3631		Au	4
	Choristoneura parallela Rob.	3633		Ju	1
	Choristoneura rosaceana Harr.	3635	×	Ju, Jl, Au	204
	Archips purpurana Clem.	3658	×	Jl, Au	7
	Archips grisea Rob.	3660		Ju	3
	Clepsis clemensiana Fern.	3684		Ju, Jl, Au	19
	Ptycholoma peritana Clem.	3688		M, Ju, Jl, Au	49
	Adoxophyes negundana McD.	3691		Jl, Au	2
	Xenotemna pallorana Rob.	3693		Jl	1
	Sparganothis sulfureana Clem.	3695	×	Jl	1
	Sparganothis pulcherrimana Wlsm.	3701		Ju	5
	Sparganothis reticulatana Clem.	3720	×	Jl, Au	10
	Sparganothis pettiana Rob.	3725		Ju	1
	Sparganothis nivaea Wlsm.	3727		Ju, Jl	24
	Sparganothis diluticostana Walsh.	—		Jl	1
	Platynota flavedana Clem.	3732		Jl, Au	4
	Platynota ideausalis Wlk.	3740		M, Ju, Jl, Au	41
	Coelostathma discopunctana Clem.	3747		Ju, Au	11
	Phtheochroa birdana Bsk.	3801		Au	2
	Phtheochroa baracana Bsk.	3804		Jl, Au	14
Limacodidae	*Lithacodes fasciola* H.-S.	4665	×	Ju, Jl	13
	Prolimacodes badia Hbn.	4671		Jl	1
Crambidae	*Scoparia biplagialis* Wlk.	4716		M, Jl, Au	35
	Synclita tinealis Mun.	4754		Au	2
	Synclita obliteralis Wlk.	4755	×	M, Au	37
	Eustixia pupula Hbn.	4794		Au	1
	Glaphyria sequistralis Hbn.	4870		Jl, Au	11
	Lipocosmodes fuliginosalis Fern.	4888	×	Ju, Jl, Au	91
	Dicymolomia julianalis Wlk.	4889		Jl	1
	Saurcobotys fumoferalis Hulst.	4935		Au	1
	Nascia acutella Wlk.	4937		Jl	2
	Crocidophora serratissimalis Zell.	4944		Ju, Jl, Au	6
	Crocidophora tuberculalis Led.	4945	×	Ju, Jl, Au	86
	Ostrinia nubilalis Hbn.	4949		M, Ju, Jl, Au	118
	Fumibotys fumalis Gn.	4950		Au	3
	Perispasta caeculalis Zell.	4951	×	Ju, Jl, Au	25
	Phlyctaenia coronata Hufn.	4953		M, Ju, Jl, Au	27
	Hahncappsia marculenta G. & R.	4962		M, Ju, Au	13
	Helvibotys helvialis Wlk.	4980	×	Ju, Jl, Au	12
	Sericoplaga externalis Warr.	4991		Ju, Jl, Au	9
	Pyrausta signatalis Wlk.	5034	×	Ju, Jl, Au	13
	Pyrausta bicoloralis Gn.	5040		Ju	1

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
	Pyrausta generosa G. & R.	5056	×	Au	2
	Pyrausta acrionalis Wlk.	5071		Jl, Au	3
	Udea rubigalis Gn.	5079		M, Ju, Jl, Au	272
	Nomophila nearctica Mun.	5156	×	M, Jl, Au	8
	Desmia funeralis Hbn.	5159	×	M, Ju, Jl, Au	10
	Anagesha primordialis Dyar	5176		J	1
	Palpita magniferalis Wlk.	5226	×	Ju, Au	3
	Polygrammodes flavidalus Gn.	5228	×	Jl, Au	2
	Polygrammodes langdonalis Grt.	5229		Au	1
	Lygropia rivulalis Hamp.	5250		Jl, Au	7
	Herpetogramma pertextalis Led.	5275		Ju, Jl, Au	135
	Herpetogramma thestealis Wlk.	5277	×	Ju, Jl, Au	21
	Herpetogramma aeglealis Wlk.	5280	×	Jl, Au	5
	Donacaula longirostrella Clem.	5319		Jl	1
	Crambus agitatellus Clem.	5362	×	Ju, Jl, Au	226
	Chrysoteuchia topiaria Zell.	5391		Jl	9
	Platytes vobisne Dyar	5394		Jl	12
	Microcrambus elegans Clem.	5420	×	Jl, Au	30
	Fissicrambus mutabilis Clem.	5435	×	M, Ju, Au	32
	Haimbachia squamulella Zell.	5482	×	Jl, Au	13
	Xubida panalope Dyar	5500		Ju	3
Pyralidae	*Aglossa cuprina* Zell.	5518	×	Jl, Au	9
	Hypsopygia costalis F.	5524	×	Ju, Au	16
	Herculia olinalis Gn.	5533	×	Jl	2
	Galasa nigrinodis Zell.	5552		Jl, Au	2
	Tosale oviplagalis Wlk.	5556		Ju, Jl, Au	78
	Arta statalis Grt.	5566		Jl	15
	Condylolomia participalis Grt.	5571	×	Jl, Au	61
	Pococera asperatella Clem.	5606		M, Ju, Jl, Au	38
	Achroia grisella F.	5623		J, Jl	2
	Acrobasis indigenella Zell.	5651		Au	11
	Acrobasis palliolella Rag.	5659		M	1
	Acrobasis angusella Grt.	5673		Au	2
	Oreana unicolorella Hulst	5767		Ju, Jl, Au	5
	Nephopteryx vetustella Dyar	5794		Au	1
	Nephopteryx celtidella Hulst	5803		M	5
	Tlascala reductella Wlk.	5808		M	1
	Canarsia ulmiarrosorella Clem.	5926		Au	25
	Homoeosoma deceptorium Heinr.	5944	×	Au	31
	Euzophera semifuneralis Wlk.	5995		Jl	1
	Eulogia ochrifrontella Zell.	5999	×	Jl, Au	9
	Vitula edmansii Pack.	6007		M, Au	2
	Eurythmia angulella Ely	6032	×	Jl, Au	15
	Peoria tetradella Zell.	6044	×	Jl, Au	7
	Peoria approximella Wlk.	6053		Jl	5
	Salebriaria bella Neunzig	—		M	4
Pterophoridae	*Platyptilia carduidactyla* Riley	6109	×	M, Jl, Au	5
Geometridae	*Heliomata cycladata* G. & R.	6261	×	Ju	1
	Eumacaria latiferrugata Wlk.	6272		Jl, Au	6
	Itame pustularia Gn.	6273	×	Jl, Au	45
	Itame ribearia Fitch	6274		Jl	2
	Itame evagaria Hulst.	6278		Ju	1
	Mellilla xanthometata Wlk.	6322	×	M, Ju, Jl, Au	429
	Semiothisa aemulataria Wlk.	6326	×	M, Ju, Jl, Au	83
	Semiothisa promiscuata Fgn.	6331		M	1
	Semiothisa aequiferaria Wlk.	6335		M, Ju, Jl	17
	Semiothisa ocellinata Gn.	6386		Au	1
	Semiothisa gnophosaria Gn.	6405		Ju	1
	Enconista dislocaria Pack.	6419	×	Ju, Jl	3
	Glenoides texanaria Hulst	6443		Jl	4
	Anacamptodes ephyraria Wlk.	6583		Jl	1

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
	Anacamptodes humaria Gn.	6584		M, J	7
	Anavitrinelia pampinaria Gn.	6590	×	M, J, Jl, Au	273
	Ectropis crepuscularia D. & S.	6597	×	Au	2
	Melanolophia canadaria Gn.	6620		Jl, Au	37
	Biston betularia L.	6640	×	M, Ju, Au	4
	Hypagirtis unipuncta Haw.	6654	×	M, Ju, Jl, Au	106
	Lomographa vestialata Gn.	6667	×	M, Ju, Jl, Au	20
	Euchlaena serrata Drury	6724	×	Jl	4
	Euchlaena obtusaria Hbn.	6726	×	Ju, Au	4
	Euchlaena johnsonaria Fitch	6729	×	M, Ju, Au	7
	Euchlaena trigrinaria Gn.	6737	×	Ju, Au	2
	Euchlaena irraria B. & McD.	6739	×	Jl	76
	Xanthotype urticaria Swett	6740	×	Ju, Jl, Au	16
	Pero honestaria Wlk.	6753	×	M, Ju, Jl, Au	105
	Ennomos subsignaria Hbn.	6798	×	M, Ju, Jl	11
	Metanema inatomaria Gn.	6819	×	M, Ju, Jl	7
	Metanema determinata Wlk.	6820	×	Au	6
	Metarranthis hypocharia H.-S.	6826	×	M, Ju	2
	Probole nyssaria H.-S.	6837	×	Ju, Jl, Au	4
	Plagodis phlogosaria Gn.	6842	×	Jl, Au	5
	Plagodis fervidaria H. S.	6843	×	M	1
	Besma quercivoraria Gn.	6885	×	M, Ju, Jl	5
	Lambdina pellucidaria G. & R.	6892	×	Ju	1
	Lambdina fervidaria Hbn.	6894	×	Jl, Au	5
	Eusarca confusaria Hbn.	6941	×	Jl	3
	Tetracis crocallata Gn.	6963	×	M, Ju, Au	18
	Eugonobapta nivosaria Gn.	6965	×	Jl	5
	Eutrapela clemataria J. E. Smith	6966	×	Jl, Au	21
	Prochoerodes transversata Drury	6982	×	Jl	5
	Nematocampa resistaria Haw.	7009	×	Ju, Jl, Au	170
	Synchlora aerata F.	7058		Jl	1
	Chlorochlamys chloroleucaria Gn.	7071	×	M, Ju, Jl, Au	13
	Pleuroprucha insulsaria Gn.	7132	×	Ju, Jl, Au	3
	Cyclophora packardi Prout	7136	×	Au	2
	Haematopis grataria F.	7146	×	Au	6
	Calothysanis amaturaria Wlk.	7147	×	Au	3
	Scopula cacumincria Morr.	7157		Ju	1
	Scopula limboundata Haw.	7159	×	M, Ju, Jl, Au	41
	Scopula inductata Gn.	7169	×	Au	3
	Leptostales rubromarginaria Pack.	7179		Jl, Au	15
	Eulithis diversilineata Hbn.	7196	×	Ju, Jl, Au	51
	Hydria prunivorata Fgn.	7292		Ju	1
	Xanthorhoe ferrugata Cl.	7388	×	M, Jl, Au	10
	Xanthorhoe laucustrata Gn.	7390	×	Jl, Au	6
	Euphyia unangulata Haw.	7399	×	Au	1
	Orthonama obstipata F.	7414	×	Jl, Au	14
	Orthonama centrostrigaria Woll.	7416	×	M, Ju, Jl, Au	122
	Hydrelia albifera Wlk.	7423		M, Ju, Au	11
	Trichodezia albovittata Gn.	7430	×	Au	1
	Eubaphe mendica Wlk.	7440	×	Ju, Jl	3
	Eupithecia miserulata Grt.	7474	×	M, Ju, Jl, Au	105
	Eupithecia cocoata S. & C.	7573		M, Ju	12
	Heterophlelps refusaria Wlk.	7645	×	M, Ju, Jl, Au	57
	Heterophlelps triguttata H.-S.	7647	×	M, Ju, Jl, Au	186
	Dyspteris arbortivaria H.-S.	7648	×	Jl	1
Epiplemidae	*Callizzia armorata* Pack.	7650		M, Ju, Jl, Au	44
Apatelodidae	*Apatelodes torrefacta* J. E. Smith	7663		Jl	1
Lasiocampidae	*Heteropacha rileyana* Harv.	7685	×	M, Au	3
	Phyllodesma americana Harr.	7687	×	Jl, Au	4
Saturniidae	*Sphingicampa bicolor* Harr.	7709	×	M, Ju, Jl, Au	35
	Dryocampa rubicunda F.	7715	×	Ju, Jl, Au	11
	Actias luna L.	7758	×	Au	4

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
Sphingidae	*Paonias excaecatus* J. E. Smith	7824	×	Jl	1
	Paonias myops J. E. Smith	7825	×	Au	2
	Laothoe juglandis J. E. Smith	7827	×	Ju, Jl, Au	3
	Hyles lineata F.	7894	×	Jl	1
Notodontidae	*Datana ministra* Drury	7902	×	Ju, Jl	34
	Datana angusii G. & R.	7903		Ju, Jl, Au	9
	Datana integerrima G. & R.	7907	×	Ju, Jl, Au	23
	Datana perspicua G. & R.	7908	×	Jl	3
	Nadata gibbosa J. E. Smith	7915	×	Ju, Jl, Au	3
	Hyperaeschra georgica H.-S.	7917	×	Au	3
	Nerica bidentata Wlk.	7929	×	M, Jl	2
	Ellida caniplaga Wlk.	7930		M, Ju, Jl, Au	29
	Gluphisia septentrionis Wlk.	7931		Ju, Jl	3
	Dasylophia anguina J. E. Smith	7957	×	M, Jl, Au	3
	Heterocampa obliqua Pack.	7983		Ju, Au	5
	Heterocampa subrotata Harv.	7985		Ju, Au	3
	Heterocampa umbrata Wlk.	7990	×	Jl, Au	3
	Heterocampa guttivitta Wlk.	7994		M, Jl, Au	7
	Heterocampa biundata Wlk.	7995	×	Ju, Jl	5
	Lochmaeus manteo Doubleday	7998	×	Jl, Au	4
	Schizura ipomoeae Doubleday	8005	×	Au	1
	Oligocentria semirufescens Wlk.	8012		Ju	2
	Oligocentria lignicolor Wlk.	8017	×	Jl	3
Arctiidae	*Crambidia pallida* Pack.	8045.1		Au	43
	Hypoprepia fucosa Hbn.	8090	×	Jl, Au	292
	Clemensia albata Pack.	8098	×	M, Ju, Au	18
	Haploa reversa Stretch	8109		Jl	4
	Haploa lecontei Guér.-Méneville	8111	×	Ju, Jl	39
	Holomelina aurantiaca Hbn.	8121	×	Au	4
	Pyrrharctia isabella J. E. Smith	8129	×	M, Ju, Au	55
	Spilosoma latipennis Stretch	8133	×	Ju	3
	Spilosoma congrua Wlk.	8134	×	M, Ju, Jl	145
	Spilosoma dubia Wlk.	8136		Ju	1
	Spilosoma virginica F.	8137	×	M, Ju, Au	31
	Hyphantria cunea Drury	8140	×	Jl, Au	2
	Ecpantheria scribonia Stoll	8146	×	Jl	1
	Phragmatobia lineata Newman & Donahue	8157		Au	1
	Apantesis vittata F.	8170	×	J, Au	5
	Grammia virguncula W. Kby.	8175	×	M, Ju, Jl, Au	5
	Grammia virgo L.	8197	×	Jl, Au	12
	Halysidata tessellaris J. E. Smith	8203	×	Jl, Au	41
	Cycnia tenera Hbn.	8230	×	Ju, Jl, Au	7
	Euchaetes egele Drury	8238	×	Ju, Jl, Au	11
	Cisseps fulvicollis Hbn.	8267	×	Au	3
Lymantriidae	*Dasychira basiflava* Pack.	8296		Au	1
	Orgyia leucostigma J. E. Smith	8316	×	Jl, Au	5
Noctuidae	*Idia americalis* Gn.	8322	×	Ju, Jl	4
	Idia aemula Hbn.	8323	×	Jl	1
	Idia rotundalis Wlk.	8326	×	Jl, Au	7
	Idia lubricalis Gey.	8334	×	Jl, Au	3
	Phalaenophana pyramusalis Wlk.	8338	×	M, Ju, Jl, Au	116
	Zanclognatha obscuripennis Grt.	8347	×	M, Ju, Jl, Au	92
	Zanclognatha pedipilalis Gn.	8348	×	M, Ju, Jl, Au	50
	Zanclognatha cruralis Gn.	8351		Ju, Jl	32
	Macrochilo absorptalis Wlk.	8357	×	Jl, Au	63
	Macrochilo lithophora Grt.	8358		Jl, Au	4
	Macrochilo orciferalis Wlk.	8360	×	Ju, Jl, Au	29
	Phalaenostola metonalis Wlk.	8362	×	Ju, Au	39
	Phalaenostola eumelusalis Wlk.	8363	×	Ju, Jl, Au	30
	Phalaenostola laurentioides Grt.	8364	×	Ju, Jl, Au	62
	Phalaenostola hanhami Sm.	8365		Au	7
	Tetanolita mynesalis Wlk.	8366		Jl	13

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
	Bleptina caradrinalis Gn.	8370	×	Au	6
	Renia flavipunctalis Gey.	8384.1	×	Jl	1
	Renia sobrialis Wlk.	8387		Jl	1
	Lascoria ambigualis Wlk.	8393		M, Ju, Jl, Au	78
	Palthis angulalis Hbn.	8397	×	M, Ju, Au	6
	Palthis asopialis Gn.	8398		Ju, Jl, Au	7
	Rivula propinqualis Gn.	8404	×	M, Ju, Jl, Au	155
	Melanomma auricinctaria Grt.	8412		Au	2
	Hypenodes fractilinea Sm.	8421	×	Au	12
	Bomolocha manalis Wlk.	8441		Jl, Au	3
	Bomolocha deceptalis Wlk.	8446	×	Au	1
	Bomolocha madefactalis Gn.	8447	×	Ju, Jl, Au	4
	Bomolocha sordidula Gn	8448		Au	1
	Plathypena scabra F.	8465	×	M, Jl, Au	27
	Spargaloma sexpunctata Grt.	8479	×	Ju, Jl	3
	Isogona tenuis Grt.	8493		M, Ju, Au	5
	Metalectra quadrisignata Wlk.	8500	×	Jl	2
	Arugisa latiorella Wlk.	8509		Jl	3
	Plusiodonta compressipalpis Gn.	8534	×	Au	1
	Lesmone detrahens Wlk.	8651	×	M, Ju, Au	20
	Zale lunata Drury	8689	×	Ju	1
	Zale minerea Gn.	8697		Ju, Jl, Au	3
	Caenurgina erechtea Cram.	8739	×	Jl, Au	17
	Catocala nebulosa Edw.	8796		Au	1
	Catocala ultronia Hbn.	8857	×	Jl, Au	4
	Catocala crataegi Saund.	8858	×	Jl	1
	Catocala grynea Cram.	8864	×	Jl, Au	16
	Catocala alabamae Grt.	8869		Jl	2
	Catocala micronymha Gn.	8876		Au	1
	Allagrapha aerea Hbn.	8898	×	M, J, Au	7
	Anagrapha falcifera Kby.	8924	×	M, J	2
	Plusia contexta Grt.	8952		Ju	1
	Paectes abrostoloides Gn.	8962		M, Jl, Au	14
	Baileya australis Grt.	8973	×	M, Jl, Au	14
	Nola cilicoides Grt.	8990		Au	2
	Ozarba aeria Grt.	9030		Jl	1
	Hyperstrotia pervertens B. & McD.	9037		Au	1
	Thioptera nigrofimbria Gn.	9044	×	Ju, Jl, Au	43
	Lithacodia muscosula Gn.	9047	×	M, Ju, Jl, Au	240
	Lithacodia synochistis G. & R.	9049	×	M, Ju, Jl	206
	Lithacodia musta G. & R.	9051		Jl	3
	Lithacodia carneola Gn.	9053	×	M, Ju, Jl, Au	271
	Homophoberia apicosa Haw.	9057	×	Jl, Au	4
	Cerma cerintha Tr.	9062	×	Jl	2
	Leuconycta diphteroides Gn.	9065	×	M, Ju, Jl	22
	Leuconycta lepidula Grt.	9066	×	M, Ju, Au	52
	Tarachidia binocula Grt.	9089	×	Au	1
	Tarachidia candefacta Hbn.	9090	×	Au	1
	Tarachidia erastrioides Gn.	9095	×	M, Ju, Jl, Au	79
	Spragueia leo Gn.	9127		Jl, Au	4
	Acontia aprica Hbn.	9136		Au	1
	Acronicta tritona Hbn.	9211		M, Au	2
	Acronicta vinnula Grt.	9225	×	M, Jl	4
	Acronicta hasta Gn.	9229		Au	1
	Acronicta interrupta Gn.	9237	×	Au	1
	Acronicta ovata Grt.	9243		Jl	1
	Acronicta haesitata Grt.	9245		M, J	4
	Acronicta inclara Sm.	9250		M, J, Au	8
	Acronicta retardata Wlk.	9251	×	M, Jl	3
	Acronicta impleta Wlk.	9257		Jl, Au	2
	Acronicta oblinita J. E. Smith	9272	×	M	1

APPENDIX 1. Continued.

Family	Species Name	Hodges No.	Present in Lindsey[1]	Months Collected[2]	Specimens Collected
	Simyra henrici Grt.	9280	×	Jl	2
	Agriopodes teratophora H.-S.	9284	×	M, J, Jl, Au	262
	Eudryas grata F.	9301	×	Jl	1
	Apamea cariosa Gn.	9329		Jl	1
	Agroperina helva Grt.	9373	×	Au	10
	Oligia modica Gn.	9404		Au	1
	Oligia fractilinea Grt.	9406	×	Jl, Au	2
	Meropleon diversicolor Morr.	9427		Au	19
	Papaipema arctivorens Hamp.	9471	×	Au	20
	Papaipema unimoda Sm.	9509		Au	3
	Hydraecia immanis Gn.	9513	×	Jl, Au	10
	Achatodes zeae Harr.	9520		Jl	3
	Euplexia benesimilis McD.	9545	×	M, Jl, Au	8
	Amphipyra pyramidoides Gn.	9638	×	Au	1
	Proxenus miranda Grt.	9647	×	M, Ju, Jl, Au	18
	Anorthodes tarda Gn.	9650		M, J, Jl	137
	Crambodes talidiformis Gn.	9661	×	M, Ju, Jl, Au	7
	Balsa malana Fitch	9662	×	M, Ju, Jl	10
	Balsa tristrigella Wlk.	9663		M, Ju	12
	Balsa labecula Grt.	9664	×	M, Ju, Jl	5
	Elaphria grata Hbn.	9684	×	Jl	1
	Galgula partita Gn.	9688	×	M, Jl	3
	Perigea xanthioides Gn.	9689		Jl	3
	Planysenta videns Gn.	9690		M, Jl	2
	Condica vecors Gn.	9696	×	M, Ju, Jl, Au	5
	Ogdoconta cinereola Gn.	9720	×	M, Ju, Jl, Au	55
	Stiriodes obtusa H.-S.	9725		Jl, Au	2
	Plagiomimicus pityochromus Grt.	9754	×	Au	32
	Amolita fessa Grt.	9818		Jl	1
	Catabena lineolata Wlk.	10033	×	Au	1
	Cuculia florea Gn.	10197		M	1
	Polia detracta Wlk.	10288		M	1
	Melanchra adjuncta Gn.	10292	×	M, Ju, Au	10
	Lacanobia subjuncta G. & R.	10299	×	Au	1
	Lacinipolia renigera Steph.	10397	×	M, Ju, Jl	62
	Lacinipolia lorea Gn.	10405	×	Ju	3
	Faronta rubripennis G. & R.	10434		Au	1
	Pseudaletia unipuncta Haw.	10438	×	M, Jl	4
	Leucania phragmitidicola Gn.	10444	×	M, Ju, Jl	8
	Leucania multilinea Wlk.	10446	×	M, Ju, Au	6
	Leucania scirpicola Gn.	10455		M, Ju	5
	Pseudorthodes vecors Gn.	10578	×	M, Ju, Au	51
	Orthodes crenulata Butler	10585	×	M, Ju, Au	7
	Orthodes cynica Gn.	10587		M	2
	Tricholita signata Gn.	10629		Au	1
	Agrotis ipsilon Hufn.	10663	×	M, Jl, Au	28
	Feltia jaculifera Gn.	10670		Au	1
	Feltia herilis Grt.	10676	×	Au	6
	Euxoa auxiliaris L.	10731		Au	1
	Euxoa redimicula Morr.	10851		Au	1
	Richia acclivis Morr.	10870		Au	2
	Peridroma saucia Hbn.	10915	×	M, Jl, Au	13
	Xestia dolosa Franc.	10942.1	×	Ju, Jl, Au	6
	Protolampra brunneicollis Grt.	11006	×	Jl, Au	9
	Abagrotis alternata Grt.	11029	×	Jl, Au	4
	Pyrrhia umbra Hufn.	11063	×	M	1
	Schinia arcigera Gn.	11128		Au	1
	Schinia rivulosa Gn.	11135		Au	3
	Noctua pronuba L.	—		Ju, Jl	3

[1]See Lindsey (1920, 1922)
[2]Abbreviations: M (May), Ju (June), Jl (July), and Au (August)