

BANISTERIA

A JOURNAL DEVOTED TO THE NATURAL HISTORY OF VIRGINIA

ISSN 1066-0712

Published by the Virginia Natural History Society

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RESEARCH ARTICLE

AN ANNOTATED CHECKLIST OF THE COLEOPTERA OF THE SMITHSONIAN ENVIRONMENTAL RESEARCH CENTER: THE CUCUJOIDEA

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Editor: T. Fredericksen | Received 1 February 2021 | Accepted 14 March 2021 | Published 17 March 2021

<https://virginiannaturalhistorysociety.com/banisteria/banisteria.htm#ban55>

Citation: Staines, C. L. and S. L. Staines. 2021. An annotated checklist of the Coleoptera of the Smithsonian Environmental Research Center: the Cucujoidea. *Banisteria* 55: 50–60.

ABSTRACT

A three year inventory at the Smithsonian Environmental Research Center, Edgewater, Maryland resulted in nine families and 35 species of Cucujoidea: Coccinellidae- 9, Cryptophagidae- 1, Cucujidae- 1, Erotylidae- 5, Laemophloeidae- 1, Lathridiidae- 1, Nitidulidae- 12, Phalacridae- 4, and Silvanidae- 1.

Keywords: Biodiversity, insects, Maryland.

INTRODUCTION

Cucujoidea (sap, flat bark, and fungus beetles) is a heterogeneous group of beetles which have a similar appearance (small, drab coloration, and clubbed antennae) that could not be placed satisfactorily in other groups. The superfamily was established for convenience and represents the largest taxonomic dumping ground in Coleoptera. They exhibit a broad range of host utilization and typically have cryptic life histories in leaf litter, dead wood or fungi. Currently, the superfamily contains 37 beetle families (Robertson et al., 2015).

The majority of Coccinellidae, lady beetles, are predaceous on aphids, psyllids, mealybugs, scales (Hemiptera), and other soft-bodied insects as adults and larvae. One subfamily (Epilachninae) is phytophagous primarily on the plant families Solanaceae, Curcubitaceae, and Fabaceae (Gordon, 1976). Most species are distasteful to predators. There are nearly 6000 species worldwide with 475 species known from the United States and Canada (Vandenberg, 2002). There are 78 species reported from Maryland (Gordon, 1985). Staines et al. (1990) found 28 species

associated with nursery stock in Maryland. Staines (2008) reported 25 species collected from 1902 to 1960 from Plummers Island (Montgomery County, Maryland).

Cryptophagidae, silken fungus beetles, are typically associated with fungal growth. A few species are incidental stored product pests. Adults are often collected by litter sifting, in rotting wood, or in flight intercept traps. There are about 600 described species worldwide with 145 species known from the United States (Leschen & Skelley, 2002a). The Maryland Biodiversity Project (MSP) (2020) reports three species from Maryland.

Cucujidae, flat bark beetles, larvae and adults are found under bark of dead trees. Larvae of the North America species of *Cucujus* are reported to be predaceous (Smith & Sears, 1982), but otherwise there is little information on their biology. There are 59 species worldwide with 40 species known from the United States and Canada (Thomas, 2002b). The Maryland Biodiversity Project (MSP) (2020) reports one species from Maryland.

Erotylidae, pleasing fungus and lizard beetles, larvae and adults of the subfamily Erotylinae feed on the fruiting bodies of larger Basidiomycete fungi in decaying wood. Lizard beetles (subfamily Larguriinae) are pests of stored grain or crops. There are about 3500 species worldwide with 82 species known from the United States (Skelley & McHugh, 2002; Leschen & Skelley, 2002b). Steury (2018) reported 20 species in a 19 year inventory at George Washington Memorial Parkway (Fairfax County, Virginia). The Maryland Biodiversity Project (MSP) (2020) reports 12 species from Maryland.

Laemophloeidae, lined flat bark beetles, mostly appear to feed on fungi but some species are associated with bark beetles (Curculionidae: Scolytinae) and may be predators. A few species are important pests of small grains. There are about 400 species worldwide with 52 species in the United States (Thomas, 2002c). The Maryland Biodiversity Project (MSP) (2020) reports two species from Maryland.

Lathridiidae, minute brown scavenger beetles, feed on fungi as adults and larvae in most species. Numerous species have been reared from mushrooms and others are found by sifting leaf litter. Adults are most common in the wetter seasons of the year. There are about 1050 species worldwide with 140 species from the United States (Andrews, 2002). The Maryland Biodiversity Project (MSP) (2020) reports no species from Maryland.

Nitidulidae, sap beetles, are primarily saprophagous and mycetophagous. Most species are found in rotting fruits and fungi. There are about 2800 species worldwide with 165 known from the United States (Habeck, 2002). Connell (1956) reported 43 species from Delaware. The Maryland Biodiversity Project (MSP) (2020) reports 25 species from Maryland.

Phalacridae, shining flower or shining mold beetles, mostly feed on various kinds of fungi. Larvae of the genus *Olibrus* live in flower heads of Asteraceae while the adults feed on pollen. There are 504 species known worldwide with 122 from the United States (Steiner, 2002). The Maryland Biodiversity Project (MSP) (2020) reports four species from Maryland.

Most species of Silvanidae, silvanid flat bark beetles, have an unknown biology. Many species are found under bark and larvae and adults probably feed on fungi. There are 470 species worldwide with 32 species known from the United States (Thomas, 2002a). The Maryland Biodiversity Project (MSP) (2020) reports five species from Maryland.

MATERIALS AND METHODS

The Smithsonian Environmental Research Center (SERC) [38°33'17.57"N; 76°33'14.29"W] consists of approximately 1,477 ha of hardwood-dominated forest, ponds, creeks,

rivers, tidal marshes, and 19.3 km of protected shoreline along the Rhode River and upper Chesapeake Bay in Anne Arundel County, Maryland (SERC 2018). Forests on the main campus of SERC can be broadly classified into three main types: (1) the majority (~85%) is a tulip-poplar (*Liriodendron tulipifera* L., Magnoliaceae) association; (2) a moist lowland assemblage, comprised of American sycamore (*Platanus occidentalis* L., Platanaceae), ash (*Fraxinus* spp., Oleaceae), elms (*Ulmus* spp., Ulmaceae), river birch (*Betula nigra* L., Betulaceae), and other woody vegetation along freshwater streams; and (3) a somewhat dry mesic assemblage that fringes tidal marshes, consisting of chestnut oak (*Quercus prinus* L.), white oak (*Quercus alba* L., Fagaceae), black gum (*Nyssa sylvatica* Marshall, Nyssaceae), mountain laurel (*Kalmia latifolia* L., Ericaceae), blueberries (*Vaccinium* spp., Ericaceae) and other woody vegetation.

Like much of the eastern U.S., SERC's forest age and structure reflect historical agricultural activities and local history. SERC's main campus was mostly fallow from the end of the Civil War to approximately 1915, when it was used as a dairy farm with grazing pastures and fields for feed production until 1945. Thus, the majority of SERC's contemporary forests are from 70-150 years old (McMahon et al., 2010; Higman et al., 2016).

Freshwater inputs into the Rhode River are primarily from the North Fork Muddy Creek, South Fork Muddy Creek, and their lower order streams. These streams are associated with several swamps, beaver impoundments, and seasonal wetlands which range from small, tannin-rich, ephemeral wetlands, to larger and clear-water permanent ponds.

On the opposite side of the Rhode River the BiodiversiTREE plots are about 30 acres containing 24,000 trees of 16 species of ecologically important deciduous trees planted in 75 plots. Established in 2013, the trees in these plots are rather stunted probably due to deer (*Odocoileus virginianus* (Zimmermann), Mammalia: Cervidae) browse and poor soil nutrients (SERC, 2018). In the annotated species list this area is referred to as Zones 5 and 6.

The goal of this project was to inventory the Coleoptera of the SERC. Collecting techniques include visual survey followed by sweeping or beating the vegetation of the area. Other collecting techniques used were pitfall traps (both baited and unbaited), head lamping, black lighting, and checking lights around buildings on the main campus.

Field work was conducted from 11 May to 24 October 2018, 30 March to 23 October 2019, 19-20 March 2020, and 26 August to 31 October 2020. Two Malaise traps were operated for 72 hour periods in May and June 2020. Voucher specimens are deposited in the SERC and the Department of Entomology Collection, Natural History Museum, Smithsonian Institution.

RESULTS

Family Coccinellidae

Coccinella septempunctata L. this introduced species feeds on aphids (Hemiptera: Aphididae) (Gordon, 1985). Specimens were taken by sweeping vegetation from May to September throughout the main campus.

Coleomegilla maculata (DeGeer) feeds on aphids (Gordon, 1985) and many other insects (Cottrell & Yeorgan, 1998). Specimens were taken sweeping vegetation on 11 May 2018 in the field behind Sellman House and on 6 June 2018 in the field at the intersection of Contees Wharf and Dock Roads.

Cycloneda munda (Say) feeds on aphids (Gordon, 1985). Specimens were taken sweeping vegetation on 6 June 2018 in the main parking lot, on 19 July 2018 in the field opposite Sellman House, on 23 April in Zone 5, and on 7 May 2019 in the maintenance area.

Epilachna varivestis Mulsant this introduced species feeds on various Fabaceae (Nong & Bennett, 1994). Specimens were taken sweeping vegetation on 23 April 2019 at Frog Haven.

Harmonia axyridis (Pallas) this introduced species feeds on scales (Hemiptera) and aphids (Chapin & Brou, 1991). Specimens were taken sweeping vegetation and in Malaise traps from April to September throughout the main campus.

Hippodamia convergens Guérin-Ménéville feeds on aphids, whiteflies (Hemiptera: Aleyrodidae), and other soft-bodied insects (Hamilton et al., 1999). Specimens were taken sweeping vegetation on 11 May 2018 in the field behind Sellman House.

Propylea quatuordecimpunctata (L.) this introduced species feeds on aphids on small grains (Dysart, 1988). Specimens were taken sweeping vegetation on 11 May 2018 in the field behind Sellman House, and on 16 May 2019 and 9 September 2020 along Contees Wharf Road.

Scymnus cervicalis Mulsant has been associated with aphids (Staines et al., 1990). Specimens were taken sweeping vegetation on 17 May 2019 at Frog Haven.

Scymnus fraternus LeConte feeds on scale insects (Gordon, 1976). Specimens were taken sweeping vegetation on 11 May 2018 in the field behind Sellman House and on 24 May 2018 along Contees Wharf Road.

Family Cryptophagidae

Cryptophagus valens Casey is usually found in stored products (Robinson, 2005). Specimens were taken beating vegetation on 20 March 2020 near the Java House ruins.

Family Cucujidae

Cucujus clavipes Fabricius adults and larvae are frequently found under the bark of decaying hardwood logs, sometimes in aggregations (Blatchley, 1910). The larvae are predaceous (Smith & Sears, 1982) or facultatively predaceous (Lawrence, 1991). Larvae were found under the bark of a decaying oak on 12 April 2019 near the intersection of Back Road and 11-6.

Family Erotylidae

Languria mozardi Latreille bores in the stems of red clover (*Trifolium pretense* L.) and alfalfa (*Medicago sativa* L., Fabaceae) (Vaurie, 1948); adults have been taken in Berlese funnel (Steury, 2018). Specimens were taken sweeping vegetation on 7 May 2019 in the maintenance area and on 16 May 2019 and 31 May 2019 along Contees Wharf Road.

Triplax thoracica L. has been collected in fungus on hemlock (*Tsuga canadensis* (L.) Carr., Pinaceae), in fungus on maple (*Acer*, Spindaceae), in *Pleurotus ostreatus* (Jacq. ex Fr.) P. Kumm. (Pleurotaceae), in gill fungus on aspen (*Populus*, Saliceae) log, under bark, on *Carya* (Juglandaceae), and on *Salix* (Salicaceae) (Boyle, 1956); over 98% of the material examined by Goodrich & Skelley (1993) was from *Pleurotus ostreatus*. Specimens were taken in *Pleurotus ostreatus* on 24 May 2018 along Contee Watershed Trail and on 2 May 2019 on Hog Island.

Tritoma biguttata Say has been collected on toadstool, on *Morus* (Moraceae), in woods trash, and on mushrooms (Boyle, 1956). Host fungi include *Amanita bisporigera* G. F. Atk., *A. ceasarea* (Scop.) Pers., *A. excelsa* (Fr.) Bertill., *A. rubescens* (Pers. ex Fr.) Gray, *A. subsolitaria* (Murrill) Murrill, *A. vaginata* (Bull.) Lam., *A. verna* (Bull.) Lam., *A. virosa* (Fr.) Bert., *Amanita* sp. (Amanitaceae), *Armillaria tabescens* (Scop.) Emel (Physalaceae), Boletaceae, *Lucoagaricus naucinus* (Fr.) Singer (Agaricaceae), *Phylloporus rhodxanthus* (Schwein.) Bres. (Boletaceae), and *Russula* sp. (Russulaceae) (Goodrich & Skelley, 1994). Specimens were taken in unidentified mushrooms on 31 August 2020 along Contee Watershed Trail.

Tritoma humeralis Fabricius has been found on *Polyposus radicans* Schwein. (Polyporaceae), on toadstool, on mushrooms, and in fungi (Boyle, 1956). Host fungi include *Agaricus* sp. (Agaricaceae), *Amanita bisporigera*, *A. citrina* (Schaeff.) Pers., *A. flavorubescens* (Berk. & Mont.) Sacc., *A. muscaria* (L.) Lam., *A. phalloides* (Fr.) Link, *A. rubescens*, *A. solitaria* (Bull.) Fr., *A. strobiliformis* (Paulet ex Vittad.) Bertill., *A. vaginata*, *Amanita* sp. (Amanitaceae), *Armillaria* sp., *A. mellea* (Vahl) P. Kumm., *A. tabescens* (Physalaceae), *Collybia* sp. (Tricholomataceae), *Lactarius piperatus* (L.) Roussel (Russulaceae), *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvardeen (Polyporaceae), *Russula* sp. (Goodrich & Skelley, 1994); taken in a Malaise trap (Steury, 2018). Specimens were taken in unidentified mushrooms on 31 August 2020 along Contee Watershed Trail.

Tritoma unicolor Say has been collected from *Calvatia craniiformis* (Schwein) Fr. ex. De Toni (Agaricaceae), in fungus at base of stump, ex *Hypoloma* (Strophariaceae), ex fungus *Omphalotus illudens* (Schwein.) Bresinsky & Besl (Marasmiaceae), and in fungi (Boyle, 1956). Host fungi include *Calvatia craniiformis*, *Hypholoma* sp., *Omphalotus illudens*, *O. olearius* (DC) Sing., Tricholomataceae (Goodrich & Skelley, 1994); taken in a Malaise trap (Steury, 2018). Specimens were taken in an unidentified mushroom on 2 May 2019 on Hog Island, on 27 June 2019 by head lamping along Back Road, and on 26 September 2019 Java History Trail by head lamping

Family Laemophloeidae

Laemophloeus fasciatus Melsheimer is found under bark (Thomas, 1993); has been collected in coniferous and mixed forests and has been found on basswood (*Tilia europea* L., Tiliaceae) (Majka, 2008). Specimens were taken at black light on 12 August 2019 along Back Road.

Family Lathridiidae

Corticarina sp. have been reared from the Deuteromycetes and Phycomycetes, *Mucor*, *Aspergillus*, *Penicillium*, *Helminthosporium*, and *Alternaria* (Andrews, 2002). This genus needs revision. Specimens were taken beating vegetation on 20 March 2020 around Java House ruins, by sweeping

vegetation on 26 August 2020 around the Reed Education Center, by sweeping vegetation on 14 September 2020 in the field opposite the Sellman House, and from 12-15 June 2020 in a Malaise trap along the woods margin in the field opposite Sellman House.

Family Nitidulidae

Amphicrossus cilatus (Olivier) is found on sap in the spring and on various flowers in the fall (Parsons, 1943); in Lindgren funnel traps baited with either banana (*Musa*, Musaceae) and fermenting brown sugar or fermenting brown sugar and bread dough, cantaloupe (*Cucumis melo cantalupo* Ser., Cucurbitaceae) traps, flight intercept traps, light traps, sap flows of *Quercus* sp. and *Acer* sp., on the bark of *Ulmus* sp. and *Quercus velutina* Lamarck, and from a fleshy, gilled fungus on a standing live tree (Price & Young, 2006). Specimens were taken at black light on 23 June 2018 at Reed Education Center.

Brassicogethes aeneus (Fabricius) this introduced species has been collected from various flowers, especially *Ranunculus* (Ranunculaceae) and *Salix* (Parsons, 1943; Larsen, 2013). Specimens were taken sweeping vegetation on 24 April 2019 in the field at the intersection of Contees Wharf and Dock Roads and on 25 April 2019 in the fields around Sellman House.

Carpophilus lugubris Murray is attracted to a wide variety of ripe fruits or fermenting vegetable material, may be a pest of sweet corn (*Zea mays* L., Poaceae) (Connell, 1956); in Lindgren funnel traps, baited with either fermenting brown sugar and bread dough or banana and fermenting brown sugar, cantaloupe traps, flight intercept traps, banana traps, barrier pitfall traps, Townes Malaise traps, recently cut stumps/sawdust of *Acer* sp., banana, a rotting fruit pile, a leaf litter sample, dried melon, flowers of *Prunus americana* Marshall (Rosaceae), scat on fallen tree, and decaying tomatoes (*Solanum lycopersicum* L., Solanaceae) (Price & Young, 2006). Specimens were taken in an unidentified mushroom around the pond at the intersection of Contees Wharf and Dock Roads on 5 June 2018.

Colopterus unicolor (Say) has been collected in light traps (Price & Young, 2006). Specimens were collected sweeping vegetation along Contee Watershed Trail on 23 October 2018.

Cyrtarcha ampla Erichson has been collected from sap of maples (*Acer*) and willows (*Salix*) (Parsons, 1943); at sap flows of oaks (*Quercus*) and hickories (*Carya*), in fungi, at lights (Downie & Arnett, 1996); in oak wilt fungal mats (*Bretziella fagacearum* (Bretz) de Boer, Marinowitz, Ducha, & Wingfield, Ceratocystidaceae) (Cease & Juzwik, 2001); fresh oak wounds (Juzwik et al. 2004); on red oak (*Quercus rubra* (Majka & Cline, 2006)); in Lindgren funnel traps baited with banana or bread dough and fermenting brown sugar (the most successful strategy), cantaloupe traps, flight intercept traps, human dung/malt/molasses pitfall traps, light traps, Malaise traps, soil at the base of a fermenting oak tree wound, a willow tree damaged by a species of *Sternochetus* (Coleoptera: Curculionidae), on rotting peaches (*Prunus perisica* (L.) Batsch, Rosaceae), reared from the stem of a milkweed (*Asclepias syriaca* L., Asclepiadaceae) (Price & Young, 2006). Specimens were taken at black light on 20 May 2019 at Frog Haven.

Epuraea rufa (Say) is found in leaf litter, at sap, in fungi, on tree bark, on driftwood, and reared from fallen seeds of sugar maple (*Acer saccharum* Marsh.) (Parsons, 1943; Price & Young, 2006).

Specimens were taken at black light on 31 May 2019 at Sellman House and in unidentified mushrooms along Contee Watershed Trail on 31 August 2020.

Glischochilus confluentus (Say) has been found on bark of dying trembling aspen (*Populus tremuloides* Michx.) (Majka & Cline, 2006); associated with oak (*Quercus* sp.), on moist decaying fungi, and on chicken of the woods (*Laetiporus sulphureus* (Fr.) Murr., Polyporaceae) (Price & Young, 2006). Specimens were taken in rotting fruit on 20 October 2020 on Hog Island.

Omosita nearctica Kirejtshuk all other species of this genus are found in carrion (Parsons, 1943). Specimens were taken on a dead bluefish (*Pomatomus saltatrix* (L.), Perciformes: Pomatomidae) on 10 September 2019 at Mathais Lab.

Pallodes pallidus (Beauvois) is found in *Tricholoma terrifera* (Schaeff.) P. Kumm. (Tricholomataceae), *Lactarius volemus* (Fr.) Kuntze (Russulaceae), *Megacollybia platyphylla* (Pers.) Kotl. & Pouzar (Tricholomataceae), and other fleshy fungi (Parsons, 1943); in flight intercept traps (Price & Young, 2006). Specimens were taken head lamping on 27 June 2019 along Back Road, in unidentified mushrooms on 26 August 2019 along Java History Trail, on 26 August 2020 on Hog Island, on 26 August 2020 along Discovery Trail, on 31 August 2020 along Contee Watershed Trail, on 2 September 2020 in the woods at the intersection of Back Road and 11-6, on 9 September 2020 in the woods behind Mathais Lab, and on 14 September 2020 in the woods opposite Sellman House.

Phenolia grossa (Fabricius) is found beneath bark and in fungi (Parsons, 1938; 1943); in oak wilt fungus mats (Cease & Juzwik, 2001); in coniferous forests, decomposing fungi, and decaying red maple (*Acer rubrum* L.) (Majka & Cline, 2006); in flight intercept traps, gilled mushrooms growing in the soil at the base of a maple tree, mating on sulfur shelf fungus (*Laetiporus sulphureus* (Fries) Murrill), from *Quercus* sp. stumps and logs, and from soil at the base of a fermenting tree wound (Price & Young, 2006). Specimens have been taken at black light on 27 May 2019 along Connector Trail between Fox Point Road and Java History Trail.

Prometopia sexmaculata (Say) has been found on sap of various trees and overwinters beneath bark (Parsons, 1943); in flight intercept traps, at blacklight, from Lindgren funnel traps, and beneath the bark of *Quercus ellipsoidalis* E. J. Hill and *Q. velutina* (Price & Young, 2006). Specimens were taken at black light on 27 June 2019 at Back Road opposite the NEON tower.

Stelidota geminata (Say) feeds on the ripe fruit of strawberry (*Fragaria*, Rosaceae), peach (*Prunus persica*), and other plants (Weber & Connell, 1975; Williams et al., 1996); in flight intercept traps, human dung/malt/molasses-baited pitfall traps, cantaloupe traps, Lindgren funnel traps baited with banana and brown sugar, rotting fruit, under scat, in leaf litter, and from a large shelf fungus growing on an old growth (100+ year old) maple tree (Price & Young, 2006). Specimens were taken in persimmon (*Diospyros virginiana* L., Ebenaceae) fruit on 23 October 2018 along Contee Watershed Trail, by head lamping on 27 June 2019 along Back Road, and in an unidentified mushroom on 9 September 2020 in the woods behind Mathais Lab.

Family Phalacridae

Acylomus sp. are associated with fungi and there are no published identification aids to the 20 described United States species (Steiner, 2002). Specimens were taken in Malaise traps in the field opposite Sellman House from 10-13 May 2020 and 12-15 June 2020.

Olibrus semistriatus LeConte occurs on flowers of *Eupatorium* and *Solidago* (Asteraceae); taken in the spring by sifting (Blatchley, 1910). Specimens were taken sweeping vegetation on 23 August 2018 in the forest plots in Zone 6.

Stilbus apicalis (Melsheimer) has been taken by sifting in the early spring and by sweeping goldenrod (*Solidago*) and other herbage in summer (Blatchley, 1910). Specimens were taken sweeping vegetation on 11 May 2018 in the field behind Sellman House, on 24 May 2018 along Contee Watershed Trail, and on 6 June 2018 around the pond at the intersection of Contees Wharf and Dock Roads.

Stilbus sp. have little published biological information and there are no identification aids to the 34 described United States species (Steiner, 2002). Specimens were taken sweeping vegetation on 23 April and 30 April 2019 in Zone 6, on 16 May 2019 along Contees Wharf Road, on 17 May 2019 at Frog Haven, at black light on 20 May 2019 at Frog Haven, at black light on 27 May 2019 along Connector Trail between Fox Point Road and Discovery Trail, sweeping vegetation on 26 June 2019 in the fields opposite Sellman House, and in the flowers of *Kosteletzkya virginica* K. Presl. ex. Gray (Malvaceae) on 26 August 2020 along Java History Trail.

Family Silvanidae

Uleiota debilis (LeConte) is found primarily under bark where both adults and larvae probably feed on ascomycete and other fungi (Thomas, 1993, 2002a); it has been recorded from white ash (*Fraxinus americana* L., Oleaceae), and honey locust (*Gleditsia triacanthos* L., Caesalpinaceae) (Majka, 2008). Specimens were taken under bark on 12 April 2019 at the intersection of Back Road and 11-6.

DISCUSSION

The 35 Cucujoidea species collected is lower than expected. This is due to only nine of the 78 (11%) Maryland species of Coccinellidae being found. Of the species collected four (44%) are introduced. The two most common and widespread coccinellid species, *Harmonia axyridis* and *Coccinella septempunctata*, are introduced species. This appears to reflect the general decline in native coccinellid species in the United States due to competition from introduced species (Harmon et al., 2007; Li et al., 2021).

The remaining eight Cucujoidea families are well represented at SERC with 33-100% of the Maryland fauna collected indicating a diverse and robust fauna. There are numerous species which may occur and future inventory work may expand the totals.

ACKNOWLEDGEMENTS

We thank Cha-Chi Fan, Eleanor Cole, Sandy and Luke Nuwar for assistance with field work. Kim Komsatu (SERC) and Kristin Jayd (University of Maryland) for access to the beetle bycatch from their Malaise trap work. Wanda West and the Interlibrary Loan staff at Smithsonian Institution Libraries for their outstanding help in obtaining needed literature.

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