# THE MARYLAND ENTOMOLOGIST

*Insect and related-arthropod studies in the Mid-Atlantic region*

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**MARYLAND ENTOMOLOGICAL SOCIETY**
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The Maryland Entomological Society (MES) was founded in November 1971, to promote the science of entomology in all its sub-disciplines; to provide a common meeting venue for professional and amateur entomologists residing in Maryland, the District of Columbia, and nearby areas; to issue a periodical and other publications dealing with entomology; and to facilitate the exchange of ideas and information through its meetings and publications. The MES was incorporated in April 1982 and is a 501(c)(3) non-profit, scientific organization.

The MES logo features an illustration of ***Euphydryas phaëton*** (Drury) (Lepidoptera: Nymphalidae), the Baltimore Checkerspot, with its generic name above and its specific epithet below (both in capital letters), all on a pale green field; all these are within a yellow ring double-bordered by red, bearing the message "● Maryland Entomological Society ● 1971 ●". All of this is positioned above the Shield of the State of Maryland. In 1973, the Baltimore Checkerspot was named the official insect of the State of Maryland through the efforts of many MES members.

Membership in the MES is open to all persons interested in the study of entomology. All members receive the annual journal, ***The Maryland Entomologist***, and the monthly e-newsletter, ***Phaëton***. Institutions may subscribe to ***The Maryland Entomologist*** but may not become members.

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| Annual Dues: | Individual Membership | $10.00 |
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Back issues of ***The Maryland Entomologist*** and recent issues of the ***Phaëton*** are available to members, via the Journal Editor, Eugene J. Scarpulla, ejscarp@comcast.net. Please contact the Journal Editor for availability and cost.

Meetings are held on the third Friday of October, November, February, March, April and May at 7:00 p.m. in Room 4 of the Biological Sciences Building, University of Maryland Baltimore County (UMBC), or occasionally at another announced site.

**Past Presidents of the MES**

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## Editor's Note

The regional scope of *The Maryland Entomologist* is apparent again this year. The 2020 issue highlights studies conducted in Maryland, Virginia, Ohio, and Kentucky. The current year's authors hail from Maryland (8), Ohio (1), Virginia (2), and Ontario, Canada (1).

For 2020, *The Maryland Entomologist* received more manuscripts than could possibly be printed in one issue. This may have been a byproduct of authors having more time for writing due to the current COVID-19 pandemic. Unprecedentedly, the maximum issue size (96 pages) was reached this year! A bit of creative formatting was necessitated to fit the manuscripts within the 96-page production limit. Three additional manuscripts were deferred until the 2021 issue.

**Call for Potential Authors**

I encourage you to publish your entomological observations in *The Maryland Entomologist*. As the late Joseph C. Mitchell, founder and longtime coeditor of the Virginia Natural History Society's journal *Banisteria*, often said, **"If it ain't published, it didn't happen!"** (*Banisteria* 52:52–73; 2019). Put your findings in print for the world to see. Please e-mail first drafts to me by April 1, 2021. Thank you for your consideration.

Eugene J. Scarpulla
Editor

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# Freshwater Isopods (Crustacea: Isopoda: Asellidae) Inhabiting Upland Vernal Pools in Maryland

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**Abstract:** Three species of surface-dwelling freshwater isopods—*Caecidotea forbesi* (Williams), *C. nodula* (Williams), and *C. scrupulosa* (Williams)—inhabit upland vernal pools in Maryland (temporary waters that are dry a substantial part of each year, and are not connected to permanent surface water). All three also occur in permanent surface waters, but were found in every ecologically uncompromised upland temporary pool examined. Despite comments in the literature to the contrary, these isopods should be considered normal members of the aquatic community of these fragile habitats. They survive the seasonal dry period by moving below the surface of the substrate and lying dormant, a mechanism identified by Kenk (1949), Belk and Cole (1975), and Wiggins et al. (1980) as a specialization exhibited by certain vernal pool inhabitants. These three species show distinctive patterns of distribution within Maryland.

**Key Words:** freshwater ecology, freshwater isopods, *Caecidotea forbesi* (Williams), *Caecidotea nodula* (Williams), *Caecidotea scrupulosa* (Williams), vernal pools, Maryland

## INTRODUCTION

In 1980, Dr. Thomas E. Bowman (Smithsonian Institution) and I initiated a survey of the freshwater isopods of Maryland. Over 400 collections were ultimately made, and we also examined material preserved in the collection of the National Museum of Natural History, Smithsonian Institution (USNM), as well as reviewing the pertinent literature. Effort was made to sample a wide variety of permanent and temporary waters throughout Maryland, including all of its 23 counties and Baltimore (city). Those collections showed that about ten species of pigmented surface-dwelling isopods inhabited Maryland's freshwaters, as many as three of which had not been named. The fieldwork was conducted primarily by me. Dr. Bowman made or confirmed identifications and was to have completed the taxonomic portion of the study. Unfortunately, he passed away in 1995, leaving the new taxa undescribed.

Because the local fauna was found to be unexpectedly rich, we originally intended to jointly publish a single paper describing the new species and recording data on distribution and natural history. I attempted to follow that plan, however, in the absence of a taxonomist to complete the descriptions, it proved to be impractical. In order to make the range extensions and other natural history information available, I decided to publish the information in several segments, the first being a discussion of the three species—*Caecidotea forbesi* (Williams), *C. nodula* (Williams), and *C. scrupulosa* (Williams)—that inhabit upland vernal pools in Maryland. Vernal pool residents were selected first due to concern over threats to these special aquatic habitats and their fauna (Williams 1997, Zedler 2003, Brown and Jung 2005, Williams 2006). The second installment will consider the remaining pigmented surface dwellers, including *Caecidotea communis* (Say), *C. kenki* (Bowman), *C. racovitzai* (Williams), *Lirceus brachyurus* (Harger), and as many as three undescribed species of *Caecidotea* Packard.

A review of the Maryland subterranean isopods—*Caecidotea alleghenyensis* Lewis and Bowman; *C. franzi* (Holsinger and Steeves); *C. holsingeri* (Steeves); *C. mausi* Lewis and Bowman; *C. nordeni* Lewis and Bowman; *C. pricei* Levi; and *C. vandeli* (Bresson)—was given by Lewis and Bowman (2010) and Lewis et al. (2011).

## VERNAL POOL HABITATS

A wide variety of temporary water bodies are found in eastern North America (Williams 1997, 2006). They differ primarily in the timing of their wet and dry cycles, and the length of time during which they remain wet. They are frequently grouped as seasonal pools even though they fall into several distinct types. The pools to be considered here typically fill in fall or early winter and usually remain wet until June, generally giving them a wet period of up to seven months. They are isolated habitats unconnected to permanent surface water and filled exclusively by rain, snowmelt, or groundwater (Brooks 2004). In the eastern United States, these have been termed vernal pools and typically support breeding mole salamanders, *Ambystoma* Tschudi spp. (Amphibia: Caudata: Ambystomatidae), and fairy shrimp, (Crustacea: Branchiopoda: Anostraca), (Brown and Jung 2005). Those species are assumed to utilize vernal pools because they lack effective defenses against predatory fishes, and the yearly summer dry period of vernal pools precludes fish populations. These habitats have often been referred to as woodland pools. (See Zedler [2003] for a more detailed discussion of terminology.)

Although the three species of isopods considered here also occur in permanent freshwater habitats (Figures 1–3), they occurred in vernal pools so regularly that they should be considered a significant part of the normal fauna. All examples of ecologically uncompromised vernal pools examined during this study supported a population of at least one of these three species. Vernal pools that occurred on floodplains receive floodwater and typically lacked these three species. Such pools in Maryland often support populations of *C. communis*, which is a common species occurring in a wide variety of freshwater habitats including streams, rivers, and permanent ponds. Because *C. communis* did not occur in upland vernal pools it is not considered here.

## METHODS

Starting in the spring of 1980, freshwater habitats throughout Maryland were surveyed for asellid isopods. They were searched for in beds of aquatic vegetation, accumulations of detritus, and beneath rocks, logs and other places of concealment. Freshwater isopods in vernal pools were occasionally observed at night with the aid of a light. Whenever

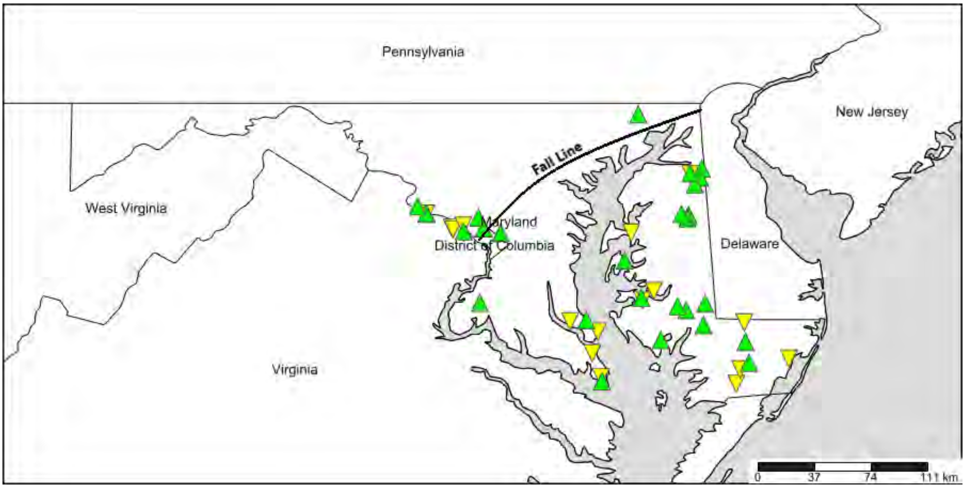


**Figure 1. Map of Maryland showing locations for 48 collections of *Caecidotea forbesi* (Williams).** Green triangles (▲) represent vernal pool habitats. Other habitats are indicated by yellow inverted triangles (▼). The transverse line shows the approximate location of the Fall Line, which separates the Atlantic Coastal Plain and the Piedmont Plateau physiographic provinces (after Vokes 1957). Some symbols encompass more than one collection site. The map was created using SimpleMappr (Shorthouse 2010).

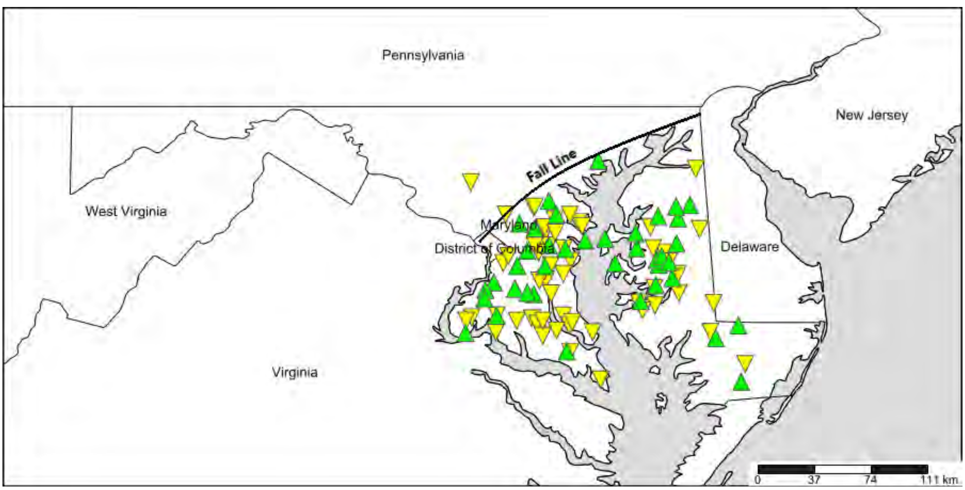


**Figure 2. Map of Maryland showing locations for 112 collections of *Caecidotea nodula* (Williams).** Green triangles (▲) represent vernal pool habitats. Other habitats are indicated by yellow inverted triangles (▼). The transverse line shows the approximate location of the Fall Line, which separates the Atlantic Coastal Plain and the Piedmont Plateau physiographic provinces (after Vokes 1957). Some symbols encompass more than one collection site. The map was created using SimpleMappr (Shorthouse 2010).

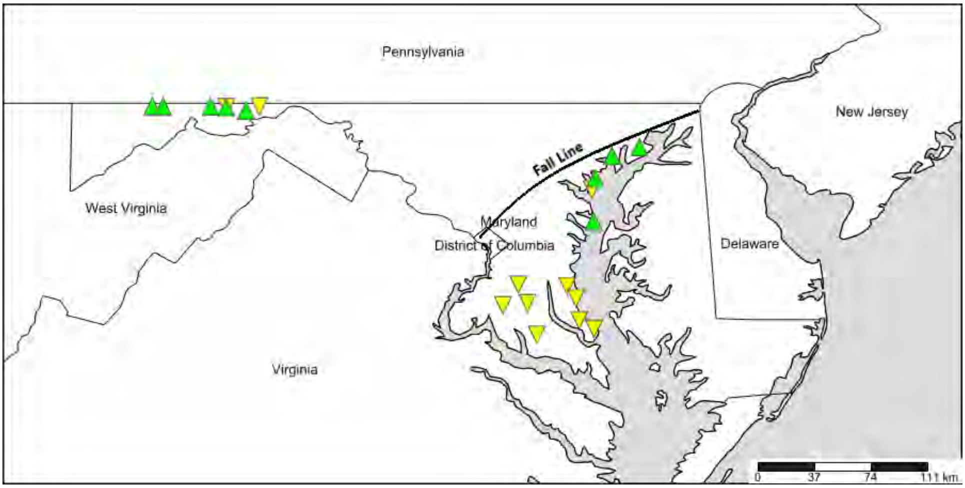


**Figure 3. Map of Maryland showing locations for 20 collections of *Caecidotea scrupulosa* (Williams).** Green triangles (▲) represent vernal pool habitats. Other habitats are indicated by yellow inverted triangles (▼). The transverse line shows the approximate location of the Fall Line, which separates the Atlantic Coastal Plain and the Piedmont Plateau physiographic provinces (after Vokes 1957). The map was created using SimpleMappr (Shorthouse 2010).

encountered, series of specimens were preserved in 70% ethyl alcohol and deposited in the USNM invertebrate collection. Maryland freshwater isopods already in the USNM collection were also examined and have been included in this study. Distributional data for Maryland asellids are given under the heading Material Examined in each of the following species accounts. Habitat data is taken from the literature, or the USNM catalogue entry. Records from the literature are discussed under the heading Range. Catalog numbers are given for all specimens in the USNM collection. Complete label data for USNM material is available at the Invertebrate Zoology Division's online collections database (https://collections.nmnh.si.edu/search/iz/). In the Material Examined sections, the collector "AN" refers to me.

The three isopods discussed here were described in detail, and features having taxonomic significance illustrated, by Williams (1970, 1976).

## SPECIES ACCOUNTS

### *Caecidotea forbesi* (Williams)

**Material Examined:** Maryland: Calvert Co.: Vernal pool at Flag Ponds, AN, 19 Apr 1985 (241813). Webster Pond at Cove Point, J. McKnight, 2 Mar 1987 (241841). Caroline Co.: Vernal pool 4 miles WNW of Goldsboro, AN & M. Dircks, 25 Apr 1985 (241811). Vernal pool at Bridgetown, J. Hill, 6 Feb 1986 (264537). Cecil Co.: Vernal pool along Rt 222 SE of Octoraro Creek, AN, 7 Mar 1987 (241848). Charles Co.: Vernal pools at Myrtle Grove WMA, AN, 30 Jan 1991 (258534). Dorchester Co.: Swamp W of

Cambridge, R. Jackson, 21 Mar 1943 (264533). Vernal pools at Nanticoke Boy Scout Reservation, AN & B. Norden, 2 Feb 1980 (264531). Vernal pools along Rt 50 E of Big Millpond, AN, 5 May 1986 (264536). Vernal pools along Lovers Lane S of Horn Point Rd, AN, 9 Mar 1993 (264539). Vernal pool along Johnson Rd N of Vienna, AN, 18 Apr 1984 (264536). Kent Co.: Vernal pool along Peacock Corner/No. 10 School Rd, AN, 18 Mar 1987. Vernal pool S of Walnut Tree Rd, AN, 18 Mar 1987 (241845). Vernal pool at Golts, AN, 14 Apr 1989 (250160). Swamp along Rt 301 S of Rt 313, AN, 30 Jan 1990 (250428). Montgomery Co.: Great Falls, C. Shoemaker & W. Appel, no date (45599). Ice pond, J. Benedict, 28 Feb 1926 (60283). Shore ponds near Plummers Island, W. Appel, 12 January 1935 (135762). Temporary pond on shore near Plummers Island, W. Appel, 5 May 1935 (122653). Temporary pond near Plummers Island, W. Appel, 19 May 1935 (135762). Pond at McKee Beshers WMA, J. Norvell, 4 Apr 1983 (250925). Vernal pool along Rock Creek in Kensington, AN, 22 Apr 1985 (241814). Pothole on Plummers Island, AN, 10 Jul 1986 (241903). Vernal pools along Meadowbrook Rd near entrance to Rock Creek Park, AN, 29 Apr 1993 (264551). Pothole at S end of Bear Island, D. Mehlman, 21 Apr 1984 (264560). Vernal pool at McKee Beshers WMA, AN, 1 May 1984 (264561). Small stream at McKee Beshers WMA, AN, 12 May 1984 (264562). Seepage area along Seneca Creek N of River Rd, AN, 1 May 1984 (264564). Prince George's Co.: Hyattsville, R. Greenfield, 18 Feb 1928 (61739). Hyattsville, R. Greenfield, 10 Feb 1929 (62659). Vernal pool along Oxon Hill Rd E of Henson Creek, AN & B. Norden, 17 May 1981 (264535). Queen Anne's Co.: Pond at Hess Rd and Rt 50, M. Dircks, 18 Mar 1985 (250921). Vernal pool along Rt 301 S of Rt 290, AN, 18 Mar 1987 (241844). Vernal pools along Roe Ingleside Rd N of Roe, AN, 30 Jan 1990 (250427). Somerset Co.: Ditch along Rt 24 N of Rt 675, AN, 17 Mar 1987 (241855). St. Mary's Co.: Rain water in ditch at Ridge, W. Ball, 26 Apr 1930 (67620). Vernal pool at Point No Point, W. Ball, 27 Apr 1930 (67619). Swamp SE corner of Patuxent Naval Air Station, AN, 20 May 1985 (241818). Vernal pools along Rt 5 S of Harry James Rd, AN, 27 Apr 1993 (254554). Talbot Co.: Vernal pool along Rt 33 W of St. Michaels, AN, 16 Mar 1987 (241850). Stream crossing Rt 50 N of Choptank River, AN, 29 Mar 1990 (250429). Wicomico Co.: Mayer Creek at Gordy Mill Rd, AN, 23 May 1984 (264558). Vernal pool along Rt 50 W of Maiden Forest Rd, AN, 17 Mar 1987 (241852). Vernal pool along Rt 347 NE of Athel Rd, AN, 29 Mar 1990 (250430). Worcester Co.: Permanent pond inland of Chincoteague Bay at Saint Lawrence Neck, D. Boone & F. Hirst, 10 Apr 1984 (264559). Vernal pool along Old Furnace Rd E of Dividing Creek, AN, 17 Mar 1987 (241858). Swamp along Dividing Creek at Rt 364, AN, 22 May 1988 (241945). Swamp along Dividing Creek at Five Bridges Rd, AN, 12 Apr 1990 (250431). Swamp along Dividing Creek at Fleming Millpond Rd, AN, 12 April 1990 (250432). Vernal pool along Fleming Millpond Rd N of Rt 364, AN, 12 Apr 1990 (250443).

**Range:** Williams (1970) recorded *C. forbesi* from the District of Columbia, Indiana, Kentucky, Maryland, Michigan, Missouri, North Carolina, Ohio, South Carolina, Virginia, West Virginia, and Ontario, Canada. Lewis (2009) gave records for Virginia and, citing Williams (1970), noted that it had a preference for vernal pools. It was also reported from northwestern Pennsylvania by Wissinger and Gallagher (1999) and from Wisconsin by Watermolen (2017). In addition, there are specimens at the USNM from Arkansas (171445), Georgia (123799), Illinois (128900), Iowa (108835), and Tennessee (1230345). This shows *C. forbesi* to be a very wide-ranging species. However, records are absent for the area north of Maryland into New England, east of the Great Lakes and Saint Lawrence River.

In Maryland, *C. forbesi* is an inhabitant of the Atlantic Coastal Plain, with encroachment onto the Piedmont Plateau along the Potomac River and Susquehanna River valleys (Figure 1). Figure 1 shows several gaps in the Maryland distribution of this species. For instance, on the Western Shore of the Chesapeake Bay it was not found in a large area drained by the Patuxent River, and on the Eastern Shore it appears to be absent from the entire middle portion of the drainage of the Choptank River. However, Figure 2 shows that both areas had numerous vernal pools that supported *C. nodula*, indicating that habitat for *C. forbesi* was present.

**Habitat:** Williams (1970) noted that this isopod had been recorded from a variety of microhabitats. He reported it from "temporary pools, flood pools, and sloughs. However, the species has also been collected from marshes, small creeks, and at least on a few occasions from lakes. One of the lakes from which it has been collected was Lake Huron where the species was obtained from a depth of 15 m [49 ft]."

Analysis of the 48 Maryland records that include specific habitat data shows that 29 (60%) were from vernal pools, six were from swamps, five were from permanent ponds, four were from small streams, two were from potholes along the Potomac River, one was from a ditch, and one was from a large river.

**Life History Notes:** *Caecidotea forbesi* was found from January through May, and once in July. It was absent from collections made in June, and August through December. Most collections occurred during March and April. Sexually mature males were found in every collection and clasping pairs were noted on 7 and 16 March. Females carrying eggs or young in their brood pouches were found on 30 January, 7 March, 16 March, 18 March, 12 April, and 14 April. Some of those earlier dates were for specimens found active beneath a layer of ice.

### ***Caecidotea nodula* (Williams)**

**Material Examined:** Maryland: <u>Anne Arundel Co.:</u> Seepage area along Rt 3 S of Crofton, AN, 14 Apr 1979 (230173). Pond at N end of Crofton Industrial Park, AN, 10 June 1979 (230183). Seepage area along Rt 295 S of Rt 175, AN, 25 Mar 1980 (230116). Muddy Creek at Rt 468, P. Dresler, 10 Mar 1981 (250929). Spring along Mill Swamp Rd E of Rt 2, AN, 23 Mar 1981 (230125). Seepage area along Rt 450 W of Rutland Rd, AN, 5 Apr 1984 (230987). Vernal pool along Severn Run N of Dicus Mill Rd, AN & D. Mehlman, 25 Apr 1984 (230997). Vernal pools along Sandpiper Ln, AN & D. Mehlman, 3 May 1984 (230998). Spring above Rucker's Pond, C. Rucker, 1 Jun 1985 (241827). Seepage area along Rt 2 N of Towneck Rd, C. Rucker, 15 Jan 1986 (241910). Vernal pools at west end of BWI Airport runway, AN, 10 Apr 1986 (230154). Spring at Rucker's Pond, AN, 20 Jun 1986 (241904). Vernal pools at Jug Bay Nature Center, AN, 24 Mar 1988 (241935). Seepage area along Rt 50 E of Rt 2, AN, 4 Apr 1990 (250421). Seepage area in woods along Rt 2 N of Rt 261, AN, 27 Apr 1993 (264552). Jug Bay Wetlands Sanctuary, springs in woods, AWN, 18 Mar 1994 (268794). Seepage area along

Rt 295 N of Rt 32, AN, 21 Mar 1994 (268789). Baltimore Co.: Vernal pools at Days Cove in Gunpowder Falls SP, AN, 15 Nov 1989 (250165). Calvert Co.: Boggy ground in Gray's Cypress Swamp, C.R. Shoemaker, 17 Apr 1938 (122058, 122059). Seepage area along Patuxent River S of Ferry Landing Rd, AN, 7 Mar 1987 (241843). Seepage area along Battle Creek Cypress Swamp, AN, 20 Apr 1984 (230993). Seep along Bromes Island Rd, AN, 20 Apr 1984 (230994). Spring-seep along Ross Rd, AN, 20 Apr 1984 (230995). Seepage area along Grays Creek in Calvert Cliffs State Park, AN, 14 Jan 1990 (250405). Seepage areas at Kings Landing Park, AN, 27 May 1987 (241862). Caroline Co.: Spring along Choptank River N of Red Bridges, AN, 15 Jun 1980 (230364). Seepage area along Tanyard Rd S of Rt 331, AN, 10 May 1984 (230999). Vernal pool along Alternate Rt 404 E of Hillsboro, AN, 20 Feb 1990 (250414). Vernal pool along Skeleton Creek Rd W of Poplar Neck Rd, AN, 10 Apr 1990 (250875). Spring seep along Marsh Creek S of Marsh Creek Rd, AN, 10 Apr 1990 (250876). Charles Co.: Rill 2.7 miles S of La Plata, L. Hubricht, 29 Feb 1959 (230193). Stream crossing Rt 301 S of La Plata, AN, 19 Apr 1982 (229827). Seepage area at head of Gilbert Swamp Run, AN, 7 Mar 1987 (241842). Seepage area along Popes Creek, AN, 25 Apr 1989 (250161). Vernal pools along lake at Cedarville State Forest, AN, 25 Apr 1989 (250404). Vernal pools along Pomfret Rd SW of Mattawomen Creek, AN, 19 Feb 1990 (250410). Spring-fed stream along Rt 6 E of Wards Run, AN, 19 Feb 1990 (250411). Swamp along Rt 425 E of Friendship Landing Rd, AN, 19 Feb 1990 (250412). Vernal pools along Rt 224 W of Rt 6, AN, 19 Feb 1990 (250413). Vernal pool along Rt 301 N of Cherry Ln, AN, 25 Mar 1994 (268790). Dorchester Co.: Ditch SW of Cambridge, R. Jackson, 21 Mar 1943 (241886). Swamp 3.3 miles W of Cambridge, R. Jackson, 21 Mar 1943 (230191). Ditch 3 miles SW of Cambridge, R. Jackson, 21 Mar 1943 (230192). Seepage area along Reliance-Delaware Rd in Galestown, AN, 30 Mar 1980 (230119). Spring seep along Rt 16 NE of Rt 50, AN, 29 Mar 1990 (250417). Swamp along Dividing Creek at Fleming Millpond Rd, AN, 12 Apr 1990 (250422). Vernal pools along Lovers Ln S of Horn Point Rd, AN, 9 Mar 1993 (264540). Seepage area along stream crossing Rt 16, AN, 25 Mar 1993 (264545). Swamp along Rt 16 N of Rt 50, AN, 22 Apr 1993 (268787). Howard Co.: Seepage area along Patuxent River W of Rt 94 in Patuxent River State Park, AN, 23 Mar 1990 (1250441). Seepage swamp along Rt 94 in Patuxent River State Park, AN, 23 Mar 1990 (250415). Kent Co.: Swamp between Sassafras River and Rt 299, AN, 30 Jan 1990 (250408). Swamp along Rt 301 S of Rt 313, AN, 30 Jan 1990 (250409). Prince George's Co.: Drinking water of home in Bowie, D. Glover, 23 Dec 1952 (95719). Seepage area along Suitland Road S of Suitland, J. Holsinger, 4 Feb 1973 (144062). Vernal pools along Rt 30 at Missouri Av, AN, 14 Apr 1979 (230176). Vernal pool along Rt 301 S of Rt 5, AN, 14 Apr 1979 (230174). Seepage area along Rt 32 SE of Rt 3, AN, 24 Apr 1979 (230175). Seepage area along Brinkley Rd E of Henson Creek, AN, 7 Feb 1982 (230123). Vernal pool along Indian Head Hwy SW of Accokeek Rd, AN, 19 Apr 1982 (229882). Spring along Rt 382 E of Charles Co. line, AN, 1 May 1982 (229823). Vernal pool along Central Av W of Patuxent River, AN, 20 Apr 1984 (230992). Seepage area along Rt 301 S of Rt 50, AN, 20 Apr 1984 (241547). Seepage area along Greencastle Rd near County line, AN, 17 Mar 1985 (241805). Vernal pool along Rt 197 at Horsepen Branch, AN, 22 Mar 1985 (241806). Seepage area along Church Rd N of Rt 214, AN, 9 Nov 1985 (230170). Vernal pools along Powder Mill Rd E of Rt 295, AN, 9 Apr 1986 (230153). Vernal pools, Accokeek, AN, 18 Mar 1987 (241847). Seepage area along Rt 50 E of Church Rd, AN, 8 Mar 1987 (241849). Seepage-fed stream along Croom Rd N of

Tanyard Rd, AN, 21 Jul 1987 (241870). Vernal pool along Brown Station Rd N of Old Marlboro Pike, AN, 27 Nov 1989 (250167). Seepage swamp along Collington Branch at Leeland Rd, AN, 26 Mar 1993 (264546). Vernal pools along White House Rd NW of Rt 202, AN, 26 Mar 1993 (264547). Vernal pools at Andrews Air Force Base, D. Feller and D. Davis, 7 Jul 1993 (264594). Mill Swamp at Marshall Rd, AN & N. Robbins, 30 Jun 1998 (250878). Queen Anne's Co.: Vernal pools along Rt 50 W of Rt 301, AN, 23 Feb 1980 (230105). Vernal pool along Rt 8 S of Matapeake, AN, 6 Mar 1984 (230982). Vernal pool along Rt 301 S of Rt 302, AN, 6 Mar 1984 (230984). Vernal pools along Wye Island Rd, AN & D. Richerson, 11 Apr 1985 (241807). Vernal pools on Wye Island, AN, 23 Nov 1989 (250164). Vernal pool along Roe Ingleside Rd N of Roe, AN, 30 Jan 1990 (250406). Vernal pools along Rt 302 E of Barkley, AN, 30 Jan 1990 (250407). Spring along Rt 50 N of Rt 404, AN, 29 Mar 1990 (250416). Saint Mary's Co.: Rain water in ditch at Ridge, W.H. Ball, 26 Apr. 1930 (122655). Stream at Mechanicsville, W.H. Ball, 11 May 1937 (122656). Spring at Bristol, A. Pizzini, 31 Oct. 1937 (122657). Ye Coole Spring in Charlotte Hall, S. Fuller, 30 Jun 1969 (230592). Seepage area along Indian Bridge Rd S of St. Andrews Church Rd, AN, 25 Aug 1986 (241907). Seepage area along Rt 301 W of Rt 213, AN, 26 Mar 1988 (241936). Vernal pool along Rt 213 at Schelhouse Rd, AN, 26 Mar 1988 (241938). Spring along Rt 6 W of Flora Corner Rd, AN, 10 Jun 1988 (229811). Seepage area along Rt 5 S of Rt 238, AN, 2 May 1989 (250162). ). Vernal pools along St. Andrews Church Rd W of Indian Bridge Rd, AN, 27 Apr 1993 (264555). Vernal pools along stream crossing Rt 235 N of Rt 489, AN, 27 Apr 1993 (264553). Somerset Co.: Vernal pool along Rt 13 N of Rt 675, AN, 17 Mar 1987 (241854). Seepage swamp along Dividing Creek at Old Furnace Road, AN, 17 Mar 1987 (241856). Talbot Co.: Vernal pool along Beaverdam Branch S of Rt 328, AN, 10 May 1984 (230101). Seepage area along Mill Creek N of Rt 662, AN, 10 May 1984 (230102). Spring-seep along Rt 328 W of Kittys Corner Rd, AN, 10 May 1984 (230100). Seepage area in Trappe, AN, 17 Mar 1987 (241851). Vernal pools along Rt 50 S of Rabbit Hill Rd, AN, 3 Feb 1989 (250157). Vernal pools along Rt 50 S of Tarbutton Rd, AN, 9 Mar 1993 (264541). Vernal pools along Rt 309 SW of Klondike Rd, AN, 25 Mar 1993 (264542). Vernal pools along Beaverdam Branch at Rt 328, AN, 25 Mar 1993 (264543). Seepage swamp along Rt 309 SW of Cordova, AN, 25 Mar 1993 (264544). Vernal pools in mixed woods at Wittman, Steiner & Swearingen, 29 Mar. 1993 (268792). Vernal pools in woods at Wittman, Steiner & Swearingen, 10 Apr. 1994 (268801). Wicomico Co.: Seepage swamp along Rt 50 W of Salisbury, AN, 17 Mar 1987 (241853). Vernal pool along Rt 513 S of Rt 13, AN, 22 May 1988 (241943). Swamp along Rt 50 E of RT 50 bridge, AN, 29 Mar 1990 (250418). Vernal pool along Rt 349 E of Rt 347, AN, 29 Mar 1990 (250419). Seep-fed ditch along Athel Rd N Rt 347, AN, 29 Mar 1990 (250420). Spring along Camp Road E of Rt 3, AN & J Norden, 8 May 1994 (268800). Worcester Co.: Vernal pools along Fleming Mill Rd N of Rt 364, AN, 12 Apr 1990 (250423).

**Range:** Williams (1970) reported *C. nodula* from a "small peninsula southeast of Washington, D.C., bordered by the Potomac River and Chesapeake Bay." The records he cited were all from three counties (Anne Arundel, Calvert, and St. Mary's) in southern Maryland. Lewis (2009) subsequently reported it from Virginia. As Figure 2 shows, *C. nodula* occurs throughout the Maryland portion of the Atlantic Coastal Plain on both sides of the Chesapeake Bay. There is also encroachment onto the Piedmont Plateau along the Patuxent River valley. The only specimens at the USNM from outside of

Maryland are two series (1436190, 1436191) from Virginia reported by Lewis (2009), and a specimen lot from the District of Columbia (241986).

The type locality for *C. nodula* is "boggy ground in Gray's Cypress Swamp, below Prince Frederick, Calvert County, Maryland" (Williams 1970). Gray's Cypress Swamp is now known as Battle Creek Cypress Swamp, most of which is a nature preserve owned by The Nature Conservancy and leased to Calvert County.

**Habitat:** Williams (1970) examined four series of *C. nodula* and noted that they came from "a variety of habitats: boggy ground in a swamp, rainwater in a roadside ditch, a woodland stream, and the outlet of a spring." Among the 112 Maryland collections that we examined, label data specifically mentions vernal pools 44 times (39%), seepage areas 33 times, springs 14 times, swamps 11 times, streams/creeks six times, ditches twice, ponds once, and drinking water brought to a home once. If the groundwater-fed habitats (springs, seeps, drinking water) are grouped they account for 48 (43%) of the *C. nodula* collections, while vernal pools account for 44 (39%). The remaining 20 (18%) collections (ditches, swamps, ponds, streams/creeks) could have been groundwater influenced.

**Life History Notes:** *Caecidotea nodula* was found during every month of the year except September and December, although most collections were made in March and April. Sexually mature males were present in all collections. Ovigerous females were present in collections made on 14 January, 30 January, 3 February, 19 February, 20 February, 23 March, 29 March, 4 April, 25 April, and 2 May.

### *Caecidotea scrupulosa* (Williams)

**Material Examined:** Maryland: Allegany Co.: Vernal pool in gorge below dam, Rocky Gap State Park, AN, 28 Apr 1988 (229814). Vernal pool N I-70 (I-68), 0.2 mi E of (Frank) Davis (Road), AN, 1 Apr 1986 (230156). Vernal pool along Town Creek, 0.3 mi S of Rt 40, E. Thompson, 17 Apr 1985 (241826). Stream along Rt 40, 5.8 mi E Flintstone, AN, 30 May 1985 (241823). Spring along Flintstone Creek just S Black Valley Road, AN, 10 Jan 1990 (250424). Anne Arundel Co.: Vernal pools, Corcoran Environmental Study Area, AN, 14 Apr 1981 (230124). Baltimore Co.: Vernal pools along Hollyneck Rd, 4 mi E Essex, AN, 24 Mar 1986 (230155). Swamp, Black Marsh, AN, 5 May 1987 (241860). Calvert Co.: Swamp, Camp Kaufmann, AN, 24 Apr 1982 (229833). Swamp along Parran Rd W of Route 4, AN, 20 Apr 1984 (230996). Swamp along Fishing Creek at Dalrymple Rd, AN, 20 Apr 1984 (230991). Swamp, Calvert Cliffs State Park, AN, 11 May 1987 (241861). Charles Co.: Pond, Myrtle Grove Wildlife Management Area, AN, 19 Apr 1982 (229828). Swamp along Rt 488, 3 mi E La Plata, AN, 1 May 1982 (229822). Garrett Co.: Spring pools along reservoir 3 mi E Frostburg, AN, 28 Apr 1988 (229815). Vernal pools along Swamp Rd, AN, 13 May 1986 (230157). Harford Co.: Vernal pools along Beach Rd, Edgewood, AN, 15 Mar 1990 (250425). Vernal pools, Aberdeen Proving Ground, AN, 15 Mar 1990 (250426). Prince George's Co.: Stream at Cedarville Rd 1 mi E of Rt 301, AN, 1 May 1982 (229826). Saint Mary's Co.: Tributary of St. Clements Creek SW of Helen, AN, 27 Apr 1993 (264556).

**Range:** The specimens described by Williams (1970) were all from vernal pools (including "woodland pools"). Subsequently, Fleming (1972) recorded this species from caves in Virginia and West Virginia, small streams in Virginia, and three localities in Georgia. A fourth Georgia occurrence was given by Nickol and Heard (1973) and one of Heard's Georgia specimens is at the USNM (238970). Additional occurrences of *C. scrupulosa* from caves and springs in Virginia and West Virginia were given by Steeves (1969), Holsinger et al. (1976), and Holsinger and Culver (1988).

**Habitat:** During this survey *C. scrupulosa* was collected at 20 locations in Maryland. Nine of these were vernal pools (45%), seven were freshwater swamps, two were low order streams, one was a spring, and one was the edge of a permanent pond. Thirteen of these Maryland localities were located in the east-central portion of the state on the Atlantic Coastal Plain (Figure 3). The other seven were in the western two counties, within the Allegheny Plateau and the Valley and Ridge portions of the Appalachian Plateau physiographic province (Vokes 1957). This species was not found east of the Chesapeake Bay, and the eastern and western populations are disjunct. These Maryland records represent the first reports of this species from the state, the northernmost localities for the species, and its first recorded occurrence on the Atlantic Coastal Plain.

**Life History Notes:** This species was the least frequently encountered of the isopods inhabiting upland vernal pools in Maryland. Collections were made during January, March, April, and May, with most in the latter two months. Sexually mature males were present in all collections, and clasping pairs were noted at two different sites on 20 April 1984. One collection made on 15 March 1990 included ovigerous females.

**Remarks:** Vernal pool and swamp habitats are abundant throughout the Maryland Atlantic Coastal Plain, where they are frequently occupied by *Caecidotea forbesi* and *C. nodula* (Figures 1 and 2). However, *C. scrupulosa* replaces those species on the northern extension of the Atlantic Coastal Plain along the western side of the Chesapeake Bay north of Baltimore.

Although *C. scrupulosa* inhabits caves in Virginia and West Virginia, it has not been found in any Maryland cave. Holsinger et al. (1976) and Steeves (1969) reported that cave populations of *C. forbesi* show varying adaptation to subterranean waters and range from normally pigmented individuals to lightly pigmented isopods with no apparent eyes. Steeves further stated that some cave populations in Virginia are more attenuate with longer appendages than non-cave populations in the same drainage. This degree of morphological variation is notable, and those cave-inhabiting populations deserve close study. Specimens from apparently eyeless cave-inhabiting populations in the USNM collection were found to have very small eyes (Thomas E. Bowman, personal communication).

## DISCUSSION

### Dry Period Survival

Since upland vernal pools are typically dry for as much as five months each year, aquatic species inhabiting them must have some way of surviving the dry period. Kenk (1949) suggested that the life history of vernal pool inhabitants must allow for at least one of the following: 1) must not be exclusively aquatic and move to and from the pool each year; 2) must produce a dormant egg or cyst; 3) must become a drought-resistant dormant adult; or 4) must follow groundwater down into the soil column. Belk and Cole (1975), Wiggins et al. (1980), and Williams (1997) discussed these adaptations in greater detail. Subsequent authors have treated aquatic isopods as having no such adaptations for dry season survival. For instance Colburn (2004) believed that aquatic isopods have no adaptations for dry season survival so should not be considered typical vernal pool residents, and Kenny and Burne (2000) stated that they "have no specialized adaptations, such as drought-resistant eggs or a diapause phase to survive the dry periods characteristic of vernal pools." Batzer and Sion (1999) studied temporary pools in western New York and noted that the occurrence of abundant isopods was surprising because they were thought to lack "desiccation-resistant stages and are poorly adapted to disperse into newly created habitat." This determination made despite the fact that isopods (*Caecidotea racovitzai*) were present in 25 temporary pools examined by them.

Kenk (1949) discussed isopods from vernal pools in Michigan—as *Asellus militaris* Hay, a junior synonym of *Caecidotea intermedia* (Forbes)—and suggested that they followed the retreating water table into the soil column and lived a subterranean existence until the pools filled again. He based this on the observation that isopods in the pools he studied appeared as small but adult individuals just after the pools filled. He thought that they could move directly down into the substrate, or occupy the water-filled chambers at the bottom of crayfish burrows as observed by Creaser (1931).

Batzer and Sion (1999) discussed the transportation of isopods into temporary pools through groundwater, by surface flooding or on the feathers or feet of water birds, but determined these mechanisms to be improbable for the pools that they studied in western New York. Although their sites were identified as "autumnal" pools, they would fall into the category of vernal pools as defined here. The isopods present at their sites were *Caecidotea racovitzai*, a species also occurring in Maryland but not found in vernal pools during this study. They believed that the isopods survived in pockets of permanent water or in "damp organic detritus in dry basins." This conclusion was based on the assumption that they had no resistant dry-season stages and did appear soon after rains began to fill the pool's basin. They were able to find small numbers of isopods in the dry substrate of a pond bed, and showed in laboratory studies that their aquatic isopods were able to survive at least three weeks in damp detritus.

Among the adaptations exhibited by vernal pool obligate macroinvertebrates in the mid-Atlantic region, dormancy in dry soil by adults is least common. The only other animals that I am aware of relying on it are mollusks, particularly some pisidiid clams (Mollusca: Pisidiidae) (Herrington 1962, McKee and Mackie 1980). Pisidiid clams are of regular occurrence in mid-Atlantic vernal pools (Brown and Jung 2005, personal observation), and several species are restricted to temporary waters (Herrington 1962). McKee and Mackie (1980) studied desiccation resistance in one of these, *Sphaerium occidentale* (J. Lewis), and found that it burrowed into the substrate when the pool dried, and lay dormant until the pool again filled. Gladden and Smock (1990) found that *Pisidium* L. Pfeiffer sp. on floodplains also survived dry periods by simply closing their valves and lying dormant in the substrate until water returned.

Williams (2006) gives an interesting summary of the occurrence of crustaceans in temporary waters in relation to hydroperiod in Ontario, Canada. *Caecidotea* was listed as occurring only in habitats that are wet for a minimum of 70 days. Since there is evidence that adults appear soon after pools fill (Kenk 1949, Batzer and Sion 1999), I suggest that this is the minimum time required for a generation to reproduce, allowing for multiple generations in a single wet cycle.

**Seasonal Occurrence**

Although isopod collections were made in Maryland during every month of the year, field effort was least during the coldest months (December, January and February) and collecting effort was greater from March through November. Collecting effort during those months was relatively even. Data collected for this study shows that all three species appeared in winter, reached peak numbers (estimated) in March–April–May then dwindled in June. That periodicity coincides with the times that vernal pools in Maryland fill (fall–winter) and then experience their dry period (late June–July through November).

It is interesting that populations of these same three species inhabiting non-vernal pool habitats (i.e., springs, seepage areas, swamps, etc.) persist slightly longer, but also decline and disappear during those months when vernal pools are dry. As noted previously, observation of a population of *Caecidotea scrupulosa* in Anne Arundel County showed them to be present and active throughout the winter, even when the pool was covered by a layer of ice. Observations made during this study showed that populations of all three species in Maryland vernal pools reached their highest density in May, then decreased in number and disappeared several weeks before the pools actually dried in June or July. Although the disappearance of the isopods was probably due to some biotic/abiotic seasonal change in the aquatic habitat, available data does not suggest what that change might be.

**Co-occurrence of Species**

Among the collections made or examined during this study, *Caecidotea scrupulosa* did not occur with either of the other two species while *C. nodula* and *C. forbesi* occurred together seven times. Since *C. scrupulosa* was found relatively few times, it is possible that had it been encountered more frequently it might have been found with another species. The substrate of vernal pools in Maryland is characteristically fallen deciduous leaves over soil. The leaves are intact at the top, but lower down the leaf material becomes more finely divided. On a number of occasions, I had the opportunity to observe isopods undisturbed atop the leaf layer. Typically, the species observed was *C. nodula*. In addition, *C. nodula* were “clean” when captured while other species frequently carried bits of detritus or other material. Based on these observations, I believe that where *C.*

*nodula* and *C. forbesi* occur together in vernal pools, they occupy different levels in the leaf/detritus layer, *C. nodula* near the top where the leaves are intact, and *C. forbesi* lower down, in the more finely divided detritus near the soil surface. Such a distribution would serve to partition the habitat as well as food resources.

**Maryland Distribution**

As Figures 1–3 show, these three isopods have distinctive distributions within Maryland. *Caecidotea forbesi* and *C. nodula* were both found on the Atlantic Coastal Plain along both sides of the Chesapeake Bay, and both were found to have gaps in their apparent distribution in the interior of the Coastal Plain. *Caecidotea forbesi*, in particular, was not found in large areas of the Western Shore.

*Caecidotea scrupulosa* inhabits Maryland's Atlantic Coastal Plain wetlands but only on the western side of the Bay. It also shows a cluster of occurrences in the western part of the State (Figure 3). This is interesting because the freshwater habitats are profoundly different. The Atlantic Coastal Plain sediments are deep unconsolidated clays, sands, and gravels, while surface and near-surface substrates in Western Maryland are typically hard, consolidated shale, sandstones, and limestone (Vokes 1957). However, as discussed above, *C. scrupulosa* occurs in Virginia and West Virginia, including solution caves in the hard rocks of the Appalachian Mountains. It is possible that when we understand the wider distribution of this isopod, it may be found to occur along the Appalachian Front, linking the Western Maryland population with *C. scrupulosa* farther south. The eastern population and the western population are clearly disjunct in Maryland.

Since the freshwater habitats available are generally similar on both sides of the Bay, the absence of *C. scrupulosa* on the Delmarva Peninsula is likely a result of the timing of recolonization of freshwater habitats in eastern Maryland at the end of the Wisconsin Glaciation when melting ice sheets restored the Chesapeake Bay, limiting habitat and restricting the movement of non-flying invertebrates.

Although vernal pool habitats are more abundant on Maryland's Atlantic Coastal Plain, they are present west of the Fall Line (separating the Atlantic Coastal Plain and the Piedmont Plateau), making the general absence of these three species from the Piedmont Plateau physiographic province surprising.

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# Protandrous Arrival in a Population of the Periodical Cicada *Magicicada septendecim* (Linnaeus) (Hemiptera: Cicadidae) in Montgomery County, Maryland

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**Abstract:** Differences in number and arrival time of male and female adult periodical cicadas, *Magicicada septendecim* (Linnaeus), Brood X, in a small geographic area of Maryland in 2004, are described and discussed. Newly emergent cicadas were counted, by sex, along various suburban streets. A probable incidence of protandry—the arrival of adult males before adult females—was observed. Data analyses by test of proportions show that for some of the first days of counting, in one of the two sample sites and in both sites combined, the disproportionate appearance of adult males was statistically significant, while for the last few days, the disproportionate appearance of adult females was also statistically significant. In one of the two sites and in both sites combined, significantly more females than males for the season as a whole were also observed. Though this study appears to confirm previous findings, there is little discussion in the literature on protandry in periodical cicadas, and no other study on this subject and species with detailed methodology for sampling, that avoids double counting. It might be useful to conduct field counts of periodical cicadas in other locations to discover where such protandry may or may not occur. It is believed that this mode of protandry is adaptive for the species, and that it evolved to enhance survivability or reproductive opportunity for both sexes.

## INTRODUCTION

Once every 17 springtimes in certain parts of the United States, periodical cicadas (Hemiptera: Cicadidae) emerge in massive numbers (Figure 1). The various populations are called broods, numbered according to their cycles. Brood X of the three 17-year species appears in Mid-Atlantic states and in some proximate areas west. *Magicicada septendecim* (Linnaeus) is the predominant Brood X species in the study area (Simon 1996).

While in the nymph stage (Figure 1), the cicadas emerge from holes in the ground; then, about 30 minutes to an hour later, they metamorphose into adults. After separating from the nymphal skin, they are almost completely white (Figure 2) for about 40 minutes. They darken to black gradually, but their bodies remain relatively soft for about four days the "teneral" period, during which time the males cannot sing, the females cannot lay eggs, and neither acquires its full adeptness at flying (Cooley and Marshall 2001).

**Figure 1. *Magicicada septendecim*: mass emergence of nymphs from the ground.** (Maryland, Michael J. Raupp, 15 May 2004)

**Figure 2. *Magicicada septendecim*: newly eclosed teneral.** (Maryland, Michael J. Raupp, 16 May 2004.)

During the first week of emergence, their large numbers and poor escape behavior make them desirable prey (Williams and Simon 1995). But after an initial time-span, predators may become satiated from eating the cicadas, and net predation declines (Karban 1981, Williams and Simon 1995).

The females can readily be distinguished from the males by the ovipositor (Figures 3 and 4). The males eventually chorus loudly in trees. Studies have indicated that males can mate more than once, but females typically only once (Williams and Simon 1995, Cooley and Marshall 2001, Saisho 2010).

"Protandry is the emergence or arrival of males before females into a seasonal population and is widespread among both plants and animals" (Holzapfel and Bradshaw 2002; see also Morbey and Ydenberg 2008). Note that in biological science, another, very different meaning of protandry is "sequential hermaphroditism," in which males become females, i.e., "the individual changes sex at some point of the life history. If the initial sex is male, the condition is known as protandry" (Warner 1975). This latter meaning of protandry is not the subject of this study.

In 1958, Tinbergen (1969) reported this phenomenon of differential arrival of males and females for the Snow Bunting, *Plectrophenax nivalis* (Linnaeus) (Passeriformes: Calcariidae). Protandry has been analyzed by researchers studying the European Pied Flycatcher, *Ficedula hypoleuca* (Pallas) (Passeriformes: Muscicapidae) (Canal et al. 2012). Entomological examples have been reported for a butterfly, Black Swallowtail, *Papilio polyxene*s Fabricius (Lepidoptera: Papilionidae) (Lederhouse et al. 1982); for the Pitcherplant Mosquito, *Wyeomyia smithii* (Coquillett) (Diptera: Culicidae) (Holzapfel and Bradshaw 2002); for a grasshopper, *Sphenarium purpurascens* Charpentier (Orthoptera: Pyrgomorphidae) (Cueva del Castillo and Núñez-Farfán 2003); and for a parasitic wasp, *Trichogramma evanescens* Westwood (Hymenoptera: Trichogrammatidae) (Doyon and Boivin 2006). This writer may also have observed protandry in the Fowler's Toad, *Anaxyrus fowleri* (Hinckley) (Anura: Bufonidae), in Chevy Chase, Maryland, about 3 km (1.9 mi) due west of this cicada study area; over successive years, on the first evening of spring emergence, the toads were observed converging on a pond, with a statistically significant preponderance of males, in an apparently random sample count, showing a male to female ratio of approximately 5:1.

A report by Charles V. Riley (1869), the 19th century naturalist and later employee of the United States Department of Agriculture, describes the 1868 17-year periodical cicada's habits, mainly in Missouri and Maryland. Riley's study supplies us an early reference to protandry in *Magicicada*. It observes, "As is the case with a great many other insects, the males make their appearance several days before the females, and also disappear sooner."

The observation of protandry has been mentioned in more recent studies outside of Maryland for several cicada genera and species, for example, *Magicicada septendecim*, *M. cassinii* (Fisher), and *M. septendecula* Alexander and Moore (Dybas and Lloyd 1974, Whiles et al. 2001); the Chorus Cicada, *Amphipsalta zelandica* (Boisduval) (Logan et al. 2014); *Meimuna mongolica* (Distant) (Hou et al. 2015); and the Giant Cicada, *Quesada gigas* (Olivier) (de Carvalho Andrade et al. 2017).

**Figure 3.** ***Magicicada septendecim*: male, ventral view of abdomen.** (Note: this specimen is a four-year early emergent of the 2021 Brood X; Maryland, Michael J. Raupp, 24 May 2017.)

**Figure 4.** ***Magicicada septendecim*: female, ventral view of abdomen showing ovipositor.** (Note: this specimen is a four-year early emergent of the 2021 Brood X; Maryland, Michael J. Raupp, 29 May 2017.)

Studying Brood X *M. septendecim* in a Western Maryland apple orchard in 1953, Graham and Cochran (1954) apparently observed protandry, "During the first week of emergence there were more males than females." The Graham and Cochran study, which includes data on sex ratios, was based on a site located approximately 64 km (40 mi) northwest from this study's area. Protandry in Maryland for *M. septendecim* was also suggested by Michael J. Raupp (in litt., 19 May 2004).

This paper, after outlining methodology, describes protandry as observed in the study location, and discusses the survival value of the phenomenon for both male and female cicadas.

## METHODS AND STUDY SITES

Newly metamorphosed adult cicadas, tenerals, were counted near and on streets and sidewalks of three suburban blocks, in an approximately seven square block area, subsequently divided into two study sites (Figure 5), in Silver Spring, Maryland. The count for this statistical study was taken from approximately 0800 to 1000 hours daily, from 14 May 2004—four days after their first appearance—until 23 May 2004. On the last day of the count, the number of newly metamorphosed adults had been declining for six days and a total of only five were found in the second sample site. During the study, the researcher walked the same route once each morning. Whenever a soft white or near-white adult cicada was found, its sex was recorded. (Generally, it should be methodologically possible to augment the data sample by counting the tenerals late at night, as well. But in the residential area of the study, walking the route nightly in the darkness with a flashlight might well prompt concerns from the residents.)

It was assumed this method would produce a random count because at any moment of this brief adult cicada emergence period, neither sex would have a higher mortality rate than the other (John R. Cooley, in litt., 12 September 2005). Statistical analyses were conducted comparing the proportion of male and female newly emerged cicadas found for each day, in each site, and for the season as a whole, using the hypothesis test of a single proportion (McClave and Sincich 2000).

It was important to count only teneral cicadas, because once the cicadas begin to fly, the sexes may selectively disperse to different heights, and the females are easier to find and count than the males, i.e., males gather in trees to chorus (Lloyd and Karban 1983).
But in the early study providing numbers for protandry (Graham and Cochran 1954), there is unclear methodology for obtaining a random sample. We do not know whether the adults they counted each day were newly emerged, and there is also no assurance that the writers were avoiding counting the same cicadas twice on successive days—their sample included "daily adults collected randomly in the orchard," but we do not know which adults.

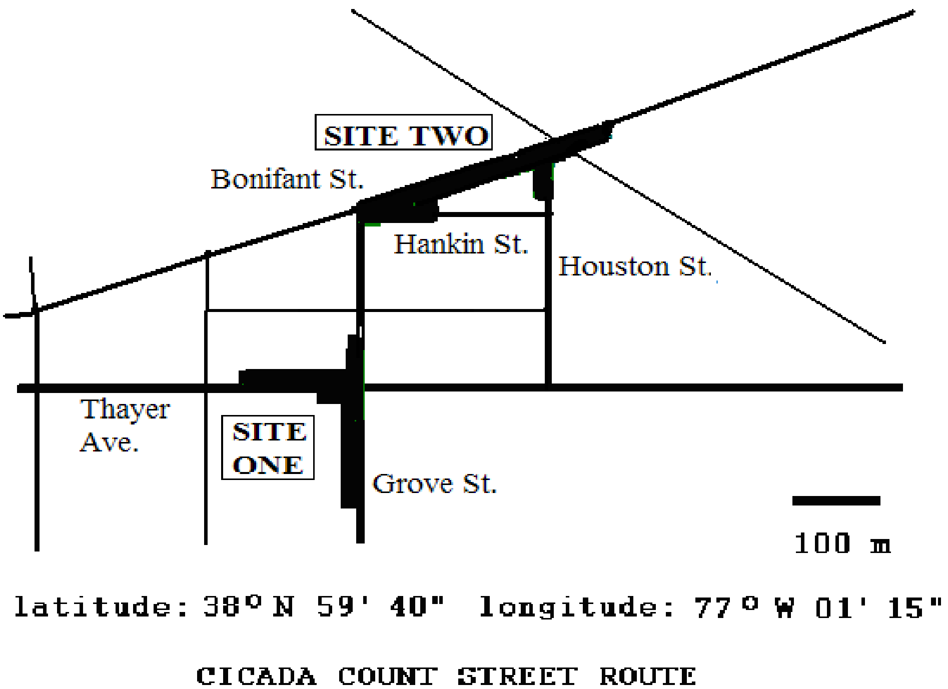



**Figure 5. The two locations where periodical cicadas, *Magicicada septendecim* Brood X, were counted in Silver Spring, Maryland, May–June 2004.**

Likewise, in a more recent study, Dybas and Lloyd (1974) thoroughly compare and report habitat preference among the three species of *Magicicada* by counting nymphal skins and dead adults, and quantify in field notes the preponderance of male nymphal skins on the first day of records. But these skins do not appear to come from *M. septendecim*, and the field notes do not follow up with data for sex ratios on subsequent days. And though it is possible to identify the sex of the cicada by examination of the nymphal skin, one cannot be sure what day that cicada emerged.

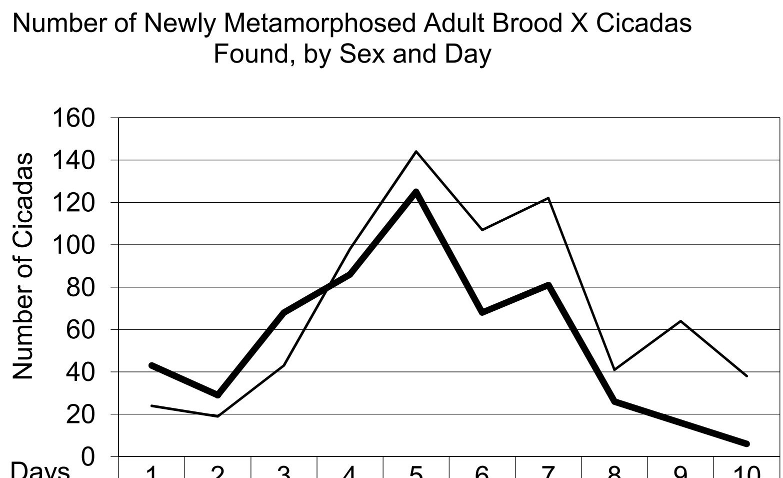
In this study area, though personal observation indicated that the predominant Brood X species was *M. septendecim*, some adults of *M. cassinii* were found in very small numbers, and their calls heard, near the study sites.

## RESULTS

According to the hypothesis tests of single proportions, the number of newly emerged adult male cicadas found for both sites combined was significantly greater than the number of females at $\alpha = 0.05$ on the first and third day of counting, which is evidence of protandry. The number of newly emerged adult female cicadas found was significantly greater than the number of males at α = 0.01 for the ninth and tenth days of counting (Figure 6).

When separating out the two sites to replicate the experiment, we see evidence for protandry at Site 2, but not at Site 1. At Site 1, there were significantly more females than males at α = 0.05 on the sixth and seventh day—but no statistically significant number of males at the start of the season, hence no protandry there (Figure 7). But at Site 2, there were significantly more males than females at α = 0.05 on the first and third day—evidence for protandry. If we group days 1 through 3 at Site 2, at approximately α = 0.01, we again see there was a significantly greater number of males than females at the start of the season (Figure 8).

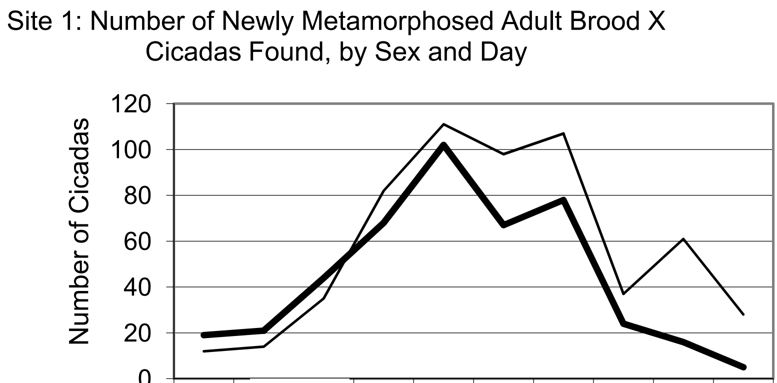
Even without statistical analysis, the differential seemed apparent in one instance, though not at a day or site that was statistically significant. On 16 May 2004, the fifth day of counting, one fence had clinging to it 15 metamorphosing males and only one female. Three days later, the same fence was covered with new adult females and no males.




| Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| males | 43 | 29 | 68 | 86 | 125 | 68 | 81 | 26 | 16 | 6 |
| females | 24 | 19 | 43 | 98 | 144 | 107 | 122 | 41 | 64 | 38 |

**Figure 6. Total Number of male and female newly metamorphosed adult periodical cicadas, *Magicicada septendecim* Brood X, found on successive mornings on 14–23 May 2004 in a fixed route of random sampling of a neighborhood of Silver Spring, Maryland.** A total of 548 newly metamorphosed males and 700 newly metamorphosed females were found. According to hypothesis tests of single proportions, the number of males is significantly greater than the number of females at α 0.05 for days 1 and 3, and the number of females is significantly greater than the number of males at α 0.01 for days 9 and 10. On days 1 and 3, this result is evidence for protandry. At α 0.01, there are also significantly more females than males for the season as a whole.

There was another observation on adult sex ratios. Over the entire season, at Site 1 and at both sites combined, at $\alpha = 0.01$, there were also significantly more newly emergent females than males found (Figures 6 and 7). This observation is consistent with the finding of significantly more female than male *M. septendecim* cicadas by other researchers: Graham and Cochran (1954) in Maryland, and Jacobs (1953) in Indiana. Hunter and Lund (1960) in Georgia found significantly more female *M. cassinii* but not significantly more female *M. septendecim*. But in the other studies, unlike in this study, the question arises whether the researchers were counting only newly emergent cicadas. Other researchers reported male:female cicada ratios of 1:1 for the season (Williams and Simon 1995). Simon (1996) suggested that "temporary biases may occur" in the sex ratios in some areas.

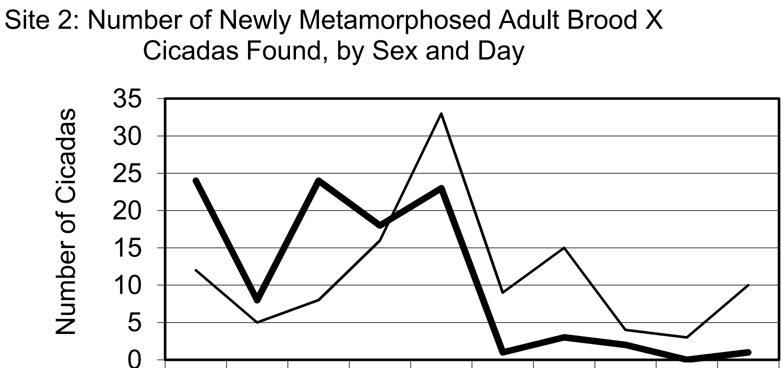



| Days | 1 | | | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| male emergent cicadas | 19 | 21 | 44 | 68 | 102 | 67 | 78 | 24 | 16 | 5 |
| female emergent cicadas | 12 | 14 | 35 | 82 | 111 | 98 | 107 | 37 | 61 | 28 |

Thayer Avenue and Grove Street, Silver Spring, Maryland

**Figure 7. Site 1: Number of male and female newly metamorphosed adult periodical cicadas, *Magicicada septendecim* Brood X, found on successive mornings on 14–23 May 2004 in a fixed route of random sampling in Silver Spring, Maryland.** A total of 444 newly metamorphosed males and 585 newly metamorphosed females were found. According to hypothesis tests of single proportions, the number of females is significantly greater than the number of males at $\alpha$ 0.05 for days 6, 7, and 9.

The newly emergent cicadas were found in greatest density under red maple, *Acer rubrum* L. (Aceraceae); black oak, *Quercus velutina* Lam. (Fagaceae); and scarlet oak, *Q. coccinea* Münchh. Proximate to high numbers of cicadas were also flowering dogwood, *Cornus florida* L. (Cornaceae); black cherry, *Prunus serotina* Ehrh. (Rosaceae); and black locust, *Robinia pseudoacacia* L. (Fabaceae). The physical environment had remained fairly stable during the previous 17 years, though, across the street from one part of the study site, two large trees were cut down about 10 days prior to cicada emergence, not preventing the nymphs beneath from emerging.




| Days | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| male emergent cicadas | 24 | 8 | 24 | 18 | 23 | 1 | 3 | 2 | 0 | 1 |
| female emergent cicadas | 12 | 5 | 8 | 16 | 33 | 9 | 15 | 4 | 3 | 10 |

**Figure 8. Site 2: Number of male and female newly metamorphosed adult periodical cicadas, *Magicicada septendecim* Brood X, found on successive mornings on 14–23 May 2004 in a fixed route of random sampling, in Silver Spring, Maryland.** A total of 104 newly metamorphosed males and 115 newly metamorphosed females were found. According to hypothesis tests of single proportions, the number of males is significantly greater than the number of females at α 0.05 for days 1 and 3 and at approximately α 0.01 for days 1–3. This result is evidence for protandry.

Observed in the general area during the study, the principle agents of cicada mortality were cars and pedestrians; House Finches, *Haemorhous mexicanus* (P. L. Statius Müller) (Passeriformes: Fringillidae), and Northern Mockingbirds, *Mimus polyglottos* (Linnaeus) (Passeriformes: Mimidae); Eastern Gray Squirrels, *Sciurus carolinensis* Gmelin (Rodentia: Sciuridae); domestic cats, *Felis catus* Linnaeus (Carnivora: Felidae); domestic dogs, *Canis lupus familiaris* Linnaeus (Carnivora: Canidae); fungi; arrested metamorphosis; wasps (Hymenoptera); and spiders (Araneae).

## DISCUSSION

Reporting of protandry has tended to focus on benefits to either males or females, and theoretical arguments have become increasingly mathematical. The principle endures that natural selection acts on individuals, but it produces changes in populations.

Protandry is most often described from the male's point of view. "Early emerging males risk death before mating and late-emerging males miss opportunities to mate" (Holzapfel and Bradshaw 2002). Since female periodical cicadas typically mate only once, male cicadas would need to emerge early enough to find available females, mate with the first females that appear, and mate with as many as possible. Among the males there develops "an intense scramble competition for mates" (Cooley and Marshall 2004). Early arrival is especially advantageous if there are enough other males present to reduce the probability of any one male being preyed upon. "For any given male, the optimal emergence time may depend on the mean and distribution of emergence of other males" (Holzapfel and Bradshaw 2002). A strategy of emerging in large numbers is "selectively advantageous to individual cicadas" (Williams and Simon 1995). Natural selection would favor males that arrive early, if they were in large numbers, because they would have more mating opportunities.

But factors could act on female cicada timing of emergence, as well. According to Cueva del Castillo and Núñez-Farfán (2003), "the possible advantage of the time of emergence for females in their mating success in protandrous insect species" might be studied. Females would have increased chance of mating success "if female maturation occurs when the population…is biased to males." Protandry could be viewed not just as males arriving early but as females arriving late. Predator satiation after male emergence also could give a survival advantage to females emerging late. These rationales are listed by Morbey and Ydenberg (2008) in their review of overlapping hypotheses explaining protandry: there could be a selection for males to arrive early for multiple mating opportunities and simultaneously a selection for females to arrive late because of the mating benefits of finding many males and also the survival benefits of waiting and avoiding predation. Those late-arriving female cicadas need not wait to hear singing for a day or even a few hours compared to earlier-arriving females.

Researchers have sought to discover, through testing hypotheses in the field and laboratory, which possible evolutionary explanation for protandry might best be represented by which species (Doyon and Boivin 2006, Canal et al. 2012). Morbey and Ydenberg (2008) conclude, what seems to be a current consensus about insects and other arthropods, that "the most important contributing factor selecting for protandry seems to be the maximization of mating opportunities with females, especially virgin females."

Saisho (2010) adds a somewhat different analysis of female cicadas and protandry. Pointing out that female cicadas in the nymph and teneral stage may have oocytes not yet developed, Saisho reasons that the eclosion, or emergence, of the female cicada might be relatively delayed if the cicada is not yet ready to mate. "It is often said that it takes times to grow eggs in the females' abdomens, which causes the shift of the eclosion period." Saisho also recalls that male cicadas can mate more than once while females mate only once, and includes this feature in mathematical modeling. From mathematical modeling, Saisho infers, as have other investigators, that it is apparently to the cicada's reproductive advantage for females to delay arrival and mating relative to males. Saisho's consideration of developing oocytes can also correspond theoretically to one of the Morbey and Ydenberg (2008) hypotheses for protandry; they hypothesize that an "indirect" cause of protandry through "constraint" on one of the sexes could correlate with or lead to the differential arrival time.

It might be interesting to inquire whether protandry in *M. septendecim* is typical, or repeats in a geographic area from one generation to the next, and, if not, to consider why protandry is not found among certain populations of periodical cicadas. Certainly, protandry may not always occur in *M. septendecim*. Alexander and Moore (1962) recall a site in Ohio in 1959 where almost all the season's cicadas emerged in a few hours on a single night.

It might also be rewarding to investigate whether the finding of more female than male periodical cicadas at a site for the season as a whole might coincide with the finding of protandry—this correlation was not found consistent in this study. Frank (1983) cautions that there are many possibly conflicting factors that influence overall sex ratios (see also Wade et al. 2003).

Additional study sites might provide a more fine-grained picture to substantiate the possible absence of protandry in the periodical cicada for some areas. Scientific investigators and all those curious about nature are invited to observe the return of the 17-year Brood X cicadas, emerging in some locales next year. Comparing different study sites and regions and implementing a protocol similar to the one used in this study, researchers could collect data on sex ratios, and specifically protandry for further study.

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## DATA APPENDIX

### Both Sites Combined (Figure 6)

| | | | |
|---|---|---|---|
| Day 1 | P□ = 43/67 = 0.642 | Proportion of males > 50% | |
| | Z = 2.32 | p value 0.0203 | Significant at 0.05 |
| Day 3 | P□ = 68/111 = 0.613 | Proportion of males > 50% | |
| | Z = 2.77 | p value 0.0176 | Significant at 0.05 |
| Day 9 | P□ = 16/80 = 0.200 | Proportion of males < 50% | |
| | Z = -5.37 | p value $8 \times 10^{-8} \approx 0$ | Significant at 0.01 |
| Day 10 | P□ = 6/44 = 0.136 | Proportion of males < 50% | |
| | Z = -4.82 | p value $1.4 \times 10^{-6} \approx 0$ | Significant at 0.01 |
| Overall | P□ = 544/1228 = 0.443 | Proportion of males < 50% | |
| | Z = -4.00 | p value 0.0007 | Significant at 0.01 |

### Site 1 (Figure 7)

| | | | |
|---|---|---|---|
| Day 6 | P□ = 67/165 = 0.406 | Proportion of males < 50% | |
| | Z = -2.41 | p value 0.0158 | Significant at 0.05 |
| Day 7 | P□ = 78/185 = 0.421 | Proportion of males < 50% | |
| | Z = -2.31 | p value 0.0330 | Significant at 0.05 |
| Day 9 | P□ = 16/77 = 0.208 | Proportion of males < 50% | |
| | Z = -5.16 | p value 8 x 10-8 ≈ 0 | Significant at 0.01 |
| Overall | P□ = 444/1029 = 0.431 | Proportion of males < 50% | |
| | Z = -4.40 | p value 0.00001 | Significant at 0.01 |

### Site 2 (Figure 8)

| | | | |
|---|---|---|---|
| Day 1 | P□ = 24/36 = 0.667 | Proportion of males > 50% | |
| | Z = 2.00 | p value 0.0455 | Significant at 0.05 |
| Day 3 | P□ = 24/32 = 0.750 | Proportion of males > 50% | |
| | Z = 2.83 | p value 0.0047 | Significant at 0.01 |
| Days 1–3 | P□ = 56/81 = 0.690 | Proportion of males > 50% | |
| | Z = 3.44 | p value 0.0006 | Significant at 0.01 |

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# Combining Data from Citizen Scientists and Weather Stations to Define Emergence of Periodical Cicadas, *Magicicada* Davis spp. (Hemiptera: Cicadidae)

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**Abstract:** The appearance of periodical cicadas, *Magicicada* Davis spp. (Hemiptera: Cicadidae), in the United States has been a source of wonder, confusion, and consternation from the time of colonization to the present. The ability to forecast the emergence of periodical cicadas has practical implications to homeowners, urban foresters, nursery growers, and orchardists trying to protect young trees from cicada damage, and to educators and the media as they teach and inform diverse audiences. By linking large numbers of cicada sightings collected on cellular phones by citizen scientists using the Cicada Safari app with widely available web-based weather data, we define dates, days of the year, and accumulated degree days for sightings of 17-year Brood X straggler cicadas. We present a procedure for coupling observations made by citizen scientists with data from weather stations to track patterns of cicada emergence which may have applicability throughout the range of periodical cicadas in the United States.

## INTRODUCTION

Massive synchronous appearances (Figures 1 and 2) of periodical cicadas, *Magicicada* Davis spp. (Hemiptera: Cicadidae), in North America have been a source of wonder, confusion, and consternation from the time of the colonists' first documented observations made in Plymouth, Massachusetts in 1663 to the present (Kritsky 2004). One of the earliest accounts of a pending emergence of periodical cicadas in the colony of Maryland was reported in the 3 April 1751 issue of *The Maryland Gazette*. A dire excerpt of this account read "…in some Places the Locusts have been found in great plenty, just under the surface of the Earth, almost at their full growth. *May God avert our impending Calamities.*" (Anonymous 1751). This ominous report most likely refers to Brood XIX, a brood of thirteen-year cicadas found in what is now St. Mary's County, Maryland which was then the former colonial capital of Maryland and an important agricultural center.

Beyond the intrinsic value of understanding the phenology of cicada emergence, knowing when cicadas appear and being able to predict their appearance has several practical implications. Established mature trees appear to suffer little long-term damage caused by ovipositing female cicadas as they insert eggs into small woody branches (Miller and

**Figure 1. Mass emergence of periodical cicadas.** After spending 17 years underground, Brood XIII periodical cicadas emerged in massive numbers in Elmhurst, Illinois during the last week of May 2007. Thousands of cicadas clinging to ancient trees were a common sight in suburban neighborhoods. Their exuvia accumulated in deep piles beneath trees and in lawns. Photographed by Michael J. Raupp.

**Figure 2. Mass emergence of periodical cicadas.** Piled one atop of another, shed skins and teneral adult periodical cicadas of Brood XIII festooned leaves of maples and other shade trees in Elmhurst, Illinois in late May 2007. Photographed by Michael J. Raupp.

Crowley 1998). However, oviposition injury on young trees and shrubs can lead to severe damage including reduced rates of growth, branch breakage, reduced flowering, and destruction of fruit bearing terminals in young fruit trees (Hogmire et al. 1990, Williams and Simon 1995, Miller 1997, Miller and Crowley 1998). Knowing when cicadas will emerge in a location can inform decisions of urban foresters planning to plant trees in cities and along roadways. Commercial nurseries, fruit growers, and homeowners need phenological information to plan and implement interdiction measures such as the use of exclusionary netting put into place to reduce cicada injury (Hogmire et al. 1990, Ahern et al. 2005). The appearance of periodical cicadas has far-reaching sociological impacts as well. Entomologists will be asked by brides and wedding planners when cicadas will emerge in geographic locations to avoid conflict with scheduling outdoor weddings in the season of cicada emergence. Teachers and others involved in scientific outreach will want to know when cicadas will emerge to plan curricula for students. Entomologists will receive numerous requests from reporters and media outlets anxious to photograph, record, and share information about cicadas and their behaviors. While entomophiles will eagerly await the arrival of cicadas, those fearful of insects will seek guidance for scheduling prophylactic counseling and planning travel to avoid encountering cicadas.

The primacy of temperature in driving what has been called the short-term synchronization of periodical cicada emergence within a season was first investigated by Heath (1968). His work provided a physiological explanation for the emergence of periodical cicadas linked to soil temperatures. By measuring the body temperature of emerging cicada nymphs and linking these data with soil temperatures at various depths, he found strong concordance of synchronous cicada emergence with a soil temperature of 17.890 °C at a 20 cm depth (64.202 °F at 7.87 in). This study forms the basis for many popular accounts predicting the emergence of cicada nymphs when soil temperatures reach 18 °C (64.4 °F) (Fitzgerald 2016, Sheikh 2017, McKeever 2020). Kritsky et al. (2005) refined the use of meteorological data to predict cicada emergence by correlating historical records of emergence dates of Broods X and XIV with ambient air temperatures from the month of April preceding the emergence. The formula to predict the beginning of a cicada emergence was $E = (19.465 - t)/0.5136$, where E = emergence start date in May and t = average April temperatures in °C. This strong correlation explained 99% of the observed variation and was highly accurate in predicting the emergence of Brood X cicadas in Cincinnati, Ohio in 2004. This robust model also predicted 17-year cicada emergence within three days in locations beyond Ohio including Tennessee, North Carolina, Massachusetts, and Kentucky (Kritsky et al. 2009). Further developments in temperature-based predictions of cicada emergence were presented by Kritsky et al. (2009) who linked ambient air temperatures to soil temperatures. Using data loggers placed in the ground at the depth of 15 cm (5.9 in) in May, Kritsky et al. (2009), found that the previous two- and three-day running average air temperatures correlated strongly ($r^2 = 0.89$) with soil temperatures. They concluded that cicada emergence forecasts might be fine-tuned using extended weather forecast information.

One of the limitations to developing predictive models for cicada emergence has been gathering large sets of data distributed in time and space. The value of involving the general public in generating data useful in clarifying geographic distribution patterns of periodical cicadas has long been recognized (Dybas 1969, Kritsky et al. 2005). While the primary concern of data quality is sometimes called into question when citizens participate in data collection, studies show that effective training coupled with clear protocols and appropriate oversight enables volunteers to collect data comparable to those of experts (Bonney et al. 2014). With citizen science programs becoming more widely implemented and accepted, it is now possible to overcome some sample size limitations and gather large amounts of data to describe spatial and temporal patterns of insects including those of periodical cicadas. In 2019, Mount St. Joseph University released an app for Android and Apple IOS phones called Cicada Safari. The goal of Cicada Safari is to allow volunteers to take images of adult periodical cicadas that can be matched to precise locations and dates of appearance, thus enabling scientists to track cicadas in space and time. After citizen scientists snap an image of an insect and load it into the app, thoroughly trained staff at Mount St. Joseph University verify that the image is indeed a periodical cicada, an exuvia of a periodical cicada, or a red-eyed cicada nymph and enter into the database the date, latitude, and longitude of the sighting. At the time of this writing thousands of vetted records from Broods VIII, IX, and “stragglers” (cicadas that emerge off-cycle from the rest of their brood, Marshall 2001) from several other broods including Brood X in the metropolis of Maryland, the District of Columbia, northern Virginia, and the Midwest including parts of Ohio and Kentucky have been entered into the data base.

By virtue of the fact that insect development is strongly linked to temperature (Taylor 1981), entomologists regularly use weather data to forecast insect activity (USPEST.ORG [2020]). Herms (2004) provided a concise explanation on the use of growing degree days for predicting phenological events such as egg hatch, colonization, and adult emergence for more than 40 important arthropod pests of trees and shrubs. Recently, a consortium of universities including Oregon State and Ohio State, several government agencies including the United States Department of Agriculture – Animal and Plant Health Inspection Service – Plant Protection and Quarantine (USDA-APHIS-PPQ), the National Plant Diagnostic Network, the USDA Regional IPM Centers, and others have created a website that provides weather data to assist in pest prediction. Included at this site are models to generate local growing degree-day accumulations used by extension personnel, growers, field persons, consultants, researchers, and students in making timely pest management decisions. Data is collected from more than 32,000 weather stations nationwide (USPEST.ORG [2020]). This database makes degree day information readily available throughout all 50 states in the United States.

The primary objective of this study was to link sightings of periodical cicadas collected by citizen scientists using the Cicada Safari app to weather data available at the USPEST.ORG (2020) website. By linking these data, we describe in degree days when Brood X stragglers emerged in the greater Baltimore-Washington metropolitan region, nearby locations in northern Virginia, and stragglers that emerged in the Midwest in southern Ohio and northern Kentucky during the spring of 2020. We also summarized the day of the year on which cicadas were sighted. A secondary objective was to compare emergence patterns of Brood X stragglers in the Baltimore-Washington metropolis, northern Virginia, and the Midwest using data collected by Cicada Safari volunteers in 2020.

## METHODS

Data on cicada emergence was collected using the Cicada Safari app. Brood X data consisted of 406 sightings made between 19 April 2020 and 14 June 2020. These cicadas, known as stragglers, emerged one year prematurely from the rest of their massive brood that will emerge in 2021. For the Baltimore-Washington metropolis (DCMD) there were 154 reported sightings; for northern Virginia (VA) there were 153 reported sightings; and for Midwest stragglers (OHKY) there were 99 reported sightings. The first step in linking data from citizen scientists via the Cicada Safari app to an appropriate weather station nearby was accomplished by entering the latitude and longitude of the cicada sighting from Cicada Safari into Google Maps at https://www.google.com/maps/. This allowed visualization of the location of the sighting. Google Maps provides the town, state, and zip code for the sighting. Degree day accumulations were generated from the database maintained by USPEST.ORG (2018) at https://uspest.org/dd/model_app. The zip code of the cicada sighting from Google Maps was entered into the USPEST.ORG (2018) station search by clicking on the "Station" tab on the tool bar and clicking "search for stations." By clicking on the "(MAP)" tab, a searchable map of weather stations near the cicada sighting appeared. We then selected a weather station to generate degree days based on two criteria. The first criterion was proximity to each cicada sighting. The second and more important criterion was the quality of the data collected by the weather station. USPEST.ORG (2018) defines and calculates the quality of weather data provided by each station in the following way. "Quality scores range from 0 to 100%; stations with scores less than 75% are not shown. Higher scores are better, but differences less than 10% are probably not important. Quality score calculation: for each day, we expect a station to report a temperature and a dewpoint at least once in each hour. We calculate the percentage of these measurements which are present. (The remainder of the data is estimated.) Each quality score is a weighted average of these daily percentages, covering the period ending yesterday and starting about as long ago as is relevant for this application. Note that the score is only an estimate of the fraction of observed data used by the model you will run, and that outages in prior years do not affect the scores." Weather data used in our analyses were taken only from stations with scores ranked 90–99%.

Following the selection of the appropriate weather station, to calculate accumulated degree days for each cicada sighting, parameters were set for the online degree day models by clicking the "Model" tab on the toolbar. These parameters include "Model category" which was set at "all models", "Select Model" which was set at "degree-day calculator (general purpose)", "calculation method" which was set to "simple averaging/growing dds", "lower" threshold which was set to "50 °F", and "upper" threshold which was set to "95 °F", "Start" date which was set to "Jan. 1 2020" and "End" date which was set at the date to the day at which each cicada sighting was made. Clicking the "Output" tab runs the model. By selecting the "show full table" button on the output page a complete list of accumulated degree days leading up to the cicada sighting appears. This degree day was linked to the cicada sighting and used for analysis. Parameter settings were selected due to their widespread use in pest prediction (Herms 2004, Davidson and Raupp 2014, Siminsky 2017, Shrewsbury 2018).

Data on which day of the year cicadas were sighted was generated by converting the reported date of the sighting to the corresponding day of the year. For example, a sighting on 24 May 2020 would be day 145 of 2020.

In addition to recording the accumulated degree days for each sighting, the distance between each cicada sighting and the weather station was determined by copying latitudes and longitudes of both locations into the Movable Type Scripts website (Veness 2002–2020) which calculates the distance between two latitude/longitude points (https://www.movable-type.co.uk/scripts/latlong.html). Average distances between cicada sightings and locations of the nearest weather stations were summarized using the Descriptive Statistics procedure of Statistix (Analytical Software 2013).

Visualization of cicada emergence patterns for Broods X stragglers was constructed using the Box and Whisker chart function of Microsoft Windows Excel version 2016. A Shapiro-Wilk Test was conducted on data from DCMD, VA, and OHKY to determine if assumptions of normality were met prior to further statistical analysis (Zar 1999, Statistix [Analytical Software 2013]). Differences in degree day accumulations and the day of sighting were compared among the three geographic regions with a nonparametric analysis of variance (Kruskal-Wallis test, Zar 1999) followed by a Dunn's All-Pairwise Comparisons test to separate ranks into homogeneous groups (Zar 1999, Statistix [Analytical Software 2013]).

## RESULTS

The earliest and latest dates of sightings for Brood X stragglers were 19 April 2020 and 14 June 2020 for DCMD, 2 May 2020 and 14 June 2020 for VA, and 15 May 2020 and 7 June 2020 for OHKY. The range of degree days from least to most for each region were 147 to 938 for DCMD, 276 to 1125 for VA, and 332 to 949 for OHKY (Figure 3, Table 1). The earliest and latest days of sightings for Brood X stragglers were days 110 and 166 for DCMD, days 123 and 166 for VA, and days 136 and 159 for OHKY (Figure 4, Table 1).

Results of Shapiro-Wilk tests for normality revealed values for degree days and day of the year not to be normally distributed: degree days DCMD, $n = 154$, $W = 0.97$, $P = 0.003$; degree days VA, $n = 153$, $W = 0.93$, $P = 0.000$; degree days OHKY $n = 99$, $W = 0.95$, $P = 0.001$; day of year DCMD, $n = 154$, $W = 0.90$, $P = 0.000$; day of the year VA, $n = 153$, $W = 0.91$, $P = 0.000$; day of the year OHKY $n = 99$, $W = 0.96$, $P = 0.004$. Results of the Kruskal-Wallis test for degree day accumulations revealed significant differences among regions (Kruskal-Wallis Statistic, corrected for ties = 11.31, $P = 0.003$). Sightings of cicadas occurred at significantly fewer degree days in DCMD than in VA while sightings in OHKY were intermediate between DCMD and VA (Dunn's All-Pairwise Comparisons, $P < 0.05$) (Figure 3). Results of the Kruskal-Wallis test for day of the year sightings also revealed significant differences among regions (Kruskal-Wallis Statistic, corrected for ties = 10.05, $P = 0.007$) (Figure 4). Sightings of cicadas occurred significantly earlier in the year in VA than in OHKY with DCMD intermediate between these locations (Dunn's All-Pairwise Comparisons, $P < 0.05$).

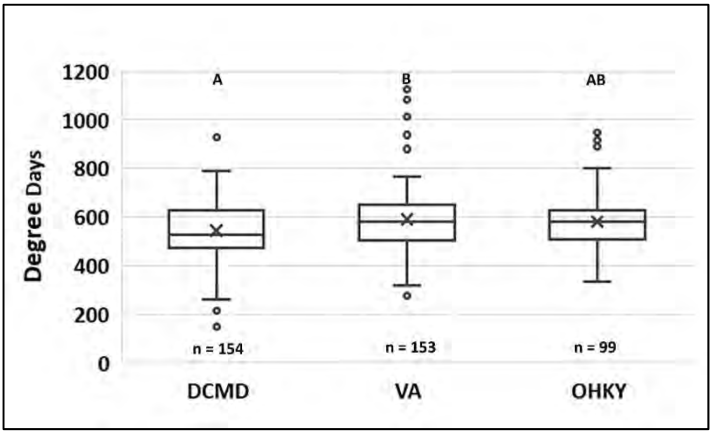


**Figure 3. Box whisker plot of accumulated degree days for Brood X stragglers in the Baltimore-Washington metropolitan region (DCMD), northern Virginia (VA), and southern Ohio and northern Kentucky (OHKY) that appeared in 2020.** Broods VIII and Brood X stragglers that appeared in 2019 and 2020, respectively. The middle line of the box represents the median, the x in the box represents the mean, the bottom line of the box represents the median of the bottom half or first quartile of the data, the top line of the box represents the median of the top half or third quartile of the data, the whiskers (vertical lines) extend from the ends of the box to the minimum value and maximum value. Outliers are represented by single data points above or below whiskers. Geographic regions that share the same letter do not differ (Dunn's All-Pairwise Comparisons, P < 0.05).

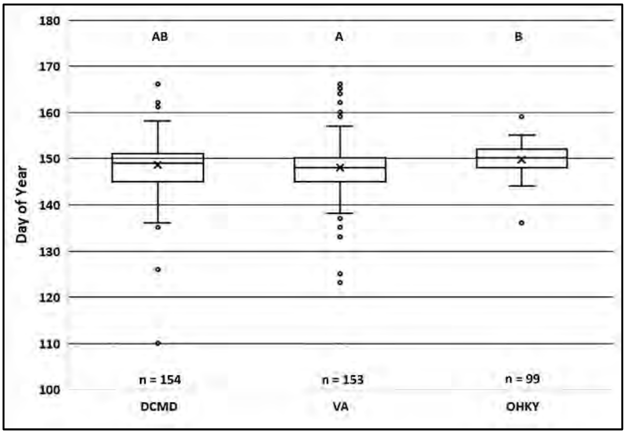


**Figure 4. Box whisker plot of day of the year for Brood X stragglers in the Baltimore-Washington metropolitan region (DCMD), northern Virginia (VA), and southern Ohio and northern Kentucky (OHKY) that appeared in 2020.** The middle line of the box represents the median, the x in the box represents the mean, the bottom line of the box represents the median of the bottom half or first quartile of the data, the top line of the box represents the median of the top half or third quartile of the data, the whiskers (vertical lines) extend from the ends of the box to the minimum value and maximum value. Outliers are represented by single data points above or below whiskers. Geographic regions that share the same letter do not differ (Dunn's All-Pairwise Comparisons, P < 0.05).

**Table 1. Summary of descriptive parameters of Brood X cicada sightings made by citizen scientists in the Baltimore-Washington metropolitan area (DCMD), northern Virginia (VA), and southern Ohio and northern Kentucky (OHKY) in 2020.**

| Parameter | DCMD (n = 154) | VA (n = 153) | OHKY (n = 99) |
|---|---|---|---|
| **Degree days of sightings** | | | |
| First degree days | 147 | 276 | 332 |
| Last degree days | 938 | 1125 | 949 |
| Mean degree days | 544.99 | 590.71 | 579.94 |
| Variance degree days | 19,277 | 17,603 | 15,628 |
| Standard deviation degree days | 138.84 | 132.68 | 125.01 |
| Coefficient of variation degree days | 25.476 | 22.460 | 21.556 |
| Median degree days | 525.00 | 579.00 | 582.00 |
| **Day of the year of sightings** | | | |
| First day | 110 | 123 | 136 |
| Last day | 166 | 166 | 159 |
| Mean day of year | 148.38 | 148.01 | 149.63 |
| Variance day of year | 49.284 | 34.928 | 11.115 |
| Standard deviation day of year | 7.02 | 5.91 | 3.34 |
| Coefficient of variation day of year | 4.731 | 3.993 | 2.232 |
| Median day of year | 149.00 | 148.00 | 150.00 |

Estimates of cicada emergence using degree days were far more variable than estimates based on the actual day of the year (Table 1). While the median degree days among locations spanned a range of 46 degree days from about 545 to 591, the median day of the year ranged between day 148 and 150, a span of two days among locations. The coefficients of variation in accumulated degree days for DCMD, VA, and OHKY were approximately 25%, 22%, and 22%, respectively (Table 1). The coefficients of variation in days of the year for DCMD, VA, and OHKY were approximately 5%, 4%, and 2%, respectively. Mean distances in kilometers between sightings reported to Cicada Safari and nearby weather stations used for degree day calculations for DCMD, VA, and OHKY were 4.06 (± 0.22 s.e.), 2.95 (± 0.26 s.e.), and 5.03 (± 0.34 s.e.), respectively.

## DISCUSSION

The first objective of this study, to link meteorological data from weather stations to vetted sightings of periodical cicadas from the Cicada Safari app, revealed differences in both degree day accumulations and day of the year patterns of appearance over the relatively small geographic distance between the Baltimore-Washington metropolitan region and northern Virginia. Cicadas in the Baltimore-Washington metropolitan region were the first to appear both by date, day, and degree day in 2020 (Figures 3 and 4) despite the fact that this region lies in close proximity to northern Virginia separated only by the Potomac River. One possible explanation for the earlier emergence in the

Baltimore-Washington region compared to northern Virginia is the level of urbanization and attendant levels of impervious surfaces. Impervious surfaces are well known to raise ambient temperatures and accelerate insect development (Raupp et al. 2012). The rapid accumulation of degree days in urbanized areas is exemplified by comparing degree days in Washington, DC to those in northern Virginia on the median day of cicada sightings, days 149 (28 May) and 148 (27 May), respectively. At a weather station nearest the greatest number of reported cicada sightings in urbanized Washington, DC, on day 149, 757 degree days had accumulated. At a weather station nearest the greatest number of cicada sightings in suburban northern Virginia on day 148, only 527 had accumulated. More than 90% of the cicada sightings in the Baltimore-Washington metropolitan region were made in counties and cities where impervious surfaces accounted for 6 to 26% of the land area. In Fairfax and Loudon Counties in Virginia where more than 90% of cicada sightings were made, impervious surfaces accounted for 9% and 16%, respectively. It is likely that warmer temperatures in highly urbanized locations may have advanced cicada development resulting in earlier emergences and sightings of adult cicadas. This hypothesis should be tested and evaluated using data specifically gathered across urbanization gradients. Urbanization gradients have been used as surrogates for predicating impacts of climate change on insects (Lahr et al. 2018). By dispersing the synchronization of cicada emergence, urbanization could disrupt the critical predatory satiation strategy for survival utilized by periodical cicadas (Karban 1982).

Smaller variation observed in the day of the year that a sighting occurred relative to the degree days at which the sighting took place may be attributed to one of several factors acting alone or in concert (Figures 3 and 4, Table 1). Dale and Frank (2014 a, 2014 b) demonstrated that temperature regimes can vary dramatically over relatively short distances within cities as urban green spaces intermix with buildings and hardscape. Local variation in temperature regimes could explain in part the relatively greater variation observed in degree day accumulations where the built environment interdigitates with green spaces and natural areas. The fact that the median ranks of sightings in the Baltimore-Washington metropolis compared to northern Virginia differed by only one day, 149 compared to 148, is surprising. Heath (1968) and Kritsky (2004) noted that the great majority of cicadas emerge during the same week and sometimes on a single night in a given location. Clearly, one environmental variable with little variation at similar latitudes is photoperiod. Williams and Simon (1995) suggested that photoperiod along with air and soil temperatures could serve as cues synchronizing emergence. The role of photoperiod in synchronizing cicada emergence likely deserves further investigation.

The second objective of this study, to compare temporal patterns of cicada sightings between Midwestern Brood X stragglers and those in the Baltimore-Washington metropolitan region and northern Virginia, revealed similarities in sightings with respect to degree day accumulations and the days at which cicadas were sighted. The most striking similarity was the concordance of the median day of the year on which cicadas emerged (Figure 4). This is not unexpected due to the latitudinal similarities between sightings in the Baltimore-Washington metropolis and northern Virginia and those in the Midwest. The average latitudinal difference between Brood X cicadas studied in the Baltimore-Washington metropolis and northern Virginia and those in the Midwest was merely 0.047 degrees. Buckley et al. (2017) found that the number of cumulative degree days required by insects to complete development changes with respect to changing latitude. In this study there was virtually no change in latitude. Future comparisons of cicada broods more widely distributed along latitudinal gradients could provide a way to elucidate and separate the relative contributions of temperature and photoperiod in synchronizing emergence of cicadas.

Recent citizen science projects have enabled entomologists to accumulate large amounts of data at lower costs for projects ranging from the vanishing of native lady beetles (Coleoptera: Coccinellidae) in the United States and United Kingdom (Gardiner et al. 2012, Losey et al. 2012) to elucidating temporal and spatial patterns of Monarch butterflies, *Danaus plexippus* (Linnaeus) (Lepidoptera: Nymphalidae), and their parasitoids (Oberhauser and Prysby 2008, Oberhauser et al. 2017). By combining data generated by citizen scientists through the Cicada Safari app and linking this data to readily available degree day data available at the USPEST.ORG website (2018, 2020), we characterized the appearance of Brood X periodical cicada stragglers. It will be interesting to compare our findings to those of Brood X cicadas when they appear en masse in spring of 2021. According to our findings, people living in Washington, DC, Maryland, northern Virginia, southern Ohio, and northern Kentucky can expect to see approximately half of Brood X cicadas appearing between day 147 and 149 (2021 is not a leap year as is 2020) when degree days have accumulated between 525 and 582 locally. We hope that the methodology outlined in this report will assist the general public, urban foresters, nursery growers, educators, and the media in predicting when periodical cicadas will appear not only at locations studied herein, but also in other regions in the United States.

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# The Curculionoidea (Weevils) of the George Washington Memorial Parkway, Virginia

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**ABSTRACT:** One-hundred thirty-five taxa (130 identified to species), in at least 97 genera, of weevils (superfamily Curculionoidea) were documented during a 21-year field survey (1998–2018) of the George Washington Memorial Parkway national park site that spans parts of Fairfax and Arlington Counties in Virginia. Twenty-three species documented from the parkway are first records for the state. Of the nine capture methods used during the survey, Malaise traps were the most successful. Periods of adult activity, based on dates of capture, are given for each species. Relative abundance is noted for each species based on the number of captures. Sixteen species adventive to North America are documented from the parkway, including three species documented for the first time in the state. Range extensions are documented for two species. Images of five species new to Virginia are provided.

**Keywords:** beetles, biodiversity, Malaise traps, national parks, new state records, Potomac Gorge.

## INTRODUCTION

This study provides a preliminary list of the weevils of the superfamily Curculionoidea within the George Washington Memorial Parkway (GWMP) national park site in northern Virginia.

Although there are more recent, phylogenetically-based classifications (e.g., Gillett et al. 2014, Gunter et al. 2016, Shin et al. 2018), we use the classification of Curculionoidea as utilized in *American Beetles* (Arnett et al. 2002) since this is the reference most likely to be used by, and most available to, readers of this paper.

The superfamily Curculionoidea contains seven North American families of weevils and weevil-like beetles, characterized by an elongated rostrum (Arnett et al. 2002). Of the seven families, six were documented from habitats within the GWMP.

The Nemonychidae (long-toothed or pine flower snout beetles) is a small family with a worldwide distribution (Oberprieler et al. 2007), containing only five North American genera. Adults are found in association with pollen of *Pinus* L. species (Pinaceae). They are similar to the Anthribidae in possessing straight antennae and a distinct labrum, but differ in the form of the rostrum which is elongate in the nemonychids but short, very broad and flat in anthribids (Anderson 2002c). Although treated as a subfamily in this paper per Arnett et al. (2002), the Cimberidinae has recently been elevated to family status as Cimberididae (Shin et al. 2018).

The Anthribidae (fungus weevils) comprise over 4,000 species and have a worldwide distribution. They are primitive weevils characterized by straight (not geniculate) antennae, very broad flat rostrum, exposed pygidium, and pronotal pubescence that is directed anteriorly (Valentine 2002). Like Nemonychidae, the adults possess a separate labrum and clypeus, unlike other Curculionoidea where these two parts of the head are fused together. Adults feed on the pollen of larval host plants or, in fungivorous species, on the fungi in which the larvae develop (Valentine 2002).

The Attelabidae (leaf-rolling weevils, tooth-nose snout beetles, and thief weevils) are represented in GWMP by all three known subfamilies (Attelabinae, Rhynchitinae, and Pterocolinae). They are considered primitive weevils based on their straight antennae. Familial characteristics include a concealed eighth tergite and exposed pygidium in both sexes; abdominal ventrites decreasing in length, the proximal three or four fused; and a body that is setose and without broad scales, and often metallic or otherwise brightly colored in many species (Hamilton 2002). The females of Attelabinae (leaf-rolling weevils) lay eggs on leaves that they have prepared by cutting with their mandibles so that the leaf can be rolled into a barrel-shaped structure that nourishes and protects the developing larvae (Hamilton 2002). In Rhynchitinae (tooth-nose snout beetles), the female oviposits in plant stems, leaves, or flowers and the larvae develop as miners of the living or dead tissue. The plant part containing the developing larvae is cut by the adult female using her mandibles and is either severed from the plant or latter dies and eventually drops. In the New World, 180 species of leaf-rolling weevils and 162 species of tooth-nose snout beetles have been described (Hamilton 2002). The female Pterocolinae (thief weevils) of the genus *Pterocolus* Say parasitize attelabid leaf-rolling weevils, preying on the eggs of the host and ovipositing in the leaf rolls prepared for the host larva. The pterocoline larvae feeds on the decaying leaf tissue and falls out to pupate in the ground (Vogt 1992).

The Brentidae (straight-snouted weevils and pear-shaped weevils) are represented in GWMP by two of the six North American subfamilies. The Apioninae are small pear-shaped weevils recognized by a long cylindrical trochanter with the femur attached at its apex. It contains approximately 140 species in North America (Anderson and Kissinger 2002). The Brentinae have elongate, parallel-sided bodies and a long, generally straight rostrum that often exhibits sexual dimorphism. The subfamily contains three species in three genera in North America (Anderson and Kissinger 2002).

The Ithyceridae (The New York Weevil) contains a single species recognized by its large size (12–18 mm [0.5–0.7 in]), distinct pubescence, and straight antennae (Anderson

2002b). This family is included in the Brentidae by some authors (e.g., Oberprieler et al. 2007).

The Curculionidae (true weevils, and snout, bark, and ambrosia beetles) are one of the most diverse beetle families in the world, following perhaps only the Staphylinidae (rove beetles) or Carabidae (ground beetles). More than 60,000 species have been described worldwide (Arnett et al. 2002). Eighteen subfamilies occur in the Nearctic, twelve of which are found in GWMP. The Curculionidae are recognized by the combination of their elongate rostrum with mouthparts that are situated at the apex and by their geniculate antennae with a compact antennal club, however some subfamilies, especially Scolytinae and Platypodinae, have the rostrum reduced and not markedly produced anteriorly (Anderson 2002a).

## STUDY SITES

The study site includes lands managed by the National Park Service as units of the GWMP in Fairfax County, Virginia. Park sites that received the greatest inventory effort included Dyke Marsh Wildlife Preserve, Great Falls Park, Little Hunting Creek, and Turkey Run Park. Additionally, one species (*Trachyphloeosoma advena* Zimmerman) was documented from the study site in Arlington County. A map of these sites is provided in Steury (2011). The area is located between latitudes 38.985° and 38.717° and longitudes -77.246° and -77.078°. The site covers an area of approximately 1,615 ha (3,991 ac). Great Falls Park and Turkey Run Park fall within the Piedmont Plateau physiographic province while all other collection sites are on the Coastal Plain. Most sites are situated along the shore of the Potomac River, and the Piedmont Plateau sites border the Potomac Gorge, an area known for high species richness of plants and animals (Evans 2008). The Potomac Gorge (Cohn 2004) is a 24 km (15 mi) long, area of the Potomac River located just west of Washington, District of Columbia, and includes a steeply dissected landscape of bluffs, ravines, and floodplains along a high-gradient reach of the river (Fleming 2007). Most of the study sites are dominated by maturing, second growth, primarily upland, deciduous woodlands. More open, herbaceous-dominated, habitats can be found along the shore of Potomac River and in the freshwater, tidal, swamp, and marsh habitats at Dyke Marsh. More than 1,313 vascular plant taxa have been recorded in GWMP and 1,020 from Great Falls Park alone (Steury et al. 2008, Steury 2011).

## MATERIALS AND METHODS

Specimens were collected during a 21-year period (1998–2018) using a variety of sporadic survey methods targeting arthropods, including: Malaise traps, Lindgren funnel traps, blacklight (UV) bucket traps, blacklight shone on sheets, leaf litter samples processed in Berlese funnels, beating sheets, pitfall traps, hand collecting, and bee bowls (96 ml [3.25 oz] white soufflé cups painted fluorescent yellow, fluorescent blue, or left non-fluorescent white and filled with a dilute mixture of detergent and water). Six Townes-style Malaise traps (Townes 1962) were set at Dyke Marsh, April 1998–December 1999; three each at Great Falls and Turkey Run Parks (March 2006–December 2009); and four at Little Hunting Creek (March–November 2017 and 2018). Traps at Dyke Marsh were set each year in the same locations: in open, tidal, freshwater marsh dominated by narrowleaf cattail (*Typha angustifolia* L. [Typhaceae]); in floodplain forest dominated by red maple and silver maple (*Acer rubrum* L. and *A. saccharinum* L. [Aceraceae]) and tuliptree (*Liriodendron tulipifera* L. [Magnoliaceae]); and at the marsh/forest ecotone. In Great Falls Park, a trap was set in each of three habitats: quarry site (dry, upland, mixed deciduous/coniferous forest), swamp (dominated by red maple), and floodplain forest (dominated by oaks [*Quercus* L. sp. (Fagaceae)], and tuliptree). In Turkey Run Park, one trap was set in upland forest dominated by oaks and tuliptree and two traps in floodplain forest along the Potomac River (dominated by oaks, American basswood [*Tilia americana* L. (Tiliaceae)], and American sycamore [*Platanus occidentalis* L. (Platanaceae)]). At Little Hunting Creek, four traps were set in upland forest dominated by an ericaceous understory and a canopy of oaks, hickory (*Carya* Nutt. sp. [Juglandaceae]), American beech (*Fagus grandifolia* Ehrh. [Fagaceae]), and some Virginia pine (*Pinus virginiana* Mill. [Pinaceae]).

Additional collections were also made by sporadically using other collecting methods, including pitfall traps set at Dyke Marsh (five years), and at Little Hunting Creek, Great Falls Park, and Turkey Run Park (three years); Lindgren funnel traps and blacklight (UV) bucket traps set at Dyke Marsh, Great Falls Park, Little Hunting Creek, and Turkey Run Park (two years); blacklight shone on sheets at Great Falls Park and Turkey Run Park (three years); leaf litter from Dyke Marsh, Great Falls Park, and Turkey Run Park processed in Berlese funnels (two years); bee bowls set in riverside prairie at Great Falls Park (one year; Steury et al. 2009); and using beating sheets and hand collecting at all sites over seven years. Collectors included Christopher Acosta, Edward M. Barrows, Michael J. Blymyer, Karolyn Darrow, Colin Davis, Arthur V. Evans, Cristina Francois, Christy Jo Geraci, Steven W. Lingafelter, Jerry A. Louton, Deblyn Mead, Erik T. Oberg, David R. Smith, Warren E. Steiner, Brent W. Steury, Jil M. Swearingen, Jessica L. Ware, and Christopher C. Wirth. Citizen scientist volunteers in the GWMP bug lab sorted weevils from Malaise trap collection jar samples. Specimens were determined by Robert S. Anderson, Arthur V. Evans, Jens Prena, Charles L. Staines, and Brent W. Steury using a variety of literature sources, most notably: Blatchley and Leng (1916), O'Brien and Wibmer (1982), Downie and Arnett (1996), and Ciegler (2010). In addition, when possible, identifications were made or confirmed by comparison of GWMP specimens with specialist-identified specimens in the Canadian Museum of Nature Insect Collection (CMNC), Ottawa, Ontario, Canada, and the Department of Entomology, National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC. In spite of these efforts, four taxa could be identified reliably only to genus in the list below. New state record determinations are based on examination of the collections and the literature (mainly O'Brien and Wibmer [1982]). Specimens from GWMP were pinned, labeled, and deposited in the collections maintained at the GWMP, Turkey Run Park Headquarters in McLean, Virginia.

## RESULTS AND DISCUSSION

## LIST OF SPECIES

Subfamilies, genera, and species are listed alphabetically within each family for the 604 specimens collected. Tribe and subtribe are included alphabetically when these are used within a subfamily. An exclamation mark (!) is used to indicate taxa not previously documented in Virginia. A double dagger (‡) indicates the six new Virginia records reported from the 2006 Potomac Gorge BioBlitz (Evans 2008) and includes one species, *Perigaster cretura* (Herbst), not then noted as a new state record. Adventive (non-native) species are indicated by a dagger (†). The number of specimens in the collection at GWMP is indicated in parentheses after each taxon. Collection sites are abbreviated as Dyke Marsh Wildlife Preserve (DM), Little Hunting Creek (LH), Great Falls Park (GF), and Turkey Run Park (TR). Other locations or collection methods are spelled out if necessary. The periods of adult activity are based on dates when live individuals were captured in the park. Dates separated by an en dash (–) indicate that the taxon was documented on at least one day during each month within this continuum of months, whereas dates separated by a comma represent individual observation dates. For traps set over multiple weeks, the first day of the set is used as the earliest date and the last day of the set as the latest date. Collection methods are designated as: bb (bee bowl), bf (Berlese funnel), bl (black-light shown on sheet), bs (beating sheet), bt (black-light bucket trap), hc (hand collected), lf (Lindgren funnel trap), mt (Malaise trap), and pf (pitfall trap). Some specimens of Apioninae were unidentifiable to species as species level identifications require examination of males and only females were available. Additionally, some specimens of the genus *Baris* Germar (Curculionidae) were unidentified to species as this genus requires taxonomic revision.

# Superfamily CURCULIONOIDEA

## Family NEMONYCHIDAE (long-toothed or pine flower snout beetles)

### Subfamily CIMBERIDINAE

**Tribe CIMBERIDINI**
*Cimberis pilosa* (LeConte) – (6); DM; 12 Apr–10 May; mt.

## Family ANTHRIBIDAE (fungus weevils)

### Subfamily ANTHRIBINAE

**Tribe CRATOPARINI**
*Euparius marmoreus* (Olivier) – (11); DM, GF, LH, TR; 9 Apr–11 Sep; mt.
*Euparius paganus* Gyllenhal – (1); DM; 12–28 Aug; mt.

**Tribe ISCHNOCERINI**
*Ischnocerus infuscatus* Fåhraeus – (7); GF, TR; 22 Jun–30 Jul; bs, mt.

**Tribe PIESOCORYNINI**
*Brachycorynus rectus* (LeConte) – (1); TR; 19–30 Jun; mt.
*Piesocorynus mixtus* LeConte – (1); GF; 27 Jul–14 Aug; mt.

*Piesocorynus plagifer* Jordan – (1); TR; 24 Jun; bs.

**Tribe PLATYSTOMINI**
*Toxonotus cornutus* (Say) – (3); GF, TR; 10–30 Apr, 24 Jun–21 Jul; bs, mt.

**Tribe TROPIDERINI**
*Eurymycter tricarinatus* Pierce – (5); GF, TR; 21 May–24 Aug; bs, mt.

**Tribe ZYGAENODINI**
*Eusphyrus walshi* LeConte – (15); DM, GF, LH, TR; 10 Apr–4 Sep; mt.
*Ormiscus saltator* LeConte – (1); LH; 1–14 Jun; mt.

### Subfamily CHORAGINAE

**Tribe CHORAGINI**
! *Choragus harrisi* LeConte – (1); LH; 1–14 Jun; mt. Valentine (1998) reported this species in the United States from Massachusetts to Maryland, west to Michigan and Oklahoma; it has also been recorded in Louisiana (Ferro and Nguyen 2016).
! *Choragus zimmermanni* LeConte – (2); LH, GF; 1–14 Jun, 15–30 Jul; mt. Valentine (1998) recorded this species in the United States as occurring from Massachusetts to Florida, west to Ohio and Texas. Although these two specimens are the first published records for Virginia, Chamorro (in litt., 12 March 2020) stated that Virginia specimens exist in the USNM as part of the recently acquired Barry D. Valentine collection.

## Family ATTELABIDAE (leaf-rolling weevils, tooth-nose snout beetles, and thief weevils)

### Subfamily ATTELABINAE

*Synolabus bipustulatus* (Fabricius) – (5); GF, LH; 21 May–30 Jul; mt. Hamilton (2002) mentions this species as *Attelabus bipustulatus* Fabricius, but Riedel and Hamilton (2007) have elevated the former subgenus *Synolabus* Jekel to generic status.

### Subfamily RHYNCHITINAE

**Tribe RHYNCHITINI**
*Eugnamptus angustatus* (Herbst) – (10); DM, GF, TR; 10 Apr–14 Aug; bs, mt.

### Subfamily PTEROCOLINAE

*Pterocolus ovatus* (Fabricius) – (1); GF; 21 May–18 Jun; mt.

## Family BRENTIDAE (straight-snouted and pear-shaped weevils)

### Subfamily APIONINAE

**Tribe APIONINI**

Apionini sp. 1 – (4); DM, GF, TR; 19 Apr–30 Jun, 19 Sep–21 Oct; mt.

Apionini sp. 2 – (2); DM; 8 Aug–21 Sep; mt. Many subgenera of *Apion* Herbst were recently elevated to genera. Genera formerly assigned to *Apion* documented in North America include: *Apion*, *Apionion* Kissinger, *Bothryopteron* Wagner, *Chrysapion* Kissinger, *Coelocephalapion* Wagner, *Stenapion* Wagner, and *Trichapion* Wagner (Anderson and Alonso-Zarazaga 2019, de Sousa et al. 2019).

**Tribe PIEZOTRACHELINI**

*Fallapion* Kissinger sp. – (2); DM, LH; 28 Jul–11 Aug, 11–26 Oct; mt.

**Tribe OXYSTOMATINI**

**Subtribe Synapiina**

† *Ischnopterapion virens* (Herbst) – (3); Collingwood Picnic Area, TR; 2 Jun, 22 Oct–1 Dec; hc (dry turf grass), mt.

**Subtribe *Trichapiina***

*Trichapion nigrum* (Herbst) – (6); DM; 30 Jul–12 Sep; mt.

*Trichapion rostrum* (Say) – (5); DM, TR; 1–20 May; mt.

### Subfamily BRENTINAE

**Tribe ARRHENODINI**

*Arrenodes minutus* (Drury) – (9); GF, TR; 21 May–26 Jul; bs, mt.

## Family ITHYCERIDAE (The New York Weevil)

*Ithycerus noveboracensis* (Forster) – (1); GF; 23 Jun; bs.

## Family CURCULIONIDAE (weevils, and snout, bark, and ambrosia beetles)

### Subfamily BAGOINAE

*Bagous magister* LeConte – (1); DM; 2–18 Jul; mt.

### Subfamily BARIDINAE

**Tribe BARIDINI**

! *Baris aeneomicans* Casey – (1); GF; 19 Sep–21 Oct; mt. This species occurs from Massachusetts to Florida, west to Illinois and Louisiana (O’Brien and Wibmer 1982).

*Baris* Germar sp. – (2); TR; 7–30 Jul; mt.

*Desmoglyptus crenatus* (LeConte) – (1); DM; 29 Aug–12 Sep; mt.

**Tribe MADARINI**
**Subtribe Madarina**
*Ampeloglypter ampelopsis* (Riley) – (2); TR; 6–30 Jul; mt.
*Glyptobaris lecontei* Champion – (10); GF, TR; 1–20 May, 19–30 Jun, 7 Jul–7 Sep; mt.
*Madarellus undulatus* (Say) – (6); DM, GF, TR; 10 Apr–2 Jul; mt.

**Tribe MADOPTERINI**
**Subtribe Torcina**
! *Sibariops concinna* (LeConte) – (2); DM; 14–24 Jun, 21 Nov–5 Dec; mt. (Figure 1). This species occurs from New York to Florida, west to Texas (O'Brien and Wibmer 1982).
! *Sibariops confinis* (LeConte) – (1); DM; 10–17 May; mt. (Figure 2). This record documents a slight southern range extension along the East Coast from New Jersey to northern Virginia. It was previously recorded from New York and New Jersey west to Iowa (O'Brien and Wibmer 1982).
**Subtribe Zygobaridina**
*Buchananius striatus* (LeConte) – (1); LH; 5–19 May; mt.
! *Buchananius sulcatus* (LeConte) – (4); LH, TR; 5 May–17 Jul; mt. O'Brien and Wibmer (1982) recorded this species from New York to Florida, west to Missouri and Louisiana.
*Geraeus penicillus* (Herbst) – (1); GF; 23 Jul; netted on nodding onion, *Allium cernuum* Roth (Liliaceae).
*Geraeus picumnus* (Herbst) – (1); DM; 24 Jun–8 Jul; mt.
! *Nicentrus lecontei* Champion – (1); GF; 27–28 Aug; bb. This species occurs from New Jersey and New York to South Carolina, west to Indiana (O'Brien and Wibmer 1982).
*Odontocorynus salebrosus* (Casey) – (1); GF; 11–12 Jul; bb.
*Plocamus echidna* (LeConte) – (1); LH; 16 Oct; hc (in leaf litter).

## Subfamily CEUTORHYNCHINAE

**Tribe CEUTORHYNCHINI**
! *Ceutorhynchus americanus* Buchanan – (1); TR; 23 May–5 Jun; mt. A widespread species in North America that reaches to South Carolina and Texas in the eastern United States (O'Brien and Wibmer 1982).
! *Ceutorhynchus anthonomoides* Dietz – (1); TR; 10–30 Apr; mt. This species was previously recorded from Indiana, Kansas, Missouri, Ohio, and the District of Columbia (O'Brien and Wibmer 1982).
† *Ceutorhynchus obstrictus* (Marsham) – (1); DM; 17–28 May; mt. Earlier North American records for this European species are under the name *C. assimilis* (Paykull). It has been recorded throughout western and eastern North America (Gillespie et al. 2006).
*Glocianus punctiger* (Sahlberg) – (1); TR; 28 Apr–12 May; mt.

**Figure 1.** ***Sibariops concinna*** **(LeConte).** Dyke Marsh Wildlife Preserve, ecotone, Malaise trap, 21 November–5 December 1999, E. M. Barrows. Left, dorsal view, right, lateral; length 3 mm (0.12 in). This is the first record of this species in Virginia.

**Figure 2.** ***Sibariops confinis*** **(LeConte).** Dyke Marsh Wildlife Preserve, marsh, Malaise trap, 10–17 May 1998, E. M. Barrows. Left, dorsal view, right, lateral; length 3.3 mm (0.13 in). This is the first record of this species in Virginia.

**Tribe CNEMOGONINI**

*Orchestomerus eisemanni* Yoshitake and Anderson – (4); GF, TR; 3 Jul–14 Aug; mt.

! *Parauleutes nebulosus* (LeConte) – (2); DM, GF; 10–17 May, 27–28 Aug; bb, mt. This species also occurs throughout the eastern United States from New York to Florida, west to Nebraska and Texas (O'Brien and Wibmer 1982).

‡ *Perigaster cretura* (Herbst) – (1); GF; 24 Jun; bs. This species occurs from Ontario to Florida, west to Kansas and Texas (O'Brien and Wibmer 1982).

**Tribe PHYTOBIINI**

*Pelenomus pusillus* Dietz – (1); DM; 12–26 Sep; mt.

**Subfamily CONODERINAE**

**Tribe LECHRIOPINI**

‡ *Acoptus suturalis* LeConte – (5); GF, LH, TR; 14 Apr–21 Jul; bs, mt. This species is widely distributed in the east from Georgia and North Carolina, north into Ontario and Quebec (O'Brien and Wibmer 1982).

*Lechriops oculata* (Say) – (22); DM, GF, LH, TR; 10 Apr–1 Dec; mt, pf.

**Tribe ZYGOPINI**

! *Cylindrocopturus binotatus* (LeConte) – (1); DM; 8–21 Nov; mt. This species occurs from New Jersey and New York south to Georgia, west to Ohio and Texas (O'Brien and Wibmer 1982).

**Subfamily COSSONINAE**

**Tribe COSSONINI**

*Cossonus impressifrons* Boheman – (23); DM, GF, TR; 23 May–26 Jul; bs, mt.

**Tribe DRYOTRIBINI**

! *Caulophilus dubius* (Horn) – (2); DM, GF; 15 Jun–8 Aug; mt. This species is widespread in eastern North America, occurring in Quebec and New York to Florida, west to Illinois, Kentucky, and Texas (O'Brien and Wibmer 1982, Douglas et al. 2013).

**Tribe ONYCHOLIPINI**

! *Pseudopentarthrum nitens* Horn – (1); TR; 19–30 Jun; mt. (Figure 3). O'Brien and Wibmer (1982) recorded this species as *Pentarthrinus nitens* (Horn) from the District of Columbia and Florida.

! *Pseudopentarthrum simplex* (Casey) – (1); TR; 19–30 Jun; mt. This species was previously known from Indiana, Mississippi, Nebraska, North Carolina, and South Carolina (O'Brien and Wibmer 1982).

*Stenoscelis brevis* (Boheman) – (7); DM, GF, LH: 18 May–15 Jul; lf, mt, pf.

**Figure 3. *Pseudopentarthrum nitens* (Horn).** Turkey Run Park, river, Malaise trap, 19–30 June 2009, D. R. Smith. Lateral view; length 2.0 mm (0.08 in). This is the first record of this species in Virginia.

**Tribe RHYNCOLINI**
**Subtribe Rhyncolina**

! *Tomolips quercicola* (Boheman) – (1); TR; 19–30 Jun; mt. This species occurs throughout eastern North America from New England to Florida, west to Indiana, Missouri, and Texas (O'Brien and Wibmer 1982).

## Subfamily CRYPTORHYNCHINAE

**Tribe CRYPTORHYNCHINI**
**Subtribe Cryptorhynchina**

*Apteromechus ferratus* (Say) – (23); DM, GF, LH, TR; 10 Apr–26 Jul; lf, mt.

*Cryptorhynchus obliquus* (Say) – (13); DM, GF, TR; 28 May–21 Oct; mt. *Cryptorhynchus fuscatus* LeConte is a junior synonym of *C. obliquus* (Say) (fide Prena [2018]).

*Cryptorhynchus tristis* LeConte – (2); GF; 23 Jun; bt.

*Eubulus bisignatus* (Say) – (8); GF, LH; 10 Apr–23 Jun; bt, mt.

*Eubulus obliquefasciatus* (Boheman) – (41); DM, GF, LH, TR; 10 Apr–19 May; mt. Thirty-three of these were captured in the same malaise trap set in Great Falls swamp from 10–30 April.

! *Phyrdenus divergens* (Germar) – (1); TR; 7–12 Jul; mt. This species is widely distributed in the eastern United States from New Jersey to Florida, west to Indiana and Texas (O'Brien and Wibmer 1982).

**Subtribe Tylodina**

‡ *Acalles carinatus* LeConte – (6); GF, TR; 28 Apr–30 Jul; bs, mt, pf. O'Brien and Wibmer (1982) recorded this species from New Jersey to Georgia, west to Ohio, Nebraska, Missouri, and Arkansas.

*Acalles minutissimus* LeConte – (1); GF; 27 Jul–14 Aug, mt.

**Tribe GASTEROCERCINI**

*Cophes fallax* (LeConte) – (2); GF, TR; 25 Jun, 19 Sep–21 Oct; hc, mt.

‡ *Cophes obtentus* (Herbst) – (3); LH, TR; 1 Jun–30 Jul; bs, mt. This species is widespread in the eastern United States, occurring from New Jersey to Florida, west to Illinois, Missouri, Arkansas, and Texas (O'Brien and Wibmer 1982).

## Subfamily CURCULIONINAE

**Tribe ANTHONOMINI**

*Anthonomus signatus* Say – (2); DM; 28 Apr–20 Jun; mt.

‡ *Anthonomus suturalis* LeConte – (3); GF, LH; 10 May–24 Jun; bs, mt. This species is widespread in eastern North America, ranging from Ontario and Québec to Florida, west to Kansas and Texas (O'Brien and Wibmer 1982, Bousquet et al. 2013).

*Pseudanthonomus helvolus* (Boheman) – (1); GF; 22 Oct–1 Dec; mt.

*Pseudanthonomus rufulus* Dietz – (4); GF; 16–30 Jul; mt.

*Pseudanthonomus validus* Dietz – (1); GF; 16–30 Jul; mt.

**Tribe CURCULIONINI**

*Curculio caryae* (Horn) – (1); DM; 12–27 Aug; mt.

*Curculio confusor* (Hamilton) – (1); DM; 18–23 Jul; mt.

*Curculio strictus* (Casey) – (1); LH; 19 Sep–10 Oct; mt.

*Curculio sulcatulus* (Casey) – (3); DM; 12 Aug–26 Oct; mt.

**Tribe ELLESCINI**

**Subtribe Ellescina**

*Ellescus ephippiatus* Say – (1); GF; 10–30 Apr; mt.

**Tribe MECININI**

† *Mecinus pyraster* (Herbst) – (4); DM; 11–28 Apr; mt.

**Tribe OTIDOCEPHALINI**

*Myrmex myrmex* (Herbst) – (7); GF, LH; 5 May–14 Aug; bs, mt.

**Tribe SMICRONYCHINI**

*Smicronyx amoenus* (Say) – (2); DM, TR; 1–20 May, 23 Jul–8 Aug; mt.

**Tribe TYCHIINI**

**Subtribe Tychiina**

† *Tychius picirostris* (Fabricius) – (8); DM, GF; 19 Apr–23 Jun, 11–26 Oct; bt, mt.

**Subtribe Lignyodina**

*Lignyodes fraxini* (LeConte) – (2); DM; 12–28 Apr; mt. This species was previously recorded as occurring from Quebec to New Jersey, west to Saskatchewan, Kansas, and Missouri (O'Brien and Wibmer 1982, Bousquet et al. 2013).

*Lignyodes helvolus* (LeConte) – (1); GF; 27 Jul–14 Aug; mt.

## Subfamily CYCLOMINAE

**Tribe RHYTHIRRININI**
**Subtribe Listroderina**

! *Listronotus frontalis* LeConte – (7); GF; 6 Aug; bl. This species is widely distributed in North America (O'Brien and Wibmer 1982, Bousquet et al. 2013).

‡ *Listronotus humilis* Gyllenhal – (2); DM, GF; 23 Jun, 24 Oct–8 Nov; bt, mt. This species is widely distributed in North America (O'Brien and Wibmer 1982, Bousquet et al. 2013).

*Listronotus punctiger* LeConte – (1); DM; 20 Jun–2 Jul; mt.

## Subfamily DRYOPHTHORINAE

**Tribe DRYOPHTHORINI**

*Dryophthorus americanus* Bedel – (1); GF; 1 May; bs.

**Tribe RHYNCHOPHORINI**
**Subtribe Sphenophorina**

*Rhodobaenus quinquepunctatus* (Say) – (3); DM, GF; 21 May–2 Jul; mt.

! *Sphenophorus sayi* Gyllenhal – (2); TR; 10 Apr–20 May; mt. This widespread North American species occurs in the East as far south as Georgia and Louisiana (O'Brien and Wibmer 1982).

*Sphenophorus venatus vestitus* Chittenden – (5); DM, TR; 8 May–4 Aug; mt.

## Subfamily ENTIMINAE

**Tribe CYPHICERINI**
**Subtribe Acanthotrachelina**

† *Calomycterus setarius* Roelofs – (1); GF; 24 Jun; bs.

**Subtribe Cyphicerina**

† *Cyrtepistomus castaneus* (Roelofs) – (26); GF, LH, TR; 10 Apr–1 Dec; mt.

!† *Myosides seriehispidus* Roelofs – (3); LH, TR; 15 Apr, 16 Oct; bf, hc (in leaf litter). This Asian species has been recorded from Québec, Connecticut, District of Columbia, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, and West Virginia (O'Brien 2000, Carlton and Anderson 2004, de Tonnancour et al. 2017).

† *Pseudoedophrys* (*Oedophrys*) *hilleri* (Faust) – (21); DM, GF, TR; 14 Jun–21 Oct; bs, mt, pf.

**Tribe EUSTYLINI**

*Brachystylus sayi* Alonso-Zarazaga – (2); DM, LH; 5 May–6 Jun; mt.

**Tribe PHYLLOBIINI**

*Aphrastus taeniatus* Say – (8); GF, TR; 23 Jun–30 Jul; bs, bt, mt.

**Tribe SCIAPHILINI**

† *Barypeithes pellucidus* (Boheman) – (5); Collingwood Picnic Area, LH, TR; 24 Mar–16 Jun; hc, pf.

**Tribe SITONINI**

† *Sitona hispidulus* (Fabricius) – (8); DM, TR; 12 Sep–8 Nov; mt, pf.
† *Sitona lineatus* (Linnaeus) – (2); DM; 26 Sep–5 Dec; mt.

**Tribe TANYMECINI**
**Subtribe Tanymecina**

*Pandeleteius hilaris* (Herbst) – (5); LH; 5 May–28 Jun, 19 Sep–10 Oct; mt.

**Tribe TRACHYPHLOEINI**
**Subtribe Trachyphloeina**

† *Pseudocneorhinus bifasciatus* (Roelofs) – (12); DM, GF, TR; 25 Apr–17 Aug; bs, mt.
!† *Trachyphloeosoma advena* Zimmerman – (1); Roaches Run; 15 Apr; hc. (Figure 4). Originally described from Hawaii, O'Brien (1984) first reported this species in the continental United States based on specimens collected in Alabama and Florida. It also occurs in South Carolina (Ciegler 2010). This record documents a northern range extension of at least 643 km (400 mi).

## Subfamily ERIRHININAE

**Tribe ERIRHININI**
**Subtribe Stenopelmina**

*Onychylis nigrirostris* (Boheman) – (1); DM; 20 Jun–2 Jul; mt.

**Subtribe Tanysphyrina**

!† *Tanysphyrus lemnae* (Fabricius) – (1); GF; 6 Aug; bl. (Figure 5). This European species is widespread across the eastern half of the United States (O'Brien and Wibmer 1982).

## Subfamily HYPERINAE

**Tribe HYPERINI**

† *Hypera nigrirostris* (Fabricius) – (3); DM; 21 Nov–5 Dec; mt.

## Subfamily LIXINAE

**Tribe LIXINI**

*Lixus concavus* Say – (1); DM; 23 May; mt.
*Lixus scrobicollis* Boheman – (2); GF; 19 Jun–30 Jul, mt.

## Subfamily MESOPTILIINAE

**Tribe LAEMOSACCINI**

*Laemosaccus nephele* (Herbst) – (4); LH, 1–14 Jun, mt.

**Figure 4.** ***Trachyphloeosoma advena*** **Zimmerman.** Roaches Run Waterfowl Sanctuary, 15 April 2012, B. W. Steury. Left, dorsal view, right, lateral; length 2.5 mm (0.10 in). This is the first record of this non-native species in Virginia.

**Figure 5.** ***Tanysphyrus lemnae*** **(Fabricius).** Great Falls Park, blacklight in mixed forest gap near river, 6 August 2007, W. E. Steiner and J. M. Swearingen. Left, dorsal view, right, lateral; length 1.5 mm (0.06 in). This is the first record of this non-native species in Virginia.

### Tribe MAGDALIDINI

! *Magdalis barbita* (Say) – (1); DM; 8–21 Nov; mt. This species is widely distributed throughout eastern North America south to Georgia and Texas (O'Brien and Wibmer 1982, Bousquet et al. 2013).

## Subfamily MOLYTINAE

### Tribe CLEOGONINI

*Rhyssomatus lineaticollis* (Say) – (1); TR; 1–17 Jun; mt.

### Tribe CONOTRACHELINI

*Conotrachelus affinis* Boheman – (4); TR; 19 Jun–4 Aug, mt.
*Conotrachelus anaglypticus* (Say) – (9); GF, LH, TR; 1 May–21 Oct; lf, mt.
*Conotrachelus buchanani* Schoof – (5); TR; 19 Sep–1 Dec; mt.
*Conotrachelus elegans* (Say) – (8); DM, GF, LH, TR; 10 Apr–18 Jun; bl, mt.
*Conotrachelus geminatus* LeConte – (7); DM, LH; 1–14 Jun, 8–15 Aug; mt.
*Conotrachelus naso* LeConte – (3); LH; 28 Jul–10 Oct; mt.
*Conotrachelus nenuphar* (Herbst) – (3); DM, GF, TR; 19–28 Apr, 16 Jul–17 Aug; mt.
*Conotrachelus posticatus* Boheman – (11); GF, LH, TR; 21 May–11 Aug; lf, mt.
*Conotrachelus seniculus* LeConte – (1); GF; 25 Jun; bs.
*Microhyus setiger* LeConte – (8); GF, LH, TR; 10–30 Apr, 1 Jun–20 Jul; mt.

### Tribe HYLOBIINI

#### Subtribe Hylobiina

*Hylobius pales* (Herbst) – (1); LH; 18 May–3 Jun; pf.

### Tribe PIAZORHININI

! *Piazorhinus pictus* LeConte – (4); DM, GF, LH; 1 Jun–13 Jul, 22 Oct–1 Dec; mt. A species widespread in eastern North America that occurs from Atlantic Canada to Florida, west to Manitoba, Wisconsin, and Missouri (O'Brien and Wibmer 1982, Bousquet et al. 2013).
*Piazorhinus scutellaris* (Say) – (2); GF; 10–30 Apr, 15 Aug–7 Sep, mt.

## Subfamily PLATYPODINAE

### Tribe PLATYPODINI

*Euplatypus compositus* (Say) – (13); GF, TR; 10 Apr–1 Dec; mt.

## Subfamily SCOLYTINAE

### Tribe HYLESININI

#### Subtribe Hylastina

*Hylastes* Erichson sp. – (1); DM; 21 Nov–5 Dec; mt.

#### Subtribe Hylesinina

*Hylesinus aculeatus* Say – (4); DM, GF, TR; 10 Apr–8 May; mt.

#### Subtribe Tomicina

*Dendroctonus valens* LeConte – (2); LH; 12 Apr–18 May; lf, pf.

**Tribe SCOLYTINI**
**Subtribe Corthylina**
*Corthylus columbianus* Hopkins – (1); DM; 11–27 Sep; mt.
*Monarthrum fasciatum* (Say) – (22); DM, GF, LH; 15 Jan, 1 Mar–14 Aug, 8–21 Nov; hc (dry leaf clusters on fallen branch of northern red oak, *Quercus rubra* L. [Fagaceae]), mt.
**Subtribe Scolytina**
*Scolytus multistriatus* (Marsham) – (1); LH; 10 Jun; hc (tidal gravel shore with driftwood).
**Subtribe Xyleborina**
*Anisandrus sayi* Hopkins – (1); DM; 25 Apr–8 May; mt.
*Cnestus mutilatus* (Blandford) – (2); LH; 5 May–14 Jun; mt.
*Xyleborus celsus* Eichhoff – (2); GF; 23 Jun; bt.
*Xyleborus ferrugineus* (Fabricius) – (1); GF; 23 Jun; bt.
† *Xylosandrus crassiusculus* (Motschulsky) – (3); DM, GF; 25 Apr–23 Jun; bt, mt.

## CONCLUDING COMMENTS

The first published record of Curculionoidea from GWMP was by Evans (2008), who documented 26 taxa (25 identified to species) during a 30-hour BioBlitz of the Potomac Gorge: Anthribidae (3 species), Attelabidae (1 species), Brentidae (1 species), Ithyceridae (1 species), and the Curculionidae (20 taxa, 19 identified to species, including six species new to Virginia. Evans also documented three additional species from the Maryland side of the Gorge).

The current study, spanning 21 years of collection effort targeting the superfamily Curculionoidea from GWMP, documented 604 specimens comprising 135 taxa (130 identified to species) in at least 97 genera. Approximately 100 Scolytini specimens remain unidentified and are not included in the list of species. Within GWMP, the Curculionoidea contains six families consisting of the Nemonychidae (1 species), Anthribidae (12 species), Attelabidae (3 species), Brentidae (7 taxa, 4 identified to species), Ithyceridae (1 species), and the Curculionidae (111 taxa, 109 identified to species). The tribes with the most species were Conotrachelini (10), Madopterini (9), and Cryptorhynchini and Scolytini (8 each). The most species-rich genera were *Conotrachelus* Dejean (9), *Curculio* Linnaeus (4), and *Ceutorhynchus* Germar and *Pseudanthonomus* Dietz (3 each). The most abundant species collected in the survey area were the native species *Eubulus obliquefasciatus* (Boheman) (41), *Apteromechus ferratus* (Say) (23), and *Monarthrum fasciatum* (Say) (22), and the non-native species *Cyrtepistomus castaneus* (Roelofs) (26) and *Pseudoedophrys* (*Oedophrys*) *hilleri* (Faust) (21). Twenty-three species are first records for the Commonwealth of Virginia. Range extensions are documented for a native species, *Sibariops confinis* (LeConte), and a non-native species, *Trachyphloeosoma advena*.

The GWMP sites with the highest species richness were Great Falls Park (68 taxa), Dyke Marsh Wildlife Preserve (58), Turkey Run Park (54), and Little Hunting Creek (38). Sixteen species (11.9%; N = 135) found in GWMP are considered adventive (non-native) to Virginia, including three species new to the state: *Myosides seriehispidus* Roelofs, *Tanysphyrus lemnae* (Fabricius), and *Trachyphloeosoma advena*. For comparison, 6.8% (4 of 59) of the weevils documented from the Potomac Gorge are non-native (Brown 2008). These four species include one species, *Sitona hispidulus* (Fabricius), documented from GWMP and three species not yet recorded from the park: *Gymnetron tetrum* (Fabricius), *Hypera punctata* (Fabricius), and *Mecinus pascuorum* (Gyllenhal). Malaise traps proved to be the most successful method of capturing weevils during this study, yielding 114 taxa. Results of the other most productive sampling methods were: beating sheets (20) and black-light bucket traps, pitfall traps, and hand collecting (8 each).

Evans (2008) documented 26 taxa from the Piedmont Plateau sites along the Potomac Gorge at Great Falls and/or Turkey Run Parks, two species of which, *Eurymycter fasciatus* (Olivier) and *Myllocerus hilleri* Faust (both Curculionidae), were not observed in the current study. Evans (2008) also documented four additional Curculionidae from the Maryland side of the Gorge, three of which, *Listronotus oregonensis* (LeConte), *Sphenophorus minimus* Hart, and *Xyleborus pubescens* Zimmermann, were not observed in the current study. Brown (2008) documented 59 species at Plummers Island on the Maryland side of the Gorge, 37 of which were not observed in the current study. Of the 92 taxa documented from Piedmont Plateau sites along the Potomac Gorge at Great Falls or Turkey Run Parks in the current study, 51 are first records for the Gorge, increasing the number of Curculionoidea documented from the Gorge to 134 (i.e., 2+3+37+92) taxa (coincidentally, the same number of taxa as are documented from GWMP).

Despite 21 years of sporadic survey effort using nine collecting techniques, 53 taxa (39.6%) documented by the current study are represented by a single specimen, indicating that the list of GWMP Curculionoidea is preliminary and much remains to be learned concerning the fauna of the parkway and of Virginia.

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# Neuropterans Collected at Flag Ponds Nature Park, Calvert County, Maryland

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The Flag Ponds Nature Park is a 132 ha (327 ac) property along the west side of the Chesapeake Bay in Calvert County, Maryland. It is publically owned and managed by the Natural Resources Division of the Calvert County Department of Parks and Recreation as a natural area. It was acquired because it was considered to be one of the most ecologically diverse properties on the Atlantic Coastal Plain (John Zyla, pers. comm.).

The property includes upland deciduous forest atop bayside uplands and an adjacent forested slope exhibiting a 24- to 30-m (80- to 100-ft) drop in elevation from the bluff to the shore of the Bay. At the base of the bluff there is a broad expanse of level, sandy flat several hundred meters wide leading to an actively accreting sandy cape that merges with sea level. As sand was deposited to form this broad beach, it formed a series of ponds that range from a fresh forested vernal pool at the base of the bluff, to several smaller ponds of varying salinity, ending with one just inside the existing beach line. Beyond the beach is a shoal that is developing offshore of the accreting cape, which may eventually become beach encircling another saline pond. The sandy expanse has been little studied ecologically but is comparable to a similar site present just to the south at Cove Point. The biota of that area has been the subject of numerous studies published by the Cove Point Natural Heritage Trust (2017).

During the summer of 1987 two Malaise traps were set at Flag Ponds as part of an effort to census the insect fauna of the site. The traps were installed on 1 June 1987 and operated through the end of September 1987. Both traps were situated in open sand flat with old field vegetation interspersed with scattered patches of woody vegetation dominated by Virginia pine, *Pinus virginiana* Mill. (Pinaceae). The contents of the traps were removed at approximately weekly intervals, labeled and stored in alcohol. The contents of the jars were rough-sorted and the resulting material was placed in the collection of the Department of Entomology, National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC. Among the numerous insect groups represented were a number of antlions (Myrmeleontidae) and other neuropteroids. These were identified to species by Dr. Oliver S. Flint, Jr. (Emeritus Curator of Neuropteroids, Department of Entomology, USNM), and form the basis for this note. The specimens, pinned and alcoholic, were deposited at the USNM.

The material from the Flag Ponds samples, including representatives of four families, eight genera, and 13 species, is identified in the following list. Collection dates, numbers, and sexes of individuals collected are given for each species. The dates given are the dates that the specimens were retrieved from the traps and represent about one week of trap time.

## BEROTHIDAE (beaded lacewings)

*Lomamyia flavicornis* (Walker): 17 August 1987 (1♂).

## CHRYSOPIDAE (common lacewings, green lacewings)

*Chrysoperla rufilabris* (Burmeister): 10 July 1987 (1♀), 20 July 1987 (1♀), 24 August 1987 (1♂).
*Chrysopa incompleta* Banks: 5 June 1987 (2♂), 9 June 1987 (1♂, 3♀), 15 June 1987 (2♂, 1♀), 23 June 1987 (1♀).
*Chrysopa nigricornis* Burmeister: 5 June 1987 (4♂), 9 June 1987 (2♂), 15 June 1987 (2♂), 23 June 1987 (2♂), 6 July 1987 (1♂), 14 July 1987 (1♂).
*Chrysopa oculata* Say: 30 June 1987 (1♂), 10 July 1987 (1♂), 14 July 1987 (3♂), 20 July 1987 (1♀).
*Chrysopa quadripunctata* Burmeister: 5 June 1987 (7♂), 9 June 1987 (3♂), 15 June 1987 (2♀), 20 July 1987 (1♀).

## HEMEROBIIDAE (brown lacewings)

*Micromus subanticus* (Walker): 5 June 1987 (1♂, 2♀).

## MYRMELEONTIDAE (antlions)

*Brachynemurus abdominalis* (Say): 15 June 1987 (1♂, 3♀), 23 June 1987 (1♀), 26 June 1987 (1♀), 6 July 1987 (1♂, 1♀), 10 July 1987 (3♀), 3 August1987 (1♂), 11 August 1987 (3♀), 17 August 1987 (1♂, 2♀), 8 September 1987 (1♂, 1♀).
*Brachynemurus longicaudus* (Burmeister): 23 June 1987 (10♂, 2♀), 26 June 1987 (12♂, 4♀), 6 July 1987 (49♂, 17♀), 10 July 1987 (7♂, 10♀), 14 July 1987 (4♂, 6♀), 20 July 1987 (4♂, 1♀), 24 July 1987 (4♂, 1♀), 3 August 1987 (8♂, 8♀), 11 August 1987 (4♂, 2♀), 17 August 1987 (6♂, 4♀), 24 August 1987 (1♂, 2♀), 8 September 1987 (1♂, 1♀), 28 September 1987 (1♀).
*Brachynemurus nebulosus* (Olivier): 9 June 1987 (2♂,1♀), 15 June 1987 (5♂, 2♀), 23 June 1987 (6♂, 2♀), 26 June 1987 (2♂), 30 June 1987 (2♂), 6 July 1987 (2♂, 1♀), 10 July 1987 (1♂), 14 July 1987 (1♂), 20 July 1987 (1♀), 24 July 1987 (1♂), 3 August 1987 (2♂), 17 August 1987 (4♂, 1♀).
*Myrmeleon carolinus* Banks or *M. crudelis* Walker: 5 June 1987 (1♀), 15 June 1987 (5♀), 18 June 1987 (1♀), 26 June 1987 (2♀), 30 June 1987 (2♀), 6 July 1987 (3♀), 14 July 1987 (3♀), 20 July 1987 (2♀), 24 July 1987 (1♀), 3 August 1987 (3♀), 7 August 1987 (1♀), 11 August 1987 (3♀), 17 August 1987 (1♀), 24 August 1987 (1♀).
*Euptilon ornatum* (Drury): 6 July 1987 (1♀).
*Vella americana* (Drury): 24 July 1987 (1♀), 24 August 1987 (1♀).

## ACKNOWLEDGMENTS

Thanks are extended to John Zyla (then with the Calvert County Department of Parks and Recreation) for permission to install and operate traps at Flag Ponds. The traps were maintained, and collected material was removed, by the author, Beth B. Norden, and park staff. As noted previously, identification of specimens was conducted by Dr. Oliver S. Flint, Jr. His assistance was greatly appreciated. Regrettably, Dr. Flint died in 2019. He was a world-class entomologist and an outstanding naturalist.

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# A Survey of the Lepidoptera of the Serpentine Barrens Area of Lake Roland Park, Baltimore County, Maryland

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**Abstract:** Lake Roland Park is owned by the City of Baltimore and was leased to Baltimore County after its original purpose as a raw water supply reservoir had become obsolete. The northern part of the park contains a tract of land that is geologically classified as serpentine barrens. This unique habitat is degrading due to clearcutting and subsequent replanting of pines approximately 70 years ago, coupled with increasing pressure from exotic species. This survey was conducted from 22 April to 21 September 2019 to provide information for an ecological restoration management plan for the serpentine barrens area of Lake Roland Park.

## INTRODUCTION

Serpentine barrens represent a unique ecosystem where the plant community is adapted to living in shallow, well drained, nutrient-poor soils that have high levels of heavy metals including nickel, cobalt, and chromium (Pollard 2016). In Maryland, many of these habitats are rich in chromite and copper and were once mined for these minerals (Friedman 2016). The plant communities in these environments frequently have endemic species not found in adjacent communities where they are unable to compete (Brady et al. 2005).

The focus of this survey was to determine the Lepidoptera species present in the persisting serpentine barrens located in Lake Roland Park, Baltimore County, Maryland, an area historically known as the Bare Hills. No attempt was made to quantify the abundance of species.

## METHODS

This survey was primarily focused in the vicinity around a large, managed clearing in the interior of the geological formation (39.3874°, -076.652°) (Figure 1). The clearing is in close proximity to an ephemeral stream and within 30 m (100 ft) of an oak grove, *Quercus* L. (Fagaceae), that was not part of the aforementioned clearcut.

Data on diurnal species was collected on 11 occasions between 22 April and 21 September and included live observation, net collection, and hand-collection of resting butterflies at night. Specimens collected by hand or net were retained for positive identification and vouchering. Additional records were provided by Debbie Terry who made visual butterfly observations on 22 April and 31 August 2019.

Nocturnal collections were conducted on 11 nights from 9 May through 21 September and utilized different methods of sampling. A 225-watt self-ballasted mercury-vapor (MV) light powered by a 1000-watt gasoline-powered generator was used during each of the 11 collections. The MV light was placed on a 122 cm x 122 cm (48 in x 48 in) white sheet that was adjacent to a vertically-hanging white sheet (216 cm x 254 cm [85 in x 100 in]). Additionally, two or three different black-light traps were placed each night within the clearing. Two 22-watt black-light Circline tube lights (BioQuip® Products #2807C) were placed on bucket traps (BioQuip® Products #2851A). One trap was powered by an 18-volt battery while another was supplied AC power by the generator. The third black-light trap used a 10-watt LED UV-light (Aplstar®) powered by a 17000mAh battery pack. The LED light was set across the top of a 19-L (5-gal) bucket topped with a funnel. All bucket traps were lined with a white plastic bag and contained permethrin-infused compressed-paper egg cartons and one Vaportape® Mini-Strip. At the conclusion of trapping each night, bags were removed, tied shut, and placed in a cooler with ice packs and then frozen overnight in a freezer. The following morning the contents of each trap were sorted by trap and returned to the freezer until pinning.

Adult specimens were prepared on foam spreading boards using size 2 or 3 stainless steel insect pins or on custom-made micro spreading boards using minutens. Specimens will be deposited into the collection of the Natural History Society of Maryland.

**Figure 1. Serpentine barrens at Lake Roland Park, Baltimore County, Maryland.** Large open area that has been expanded through mechanical removal of trees and mowing. A sheet with a mercury vapor lamp for the attraction of insects can be seen in the distance.

Specimens were identified using a variety of field guides, monographs, and journal articles. When required, specimens were dissected and/or compared to specimens in the collections of the Department of Entomology, National Museum of Natural History (USNM), Smithsonian Institution, Washington, District of Columbia, and of The Natural History Society of Maryland, Baltimore, Maryland. Resources used extensively included: Opler and Malikul (1998), Gilligan et al. (2008), Beadle and Leckie (2012), Lotts and Naberhaus (2017), the *Moths of America North of Mexico* series (Wedge Entomological Research Foundation 1971–2019), and the Moth Photographers Group website (2019). The collection, pinning, and identification of specimens is estimated to have taken ~450 hours. Approximately 2,400 specimens were collected, of which 2,315 were identified. The remaining specimens were too badly damaged to be identified by morphological methods.

## RESULTS

Diurnal species were collected on nine different collecting events from 9 May through 21 September 2019; additionally, butterflies were observed on 22 April and 31 August 2019. Nocturnal surveys were conducted from 9 May through 21 September 2019 for a total of 11 collecting events. Conditions for each nocturnal collection event are provided in Table 1.

**Table 1. Dates of nocturnal collections with time and air temperature at sundown, cloud cover, and lunar conditions.**

| Date | Sundown (24 hour) | Air Temperature °F (°C) | Cloud Cover | Lunar Phase and % Illumination |
|---|---|---|---|---|
| 09 MAY 2019 | 2008 | 72 (22) | none | waxing 23% |
| 17 MAY 2019 | 2016 | 80 (27) | thin clouds | waxing 98% |
| 31 MAY 2019 | 2027 | 80 (27) | cloudy | waning 10% |
| 15 JUN 2019 | 2035 | 80 (27) | partly cloudy | waxing 96% |
| 28 JUN 2019 | 2035 | 84 (29) | thin clouds | waning 21% |
| 12 JUL 2019 | 2032 | 86 (30) | none | waxing 81% |
| 27 JUL 2019 | 2022 | 85 (29) | none | waning 26% |
| 10 AUG 2019 | 2005 | 80 (27) | thin clouds | waxing 78% |
| 24 AUG 2019 | 1948 | 74 (23) | clear | waning 74% |
| 06 SEP 2019 | 1928 | 70 (21) | clear | waxing 54% |
| 21 SEP 2019 | 1904 | 78 (26) | clear | waxing 56% |

Three hundred and seventy-five (375) taxa from 39 families of Lepidoptera were collected during the survey period. A list of the taxa encountered on each date is provided for diurnal taxa (Table 2) and nocturnal taxa (Table 3). Species richness of each family encountered on the site is presented in Figure 2. Taxa are arranged taxonomically with primitive families at the bottom of the table near the x-axis and more advanced families at the top. The superfamilies Noctuoidea (Erebidae, Noctuidae, Nolidae, Notodontidae), Pyraloidea (Crambidae, Pyralidae), Tortricoidea (Tortricidae) and Geometroidea (Geometridae) were found to be the most speciose with 109, 62, 51, and 44 species, respectively.

**Table 2. Diurnal taxa encountered on each survey date arranged alphabetically by family, then genus and species.** Dates followed by a plus sign (+) were visual observations conducted by Debbie Terry.

| Taxa | 22 APR 2019+ | 09 MAY 2019 | 02 JUN 2019 | 15 JUN 2019 | 28 JUN 2019 | 06 JUL 2019 | 11 AUG 2019 | 24 AUG 2019 | 31 AUG 2019+ | 06 SEP 2019 | 21 SEP 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hesperiidae (skippers)** | | | | | | | | | | | |
| *Ancyloxypha numitor* (Fabricius) – Least Skipper | | | X | | | | X | | X | | |
| *Atalopedes campestris* (Boisduval) – Sachem | | | | | | | | | X | X | |
| *Atrytonopsis hianna* (Scudder) – Dusted Skipper | | | X | | | | | | | | |
| *Epargyreus clarus* (Cramer) – Silver-spotted Skipper | | | | | | | X | | | | |
| *Erynnis baptisiae* (W. Forbes) – Wild Indigo Duskywing | | | | | | X | X | | | | |
| *Erynnis juvenalis* (Fabricius) – Juvenal's Duskywing | | | | | | X | | | | | |
| *Hylephila phyleus* (Drury) – Fiery Skipper | | | | | | | | | | X | |
| *Nastra lherminier* (Latreille) – Swarthy Skipper | | | | | | | | X | | | |
| *Polites peckius* (W. Kirby) – Peck's Skipper | | | | | | | | | X | | |
| *Polites themistocles* (Latreille) – Tawny-edged Skipper | | | X | | | | | | | | |
| **Lycaenidae (gossamer-wing butterflies)** | | | | | | | | | | | |
| *Celastrina* sp. [prob. *ladon* (Cramer) – Spring Azure] | X | | | | | | | | | | |
| *Celastrina neglecta* (W.H. Edwards) – Summer Azure | | | | | | | | | X | | |
| *Cupido comyntas* (Godart) – Eastern Tailed-Blue | | X | X | | | X | | X | X | | |
| **Nymphalidae (brush-footed butterflies)** | | | | | | | | | | | |
| *Boloria bellona* (Fabricius) – Meadow Fritillary | | | | X | | | | | | | |
| *Euptoieta claudia* (Cramer) – Variegated Fritillary | | | X | X | | | X | | | | |
| *Junonia coenia* Hübner – Common Buckeye | | | | X | X | | X | | X | | X |
| *Limenitis arthemis astyanax* (Fabricius) – Red-spotted Purple | | | | X | | | X | | X | | |
| *Megisto cymela* (Cramer) – Little Wood-Satyr | | | X | X | | | | | | | |
| *Phyciodes cocyta* (Cramer) – Northern Crescent | | | | | | | X | | | X | X |
| *Phyciodes tharos* (Drury) – Pearl Crescent | X | | | X | | X | X | | X | X | X |
| *Polygonia interrogationis* (Fabricius) – Question Mark | | | | X | | | | | | | |
| *Vanessa atalanta* (Linnaeus) – Red Admiral | X | | | | X | X | | | X | | |
| *Vanessa virginiensis* (Drury) – American Lady | X | | | X | X | | | | X | | |
| **Papilionidae (swallowtail butterflies)** | | | | | | | | | | | |
| *Battus philenor* (Linnaeus) – Pipevine Swallowtail | | | | X | | | | | | | |
| *Papilio glaucus* Linnaeus – Eastern Tiger Swallowtail | X | | | X | X | | | | X | | |
| *Papilio troilus* Linnaeus – Spicebush Swallowtail | | | | X | | | X | | X | | |
| **Pieridae (whites and sulphur butterflies)** | | | | | | | | | | | |
| *Anthocharis midea* (Hübner) – Falcate Orangetip | X | | | X | X | | | | | | |
| *Colias eurytheme* Boisduval – Orange Sulphur | X | | | X | X | | | | X | | X |
| *Colias philodice* Godart – Clouded Sulphur | | | | | | | | | | X | |
| *Phoebis sennae* (Linnaeus) – Cloudless Sulphur | | | | X | | | | | | | |
| *Pieris rapae* (Linnaeus) – Cabbage White | X | | | | X | X | | | X | | |
| **Sphingidae (hawk moths, sphinx moths)** | | | | | | | | | | | |
| *Hemaris diffinis* (Boisduval) – Snowberry Clearwing | | | | | | X | | | | | |

**Table 3. Nocturnal taxa encountered on each survey date arranged alphabetically by family, then genus and species.** Names followed by an asterisk (*) were confirmed by inspection of the genitalia and comparison to published literature or specimens in the USNM.

| Taxa | 09 MAY 2019 | 17 MAY 2019 | 31 MAY 2019 | 15 JUN 2019 | 28 JUN 2019 | 12 JUL 2019 | 27 JUL 2019 | 10 AUG 2019 | 24 AUG 2019 | 06 SEP 2019 | 21 SEP 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Attevidae (tropical ermine moths)** | | | | | | | | | | | |
| *Atteva aurea* (Fitch) – Ailanthus Webworm | X | | X | X | X | | X | X | X | X | X |
| **Autostichidae (autostichid moths)** | | | | | | | | | | | |
| *Gerdana caritella* Busck – Gerdana Moth | | | | | | | X | | | | |
| *Sceptea aequepulvella* Chambers – (no common name) | | | | | | | | X | | | |
| *Symmoca signatella* Herrich-Schäffer – (no common name) | | | | | X | | | | | | |
| **Blastobasidae (scavenger moths)** | | | | | | | | | | | |
| *Asaphocrita aphidiella* (Walsingham) – (no common name)* | | | X | | | | | | | | |
| *Blastobasis glandulella* (Riley) – Acorn Moth* | | | X | | | X | | X | X | | |
| **Bucculatricidae (ribbed cocoon-making moths)** | | | | | | | | | | | |
| *Bucculatrix canadensisella* Chambers – Birch Skeletonizer | | | | | X | | | | | | |
| *Bucculatrix* sp. [poss. *angustata* Frey & Boll – Narrow Bucculatrix] | | | | X | | | | | | | |
| **Coleophoridae (casebearer moths)** | | | | | | | | | | | |
| *Coleophora borea* Braun – (no common name) | | | X | | | | | | X | X | X |
| *Coleophora cratipennella* Clemens – Streaked Coleophora | | | | | | | | | X | | |
| **Cosmopterigidae (cosmet moths)** | | | | | | | | | | | |
| *Limnaecia phragmitella* Stainton – Shy Comet | | | | X | | | | | | | |
| *Cosmopterix floridanella* (Beutenmüller) – (no common name)* | | | | | | | X | | | | |
| **Crambidae (crambid moths)** | | | | | | | | | | | |
| *Agriphila vulgivagellus* (Clemens) – Vagabond Crambus | | | | | | | | | | | X |
| *Anageshna primordialis* (Dyar) – Yellow-spotted Webworm | | | X | X | X | | | | | | |
| *Apogeshna stenialis* (Guenée) – Checkered Apogeshna | | | | | X | | | | | | |
| *Blepharomastix ranalis* (Guenée) – Hollow-spotted Blepharomastix | | | X | X | X | | | | | | |
| *Chrysoteuchia topiarius* (Zeller) – Topiary Grass-Veneer | | | | | X | | | | | | |
| *Conchylodes ovulalis* (Guenée) – Zebra Conchylodes | | | | | | | X | | | | |
| *Crambus agitatellus* Clemens – Double-banded Grass-Veneer | | | | | | X | | | | | |
| *Crambus laqueatellus* Clemens – Eastern Grass-Veneer | | X | | | | | | | | | |
| *Crambus saltuellus* Zeller – Pasture Grass-Veneer | | | X | X | X | X | X | | | | |
| *Crocidophora tuberculalis* Lederer – Pale-winged Crocidophora | | X | X | | X | | X | | | | |
| *Desmia funeralis* (Hübner) – Grape Leaffolder | | | X | | X | | X | X | | | |
| *Desmia maculalis* Westwood – White-headed Grape Leaffolder | | | | | | | X | | | | |
| *Diacme adipaloides* (Grote & Robinson) – Darker Diacme | | X | | X | | X | | X | | | |
| *Diastictis argyralis* Hübner – White-spotted Orange Moth | | | | | X | | | | | | |
| *Diastictis ventralis* (Grote & Robinson) – White-spotted Brown Moth | | X | | | X | | | X | | | |
| *Diathrausta harlequinalis* Dyar – Harlequin Webworm | | | | | | X | X | | | | |
| *Dicymolomia julianalis* (Walker) – Julia's Dicymolomia | | | | | | | | | | | X |
| *Donacaula sordidellus* (Zincken) – (no common name) | | | X | X | | | X | | | | |
| *Elophila obliteralis* (Walker) – Waterlily Leafcutter | | | | X | | | | | | | |
| *Glaphyria sesquistrialis* Hübner – White-roped Glaphyria | | | | | | | X | | | | |
| *Hahncappsia mancalis* (Lederer) – (no common name) | | | | | | | X | | | | |
| *Herpetogramma abdominalis* (Zeller) – (no common name) | | | | | X | | | | | | |
| *Herpetogramma aeglealis* (Walker) – Serpentine Webworm | | | | X | | | | | | | |
| *Herpetogramma sphingealis* Handfield & Handfield – (no common name) | | | | | X | | | | X | | |
| *Herpetogramma thestealis* (Walker) – Zigzag Herpetogramma | | | | | | | X | X | | | X |

| **Taxa** | **09 MAY 2019** | **17 MAY 2019** | **31 MAY 2019** | **15 JUN 2019** | **28 JUN 2019** | **12 JUL 2019** | **27 JUL 2019** | **10 AUG 2019** | **24 AUG 2019** | **06 SEP 2019** | **21 SEP 2019** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Microcrambus biguttellus* (Forbes) – Gold-stripe Grass-Veneer | | | | | | | | X | | X | |
| *Microcrambus elegans* (Clemens) – Elegant Grass-Veneer | | | X | X | X | | X | X | X | X | |
| *Neodactria* sp. [poss. *murellus* (Dyar) – (no common name)] | | | | | X | | | | | | |
| *Neodactria zeellus* (Fernald) – (no common name) | | | X | | | | | | | | |
| *Nomophila nearctica* Munroe – Lucerne Moth | | | | | | | X | X | X | X | X |
| *Palpita magniferalis* (Walker) – Splendid Palpita | | | X | X | | X | X | X | | | |
| *Pantographa limata* (Grote & Robinson) – Basswood Leafroller | | | | | | | X | X | | | |
| *Parapediasia decorellus* (Zincken) – Graceful Grass-Veneer | | | | X | X | | | | | | |
| *Parapediasia teterrellus* (Zincken) – Bluegrass Webworm | | | X | X | | | | | | | |
| *Pediasia trisecta* (Walker) – Sod Webworm | | | | | X | | | | | | |
| *Saucrobotys fumoferalis* (Hulst) – Dusky Saucrobotys | X | | | | | | | | | | |
| *Scoparia biplagialis* Walker – Double-striped Scoparia | | | X | | | X | | | | | |
| *Udea rubigalis* (Guenée) – Celery Leaftier | | X | X | X | X | | X | X | X | | |
| *Urola nivalis* (Drury) – Snowy Urola | | | X | X | | | X | | X | | |
| **Depressariidae (flat-bodied moths)** | | | | | | | | | | | |
| *Agonopterix thelmae* Clarke – Thelma's Agonopterix | | | | | | | X | | | | |
| *Psilocorsis cryptolechiella* (Chambers) – Black-fringed Leaftier | | | | | | | X | | | | |
| *Psilocorsis reflexella* Clemens – Dotted Leaftier | X | | | | | | | | | | |
| **Elachistidae (grass leafminer moths)** | | | | | | | | | | | |
| *Elachista illectella* (Clemens) – (no common name) | | | | | | | | X | | | |
| **Erebidae (tussock moths, lichen moths, tiger moths, litter moths, owlets, snouts, underwings, zales)** | | | | | | | | | | | |
| *Allotria elonympha* (Hübner) – False Underwing | | | | | X | | X | | | | |
| *Apantesis figurata* (Drury) – Figured Tiger Moth | | X | X | | | X | | | | | |
| *Apantesis nais* (Drury) – Nais Tiger Moth | X | X | X | | X | X | X | X | X | | X |
| *Apantesis* Walker sp. – (no common name) | | | | | | | X | | | | |
| *Arugisa lutea* (Smith) – Common Arugisa | | | | | | | | X | | | |
| *Bleptina caradrinalis* Guenée – Bent-winged Owlet | | | X | X | X | | | | | | |
| *Caenurgia chloropha* (Hübner) – Vetch Looper | | | | X | | | | | X | | |
| *Cisthene plumbea* Stretch – Lead-colored Lichen Moth | | | | | | | | | X | | |
| *Crambidia pallida* Packard – Pale Lichen Moth | | | | | | | | | | X | |
| *Crambidia uniformis* Dyar – Uniform Lichen Moth | | | | | | | | | | X | |
| *Euparthenos nubilis* (Hübner) – Locust Underwing | | | | | | | X | | | | |
| *Halysidota harrisii* (Walsh) – Sycamore Tussock Moth* | | | | X | | | | | | | |
| *Halysidota tessellaris* (Smith) – Banded Tussock Moth* | | | | | | | X | | | | |
| *Hypena baltimoralis* Guenée – Baltimore Bomolocha (Baltimore Snout) | | | | | | X | | | | | X |
| *Hypena humuli* Harris – Hop Vine Moth | | | | X | | | | | | | |
| *Hypena madefactalis* Guenée – Gray-edged Bomolocha (Gray-edged Snout) | | | | X | X | | | | | | |
| *Hypena scabra* (Fabricius) – Green Cloverworm | | | | X | | X | | | X | X | X |
| *Hypena sordidula* Grote – Sordid Bomolocha (Sordid Snout) | | | | | | X | | | | | |
| *Hypenodes fractilinea* (Smith) – Broken-line Hypenodes | | | X | X | X | | | | X | X | |
| *Hypenula cacuminalis* (Walker) – Long-Horned Owlet | | | | | | X | | | | | |
| *Hyperstrotia nana* (Hübner) – White-lined Graylet | | | X | | | | X | X | | | |
| *Hyphantria cunea* (Drury) – Fall Webworm | | | X | | | | X | | | | |
| *Idia aemula* Hübner – Common Idia | | | | | X | | | | | | |
| *Idia americalis* (Guenée) – American Idia | | X | | | | | | | X | | X |
| *Idia denticulalis* (Harvey) – Toothed Idia* | | | X | | | | | | | | |
| *Idia diminuendis* (Barnes & McDunnough) – Orange-spotted Idia | | | | X | X | X | X | | | | |
| *Lascoria ambigualis* (Walker) – Ambiguous Moth | X | | X | | X | | | X | | | |
| *Macrochilo orciferalis* (Walker) – Bronzy Macrochilo | | | | | | | | | | | X |

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| *Metalectra discalis* (Grote) – Common Fungus Moth | | | | | | | X | | | | |
| *Metalectra richardsi* Brower – Richards' Fungus Moth | | | | | | | | X | | | |
| *Mocis texana* (Morrison) – Texas Mocis | X | X | X | | | | X | | X | | |
| *Orgyia leucostigma* (Smith) – White-marked Tussock Moth | | | | | | | | | | | X |
| *Palthis angulalis* (Hübner) – Dark-spotted Palthis | X | X | X | X | | X | X | | | | X |
| *Palthis asopialis* (Guenée) – Faint-spotted Palthis | | | | | | | | | | | X |
| *Panopoda rufimargo* (Hübner) – Red-lined Panopoda | | | | | | | | X | | | |
| *Phalaenophana pyramusalis* (Walker) – Dark-banded Owlet | | X | | | | | X | | | | |
| *Phalaenostola larentioides* Grote – Black-banded Owlet | | | X | X | | | | | | X | |
| *Phyprosopus callitrichoides* Grote – Curve-lined Owlet | | | X | | | | | | | | |
| *Pyrrharctia isabella* (Smith) – Isabella Tiger Moth | | | X | | | | | X | | | |
| *Renia adspergillus* (Bosc) – Speckled Renia | | | | | | | | X | X | X | |
| *Renia discoloralis* Guenée – Discolored Renia | | | | | X | | X | | | | |
| *Renia fraternalis* Smith – Fraternal Renia | | | | X | | | | X | | | |
| *Rivula propinqualis* Guenée – Spotted Grass Moth | | | | | | | | | X | | X |
| *Rivula salusalis* (Walker) – (no common name) | | | | | | | | | X | | |
| *Spargaloma sexpunctata* Grote – Six-spotted Gray Moth | | X | | | | | | | | | |
| *Spilosoma virginica* (Fabricius) – Virginian Tiger Moth | X | | | | | | | | | | |
| *Tetanolita floridana* Smith – Florida Tetanolita | | | | | | | | | | | X |
| *Virbia opella* (Grote) – Tawny Holomelina (Tawny Virbia) | | | X | | | | | | | | |
| *Zale helata* (Smith) – Brown-spotted Zale | | | X | | | | | | | | |
| *Zale lunata* (Drury) – Lunate Zale | | | X | | | | | | | | |
| *Zale undularis* (Drury) – Black Zale | | | X | | | | X | | | | |
| *Zanclognatha cruralis* (Guenée) – Early Zanclognatha (Early Fan-Foot) | | | | | | | | X | | | |
| *Zanclognatha lituralis* (Hübner) – Lettered Zanclognatha (Lettered Fan-Foot) | X | | X | | | | | | | | |
| *Zanclognatha martha* Barnes – Pine Barrens Zanclognatha | | | X | | | | X | | | | |
| *Zanclognatha obscuripennis* (Grote) – Dark Zanclognatha | | | X | X | | | | X | | | |
| **Gelechiidae (twirler moths, gelechiid moths)** | | | | | | | | | | | |
| *Aroga epigaeella* (Chambers) – (no common name)* | | | | | | | | X | | | |
| *Battaristis vittella* (Busck) – Stripe-backed Moth (Orange Stripe-backed Moth) | | X | X | X | X | | | | | | |
| *Chionodes discoocellella* (Chambers) – Eye-ringed Chionodes | | X | | | | | | | | | |
| *Chionodes imber* Hodges – (no common name)* | | X | X | | | | | | | | |
| *Chionodes mediofuscella* (Clemens) – Black-smudged Chionodes | X | X | | | | X | X | X | | | |
| *Chionodes sevir* Hodges – (no common name)* | | | | X | | | | | | | |
| *Chionodes thoraceochrella* (Chambers) – (no common name) | | | | | X | | | | | | |
| *Coleotechnites quercivorella* (Chambers) – (no common name) | X | | X | X | | | | | | | |
| *Coleotechnites* sp. [poss. *florae* (Freeman)] – Coleotechnites Flower Moth] | | | X | | | | | | | | |
| *Dichomeris copa* Hodges – Copa Dichomeris | | | | | | | | | | | X |
| *Dichomeris flavocostella* (Clemens) – Cream-edged Dichomeris | | | | X | | | | | | | |
| *Dichomeris kimballi* Hodges – (no common name)* | X | | X | X | X | | X | | X | | |
| *Dichomeris ligulella* Hübner – Palmerworm Moth | | X | | | | | X | X | X | | |
| *Dichomeris setosella* (Clemens) – (no common name) | | X | | | | | | | | | |
| *Dichomeris offula* Hodges – (no common name)* | | | | | | X | | | | | |
| *Dichomeris ventrellus* (Fitch) – (no common name) | | X | | X | X | | | | | | |
| *Exoteleia pinifoliella* (Chambers) – Pine Needleminer Moth | X | X | X | X | | | | | | | |
| gen. nova et sp. nova 420495.97 – (no common name) | | | | | | X | | | | | |
| *Glauce pectenalaeella* Chambers – (no common name)* | | | X | | | | | | | | |
| *Helcystogramma hystricella* (Braun) – Lanceolate Helcystogramma | | | | | | | | | | | |

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| (Lanceolate Moth) | | | | | | | | | | | |
| *Keiferia lycopersicella* (Walsingham) – Tomato Pinworm Moth* | | | | X | | | | X | | X | |
| *Recurvaria nanella* ([Denis & Schiffermüller]) – Lesser Bud Moth* | | | | | | X | | | | | |
| *Stereomita* Braun sp. nova – (no common name)* | | | X | | | | | X | X | X | |
| **Geometridae (geometer moths)** | | | | | | | | | | | |
| *Aethalura intertexta* (Walker) – Four-Barred Gray | | | | | | | | X | | | |
| *Anavitrinella pampinaria* (Guenée) – Common Gray | X | | | | | | | | | | |
| *Campaea perlata* (Guenée) – Pale Beauty | | | | | | | | | | | X |
| *Chlorochlamys chloroleucaria* (Guenée) – Blackberry Looper | X | X | | | | | | | | | |
| *Cleora projecta* (Walker) – Projecta Gray | | | X | | | | | | | | |
| *Costaconvexa centrostrigaria* (Wollaston) – Bent-line Carpet | | X | | X | X | X | X | | X | X | X |
| *Cyclophora packardi* (Prout) – Packard's Wave | | | | | | | | | | | X |
| *Digrammia continuata* (Walker) – Curve-lined Angle | | | | | | | | | | | X |
| *Epimecis hortaria* (Fabricius) – Tulip-Tree Beauty | | | | | | | X | | X | | |
| *Eubaphe mendica* (Walker) – The Beggar | | | X | X | | | | | | | |
| *Euchlaena madusaria* (Walker) – Scrub Euchlaena* | X | | X | | | | | | | | |
| *Eulithis gracilineata* (Guenée) – Greater Grapevine Looper | | | | X | | | | | | | |
| *Eupithecia miserulata* Grote – Common Eupithecia (Common Pug)* | X | | | | | | | | | | |
| *Eusarca confusaria* Hübner – Confused Eusarca | | | X | | X | | | | | | |
| *Eutrapela clemataria* (Smith) – Curved-Toothed Geometer | | | | | | X | | | | | |
| *Hypagyrtis esther* (Barnes) – Esther Moth | | | | | | | X | X | X | | |
| *Hypagyrtis unipunctata* (Haworth) – One-spotted Variant | | | X | X | | | | | | | |
| *Hypomecis umbrosaria* (Hübner) – Umber Moth | | | | | X | | | | | | |
| *Ilexia intractata* (Walker) – Black-dotted Ruddy | X | | | | X | | X | | | | |
| *Iridopsis defectaria* (Guenée) – Brown-shaded Gray | | | | | | | | | | X | X |
| *Lomographa vestaliata* (Guenée) – White Spring Moth | | | | | X | X | X | | | | |
| *Macaria aemulataria* Walker – Common Angle | | | X | | X | | | | | | |
| *Macaria bicolorata* (Fabricius) – Bicolored Angle | | | | | | | X | | | | X |
| *Macaria bisignata* Walker – Red-headed Inchworm | | | | X | | | | | | | |
| *Macaria granitata* Guenée – Granite Moth | | | | X | | | X | X | X | X | X |
| *Macaria notata* (Linnaeus) – Birch Angle | | | | | | X | X | | | X | |
| *Melanolophia canadaria* (Guenée) – Canadian Melanolophia | | | | | X | | | | | | |
| *Melanolophia signataria* (Walker) – Signate Melanolophia | X | | | | | | | | | | |
| *Mellilla xanthometata* (Walker) – Orange Wing | | | | | | X | | X | | | |
| *Metarranthis angularia* Barnes & McDunnough – Angled Metarranthis | | | X | | | | | | | | |
| *Metarranthis hypochraria* (Herrich-Schäffer) – Common Metarranthis | | | X | | | | | | | | |
| *Orthonama obstipata* (Fabricius) – The Gem | X | | | | | X | X | | X | | |
| *Patalene olyzonaria* (Walker) – Juniper Geometer (Juniper-twig Geometer) | | | | | | | X | X | | | |
| *Pero ancetaria* (Hübner) – Hubner's Pero* | | | | | | | X | | | | |
| *Pero honestaria* (Walker) – Honest Pero* | X | X | | | | | X | | X | | |
| *Pero morrisonaria* (Edwards) – Morrison's Pero* | | | | | | | X | | | | |
| *Petrophora subaequaria* (Walker) – Northern Petrophora | | | | | | | X | | | | |
| *Pleuroprucha insulsaria* (Guenée) – Common Tan Wave | | | | | | | X | X | X | X | X |
| *Prochoerodes lineola* (Goeze) – Large Maple Spanworm | | | | X | | | | | | | |
| *Protitame virginalis* (Hulst) – Virgin Moth | X | X | | | | | | | | | |
| *Protoboarmia porcelaria* (Guenée) – Porcelain Gray | | | | | | | | X | X | | |
| *Scopula limboundata* (Haworth) – Large Lace-border | | | X | X | | | | | X | | |
| *Selenia kentaria* (Grote & Robinson) – Kent's Geometer | | | | | | | X | | | | |
| *Speranza pustularia* (Guenée) – Lesser Maple Spanworm | | | | X | X | | | | | | |

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| **Glyphipterigidae (sedge moths)** | | | | | | | | | | | |
| *Diploschizia impigritella* (Clemens) – Yellow Nutsedge Moth | | | | X | X | | | | | | |
| **Gracillariidae (leaf blotch miner moths)** | | | | | | | | | | | |
| *Leucospilapteryx venustella* (Clemens) – Snakeroot Leafminer | | | | | | | | X | | | |
| *Macrosaccus robiniella* (Clemens) – (no common name) | | X | | | | | | | | | |
| *Marmara fasciella* (Chambers) – White Pine Barkminer | X | | | | | | | | | | |
| *Marmara* sp. [nr. *viburnella* Eiseman & Davis – (no common name)]* | | | | | | | X | | | | |
| *Neurobathra strigifinitella* (Clemens) – Finite-channeled Leafminer | | | X | | | | | | | | |
| *Phyllocnistis insignis* Frey & Boll – (no common name) | | | X | | | | | | | | |
| **Heliozelidae (leaf miners, shield bearers)** | | | | | | | | | | | |
| *Antispila viticordifoliella* Clemens – (no common name)* | | | | | | | | X | | | |
| **Incurvariidae (fairy moths, incurvarid moths, yucca moths)** | | | | | | | | | | | |
| *Phylloporia bistrigella* (Haworth) – (no common name) | X | | | | | | | | | | |
| **Lasiocampidae (tent caterpillar moths)** | | | | | | | | | | | |
| *Malacosoma americana* (Fabricius) – Eastern Tent Caterpillar Moth | | | X | | | | | | | | |
| **Limacodidae (slug caterpillar moths)** | | | | | | | | | | | |
| *Apoda biguttata* (Packard) – Shagreened Slug Moth | | | | X | | | | | | | |
| *Euclea delphinii* (Boisduval) – Spiny Oak-Slug Moth | | | X | X | | | | | | | |
| *Heterogenea shurtleffi* Packard – Red-eyed Button Slug Moth | | | | | X | X | | X | | | |
| *Isa textula* (Herrich-Schäffer) – Crowned Slug Moth | | | | | | X | X | | | | |
| *Lithacodes fasciola* (Herrich-Schäffer) – Yellow-shouldered Slug Moth | | | | | | X | | | | | |
| *Natada nasoni* (Grote) – Nason's Slug Moth | | | | X | | | | | | | |
| *Parasa indetermina* (Boisduval) – Stinging Rose Caterpillar Moth | | | | | X | | | | | | |
| **Momphidae (momphid moths)** | | | | | | | | | | | |
| *Mompha murtfeldtella* (Chambers) – (no common name) | | | X | | | | | | | | |
| **Nepticulidae (pygmy moths, midget moths)** | | | | | | | | | | | |
| *Ectoedemia* sp. [poss. *nyssaefoliella* (Chambers)] – (no common name)* | | | | | X | | | | | | |
| *Stigmella* Schrank sp. – (no common name) | | | | X | X | | | | | | |
| **Noctuidae (dagger moths, noctuid moths, owlet moths, underwings)** | | | | | | | | | | | |
| *Abrostola urentis* Guenée – Spectacled Nettle Moth (Variegated Brindle) | | | | | X | | | | | | |
| *Acronicta americana* (Harris) – American Dagger | | | X | | | | | | | | |
| *Acronicta haesitata* (Grote) – Hesitant Dagger | | | | | X | | X | | | | |
| *Acronicta modica* (Walker) – Medium Dagger | | | X | | | | X | | | | |
| *Agrotis ipsilon* (Hufnagel) – Ipsilon Dart | | | | | X | | | | | | |
| *Amphipyra pyramidoides* Guenée – Copper Underwing | | | | | | | | | | X | |
| *Anicla forbesi* (Franclemont) – Forbes' Dart* | | | | | | | X | | | | |
| *Anicla illapsa* (Walker) – Snowy Dart* | | | | | | X | X | | | | X |
| *Anicla infecta* (Ochsenheimer) – Green Cutworm* | | | | | | X | | | X | X | X |
| *Autographa precationis* (Guenée) – Common Looper* | | | | | | | X | | | | |
| *Calophasia lunula* (Hufnagel) – Toadflax Brocade | | | | | | | | | X | | |
| *Chloridea virescens* (Fabricius) – Tobacco Budworm | | | | | | | | | X | | |
| *Chrysodeixis includens* (Walker) – Soybean Looper | | | | | | | | | X | | X |
| *Chytonix palliatricula* (Guenée) – Cloaked Marvel | | X | | | | | | | | | |
| *Condica mobilis* (Walker) – Mobile Groundling | X | X | | | | | | | | | |
| *Condica sutor* (Guenée) – The Cobbler | | | | | | | | | | X | |
| *Condica vecors* (Guenée) – Dusky Groundling | | | | | X | X | X | X | X | | |
| *Dichagyris acclivis* (Morrison) – Inclined Dart | | | | | | | | | X | | |

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| *Elaphria grata* Hübner – Grateful Midget | | | | | X | | X | | X | | X |
| *Elaphria versicolor* (Grote) – Variegated Midget | | X | | | X | | X | | | | X |
| *Feltia herilis* (Grote) – Master's Dart | | | | | | | | | X | | X |
| *Galgula partita* Guenée – The Wedgling | | | X | | | | | | | | X |
| *Hyperstrotia pervertens* (Barnes & McDunnough) – Dotted Graylet | | | | X | X | | | | | | |
| *Lacinipolia renigera* (Stephens) – Bristly Cutworm | | | X | | | | | | X | X | X |
| *Leucania adjuta* (Grote) – Adjutant Wainscot* | | | | X | | X | X | | X | X | X |
| *Leucania commoides* Guenée – Comma Wainscot* | | | | X | | | | | | | X |
| *Leucania inermis* (Forbes) – Unarmed Wainscot* | | | | | | | | | X | | |
| *Leucania linda* Franclemont – Linda Wainscot* | | | | | | | | | X | | |
| *Leucania multilinea* Walker – Many-lined Wainscot* | | | | | | | | X | | | |
| *Leucania phragmitidicola* Guenée – Phragmites Wainscot* | | | | | | | X | | | | |
| *Leucania ursula* (Forbes) – Ursula Wainscot* | | X | | | | | | X | | | |
| *Lithacodia musta* (Grote & Robinson) – Small Mossy Lithacodia (Small Mossy Glyph) | | | | X | | | X | | X | | |
| *Maliattha synochitis* (Grote & Robinson) – Black-dotted Maliattha (Black-dotted Glyph) | | | X | X | | | | | | | |
| *Marimatha nigrofimbria* (Guenée) – Black-bordered Lemon | | | X | X | X | X | X | | X | | X |
| *Mythimna oxygala* (Grote) – Lesser Wainscot | X | | | | | | | | | | |
| *Mythimna unipuncta* (Haworth) – Armyworm (The White-Speck) | X | | X | X | | | X | | X | | |
| *Nephelodes minians* Guenée – Bronzed Cutworm | | | | | | | | | | | X |
| *Orthodes majuscula* Herrich-Schäffer – Rustic Quaker | | | | | | | X | X | | | |
| *Panthea furcilla* (Packard) – Eastern Panthea | X | | | | | | | X | X | | |
| *Phosphila miseliodes* (Guenée) – Spotted Phosphila | | | | X | | | | | | | |
| *Phosphila turbulenta* Hübner – Turbulent Phosphila | | | | | | | X | X | | | |
| *Protodeltote muscosula* (Guenée) – Large Mossy Lithacodia (Large Mossy Glyph) | | | X | X | | | | | | | |
| *Pseudeustrotia carneola* (Guenée) – Pink-barred Lithacodia (Pink-barred Pseudeustrotia) | | | | | | X | | | | | |
| *Raphia frater* Grote – The Brother | | | X | | | | | | | | |
| *Schinia arcigera* (Guenée) – Arcigera Flower Moth | | | | | | | | | | X | X |
| *Spodoptera frugiperda* (Smith) – Fall Armyworm | | | | | | | | | | | X |
| *Spodoptera ornithogalli* (Guenée) – Yellow-striped Armyworm | | | | | | | X | X | X | X | |
| *Spragueia leo* (Guenée) – Common Spragueia | | | | | | | X | | X | | |
| *Xestia c-nigrum* (Linnaeus) – Lesser Black-letter Dart (Setaceous Hebrew Character) | | | | | | | X | | X | X | X |
| **Nolidae (nolid moths)** | | | | | | | | | | | |
| *Meganola phylla* (Dyar) – Coastal Plain Meganola | X | X | | | | X | X | | | | |
| *Meganola spodia* Franclemont – Ashy Meganola | X | | | | | | X | | | | |
| **Notodontidae (prominents)** | | | | | | | | | | | |
| *Dasylophia thyatiroides* (Walker) – Gray-patched Prominent | | | | X | | | | | | | |
| *Heterocampa biundata* Walker – Wavy-Lined Heterocampa | | | | | | | X | | | | |
| *Schizura concinna* (Smith) – Red-humped Caterpillar Moth | | | | | X | | | | | | |
| **Oecophoridae (oecophorid moths)** | | | | | | | | | | | |
| *Epicallima argenticinctella* (Clemens) – Orange-headed Epicallima | | | | | X | | | | | | |
| *Promalactis suzukiella* (Matsumura) – Suzuki's Promalactis | | | | | X | | | | | | |
| **Plutellidae (diamondback moths)** | | | | | | | | | | | |
| *Plutella xylostella* (Linnaeus) – Diamondback Moth | X | X | X | X | | | X | | | | |
| **Pterophoridae (plume moths)** | | | | | | | | | | | |
| *Emmelina monodactyla* (Linnaeus) – Morning-glory Plume Moth* | | | | | X | | | | | X | |
| *Stenoptilia zophodactylus* (Duponchel) – Dowdy Plume Moth* | | | | | | | | | | X | |
| **Pyralidae (grass moths, snout moths)** | | | | | | | | | | | |

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| *Acrobasis exsulella* (Zeller) – Cordovan Pyralid | | | | | | | X | | | | |
| *Acrobasis* sp. [poss. *juglandis* (LeBaron) – Pecan Leaf Casebearer] | | | | | | | | | | | X |
| *Aphomia sociella* (Linnaeus) – Bee Moth | X | | | | | | | | | | |
| *Ephestia kuehniella* Zeller – Mediterranean Flour Moth | | | | | | | | | | | X |
| *Ephestiodes infimella* Ragonot – (no common name) | | | | | | | | | | X | |
| *Eulogia ochrifrontella* (Zeller) – Broad-banded Eulogia | | | X | | | | X | | | | X |
| *Macalla zelleri* (Grote) – Zeller's Macalla | | | X | | | | | | | | |
| *Moodna ostrinella* (Clemens) – Darker Moodna | | | | X | | | | | | | |
| *Oneida lunulalis* (Hulst) – Orange-tufted Oneida | | | | | | | | X | | | |
| *Oreana unicolorella* (Hulst) – (no common name) | | | | | | | | X | X | | |
| *Palatka nymphaeella* (Hulst) – (no common name) | | | | | | | | X | | | |
| *Peoria gemmatella* (Hulst) – (no common name) | | | | | | | | X | | | |
| *Pococera expandens* (Walker) – Striped Oak Webworm (Double-humped Pococera) | | | | | | | X | | | | |
| *Pococera robustella* (Zeller) – Pine Webworm | | | | | X | X | | | | | |
| *Pococera scortealis* (Lederer) – Lespedeza Webworm | | | | | | | | X | | | |
| *Pyla aenigmatica* Heinrich – (no common name)* | | | X | X | | | | | | | |
| *Salebriaria engeli* (Dyar) – Engel's Salebriaria | | | | | X | | X | | | | |
| *Salebriaria turpidella* (Ragonot) – (no common name)* | | | | X | | | | | | | |
| *Sciota uvinella* (Ragonot) – Sweetgum Leafroller | | | | | | | X | | | | |
| *Tosale oviplagalis* (Walker) – Dimorphic Tosale | | | | X | | | X | | | | |
| *Varneria postremella* Dyar – (no common name) | | | | | | X | | | | | |
| *Vitula broweri* (Heinrich) – Brower's Vitula | | X | | | X | | | | | | |
| *Vitula edmandsii* (Packard) – Dried Fruit Moth | | | | X | | | | | | | |
| **Saturniidae (giant silkworm moths, royal moths)** | | | | | | | | | | | |
| *Dryocampa rubicunda* (Fabricius) – Rosy Maple Moth | X | | X | X | | | X | X | | | |
| *Eacles imperialis* (Drury) – Imperial Moth | | | | | | | X | | | | |
| **Scythrididae (flower moths)** | | | | | | | | | | | |
| *Scythris eboracensis* (Zeller) – (no common name) | | | | X | | | | | | | |
| **Sphingidae (hawk moths, sphinx moths)** | | | | | | | | | | | |
| *Lapara coniferarum* (Smith) – Southern Pine Sphinx | | | | | | X | | | | | |
| *Smerinthus jamaicensis* (Drury) – Twin-spotted Sphinx | | | | | | X | | | | | |
| **Tineidae (fungus moths, cloths moths, tube moths)** | | | | | | | | | | | |
| *Acrolophus arcanella* (Clemens) – Grass Tubeworm* | | | X | | | | | | | | |
| *Acrolophus panamae* Busck – Panama Grass Tubeworm | | | X | | X | X | X | | | | |
| *Acrolophus plumifrontella* (Clemens) – Eastern Grass Tubeworm | | | | | | X | X | | | | |
| *Acrolophus propinqua* (Walsingham) – Walsingham's Grass Tubeworm | | | | | | X | | X | | | |
| *Homostinea curviliniella* Dietz – (no common name) | | | X | | | | | | | | |
| *Tinea apicimaculella* Chambers – Dark-collared Tinea | | | | | | | | | | X | |
| **Tortricidae (leaf rollers, leaf tiers)** | | | | | | | | | | | |
| *Aethes angulatana* (Robinson) – Angular Aethes* | | | | X | | | | X | X | | X |
| *Aethes promptana* (Robinson) – (no common name)* | | | | | | | | | | X | |
| *Aethes razowskii* Sabourin & Metzler – Razowski's Aethes* | | | | X | | | | | | X | |
| *Aethes seriatana* (Zeller) complex – (no common name)* | | | | | | X | | | | X | |
| *Amorbia humerosana* Clemens – White-line Leafroller | X | X | | | | | | | | | |
| *Ancylis comptana* (Frölich) – Strawberry Leafroller | | | | | | | X | | X | | |
| *Ancylis discigerana* (Walker) – Yellow Birch Leaffolder | | X | X | | | | | | | | |
| *Ancylis laciniana* (Zeller) – (no common name) | X | | | | | | | | | | |
| *Archips purpurana* (Clemens) – Omnivorous Leafroller | | | | X | | | | | | | |
| *Archips rosana* (Linnaeus) – Rose Tortrix | | | | | | X | | | | | |
| *Argyrotaenia pinatubana* (Kearfott) – Pine Tube Moth | X | X | X | X | X | | | | | | |

| Taxa | 09 MAY 2019 | 17 MAY 2019 | 31 MAY 2019 | 15 JUN 2019 | 28 JUN 2019 | 12 JUL 2019 | 27 JUL 2019 | 10 AUG 2019 | 24 AUG 2019 | 06 SEP 2019 | 21 SEP 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Argyrotaenia tabulana* Freeman complex – (no common name)* | | X | | | X | X | X | | X | X | |
| Argyrotaenia velutinana (Walker) – Red-banded Leafroller | | | | | X | X | X | X | X | | |
| *Celypha cespitana* (Hübner) – Celypha Moth | | | X | | | | | | | | |
| *Cenopis pettitana* (Robinson) – Maple-basswood Leafroller | | X | X | | | | | | | | |
| *Choristoneura conflictana* (Walker) – Large Aspen Tortrix | X | | | | | | | | | | |
| *Choristoneura rosaceana* (Harris) – Oblique-banded Leafroller | | | X | X | | | | X | X | X | |
| *Clepsis peritana* (Clemens) – Garden Tortrix* | | | | | | | | X | X | X | |
| *Cydia candana* (Forbes) – (no common name)* | | X | | | | | | | | | |
| *Cydia caryana* (Fitch) – Hickory Shuckworm* | | X | | | | | | | | | |
| *Cydia latiferreana* (Walsingham) – Filbertworm Moth | | X | | | | | X | | X | X | X |
| *Cydia toreuta* (Grote) – Eastern Pine Seedworm | | | X | X | | | | | | | |
| *Dichrorampha leopardana* (Busck) – (no common name) | | | | | | | X | | | | |
| *Ecdytolopha insiticiana* Zeller – Locust Twig Borer | | | | | | | X | | | | |
| *Endothenia hebesana* (Walker) – Verbena Bud Moth (Dull-barred Endothenia) | | | | | | | X | | | | |
| *Epiblema obfuscana* (Dyar) – (no common name)* | | | X | | | | | | | | |
| *Eucopina monitorana* (Heinrich) – Red Pinecone Borer | | X | | | X | | | | | | |
| *Eucopina tocullionana* (Heinrich) – White Pinecone Borer | | | | | X | | | | | | |
| *Eucosma ambodaidaleia* (Miller) – (no common name) | X | | | | | | | | | | |
| *Eucosma parmatana* (Clemens) – (no common name) | | | | | | | | | X | | X |
| *Eugnosta sartana* (Hübner) – (no common name)* | | | X | | X | X | | X | X | | |
| *Grapholita packardi* (Zeller) – Cherry Fruitworm | | X | | | | | | | | | |
| *Gretchena concitatricana* (Heinrich) – (no common name) | | | | X | X | | | | | | |
| *Gymnandrosoma punctidiscanum* Dyar – Dotted Ecdytolopha (Dotted Gymnandrosoma) | | | | | | X | X | | | | |
| *Gypsonoma fasciolana* (Clemens) – (no common name) | | | | | | | X | | | | |
| *Olethreutes connectum* (McDunnough) – Bunchberry Leaffolder | | | | | | | | | | X | |
| *Olethreutes inornatana* (Clemens) – Inornate Olethreutes | | | | | X | | | | | | |
| *Pandemis limitata* (Robinson) – Three-lined Leafroller | | | | | | X | X | X | | | |
| *Phaecasiophora confixana* (Walker) – Macramé Moth | | | X | X | | | | | | | |
| *Platphalonidia magdalenae* (Metzler & Albu) – (no common name) | | | | | | X | | | | | |
| *Platynota flavedana* Clemens – Black-shaded Platynota | | X | X | | | | X | X | | | |
| *Platynota idaeusalis* (Walker) – Tufted Apple-Bud Moth | | | X | X | | | X | X | | | |
| *Proteoteras crescentana* Kearfott – Northern Boxelder Twig Borer (Black-crescent Proteoteras) | | | X | | | | | | | | |
| *Retinia comstockiana* Fernald – Pitch Twig Moth | X | X | X | | | | | | | | |
| *Retinia gemistrigulana* (Kearfott) – Gray Retinia | | | | X | | | | | | | |
| *Retinia virginiana* (Busck) – Wenzel's Pitch-blister Moth | X | | X | | | | | | | | |
| *Rhyacionia frustrana* (Comstock) – Nantucket Pine Tip Moth* | | | | | | | | X | | | |
| *Sparganothis sulfureana* (Clemens) – Sparganothis Fruitworm | | | X | X | | | X | X | X | | |
| *Sparganothis xanthoides* (Walker) – Mosaic Sparganothis | | X | | | | | | | | | |
| *Sparganothoides lentiginosana* (Walsingham) – Lentiginos Moth | X | X | X | | | | | | | | |
| *Zomaria interruptolineana* (Fernald) – Broken-line Zomaria | X | | | | | | | | | | |
| **Yponomeutidae (ermine moths, needleminer moths)** | | | | | | | | | | | |
| *Yponomeuta multipunctella* (Clemens) – American Ermine | | | | X | | | | | | | |
| **Zygaenidae (leaf skeletonizers)** | | | | | | | | | | | |
| *Pyromorpha dimidiata* Herrich-Schäffer – Orange-patched Smoky Moth | | | X | | | | | | | | |

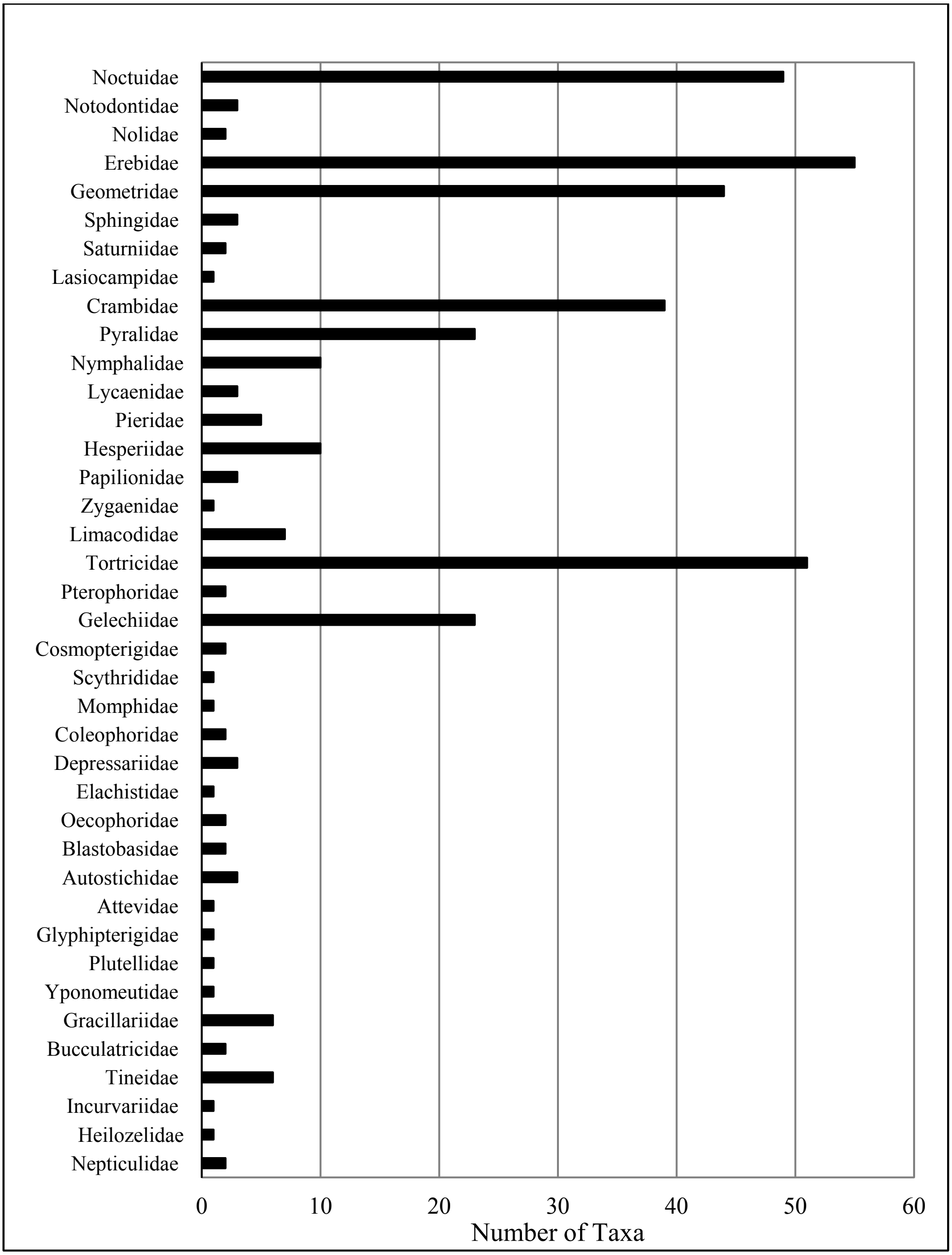


**Figure 2. Observed species richness of each family of Lepidoptera encountered.** Arranged taxonomically with primitive families at the bottom of the table near the x-axis and more advanced families at the top according to van Nieukerken et al. (2011).

## DISCUSSION

During the course of this study, no threatened or endangered Lepidoptera, as determined by the Maryland Natural Heritage Program (2016), were encountered. The plants associated with serpentine soils in the list of Rare, Threatened, and Endangered Plants of Maryland (Maryland Natural Heritage Program 2019) were cross referenced with the caterpillar host lists in Tietz (1972). In total, the Maryland Natural Heritage Program lists 41 rare, threatened or endangered plants being associated with serpentine soils the majority of which appear in Tietz (1972). However, only a few of the associated Lepidoptera were found during this survey. Those that were found are all generalists—e.g., Silver-spotted Skipper, *Epargyreus clarus* (Cramer) (Hesperiidae); Tobacco Budworm, *Chloridea virescens* (Fabricius) (Noctuidae); and Lesser Black-letter Dart, *Xestia c-nigrum* (Linnaeus) (Noctuidae)—and therefore could not be linked to a specific host. It is worth noting that many species of Lepidoptera, especially the Microlepidoptera encountered in this study, have unknown larval hosts (Robinson et al. 2010). This is largely due to their small size, quick larval development, and cryptic feeding habits.

In total 32 species of diurnal Lepidoptera were encountered during the six-month study of the site. In comparison a three-year study of the butterflies of the serpentine barrens of Soldiers Delight Natural Environment Area (approximately 13 km [8 mi] WNW as the crow flies) found 51 species of butterflies on the site (Smith 1981, 2010). Of the 51 species, 19 were found at both sites. Seventeen of these species are common throughout the region and do not infer a unique association to any plants that are specific to serpentine soils. The Dusted Skipper, *Atrytonopsis hianna* (Scudder), and the Swarthy Skipper, *Nastra lherminier* (Latreille) (both Hesperiidae), are exceptions. The Dusted Skipper was reported by Smith (1981, 2010) to be "special" to the serpentine barrens of Soldiers Delight due to the abundance of its hosts, bluestem grasses, *Andropogon* L. spp. (Poaceae) but further explanation was not provided. The Dusted Skipper is reported from 14 counties in Maryland (Hubick and Brighton 2012–2020); it is possible that Smith's comments may relate more to the abundance of the species and not its uniqueness. The Swarthy Skipper is recorded by Steinberg (2002) to feed on little bluestem, *Schizachyrium scoparium* (Michx.) Nash (Poaceae), which is a species that is commonly associated with serpentine oak and pine barrens, *Quercus* L. (Fagaceae) and *Pinus* L. (Pinaceae) respectively, in Maryland and Pennsylvania and benefits from a fire regime.

A restoration and management plan created for the Unionville Serpentine Barrens (Latham and McGeehin 2012) lists five taxa that are of special conservation concern in Pennsylvania: Falcate Orangetip, *Anthocharis midea* (Hübner) (Pieridae); Swarthy Skipper; Esther Moth, *Hypagyrtis esther* (Barnes) (Geometridae); Inclined Dart, *Dichagyris* (*Richia*) *acclivis* (Morrison) (Noctuidae); and Pine Barrens Zanclognatha, *Zanclognatha martha* Barnes (Erebidae). None of these species are known to be of concern in Maryland (Maryland Natural Heritage Program 2016). The Maryland Biodiversity Project (Hubick and Brighton 2012–2020) was used to determine the distribution of these five species in Maryland. The Falcate Orangetip is recorded from 23 of the 24 Maryland jurisdictions (i.e., 23 counties plus Baltimore), Swarthy Skipper from 21, Esther Moth from 18, Inclined Dart from 11, and Pine Barrens Zanclognatha from 5 This suggests that at least the Inclined Dart and the Pine Barrens Zanclognatha may be under-collected or have limited or restricted distributions in Maryland and warrant further investigation to determine the stability of these species.

There are potentially two undescribed taxa, *Stereomita* Braun (Gelechiidae), and *Stigmella* Schrank (Nepticulidae), and an almost entirely black *Apantesis* Walker (Erebidae) that were encountered during the course of this study and could not be identified. They will be addressed in future studies and subsequent publications if warranted.

## ACKNOWLEDGMENTS

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*The Maryland Entomologist* 7(4):81–96

# Maryland Entomological Society BugBlitz at the Maryland Ornithological Society's Carey Run Sanctuary, Garrett County, Maryland, 12–14 July 2019 (abbreviated entomology version)

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[*Editor's note: The complete version of this article, which includes fish, amphibian, reptile, bird, mammal, fungi, and flora results, will be published in the fall 2020 issue of* Maryland Birdlife *(Scarpulla 2020).*]

**ABSTRACT:** The Maryland Entomological Society conducted a BugBlitz on 12–14 July 2019 at the Maryland Ornithological Society's Carey Run Sanctuary in Garrett County, Maryland. This was a cooperative effort between the two societies to help develop an inventory of the fauna of the sanctuary. Although the emphasis was on insect species, all identifiable fauna and flora were included in the results.

With reinvigoration of the Maryland Ornithological Society (MOS) Sanctuary Committee, it became apparent that little was known about the fauna and flora present at the Society's ten sanctuaries. It was decided to hold BioBlitzes at individual sanctuaries to help obtain this information. The first effort was trimmed down to a BugBlitz at the Carey Run Sanctuary (Figure 1) over the 12–14 July 2019 weekend that was coordinated by Gene Scarpulla and Marcia Watson, both members of MOS and the Maryland Entomological Society (MES).

## LOCATION

Location information is excerpted from the "Carey Run MOS Sanctuary" and the "Carey Run Sanctuary (Garrett County)" websites (MOS 2020a, 2020b).

Carey Run Sanctuary was the first property to be purchased by MOS, which now owns ten sanctuaries across the state. The original purchase in 1962 was a 52-ac (21-ha) farm, complete with a farmhouse (Figure 2), which had been abandoned for several years. In 1973, MOS purchased another 110 ac (45 ha), bringing Carey Run to its current size of 162 ac (66 ha).

The sanctuary is located in eastern Garrett County and is named for the stream, Carey Run, which flows through the property (Figure 3). Carey Run is a tributary of the Savage River and joins the river just outside the entrance to the sanctuary. Another stream, Hefner Run, flows into Carey Run within the sanctuary. The two stream valleys form a Y-shape that cradles the old farmhouse, built in 1887 from white pines, *Pinus strobus* L., grown on the property. A small freshwater pond (Figure 4), formed by damming Carey Run, is located a short distance from the house. The original dam was manmade but American Beavers, *Castor canadensis* Kuhl, occasionally assist in dam remodeling. There are also North American River Otters, *Lontra canadensis* (Schreber), at Carey Run Sanctuary, as well as American Black Bears, *Ursus americanus* Pallas, Coyotes, *Canis latrans* Say, and Timber Rattlesnakes, *Crotalus horridus* Linnaeus.


**Figure 1. Entrance to Carey Run Sanctuary, Garrett County, Maryland.** Photographed by Dominic Nucifora.

**Figure 2. The farmhouse at Carey Run Sanctuary.** Photographed by Dominic Nucifora.

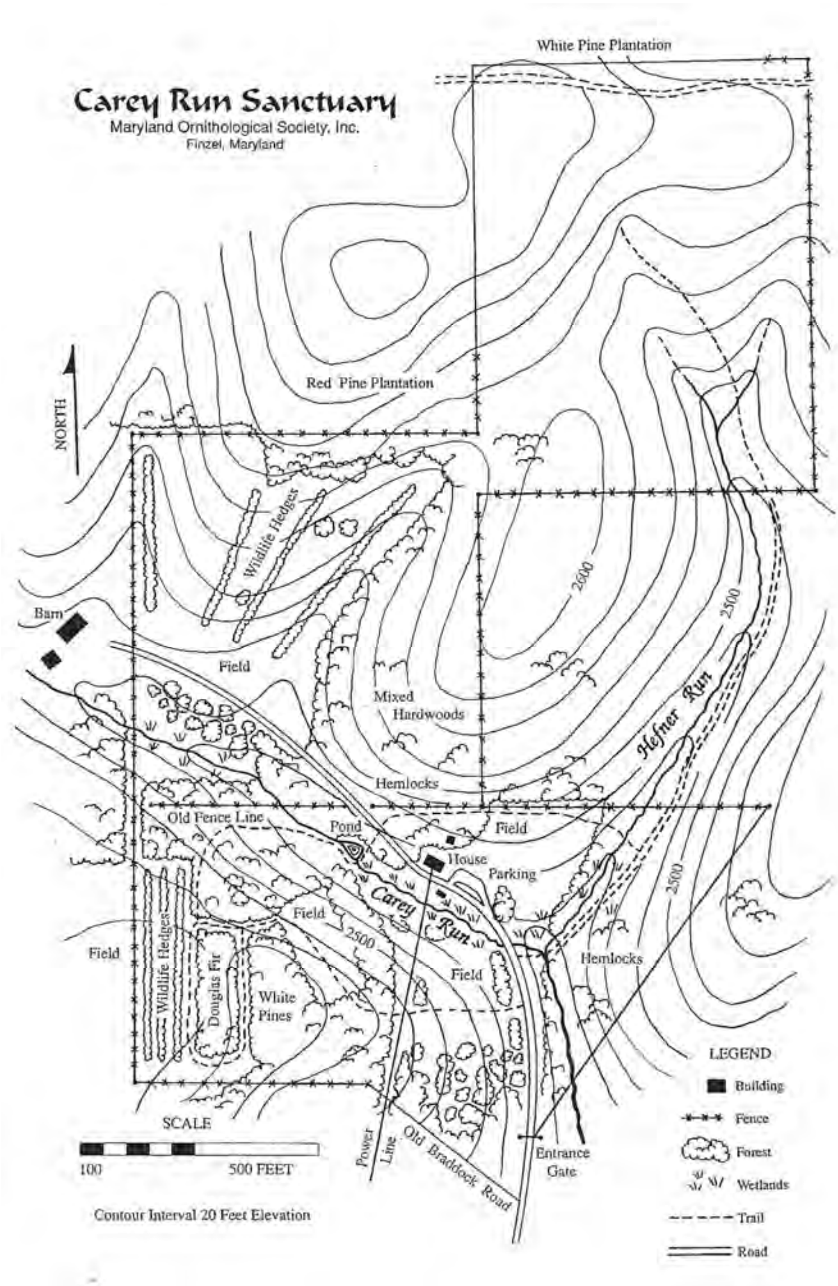


**Figure 3. Carey Run Sanctuary.**

**Figure 4. The pond located on Carey Run at the Carey Run Sanctuary.**
Photographed by Dominic Nucifora.

**Figure 5. Wildlife hedges and grassy meadows at Carey Run Sanctuary.**
Photographed by Dominic Nucifora.

Carey Run Sanctuary has diverse plant communities. The majority of the land is covered by mixed deciduous forest interspersed with eastern hemlock, *Tsuga canadensis* (L.) Carrière, groves. The sanctuary also holds plantations of white pine and Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, planted when these species were important timber crops. There is a small meadow near the house; a large field and hedgerow combination, along with an old orchard, at the northwest border; and a set of wildlife hedges and grassy meadows in the southwest corner (Figure 5). The fields and meadows are mown once annually to maintain good habitat for a diverse assortment of grassland birds as well as for pollinators.

The many trails at Carey Run Sanctuary guide visitors through each of its habitats. The Old Braddock Road, which runs along the Sanctuary's southern border, has significant historical importance as the route created by British Major General Edward Braddock's troops during the French and Indian War in the mid-1700s. Interpretive signage marks the nature trail that parallels the historic road; the placards present a unique interweaving of the military history of the war, the natural history of the land, and the use of the land and its resources by the indigenous Native Americans. The interpretive trail and its signage were created by T. C. Hager as an Eagle Scout project.

The Carey Run Sanctuary farmhouse is available from spring through fall for overnight stays by individuals or organized groups engaging in natural history projects. The house has a modernized kitchen, three bedrooms with bunk beds, and a small parlor, and is heated with two wood stoves. Advance reservations are necessary (MOS 2020b).

## METHODS

The 13 participants of the 12–14 July 2019 BugBlitz were John Bocan, Sam Droege, Tim Foard, Bob Gardner, Peggy Israel, Phil Kean, Sue Muller, Gene Scarpulla, Andrew Sharp, Joanne Sharp, Jackie Sin, Bob Trumbule, and Marcia Watson.

The participants employed various methods to document the fauna and flora of Carey Run Sanctuary. These methods included netting, bee bowls, four black light sheet arrays, photography, and acoustic recording of flyover bats.

## RESULTS and DISCUSSION

Participants have provided summaries for taxa that have numerous observations.

## ARACHNIDS

The sequence of arachnid orders is based on Zhang (2011). Taxonomy is based on Bradley (2013) and ITIS (2020).

### Opiliones (harvestmen)

**Sclerosomatidae**

*Leiobunum aldrichi* (Weed) – a harvestman

*Leiobunum aldrichi*, which was photographed by me, represents a first record for the Maryland Biodiversity Project database. — *Marcia Watson*

## Ixodida (ticks)

**Ixodidae (hard ticks)**
*Dermacentor variabilis* (Say) – American Dog Tick

## Araneae (spiders)

**Tetragnathidae (long-jawed orbweavers)**
*Leucauge venusta* (Walckenaer) – Orchard Orbweaver
**Thomisidae (crab spiders)**
*Misumessus oblongus* (Keyserling) – a crab spider

## INSECTS

The sequence of insect orders is based on Zhang (2011).

## Ephemeroptera (mayflies)

**Ephemeridae (common burrowing mayflies)**
*Ephemera blanda* Traver – a mayfly

## Odonata (dragonflies, damselflies)

**Libellulidae (common skimmers)**
*Libellula luctuosa* Burmeister – Widow Skimmer
*Libellula vibrans* Fabricius – Great Blue Skimmer
*Plathemis lydia* (Drury) – Common Whitetail

## Orthoptera (grasshoppers, crickets, katydids)

**Acrididae (short-horned grasshoppers)**
*Chortophaga viridifasciata* (De Geer) – Northern Green-striped Grasshopper
*Pseudochorthippus curtipennis* (Harris) – Marsh Meadow Grasshopper

The Marsh Meadow Grasshopper was photographed by me and identified by Brandon Woo. Brandon noted that "This is a male *Pseudochorthippus curtipennis* (often seen under the old name *Chorthippus curtipennis*). Likes open wet meadows, and is more of a northern species, although it does sneak down into the Appalachians - so makes sense that it occurs in Garrett County. Doesn't look like there are any Maryland records on BugGuide, iNaturalist, or Maryland Biodiversity Project as of yet!" — *Marcia Watson*

## Phasmida (phasmids)

**Diapheromeridae**
*Diapheromera femorata* (Say) – Northern Walkingstick

## Plecoptera (stoneflies)

**[family unknown]**
an adult stonefly sp.

## Hemiptera (true bugs)

**Aphididae: Eriosomatinae (woolly aphids)**
a wooly aphid sp.
**Cicadellidae (leaf hoppers)**

*Graphocephala* Van Duzee sp. – a leafhopper sp.

Some BugBlitz participants reported not seeing any Hemlock Woolly Adelgids, *Adelges tsugae* Annand (Adelgidae), in the eastern hemlock groves. — *Gene Scarpulla*

## Hymenoptera (bees only)

Taxonomy is based on Michener (2007), Ascher and Pickering (2020), and ESA (2020).

**Colletidae (plasterer bees, polyester bees)**
*Hylaeus affinis* (Smith) – a yellow-faced bee
*Hylaeus affinis* (Smith) or *H. modestus* Say – a yellow-faced bee
**Andrenidae (mining bees)**
*Andrena wilkella* (Kirby) – a mining bee
**Halictidae (sweat bees)**
*Agapostemon texanus* Cresson – a green sweat bee
*Augochlora pura* (Say) – a green sweat bee
*Augochlorella aurata* (Smith) – a green sweat bee
*Halictus ligatus* Say – a sweat bee
*Halictus rubicundus* (Christ) – a sweat bee
*Lasioglossum acuminatum* McGinley – a sweat bee
*Lasioglossum coeruleum* (Robertson) – a sweat bee
*Lasioglossum coriaceum* (Smith) – a sweat bee
*Lasioglossum cressonii* (Robertson) – a sweat bee
*Lasioglossum gotham* Gibbs – a sweat bee
*Lasioglossum hitchensi* Gibbs – a sweat bee
*Lasioglossum lineatulum* (Crawford) – a sweat bee
*Lasioglossum nigroviride* (Graenicher) – a sweat bee
*Lasioglossum oceanicum* (Cockerell) – a sweat bee
*Lasioglossum pectorale* (Smith) – a sweat bee
*Lasioglossum tegulare* (Roberson) – a sweat bee
*Lasioglossum versans* (Lovell) – a sweat bee
*Lasioglossum versatum* (Robertson) – a sweat bee
**Megachilidae (leafcutting bees, resin bees)**
*Megachile inermis* Provancher – a leafcutting bee
*Megachile mendica* Cresson – a leafcutting bee
*Megachile relativa* Cresson – a leafcutting bee
**Apidae (long-horned bees, honey bees, bumble bees, carpenter bees)**
*Bombus bimaculatus* Cresson – Two-spotted Bumble Bee
*Bombus impatiens* Cresson – Common Eastern Bumble Bee
*Bombus vagans* Smith – Half-black Bumble Bee
*Bombus terricola* Kirby – Yellow-banded Bumble Bee
*Melissodes desponsus* Smith – a long-horned bee

For bee diversity, July is the ebb tide of the year; the spring bees have finished flying and the fall bees have yet to begin. Remaining are mostly bees that are either colonial (*Bombus* species), eusocial (*Lasioglossum* species), and a few bees that are just beginning to exploit the late summer flowers or may have multiple generations (*Megachile* species). Additionally, we have *Andrena wilkella* which is an introduced late-spring species with a broad range of preferences for weedy plant species and *Melissodes desponsus* which is a thistle specialist (a few thistles were just beginning to bloom on the Sanctuary).

While most of the species on the list are common and expected, it was significant to see the two female specimens of *Bombus terricola* (Yellow-banded Bumble Bee) that were captured at the Sanctuary on 14 July 2019. This is an "S1 Critically Imperiled / Highly State Rare" species "At very high risk of extinction or extirpation due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors." (Maryland Natural Heritage Program 2016). These specimens represent only the second recent record of the species in Maryland (there was one previous Garrett County specimen, a male at Rock Lodge Trust, near McHenry on 7 July 2012) and it is one of the few known records for the state. This species underwent population decreases throughout its range over the past few decades, most likely from introduced pathogens; thus, it is significant and nice to see that this species is still present in the state on the protected grounds of the Sanctuary. — *Sam Droege*

## Hymenoptera (wasps only)

Taxonomy is based on Bohart and Menke (1976), Bohart and Kimsey (1979, 1982), Kimsey and Bohart (1990), Goulet and Huber (1993), Buck et al. (2008), and ITIS (2020).

**Chrysididae (cuckoo wasps)**
*Hedychrum confusum* Buysson – a cuckoo wasp
*Hedychrum parvum* Aaron – a cuckoo wasp
**Crabronidae (sand wasps)**
*Ectemnius borealis* (Zetterstedt) – a sand wasp (♂)
*Ectemnius lapidarius* (Panzer) – a sand wasp (♂ and ♀)
**Ichneumonidae (ichneumon wasps)**
an ichneumon wasp sp.
**Tenthredinidae (common sawflies)**
a common sawfly sp.
**Vespidae (hornets, paper wasps, potter wasps, yellowjackets)**
*Polistes* Latreille sp. – a paper wasp sp.
*Symmorphus canadensis* (de Saussure) – a potter wasp

## Hymenoptera (ants only)

Taxonomy is based on Ellison et al. (2012) and ITIS (2020).

**Formicidae (ants)**
*Aphaenogaster rudis* Enzmann – Rough Aphaenogaster
*Aphaenogaster picea* (Wheeler) – Pitch-black Aphaenogaster
*Camponotus pennsylvanicus* (De Geer) – Black or Eastern Carpenter Ant
*Camponotus nearcticus* Emery – Nearctic Carpenter Ant
*Crematogaster lineolata* (Say) – Small-lined Crematogaster
*Formica incerta* Buren – Uncertain Ant
*Formica neogagates* Viereck species 1 – New World Black Ant species 1
*Formica neogagates* Viereck species 2 – New World Black Ant species 2
*Formica subsericea* Say – Somewhat Silky Ant

*Lasius umbratus* (Nylander) – Shaded Fuzzy Ant
*Lasius nearcticus* Wheeler – New World Fuzzy Ant
*Lasius americanus* Emery – New World Cornfield Ant
*Myrmecina americana* Emery – American Myrmecina
*Myrmica punctiventris* Roger – Punctured Ant
*Myrmica* species code AF-smi – an undescribed species
*Prenolepis imparis* (Say) – Winter Ant
*Solenopsis molesta* (Say) – Thief Ant
*Stenamma impar* Forel – Odd Stenamma
*Tapinoma sessile* (Say) – Odorous House Ant

Most of the ants identified during the BugBlitz were species which are widely distributed throughout the state. No habitat specialists, state records, or invasive species were found. Despite that, there were several observations of the ant fauna which are worthy of note. The first is that three unnamed species were collected during the survey. Within the *Formica neogagates* species group, Fisher and Cover (2007) recognized a few valid species and posited that additional ones might currently be lumped within "*F. neogagates*" and "*F. lasioides* Emery". One of the two collected species could very well be identified as "*F. neogagates* sensu stricto" once the taxonomy of the species group is finally resolved.

Another observation, also pertaining to the genus *Formica*, was that there were fewer species recorded from this survey than expected. Within the state, the genus reaches its greatest diversity in the western half and in the higher elevations. At least twice the number of collected species were expected at the start of the BugBlitz. The species which were collected are very common species elsewhere in the state, but were not observed to be common on the property. Conspicuously absent were the mound-building *Formica* species. The low diversity was the most surprising observation, given the large open areas present at Carey Run Sanctuary which would be ideal for the establishment of several species in this genus.

The final observation may help explain in part the low *Formica* diversity observed. Extensive sweeping in the grassland area resulted in large numbers of a species of *Myrmica*. At first, so many were recovered from the sweep net that they were suspected of being the invasive European species *M. rubra* (Linnaeus). This suspicion was also coupled with the observation that there was an abundance of small low mounds (five were counted in 1 $m^2$ [10.8 $ft^2$]). It was not until much later after the BugBlitz that identification of the *Myrmica* species was made and it turned out to be *Myrmica* species code AF-smi. The abundance of *Myrmica* colonies may have prevented the establishment of *Formica* colonies and it would explain why very few *Formica* species were encountered in this habitat and it opens up promising research into the biology of an undescribed species. — *Tim Foard*

## Coleoptera (beetles)

Taxonomy is based on Arnett et al. (2001, 2002), Evans (2014), and ITIS (2020).

**Carabidae (ground beetles)**
*Dicaelus teter* Bonelli – a ground beetle
*Pterostichus* Bonelli sp. – a ground beetle sp.

**Silphidae (carrion beetles)**
*Necrophila americana* (Linnaeus) – American Carrion Beetle
*Nicrophorus tomentosus* Weber – Tomentose Burying Beetle
**Scarabaeidae (scarab beetles)**
*Popillia japonica* Newman – Japanese Beetle
**Lampyridae (fireflies)**
*Photuris* Dejean sp. – a firefly sp.
**Cantharidae (soldier beetles)**
*Pacificanthia rotundicollis* (Say) – a soldier beetle
**Nitidulidae (sap beetles)**
*Glischrochilus sanguinolentus* (Olivier) – a sap beetle
**Endomychidae (handsome fungus beetles)**
*Mycetina perpulchra* (Newman) – a handsome fungus beetle
**Coccinellidae (ladybird beetles)**
*Harmonia axyridis* (Pallas) – Multicolored Asian Lady Beetle
**Meloidae (blister beetles)**
*Epicauta funebris* Horn – Margined Blister Beetle
**Cerambycidae (long-horned beetles)**
*Lepturopsis biforis* (Newman) – a flower long-horned beetle
*Saperda candida* Fabricius – Round-headed Apple Tree Borer
*Typocerus velutinus* (Olivier) – Banded Longhorn
**Chrysomelidae (leaf beetles)**
*Chrysochus auratus* (Fabricius) – Dogbane Beetle
*Deloyala guttata* (Olivier) – Mottled Tortoise Beetle
*Leptinotarsa juncta* (Germar) – False Potato Beetle
*Trirhabda* J.L. LeConte sp. – a skeletonizing leaf beetle sp.

## Megaloptera (alderflies, dobsonflies, fishflies)

**Corydalidae (dobsonflies, fishflies)**
*Chauliodes pectinicornis* (Linnaeus) – Summer Fishfly

## Lepidoptera (butterflies only)

Taxonomy is based on Glassberg (1999) and ITIS (2020).

**Papilionidae (swallowtails)**
*Battus philenor* (Linnaeus) – Pipevine Swallowtail
*Papilio polyxenes* Fabricius – Black Swallowtail
*Papilio glaucus* Linnaeus – Eastern Tiger Swallowtail
**Pieridae (whites, yellows)**
*Pieris rapae* (Linnaeus) – Cabbage White
*Colias philodice* Godart – Clouded Sulphur
*Colias eurytheme* Boisduval – Orange Sulphur
*Phoebis sennae* (Linnaeus) – Cloudless Sulphur
**Lycaenidae (gossamer-wings)**
*Satyrium titus* (Fabricius) – Coral Hairstreak
*Cupido comyntas* (Godart) – Eastern Tailed-Blue
*Celastrina neglecta* (W. H. Edwards) – Summer Azure

**Nymphalidae (brushfoots)**
*Speyeria cybele* (Fabricius) – Great Spangled Fritillary
*Speyeria aphrodite* (Fabricius) – Aphrodite Fritillary
*Phyciodes tharos* (Drury) – Pearl Crescent
*Euphydryas phaeton* (Drury) – Baltimore Checkerspot
*Polygonia comma* (T. Harris) – Eastern Comma
*Vanessa atalanta* (Linnaeus) – Red Admiral
*Junonia coenia* Hübner – Common Buckeye
*Limenitis arthemis astyanax* (Fabricius) – Red-spotted Purple
*Lethe anthedon* (A. Clark) – Northern Pearly-eye
*Lethe appalachia* R. Chermock – Appalachian Brown
*Cercyonis pegala* (Fabricius) – Common Wood-Nymph
*Danaus plexippus* (Linnaeus) – Monarch
**Hesperiidae (skippers)**
*Epargyreus clarus* (Cramer) – Silver-spotted Skipper
*Pyrgus communis* (Grote) – Common Checkered-Skipper
*Polites origenes* (Fabricius) – Crossline Skipper
*Wallengrenia egeremet* (Scudder) – Northern Broken Dash
*Pompeius verna* (W. H. Edwards) – Little Glassywing
*Anatrytone logan* (W. H. Edwards) – Delaware Skipper
*Euphyes vestris* (Boisduval) – Dun Skipper

In surveying the property for butterflies, 29 species of butterflies and skippers were recorded. The majority were common species that are virtually statewide in distribution, one exception being *Speyeria aphrodite* (Aphrodite Fritillary) which is primarily found in the Appalachian Plateau and Ridge and Valley regions (Smith 2014). Its numbers seem to be declining in some of its usual locations.

One notable migrant was *Phoebis sennae* (Cloudless Sulphur). While this southern species regularly reaches Maryland in most years, it is usually to be expected in late summer or fall. Our sighting of this species was probably a little earlier than normal this far from Maryland's coastal counties.

Three species of satyrines (Nymphalidae: Satyrinae) were also observed. They were *Cercyonis pegala* (Common Wood-Nymph), *Lethe anthedon* (Northern Pearly-eye), and *Lethe appalachia* (Appalachian Brown). While fairly widespread in Maryland, all three of these species tend to be found in localized colonies.

The most notable species recorded was *Euphydryas phaeton* (Baltimore Checkerspot) (Figure 6) which is an "S2 Imperiled / State Rare" species that is "At high risk of extinction or extirpation due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors." (Maryland Natural Heritage Program 2016). Two definite sightings of this species, our Maryland State Insect, were made during the survey.

On a final note, there was one other interesting find made on the trip. Among the skippers found on the Sanctuary was *Anatrytone logan* (Delaware Skipper). While being fairly widespread in Maryland, it is also known to be a rather uncommon species. Indeed, during our survey, only a couple of individuals were sighted during the entire day.

However, over a dozen specimens were found as bycatch in Gene Scarpulla's "bee bowls". — *Phil Kean*

**Figure 6. Baltimore Checkerspot, *Euphydryas phaeton* (Drury) at Carey Run Sanctuary.** Photographed by Tim Foard, 13 July 2019.

**Lepidoptera (moths only)**

Taxonomy is based on Beadle and Leckie (2012) and ITIS (2020).

**Bucculatricidae (ribbed cocoon-making moths)**
*Bucculatrix ainsliella* Murtfeldt – Oak Skeletonizer (caterpillar)
**Limacodidae (slug moths)**
*Prolimacodes badia* (Hübner) – Skiff Moth
*Isa textula* (Herrich-Schäffer) – Crowned Slug Moth
**Pyralidae (grass moths, snout moths)**
*Pyralis farinalis* Linnaeus – Meal Moth
**Crambidae (crambid snout moths)**
*Udea rubigalis* (Guenée) – Celery Leaftier
*Pantographa limata* (Grote and Robinson) – Basswood Leafroller Moth
**Geometridae (geometer moths, looper moths)**
*Rheumaptera prunivorata* (Ferguson) – Cherry Scallop Shell
*Euphyia intermediata* (Guenée in Boisduval and Guenée) – Sharp-angled Carpet
*Trichodezia albovittata* (Guenée in Boisduval and Guenée) – White-striped Black
*Scopula limboundata* (Haworth) – Large Lace-border
*Speranza pustularia* (Guenée in Boisduval and Guenée) – Lesser Maple Spanworm
*Digrammia ocellinata* (Guenée in Boisduval and Guenée) – Faint-spotted Angle
*Protoboarmia porcelaria* (Guenée in Boisduval and Guenée) – Porcelain Gray
*Biston betularia* (Linnaeus) – Pepper-and-salt Geometer
*Cabera variolaria* Guenée in Boisduval and Guenée – Pink-Striped Willow Spanworm (The Vestal)

*Phaeoura quernaria* (Smith in Smith and Abbot) – Oak Beauty
*Eugonobapta nivosaria* (Guenée in Boisduval and Guenée) – Snowy Geometer
*Eutrapela clemataria* (Smith in Smith and Abbot) – Curved-Toothed Geometer
*Prochoerodes lineola* (Goeze) – Large Maple Spanworm

**Saturniidae (giant silkworm moths, royal moths)**
*Dryocampa rubicunda* (Fabricius) – Rosy Maple Moth
*Automeris io* (Fabricius) – Io Moth
*Callosamia promethea* (Drury) – Promethea Silkmoth

**Sphingidae (hawk moths, sphinx moths)**
*Ceratomia undulosa* (Walker) – Waved Sphinx
*Paonias excaecata* (J. E. Smith) – Blinded Sphinx
*Paonias myops* (J. E. Smith) – Small-eyed Sphinx

**Notodontidae (prominents)**
*Peridea basitriens* (Walker) – Oval-based Prominent

**Erebidae (tiger moths, tussock moths, underwings, zales)**
*Lymantria dispar* (Linnaeus) – Gypsy Moth (egg masses)
*Hypoprepia fucosa* Hübner – Painted Lichen Moth
*Phragmatobia fuliginosa* (Linnaeus) – Ruby Tiger Moth
*Halysidota tessellaris* (J. E. Smith) – Banded Tussock Moth
*Lophocampa caryae* Harris – Hickory Tussock Moth
*Cycnia tenera* Hübner – Delicate Cycnia
*Ctenucha virginica* (Esper) – Virginia Ctenucha
*Zanclognatha laevigata* (Grote) – Variable Fan-Foot
*Catocala crataegi* Saunders – Hawthorn Underwing
*Catocala blandula* Hulst – Charming Underwing
*Zale lunata* (Drury) – Lunate Zale
*Zale minerea* (Guenée) – Colorful Zale
*Euparthenos nubilis* (Hübner) – Locust Underwing
*Panopoda rufimargo* (Hübner) – Red-lined Panopoda

**Noctuidae (cutworms, dagger moths, owlet moths)**
*Panthea acronyctoides* (Walker) – Black Zigzag
*Loscopia velata* (Walker) – Veiled Ear Moth
*Polia nimbosa* (Guenée) – Stormy Arches

On the evenings of 13 and 14 July 2019, moths were observed and recorded via black light or mercury vapor lights. Over the two evenings, a total of 41 moth species were recorded representing ten families. Two more species were added during the day: *Bucculatrix ainsliella* (an Oak Skeletonizer caterpillar) and *Lymantria dispar* (Gypsy Moth egg masses). The families with the most species were Geometridae (13) and Erebidae (14). Of the 43 total species recorded, five (three erebids and two noctuids) are to be noted as more northerly United States species. The first erebid, *Phragmatobia fuliginosa* (Ruby Tiger Moth), is primarily a much more northerly species. In Maryland, it occurs in Garrett and Allegany Counties and occasionally has been found along the northern tier of Maryland counties. The two other erebids are *Catocala blandula* (Charming Underwing), a more northerly species, and *Catocala crataegi* (Hawthorn Underwing), a more northerly and westerly species, both of their distributions extending south along the Appalachian Mountains. Both species are primarily found in Western

Maryland, with *C. blandula* records extending eastward in Maryland counties just south of the Mason-Dixon Line. The two noctuids, *Panthea acronyctoides* (Black Zigzag) and *Polia nimbosa* (Stormy Arches), are more northerly species whose distribution extends down the Appalachian Mountains. While *P. nimbosa* occurs in Western Maryland, *P. acronyctoides* only occurs in far Western Maryland. — *Bob Gardner*

## Diptera (gnats, mosquitoes, true flies)

Taxonomy is based on McAlpine (1981, 1987, 1989) and ITIS (2020).

**Tipulidae (crane flies)**
*Tipula metacomet* Alexander – a large crane fly
**Ptychopteridae (phantom crane flies)**
*Bittacomorpha clavipes* (Fabricius) – a phantom crane fly
**Culicidae (mosquitoes)**
*Aedes* Meigen sp. – a mosquito sp.
**Tabanidae (deer flies, horse flies)**
*Chrysops* Meigen sp. – a deer fly sp.
**Asilidae (robber flies)**
*Laphria* Meigen sp. – a bee-like robber fly sp.
**Syrphidae (flower flies)**
*Eristalis tenax* (Linnaeus) – Common Drone Fly
*Spilomyia fusca* Loew – Bald-faced Hornet Fly
*Toxomerus marginatus* (Say) – Margined Calligrapher
**Agromyzidae (leafminer flies)**
*Phytoliriomyza melampyga* (Loew) – Jewelweed Leafminer

## Mecoptera (scorpionflies, hangingflies, snowflies)

**Panorpidae (common scorpionflies)**
*Panorpa* Linnaeus sp. – a common scorpionfly sp.

## SUMMARY

Table 1 summarizes the results of the three-day Carey Run BugBlitz. The 13 participants detected 337 taxa (4 arachnids, 166 insects, 1 fish, 7 amphibians, 54 birds, 7 mammals, 15 fungi, 83 flora). The arachnids included 1 Opiliones, 1 Ixodida, and 2 Araneae. The insects included 1 Ephemeroptera, 3 Odonata, 2 Orthoptera, 1 Phasmida, 1 Plecoptera, 2 Hemiptera, 55 Hymenoptera, 18 Coleoptera, 1 Megaloptera, 72 Lepidoptera, 9 Diptera, and 1 Mecoptera.

The data are a mere one-weekend snapshot of the biodiversity of Carey Run Sanctuary. There are undoubtedly numerous additional species that remain to be documented on the Sanctuary. More faunal and floral specialists are needed to survey the property throughout the different seasons of the year. We hope that this preliminary list will inspire others to visit and conduct surveys on the property.

## ACKNOWLEDGMENTS

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**Table 1. Taxa observed during the 12–14 July 2019 Carey Run Sanctuary BugBlitz.**

| | Orders | Families | Genera | Species |
|---|---|---|---|---|
| Arachnids | Opiliones | 1 | 1 | 1 |
| | Ixodida | 1 | 1 | 1 |
| | Araneae | 2 | 2 | 2 |
| Insects | Ephemeroptera | 1 | 1 | 1 |
| | Odonata | 1 | 2 | 3 |
| | Orthoptera | 1 | 2 | 2 |
| | Phasmida | 1 | 1 | 1 |
| | Plecoptera | 1 | 1 | 1 |
| | Hemiptera | 2 | 2 | 2 |
| | Hymenoptera (bees) | 5 | 10 | 28 |
| | Hymenoptera (wasps) | 5 | 6 | 8 |
| | Hymenoptera (ants) | 1 | 11 | 19 |
| | Coleoptera | 11 | 18 | 18 |
| | Megaloptera | 1 | 1 | 1 |
| | Lepidoptera (butterflies) | 5 | 25 | 29 |
| | Lepidoptera (moths) | 10 | 40 | 43 |
| | Diptera | 7 | 9 | 9 |
| | Mecoptera | 1 | 1 | 1 |
| Fishes | | 1 | 1 | 1 |
| Amphibians | | 4 | 5 | 7 |
| Reptiles | | 0 | 0 | 0 |
| Birds | | 23 | 43 | 54 |
| Mammals | | 6 | 6 | 7 |
| Fungi | | 14 | 15 | 15 |
| Flora | | 43 | 78 | 83 |
| **Total** | | **148** | **282** | **337** |

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## COVER PHOTOGRAPH

Mating by Brood X periodical cicadas, *Magicicada septendecim* (Linnaeus) (Hemiptera: Cicadidae). Photographed in Howard County, Maryland, 22 May 2004. *Billions will return to our region in spring 2021!*

Photographed by Michael J. Raupp