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Occurrence of Treehopper (Hemiptera: Membracidae) Bycatch on Purple Panel Traps and Lindgren Funnel Traps in Pennsylvania, with New State Records

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Abstract

Surveys for invasive insects in Pennsylvania conducted from 2009-2013 captured large numbers of native treehoppers (Hemiptera: Membracidae). These were collected using Lindgren funnel traps and purple prism traps totaling 1,434 specimens in eight tribes, 20 genera, and 57 species. As a result of this work Pennsylvania now has four new published species records: *Heliria gibberata* Ball 1925, *Palonica pyramidata* (Uhler 1877), *Telamona projecta* Butler 1877, and *Telamona westcotti* Goding 1893. With proper site selection Lindgren funnel traps may be able to capture ten to hundreds of treehoppers in a single season, especially within the Smiliinae: Smiliini and Telamonini.

Treehoppers (Hemiptera: Auchenorrhyncha: Membracidae) are phloem-feeding insects whose diversity in the Nearctic was recently treated in a checklist using literature records (Deitz and Wallace 2012). This work produced state-level resolution for the United States and Northern Mexico and places 94 species, one third of the known Nearctic fauna, in Pennsylvania. An additional 36 species were listed in surrounding states (Ohio, New York, New Jersey, Delaware, and Maryland). This diversity is largely tied to the presence and diversity of oak (Fagales: Fagaceae: *Quercus*) in the Eastern United States (Wallace 2008).

Treehoppers are collected commonly by sweeping, beating, malaise traps, yellow sticky cards, and with lights (Mason and Loye 1981, Johnson and Freytag 1997, Wallace and Troyano 2006, Wallace 2008, Wallace and Maloney 2010). Each of these methods contributes a different representation of treehopper fauna by targeting different behaviors and habitats. While yellow sticky cards are most commonly employed for trapping arboreal treehoppers, sweeping and beating are able to yield both arboreal and non-arboreal species. The faunal composition between methods can vary greatly and produce different community compositions as well as age striations.

Treehoppers can also be collected as bycatch in traps designed for insects in other orders. Delta traps, pit fall traps, and others can occasionally yield treehoppers by chance because of the variety of environments they inhabit and localized areas of high abundance (Pers. obs.). Purple panel traps and Lindgren funnel traps, intended for wood-boring beetles such as Cerambycidae, Curculionidae: Scolytinae, and Buprestidae, will also occasionally yield treehopper bycatch. No known publication discusses treehopper diversity in Lindgren funnel traps or purple panel traps. These traps are typically employed in or near trees in exposed light situations similar to treehopper traps such as yellow sticky cards (Wallace and Maloney 2010).

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This paper represents the collection of treehoppers from a variety of survey efforts in Pennsylvania by the Pennsylvania Department of Agriculture (PDA) Division of Entomology from 2009 to 2013. The PDA survey efforts were directed at detecting invasive insect species using Lindgren funnel traps, and purple panel traps, which are not normally associated with treehopper collecting. These records are intended to provide abundance-based data for treehoppers using a nontraditional sampling method, to contribute information on their life history in Pennsylvania, and to update the list of known treehoppers for the state.

Materials and Methods

Panel Traps. Panel traps, also known as prism traps (Coroplast, Dallas TX), are triangular prisms consisting of three panels measuring 19.5 inches long x 14.0 inches wide with exterior sides coated in glue (Francese et al. 2008). The traps used in this study by PDA were either green or purple designed to attract emerald ash borer (EAB) (*Agrilus planipennis* Fairmaire). A Phoebe oil or a Manuka/*Z*-3 Hexenol (Synergy Semiochemicals, Burnaby, British Columbia) combination lure was attached to the trap to mimic stressed trees (Crook and Mastro 2010) and increase trap efficacy.

Panel traps were established across the state in areas at high risk for the spread or presence of EAB such as campgrounds, along major roadways, rest stops, truck pull-offs, ash trafficking sites, near waterways, wood products facilities, and parks (especially those that offered camping). Traps were placed in or adjacent to (if the host tree was inaccessible) *Fraxinus* spp. in full-light situations in the canopy anywhere from 5-40 feet above the ground. In some areas a double-decker configuration was utilized in which two traps were placed vertically on a PVC post anchored to the ground suspending the traps two to five feet above the ground (Poland et al. 2011). Earlier trapping (2009 and 2010) focused on the western and central portions of the state. In 2011 and 2012 traps were shifted eastward to coincide with the leading edge of EAB infestation.

EAB sampling occurred from 2009 to 2012. Each year traps were set out in May and removed in August. Traps were serviced at least twice a year. This timing overlapped with the predicted peak flight of EAB in Pennsylvania. All specimens were placed into 100% ethanol immediately after removal from the trap. Specimens were later soaked in a solvent, Histoclear (Electron Microscopy Sciences, Hatfield, PA), for 24 hours to remove glue residue. After soaking, samples were returned to 90% ethanol.

Funnel Traps. Twelve-unit Lindgren funnel traps (Lindgren 1983) were used to specifically target EAB as well as an additional suite of agricultural pests particularly Curculionidae, Cerambycidae, Bostrichidae, and Buprestidae. Funnels were black, purple, or green, coated in Fluon PTFE (AGC Chemicals Americas, Inc. Exton, PA) to increase trap efficacy, and fitted with collection cups filled with propylene glycol antifreeze (Sierra, Northbrook, IL). Trap color was determined by the targeted pest, with green and purple used for EAB. Black funnels were used for the Cooperative Agricultural Pest Surveys (CAPS) targets.

Lindgren funnel traps targeting EAB were hung from ash trees high in the canopy in full light and were baited with Manuka oil/*Z*-3 Hexenol or *Z*-3 Hexenol/3-*Z* Lactone (Synergy Semiochemicals, Burnaby, B.C.). These traps were deployed in 2010 through 2012 and were set out in May and removed in August. Lindgren funnel traps used for CAPS taxa were placed at facilities at high risk for invasive pest introductions and detections. High-risk sites include locations where international products were stored, previous detection of regulatory pests, industrial areas, or locations at which dunnage and woody debris were stored or destroyed. Trapping sites were scattered across the state in 12 counties, with the selected counties changing from year to year. Traps at these locations were hung 2-10 feet above the ground in open light on suitable vertical structures or, preferably, in woodland edges. When matching tree species were available they were selected to match the host preference of the targeted pests; many of the listed lures call for oak trees as the host. Lures used were: ethanol (Science Lab, Houston, TX), reagent isopropyl alcohol, *Scolytus* lure (Curculionidae: Scolytinae) (Synergy Semiochemicals, Burnaby, B.C.), Manuka oil (Synergy Semiochemicals, Burnaby, B.C.), *Sirex* lure (Siricidae) (Contech Enterprises, Victoria, B.C.), *Pityophthrous* lure (Curculionidae: Scolytinae) (Contech Enterprises), *Ips* lure (Curculionidae: Scolytinae) (Chemtica, Durant, OK), Quercivorol lure (Platypodidae) (Contech Enterprises, Victoria, B.C.), Lineatin lure (Curculionidae: Scolytinae) (Contech Enterprises), and pheromone blends for Cerambycidae.

CAPS traps in 2009-2013 were hung from April to September, with some traps being removed as late as October in 2013. Trap sampling for Lindgren funnels occurred every two weeks as well as a final collection during trap removal. Collection cup contents were strained and placed into 100% alcohol until sorted.

Identification. All adult treehoppers were extracted, identified to species when possible, and curated into PDA's collection (PADA) (Arnett et al. 1993). Only reliably identified specimens were tabulated; as a result nymphs, some females, cryptic species, and damaged specimens of some taxa were not included in the analysis. The genus *Stictocephala* Stal was excluded due to the difficulty in identifying species. Specimens were identified by comparison to materials in the PADA collection and with published descriptions and illustrations (notably Kopp and Yonke 1973a, b, c, 1974; Wallace 2008, Wallace 2015). Several identifications were also confirmed by Dr. Matthew S. Wallace of East Stroudsburg University and by Mark Rothschild, Research Associate, Florida State Arthropod Collection.

Results

Three subfamilies, 8 tribes, 20 genera, and 57 species of treehoppers were represented (Table 1). The subfamily Stegaspidinae was represented by a single tribe, Microcentrini, with one genus and two species. Total collections for Stegaspidinae totaled less than 1% of all captures. Within the Membracinae, two tribes, three genera, and three species were collected. Collections

Table 1. An analysis of diversity by subfamily and tribe. Three subfamilies and eight tribes of Membracidae were collected between 2009 and 2013 in surveys using purple panel traps and Lindgren funnels. Specimen count is the number of individuals captured using both methods within that tribe.

	Genera	Species	Specimen Count
Stegaspdinae			
Microcentrini	1	2	15
Membracinae			
Holophorionini	1	1	158
Membracini	2	2	87
Smiliinae			
Amastrini	1	1	172
Micrutalini	1	1	12
Polyglyptini	2	2	162
Smiliini	5	22	174
Telamonini	7	26	654

for Membracinae totaled 17% of all captures. Smiliinae contained five tribes (Amastrini, Micrutalini, Polyglyptini, Smiliini, and Telamonini) and 16 genera, and 52 species, making it the most diverse and abundant with 81% of the collected specimens.

A total of 1,434 treehopper specimens met the criteria for identification and examination. Of those, 1,200 (84%) were from Lindgren funnel traps and 234 (16%) were from panel traps. Of the 57 species collected, 50 were collected in funnel traps and 36 from panel traps, with 32 species collected from both. Funnel traps yielded 21 unique species and panel traps yielded 4. From the 1,169 collection events, singleton (83%) and doubleton (9%) captures of a species were the most common. Collections events of 3-9 individuals of a single species were collected only 7% of the time, and double-digit collections (10+) occurred at 1% frequency.

Species captured are summarized by order and family along with their authority names in Table 2. *Telamona ampelopsidis* was the most numerous species (212 specimens, 15% of the total), followed by *Vanduzea arquata* (172, 12%), *Platycotis vittata* (158, 11%), *Entylia carinata* (156, 11%), and *Thelia bimaculata* (146, 10%). When sorted by generic abundance, the order follows the species trend (*Telamona*, *Vanduzea*, *Platycotis*, *Entylia,* and *Thelia*). *Telamona*, as the only non-monotypic genus, is the only genus to increase its total percentage, from 15% to 24% (347 specimens).

The most numerous captures for Lindgren funnel traps were similar to the overall abundance (combined trapping) with *Telamona ampelopsidis* (169 specimens), *Platycotis vittata* (153), *Entylia carinata* (149), *Vanduzea arquata* (131), and *Thelia bimaculata* (129). All other Lindgren funnel trap collections had total specimens counts of 71 or fewer. The two largest catches for panel traps were *V. arquata* (41 specimens) *and Telamona ampelopsidis* (43). All other species collected on panel traps had total specimen counts of 10 or fewer.

The earliest record was April 16 for *Platycotis vittata* and the latest was September 27 for *Telamona reclivata*. Peak diversity and abundance values were greatest during June and July. July had the highest abundance and diversity with 48 species and 515 specimens, encompassing all but 9 of the species recorded. June had diversity and abundance values of 45 species and 351 specimens respectively. The remaining months results were April (3 species, 30 specimens), May (10, 120), August (35, 207), and September (22, 112).

New State Records. Four new state records for Pennsylvania were also collected during the 5 years of survey: *Heliria gibberata* Ball 1925, *Telamona projecta* Butler 1877 (currently valid name for species in the eastern U.S. historically identified as *Helonica excelsa* Fairmaire; Wallace 2014), *Palonica pyramidata* (Uhler 1877), and *Telamona westcotti* Goding 1893. All four new state records are species in the tribe Telamonini.

Information from specimen labels was edited for style and consistency. Line breaks on labels are indicated by "/". Determination label text was not recorded.

Heliria gibberata, which has been collected on common hackberry (*Celtis occidentalis*) (nymphs have only been found on hackberry), American hornbeam (*Carpinus caroliniana*), and white oak (*Quercus alba*) (Dietrich et al 1999) was found only in the southeastern counties of Northampton, Schuylkill, and Dauphin. The adjacent records from New Jersey, Maryland, and Delaware also support the concept of this species range (Deitz and Wallace 2012).

Heliria gibberata Ball 1925. USA: PA: Northampton Co. / 1772 Rt 512 / 40.89737343°N -75.13266989°W / 18 July 2011 / Coll. Serson, William / PAD: 6211 (1♂); USA: PA: Schuylkill Co. / Goodspring-5 / 40.62975°N -76.46232°W / 11 August 2011 / Coll. Najda, Karen / PDA: 6214 (1♂); USA: PA: Dauphin

Table 2. Collection method, trapping occurrence ranges, and abundance of treehoppers collected throughout Pennsylvania in 2009-2013. A check (X) in the column for Lindgren Funnel or Panel Trap indicates that at least one specimen was collected by that trap type. The earliest and latest records columns are the earliest and latest date the species were collected. The month columns denote how many individuals were collected in the month with numbers left of the slash (/) from Lindgren funnels, numbers right of the slash (/) from panel traps, and a dash (-) indicated none collected.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
STEGASPIDINAE										
Microcentrini										
Microcentrus caryae (Fitch)	x		July 24	Sept 26				1/-	7/-	3/-
Microcentrus perditus (Amyot & Serville)	x		May 31	July 13		1/-	2/-	1/-		
MEMBRACINAE										
Holophorionini										
Platycotis vittata (Fabricius)	x	x	April 16	September 20	24/-	3/-	20/2	67/-	37/3	2/-
Membracini										
Campylenchia latipes (Say)	x	x	July 13	September 13				4/1	1/1	1/-
Enchenopa binotata (Say)	x	x	June 20	September 26			9/-	50/2	11/-	7/-
SMILIINAE										
Amastrini										
Vanduzea arquata(Say)	x	x	June 13	September 21			15/38	10/2	31/1	75/-

Table 2. Continued.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
Micrutalini										
Micrutalis calva (Say)	x	x	June 12	September 19			4/-	3/2	1/1	1/-
Polyglyptini										
Entylia carinata (Forster)	x	x	April 17	August 20	5/-	95/4	12/-	14/3	23/-	
Publilia concava (Say)	x	x	May 3	July 8		5/-		-/1		
Smiliini										
Atymna helena (Woodruff)	x		June 14	June 20			2/-			
Atymna querci (Fitch)	x	x	May 22	August 7		1/-	7/3	-/1	-/1	
Cyrtolobus arcuatus (Emmons)	x		August 26	August 26					1/-	
Cyrtolobus discoidalis (Emmons)	x	x	June 29	June 30			1/1			
Cyrtolobus dixianus Woodruff		x	June 24	August 11			-/1		-/1	
Cyrtolobus fenestrus (Fitch)	x	x	June 4	July 16			1/-	-/2		
Cyrtolobus fuscipennis Van Duzee	x		June 8	August 30			12/-	4/-	3/-	
Cyrtolobus griseus Van Duzee	x		June 14	August 6			14/-	4/-	1/-	

Table 2. Continued.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
Cyrtolobus maculifrontis (Emmons)	x		June 1	September 19			2/-			1/-
Cyrtolobus pallidifrontis (Emmons)	x	x	June 14	August 24			7/4	1/-	1/1	
Cyrtolobus puritanus Woodruff	x		June 15	June 15			1/-			
Cyrtolobus tuberosus (Fairmaire)		x	July 7	July 28				-/2		
Cyrtolobus vau (Say)	x	x	May 28	September 18		2/2	5/1	2/2	-/3	1/-
Ophiderma definita Woodruff	x	x	May 29	August 20		1/1	10/7		1/1	
Ophiderma flava Goding	x	x	May 30	August 17		2/-	1/-	2/1	-/1	
Ophiderma flavicephala Goding	x	x	June 14	September 7			2/-	-/1		1/-
Ophiderma pubescens (Emmons)	x	x	April 18	September 7	1/-		2/2	1/4	1/-	1/-
Ophiderma salamandra Fairmaire	x	x	June 11	August 4			1/1	1/3	-/1	
Smilia camelus (Fabricius)	x	x	June 2	August 11			1/2	1/4	-/1	
Xantholobus intermedius (Emmons)	x		June 8	September 9			4/-			1/-

Table 2. Continued.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
Xantholobus lateralis (Van Duzee)		x	July 8	July 10				-/2		
Xantholobus muticus (Fabricius)	x	x	May 16	July 14		3/-	3/-	1/1		
Telamonini										
Archasia belfragei (Fairmaire)	x	x	June 24	August 21			6/-	9/7	2/3	
Archasia pallida (Fairmaire)	x		June 24	August 14			2/-		2/-	
Carynota mera (Say)	x	x	June 21	September 18			8/-	35/4	6/1	2/2
Glossonotus acuminatus (Fabricius)	x	x	June 12	September 6			5/-	3/1	5/1	1/-
Glossonotus crataegi (Fitch)	x	x	July 6	August 13				5/-	-/2	
Glossonotus univittatus (Harris)	x		June 14	August 6			3/-	2/-	2/-	
Heliria cristata (Fairmaire)	x	x	June 14	September 19			5/-	2/1	1/1	1/-
Heliria fitchi Ball	x	x	June 18	September 24			2/1	1/4		1/-
Heliria gibberata Ball	x		July 6	September 6				1/-	2/-	
Heliria scalaris (Fairmaire)	x		June 29	August 16			1/-	4/-	3/-	

Table 2. Continued.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
Palonica pyramidata (Uhler)	x		June 26	September 18			1/-	3/-		
Telamona ampelopsidis (Harris)	x	x	June 6	September 26			42/9	100/9	23/21	4/4
Telamona collina (Walker)	x		July 13	September 21				1/-		1/-
Telamona compacta Ball	x	x	July 8	July 22				1/2		
Telamona concava Fitch	x	x	June 21	July 11			1/-	1/1		
Telamona decorata Ball	x	x	June 11	September 24			14/-	10/3		1/-
Telamona excelsa Fitch	x	x	June 12	August 23			7/-	4/4	2/-	
Telamona extrema Ball	x		Jun3 27	July 13			1/-	1/-		
Telamona maculata Van Duzee	x		June 13	September 18			1/-	3/-		1/-
Telamona monticola (Fabricius)	x	x	May 30	September 21		1/-	22/-	9/7	1/1	4/-
Telamona projecta Butler	x	x	July 7	July 24				4/2		
Telamona reclivata (Fitch)	x	x	July 6	September 27				9/1	-/1	3/-

Table 2. Continued.

	Lindgren Funnel	Panel Trap	Earliest Record	Latest Record	April	May	June	July	Aug.	Sep.
Telamona tiliae Ball		x	June 25	August 3			-/1	-/1	-/1	
Telamona tristis Fitch	x		June 22	July 12			1/-	4/-		
Telamona westcotti Goding	x	x	June 15	August 9			2/1	4/1	1/-	
Thelia bimaculata Fabricius	x	x	June 27	September 26			15/-	42/8	35/9	37/-

Co. / Wildwood / 40.30734183°N -76.88606815°W / 10 August 2011 / Coll. Miller, Emily / PDA: 6209 (1♂).

Palonica pyramidata, which has been collected on willows (*Salix* spp.), red maple (*Acer rubrum*), oaks (*Quercus spp.*) and others (Kopp and Yonke 1974, Wallace 2014) was collected from Bradford and Bedford Counties. The records adjoin a discontinuous distribution of Delaware, Maryland, New Jersey, and New York (Deitz and Wallace 2012).

Palonica pyrimidata (Uhler 1877). USA: PA: Bradford co. / Oak Hill Veneer / 41.81719°N -76.79819°W / 26 July 2012 / Col. Malak, Rick / PDA: 6219 (1♀); USA: PA: Bradford co. / Oak Hill Veneer / 41.81719°N -76.79819°W / 26 July 2012 . Col. Malak, Rick / PDA: 6220 (1♀); USA: PA: Bradford co. / Oak Hill Veneer / 41.81719°N -76.79819°W / 13 July 2012 / Col. Malak, Rick / PDA: 6217 (1♂); USA: PA: Bedford Co. / Bedford Pallet – trap 7 / 40.081386°N -78.521647°W / 26 June 2013 / Col. N. Delp / Lindgren Funnel Trap / PDA: 7310 (1♂).

Telamona projecta, which has been collected on wild grape (*Vitis* sp.) and a variety of oaks (nymphs have been reared from white and black oak; Wallace 2014), has a wide distribution stretching across Pennsylvania (Kopp and Yonke 1974, Wallace 2014). The Monroe county record collaborates with nymphal collection records in Wallace 2014. This species is also known from DE, MD, NJ, and NY (Deitz and Wallace 2012; as *Helonica excelsa* Fairmaire).

Telamona projecta 1877. USA: PA: Mifflin Co. / Bald Eagle SF 2 / 40.731835°N -77.636451°W / 06 July 2011 / Coll. Fulton, Liz / PDA: 6230 (1♂); USA: PA: Mifflin Co. / Bald Eagle SF 2 / 40.731635°N -77.363775°W / 19 July 2012 / Coll. Fulton, Liz / PDA 6232 (1♀); USA: PA: Union Co. / Centennial road 2 / 40.987302°N -77.035238°W / 07 July 2011 / Coll. Fulton, Liz / PDA: 6231 (1♂); USA: PA: Clarion Co. / 579 Huefner Spring Road / 41.31515°N -79.42321°W / 24 July 2009 / Coll. M. Mcdonald / Purple Panel Trap / PDA: 3893 (1♀); USA: PA: Monroe Co. / SnowHillRd+StonyRunRd / 41.455895°N -75.203953°W / 09 July 2012 / Col. Mislinski, Danielle / PDA: 6229 (1♀); USA: PA: Beaver Co. / Raccoon Creek Sp (Site 5) / 40.52073°N -80.43826°W / 08 July 2009 / Coll. L. Wheatall / Green Panel Trap / PDA: 3945 (1♂).

Telamona westcotti, which has been collected on *Quercus spp.* (nymphs observed on white and burk oak; Wallace 2014), basswood (*Tilia spp.)*, and elm (*Ulmus spp.)* (Deitrich et al 1999, Wallace 2014), has a wide, centrally distributed range in Montgomery, Northumberland, Juniata, Snyder and Alleghany counties. These records fill in a gap in range with the adjoining states of Ohio, New York, Maryland, Delaware (Deitz and Wallace 2012).

Telamona westcotti Goding 1893: USA: PA: Montgomery Co. / Horsham Community Center / 40.20619°N -75.18005°W / 12 July 2013 / Coll. J. Shannon / Lindgren Funnel Trap / PDA: 7206 (1 ♂); USA: PA: Northumberland Co. / Cleveland Bros. 3 / 41.125675°N -76.801988°W / 08 July 2013 / Coll. K. Carey / Lindgren funnel trap / PDA: 7209 (1 ♂); USA: PA: Northumberland Co. / Cleveland Bros. 3 /41.125675°N -76.801988°W / 09 August 2013 / Coll. K. Carey / Lindgren funnel trap / PDA: 7203 (1 ♂); USA: PA: Northumberland Co. / Cleveland Bros. 3 /41.125675°N -76.801988°W / 22 July 2013 / Coll. K. Carey / Lindgren funnel trap / PDA: 7208 (1 ♂); USA: PA: Northumberland Co. / Cleveland Bros. 4 / 41.125821°N -76.80221°W / 25 June 2013 / Coll. K. Carey / Lindgren funnel trap / PDA: 7207 (1 ♂); USA: PA: Juniata Co. / Train Crossing / 40.543343°N -77.26136°W / 26 July 2012 / Coll. Queen, Julie / PDA: 6406 (1 ♂); USA: PA: Juniata Co. / Rt 333, Hawstone / 40.596886°N -77.493653°W / 19 July 2011 / Coll. Fulton, Liz / PDA: 6409 (1 ♂); USA: PA: Snyder Co. / Pull off / 40.77387°N -77.12412°W / 27 June 2012 / Coll. Queen, Julie / PDA: 6408 (1 ♂); USA: PA: Allegheny Co. / Diamondmulch-4 / 40.56605°N -79.85602°W / 15 June 2012 / Coll. Heinze, Kristen / PDA: 6407 (1 ♂).

Discussion

Although designed to attract wood boring beetles (Lindgren 1983), non-traditional collecting methods for treehoppers captured a large diversity of membracids in Pennsylvania. The factors that influenced these successful collections are unclear. While described in the materials, the lures that accompanied these traps were not examined as an attractant. The mechanical aspects and physical locations of both trap types were likely mechanisms for capture which has been shown to be an important factor when targeting wood-boring beetles (Graham et al. 2012, McIntosh et al. 2001). It is probable that the presentation of a strong visual profile, large trapping surface, and flight interception properties are greater factors than chemical attractants. Trapping efforts in the Delaware Water Gap and Long Pond, PA, for example, used lure-less traps with great success (Wallace 2008, Wallace and Troyano 2006, Wallace and Maloney 2010).

Color preference, however, does play a role in treehopper collection. Yellow is the predominant choice for the collection of certain hemipterans, particularly aphids, treehoppers, and leafhoppers (Mason and Loye 1981, Johnson and Mueller 1988, Johnson and Freytag 1997, Wallace and Maloney 2010). The attractiveness of yellow has been examined in treehoppers using *Spissistilus fenstinus* (Say) as a model; this indicated that treehoppers preferred yellow significantly over other colors. The particular shade of purple used for EAB traps, however, was not tested in this way. It is unclear whether the bycatch was due to color or chance proximity to host trees. Although specimens collected in Lindgren funnel traps and on panel traps cannot accurately indicate a host, they may be used as an indicator of association as is typically done with sticky card surveys.

The presence of the two most common species on panel traps can only be partially explained. The host plant of *Telamona ampelopsidis*, Virginia Creeper (*Parthenocissus quinquefolia*), is a common vine across Pennsylvania and grows in many habitats and in a diverse array of trees including *Fraxinus* spp. (Claire Ciafré, Pers. comm.). The *Vanduzea arquata* count can be partly explained by proximity of the suitable host trees, Black Locust (*Robinia pseudoacacia*), and that this species has multiple generations in a year. While *T. ampelopsidis* peaked in abundance in July, *V. arquata* had peaks in June and September.

The duration of surveys conducted by PDA also extended the timeframe that treehoppers are generally collected in studies. Other recent survey efforts in Pennsylvania started in May (Wallace and Troyano 2006, Wallace 2008, Wallace and Maloney 2010) and therefore miss the April records for species such as *Platycotis vittata*, *Entylia carinata*, and *Ophiderma pubescens* (although these studies focused on Smiliini and Telamonini, unavailable until late May in PA). Data from these works demonstrated that June and July are the key months to collect treehoppers for both abundance and diversity (Mason and Loye 1981, Wallace and Troyano 2006, Wallace 2008, Wallace and Maloney 2010). PDA's survey's with Lindgren funnels and panel traps followed these same trends. The extensions of the collecting efforts into October yielded notable records. These include a late surge in abundance of *Vanduzea arquata* as well as *Enchenopa binotata* and *Thelia bimaculata*. Late season *V. arquata* collections concur with Funkhouser's (1915) description of the biology of this species in New York as having four generations per year. The late season occurrence for *E. binotata* into October and the large numbers of *T. bimaculata* are both consistent with Missouri records which share a similar climate (Kopp and Yonke 1973a, 1974). However the low diversity in October collections does not strongly support extending the collections into October or later months.

Lindgren funnel traps have two advantages over other traps: the propylene glycol in the collection cup allows for less frequent collection with a lower risk of deterioration and the structure of the trap protects against bird predation (as documented in Wallace and Maloney 2010) by limiting specimen visibility and accessibility. Trapping treehoppers with Lindgren funnel traps may be a valuable tool, especially with collection of species within Smiliinae: Telamonini. All four state records were within this tribe as well as two of the more abundantly collected species, *Telamona ampelopsidis* and *Thelia bimaculata*. With proper site selection each Lindgren funnel trap may be able to capture tens to hundreds of treehoppers in a single season.

Purple panel traps, however, do not show much promise as method to collect treehoppers. Comparatively low counts (234 on panel traps vs. 1200 in funnel traps), specimen damage from bird predation and removal from the trap, and the necessity of more frequent trap monitoring make them a more labor intensive choice. Specimens were also more frequently damaged and unusable. Additionally, panel traps only captured four unique species, *Cyrtolobus dixianus, Cyrtolobus tuberosus, Xantholobus lateralis,* and *Telamona tiliae*, compared to the Lindgren funnel traps' 21 unique species.

In an age where funding for research can be difficult to obtain, using bycatch to stretch resources is both practical and valuable. For treehoppers, using bycatch from nonconventional trapping methods, particularly Lindgren funnel traps, can be a valuable tool for extending the collection season, discovering new distribution records, enhancing host associate information, and capturing a high proportion of usable specimens using existing infrastructure. The further elucidation of why treehoppers are captured by these methods, and whether lure type plays a part, would be helpful to increase further the efficiency and usefulness of nonconventional trapping of treehoppers. Lure may also be a potential tool to supplement catch rates of traditional capture methods.

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