Aquatic Insects
International Journal of Freshwater Entomology

ISSN: 0165-0424 (Print) 1744-4152 (Online) Journal homepage: https://www.tandfonline.com/loi/naqi20

A comparison of aquatic and semiaquatic Heteroptera (Hemiptera) inhabiting natural habitats and experimental mesocosms at the University of Mississippi Field Station

Matthew R. Pintar & William J. Resetarits Jr

To cite this article: Matthew R. Pintar & William J. Resetarits Jr (2020) A comparison of aquatic and semiaquatic Heteroptera (Hemiptera) inhabiting natural habitats and experimental mesocosms at the University of Mississippi Field Station, Aquatic Insects, 41:1, 76-84, DOI: 10.1080/01650424.2019.1710539

To link to this article: https://doi.org/10.1080/01650424.2019.1710539

AQUATIC INSECTS
2020, VOL. 41, NO. 1, 76–84
https://doi.org/10.1080/01650424.2019.1710539

Taylor & Francis
Taylor & Francis Group

A comparison of aquatic and semiaquatic Heteroptera (Hemiptera) inhabiting natural habitats and experimental mesocosms at the University of Mississippi Field Station

Matthew R. Pintar and William J. Resetarits Jr

Department of Biology and Centers for Water and Wetlands Resources, and Conservation and Biodiversity Research, University of Mississippi, University, Mississippi, USA

ABSTRACT

Aquatic and semiaquatic Heteroptera (Hemiptera) in the infraorders Gerromorpha and Nepomorpha were collected from the University of Mississippi Field Station (UMFS) in north-central Mississippi from May 2014 until August 2019. UMFS encompasses over 200 ponds, springs, wetlands, and streams in the headwaters of the Little Tallahatchie River. We collected insects from mesocosm experiments and natural water bodies in order to survey and document the aquatic and semiaquatic Heteroptera of UMFS. A total of 20,304 individuals were collected representing 43 species in 20 genera and 10 families (Belostomatidae, Corixidae, Gerridae, Hebridae, Hydrometridae, Mesoveliidae, Naucoridae, Nepidae, Notonectidae, Veliidae). We compare mesocosms and natural water bodies in terms of species present and their abundances, and we also provide notes on the abundance, distribution, and habitats of some species, with new state records for three species.

ARTICLE HISTORY
Received 1 September 2019
Accepted 23 December 2019
First published online
30 January 2020

KEYWORDS
biodiversity; freshwater macroinvertebrates; Gerromorpha; Nepomorpha; Mississippi

Introduction

The University of Mississippi Field Station (UMFS; 34°25′N, 89°23′W; Figure 1) is situated on the Interior Gulf Coastal Plain in Lafayette County near Oxford in north-central, Mississippi. UMFS covers 318 ha west of Holly Springs National Forest at elevations ranging from over 170 m in upland areas along the western and northern boundaries down to 118 m on Bay Springs Branch at the eastern boundary. UMFS is located in the headwaters of the Little Tallahatchie River, one of the largest rivers in the Yazoo River watershed within the lower Mississippi River basin. Bay Springs Branch (Figure 2a) and its first to second order tributaries drain the majority of UMFS, forming shallow valleys, and the numerous springs provide a perennial water supply for many of the streams and some of the over 200 ponds that fill the valleys (Figure 2b). Soils are mostly sand and sandy-loam, and fields occur mainly in upland areas, although areas around ponds are also primarily grasses. Forests are dominated

CONTACT Matthew R. Pintar matthew.pintar@gmail.com
Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/naqi.

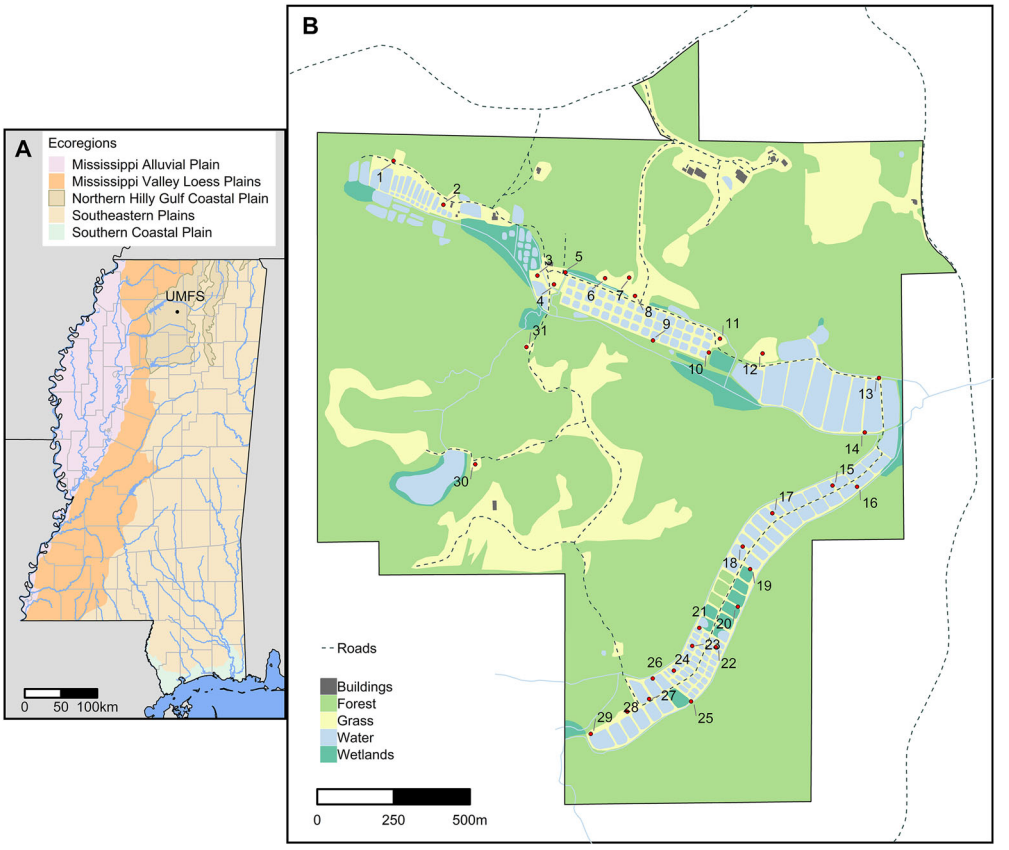

Figure 1. (a) Map of Mississippi displaying the location of UMFS, the major rivers of the state, county borders, and state's four level III ecoregions, with the Northern Hilly Gulf Coastal Plain (level IV ecoregion) emphasised within the Southeastern Plains. (b) Map of UMFS showing facility boundary, roads, dominant land cover, streams, and numbered locations of mesocosm sites.

by *Pinus* L. and *Quercus* L. in upland areas and *Acer rubrum* L. and *Liquidambar styraciflua* L. in lowland areas. The ponds, which range in area from 0.01 to 1.9 ha, vary in depth, hydroperiod, and fish assemblages, among other characteristics. Most of the ponds were originally constructed as a part of a fish hatchery that opened in 1947 and raised primarily *Carassius auratus* (L., 1758) and *Notemigonus crysoleucas* (Mitchill, 1814). The hatchery operated until the early 1980s, the land was acquired by the University of Mississippi in 1985, and UMFS was established in 1986, while one additional pond and 91 ha of UMFS were originally part of a cattle farm. Some streams were rerouted from their natural course to both sides of the valleys during construction of the original ponds. Seven of the original ponds were converted to forty-five 400-m^2 experimental ponds in 1990–1991 (Knight 1996).

Located within the Northern Hilly Gulf Coastal Plain level IV ecoregion (Figure 1a; Omernik 1987; Omernik and Griffith 2014), UMFS is part of the North American Coastal Plain, a recently recognised biodiversity hotspot (Noss et al. 2015). At UMFS, there are records of 345 species of vascular plants, 132 aquatic beetles, 55 butterflies, 40 mammals (8 additional species from Lafayette County), 26 fish, 25 snakes, 15

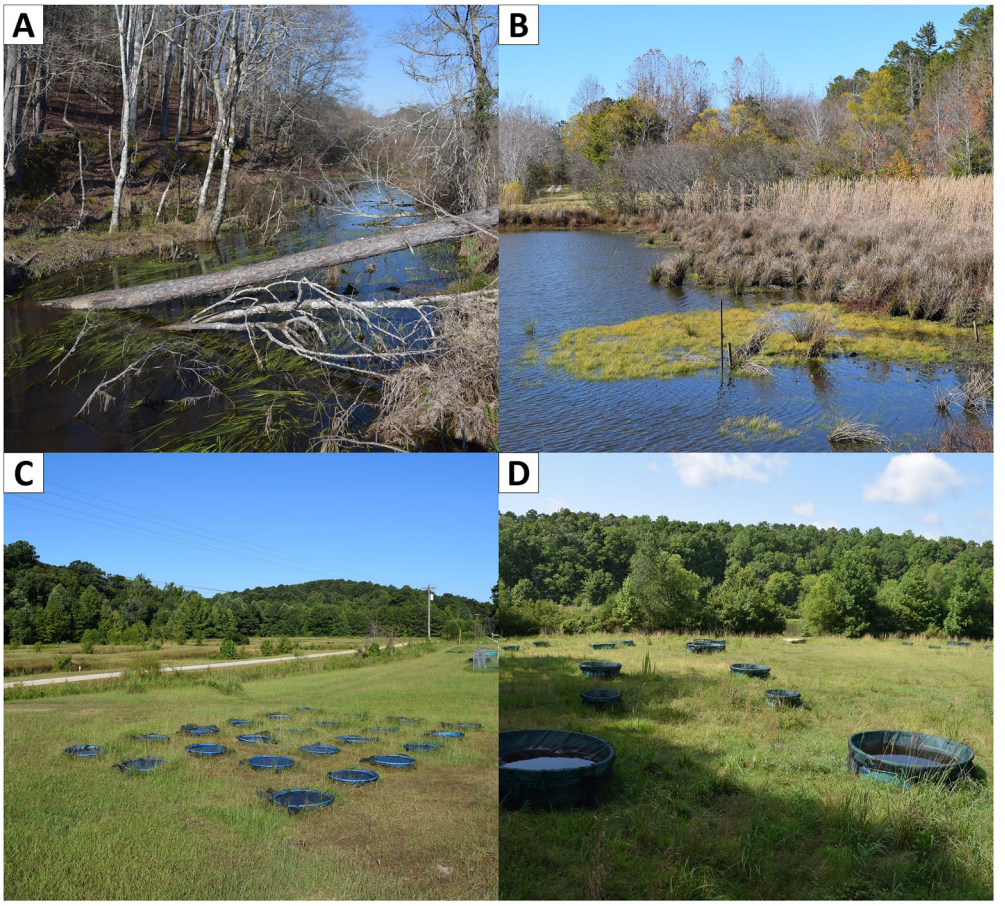

Figure 2. Examples of collection sites at UMFS: (a) Bay Springs Branch in March 2018; (b) pond #98 in December 2016; (c) 110 L mesocosms at site 8 in July 2015 (with ponds in the background past the road); and (d) 590, 1330, and 3100 L mesocosms at site 12 in July 2016 (see Figure 1 for sites).

frogs, 12 salamanders, 10 turtles, and 9 lizards (Keiser 1999, 2001, 2008, 2010, 2014; King, McBride, and Lago 2002; Menon and Holland 2012; Pintar and Resetarits in press), but other taxa have not been assessed.

Freshwater ecosystems cover only 0.8% of Earth's surface and account for only 0.1% of Earth's water, but are home to 9.5% of all described animal species, 60% of which are aquatic insects (Dudgeon et al. 2006; Balian, Segers, Lévèque, and Martens 2008). Globally, there are over 4500 species in 19 families in the insect infraorders Nepomorpha and Gerromorpha, with 353 species in the Nearctic Region (Polhemus and Polhemus 2007). In the southeastern United States, freshwater ecosystems have particularly high levels of biodiversity and endemism (Abell 2000; Elkins et al. 2019). However, much of the diversity in freshwater systems remains poorly geographically documented or taxonomically undescribed. Improving our knowledge of freshwater biodiversity at numerous scales is important for understanding and documenting freshwater systems in a changing world (Balian et al. 2008; Strayer and Dudgeon 2010).

Aquatic insects are major components of freshwater communities, particularly in ephemeral and fishless habitats (Maguire 1963; Schneider and Frost 1996). Many species are strong dispersers and colonise experimental mesocosms, which makes them useful for studying ecological questions (Binckley and Resetarits 2005, 2007). Wilson (1958) previously documented the aquatic and semiaquatic Hemiptera of Mississippi, with one additional state record later documented by Lago and Testa (1989), for a total of 133 species, including those in the infraorder Leptopodomorpha, which we did not collect. Here, we summarise the aquatic and semiaquatic Heteroptera of UMFS by presenting collection data from five years of mesocosm experiments and pond and stream sampling.

Material and methods

Mesocosms were used to collect insects from natural populations dispersing across the landscape as part of various experiments at UMFS (Figure 2c, d) (e.g., Resetarits, Pintar, Bohenek, and Breech 2019). Sizes of cylindrical mesocosms ranged from plastic wading pools (0.85 m diameter, 0.18 m deep, 70 L) to large plastic cattle watering tanks (2.7 m diameter, 0.74 m deep, 3100 L). Mesocosms in all except one experiment were covered with screen lids (1.3 × 1.13 mm opening) that were depressed below the water to separate insects from the rest of the mesocosm and allow for efficient collection. All mesocosms included some form of leaf litter as a nutrient base that varied by experiment. Insects were typically collected once per week, although some experiments had shorter or longer collection intervals. Fine mesh nets were used to exhaustively remove all colonists from above mesocosm screens. Mesocosm collecting began on 8 May 2014, lasted until 21 August 2019, and occurred every week year-round, with the exception of some weeks in winter when mesocosms were frozen. Mesocosms were situated in terrestrial habitats, usually in grassy areas (old fields and mowed grass), all within 70 m of the nearest water body. We also sampled non-mesocosm aquatic habitats (streams, ponds, etc.) at UMFS with standard D-frame nets from 22 January 2019 until 30 August 2019. Of the 122 non-mesocosm sites sampled, 12 were lotic and 110 were lentic (1 one-person 20-minute sampling event per site); 114 of the sites were sampled between 22 April and 18 July, within the period of peak adult insect activity at UMFS. Collection efforts focused on lentic habitats as there are many more discrete lentic patches that cover a much larger area than lotic habitats at UMFS.

All specimens were preserved in 70+% ethanol. Because the aim of most of our experiments was to assess colonization, and insects arrived from other habitats via aerial dispersal, the majority of individuals collected were winged adults. This limited our ability to identify *Microvelia* Westwood, 1834, for which keys are only for wingless adults. Due to extremely high abundances, particularly later in summer, we often did not sort and count *Microvelia* from many samples. Taxa without keys to females (particularly *Buenoa* Kirkaldy, 1904 and *Sigara* Fabricius, 1775) further limited species identifications, and some *Hesperocorixa* Kirkaldy, 1908 were not always identified to species due to similarity among species and high abundances. Otherwise, we aimed to identify insects to species, and we definitively identified some individuals of all

species within aggregate genera groups listed here (see Table 1). Identifications were primarily based on Epler (2006), with Hungerford (1948) referred to often for Corixidae and numerous additional sources consulted when necessary. Voucher specimens were deposited in the Mississippi Entomological Museum, with a reference collection remaining at UMFS. All remaining insects are in the collection of M.R. Pintar, who is responsible for all identifications.

Results and discussion

A total of 20,304 individuals were collected representing 43 species in 20 genera and 10 families (Table 1). There were 19,758 individuals of 24 taxa from mesocosms and 546 individuals of 28 taxa from pond/stream sampling. Mesocosm sites are mapped on Figure 1b, and pond/stream sampling was conducted in many of the ponds/streams mapped on Figure 1b. We had 11,841 unique mesocosm samples taken on 419 different days and 122 pond/stream samples taken on 28 different days.

Several of our mesocosm experiments had low abundances of hemipterans, which were sometimes excluded, and therefore only have published results for beetles (e.g., Pintar and Resetarits 2017a; b, among others), but are included in our totals here. An experiment eventually determined that a major factor influencing colonization of insects is patch size, with hemipterans (at least those taxa present in the experiment) universally colonising larger patches (Resetarits et al. 2019). This preference for larger patches has likely played an important role in generating not only the often-lower abundances of hemipterans from experiments using smaller mesocosms, but also their overall use of mesocosms of all sizes.

We collected 11 species during our pond/stream sampling that were not found in mesocosms, despite considerably greater sampling effort across multiple years from mesocosms. Other studies of the aquatic and semiaquatic Hemiptera in Mississippi (Penn and Ellis 1949; Wilson 1958) and known distributions of many taxa (Hungerford 1948; Smith and Polhemus 1978; Dunn 1979; Sites and Polhemus 1994) indicate there could perhaps be more than twice as many species present at UMFS. However, given the typical asymptotic nature of species accumulation curves, we expect it would require much more intensive sampling of ponds/streams over a longer time period (potentially years) to accumulate all species found within this region. Nevertheless, we expect that we captured all of the common species present at UMFS. Excluding *Microvelia*, specimens collected from mesocosms are dominated by a few abundant species, with most others being quite uncommon. In particular, *Notonecta irrorata* Uhler, 1979 was the dominant species of *Notonecta* L., 1758 in mesocosms, while *B. scimitra* Bare, 1925 was the only male *Buenoa* recorded from mesocosms. Out of 31 *Buenoa* males collected from ponds, 18 were *B. scimitra* and 13 were *B. confusa* Truxal, 1953. Similarly, *Limnoporus canaliculatus* (Say, 1832) was the dominant gerrid in mesocosms and *S. pectenata* (Abbott, 1913) the dominant *Sigara* overall. Using mesocosms for assessing the diversity of aquatic and semiaquatic Hemiptera appears to be inefficient and far less effective than for aquatic beetles (Pintar and Resetarits in press), although mesocosms remain effective for testing ecological questions with those taxa that colonise them.

Table 1. List of the 43 species collected at UMFS. Specimens are the number of adult individuals collected from mesocosm experiments (M) and sampling of ponds and streams (S).

		Specimens	
Taxon	Author	M	S
Belostomatidae (3 species)		**12**	**26**
Belostoma lutarium	(Stål, 1856)	12	10
Belostoma testaceum	(Leidy, 1847)	0	13
Lethocerus uhleri	(Montandon, 1896)	0	6
Corixidae (14 species)		**5146**	**168**
Hesperocorixa brimleyi	(Kirkaldy, 1908)	1	0
Hesperocorixa lucida	(Abbott, 1916)	2	1
Hesperocorixa minor	(Abbott, 1913)	18	14
Hesperocorixa	Kirkaldy, 1908	2433	90
Hesperocorixa interrupta	(Say, 1825)		
Hesperocorixa nitida	(Fieber, 1851)		
Hesperocorixa vulgaris	(Hungerford, 1825)		
Palmacorixa buenoi	Abbott, 1913	0	5
Sigara	Fabricius, 1775	2555	19
Sigara pectenata	(Abbott, 1913)		
Sigara virginiensis	Hungerford, 1948		
Sigara zimmermanni	(Fieber, 1851)		
Trichocorixa calva	(Say, 1832)	101	16
Trichocorixa kanza	Sailer, 1948	34	0
Trichocorixa macroceps	(Kirkaldy, 1908)	0	23
Trichocorixa sexcincta	(Champion, 1901)	2	0
Gerridae (6 species)		**725**	**33**
Gerris argenticollis	Parshley, 1916	5	2
Gerris comatus	Drake and Hottes, 1925	5	0
Gerris marginatus	Say, 1832	17	7
Neogerris hesione	(Kirkaldy, 1902)	0	3
Limnoporus canaliculatus	(Say, 1832)	698	21
Trepobates subnitidus	Esaki, 1926	0	3
Hebridae (2 species)		**1**	**1**
Hebrus beameri	Porter, 1952	0	1
Hebrus burmeisteri	Lethierry and Severin, 1896	1	0
Hydrometridae (2 species)		**3**	**36**
Hydrometra australis	Say, 1832	1	30
Hydrometra martini	Kirkaldy, 1900	2	6
Mesoveliidae (2 species)		**10**	**0**
Mesovelia amoena	Uhler, 1894	9	0
Mesovelia mulsanti	White, 1879	1	0
Naucoridae (1 species)		**0**	**10**
Pelocoris femoratus	(Palisot de Beauvois, 1820)	0	10
Nepidae (2 species)		**117**	**58**
Ranatra australis	Hungerford, 1922	2	19
Ranatra buenoi	Hungerford, 1922	115	39
Notonectidae (6 species)		**4321**	**188**
Buenoa	Kirkaldy, 1904	711	119
Buenoa confusa	Truxal, 1953		
Buenoa scimitra	Bare, 1925		
Notonecta indica	Linnaeus, 1771	129	37
Notonecta irrorata	Uhler, 1879	3481	21
Notonecta raleighi	Torre-Bueno, 1907	0	10
Notonecta uhleri	Kirkaldy, 1897	0	1
Veliidae (5 species)		**9423**	**26**
Microvelia	Westwood, 1834	9423	7
Microvelia americana	Uhler, 1884		
Microvelia hinei	Drake, 1920		
Microvelia paludicola	Champion, 1989		
Platyvelia brachialis	(Stål, 1860)	0	13
Rhagovelia obesa	Uhler, 1871	0	3

Notes on species

Gerris comatus Parshley, 1916

New state record. A species with a relatively poorly documented distribution, it is found across North America from Maine west to Colorado and Montana, including in Illinois (Drake and Hottes 1925; Drake and Harris 1928; Tinerella, Taylor, and McPherson 2009). This species was rare at UMFS, is very similar to *G. marginatus*, and was collected exclusively from 110 L mesocosms (1 m diameter).

Hebrus beameri Porter, 1952

New state record. There are few records of this species from Kansas, Indiana, and Georgia (Polhemus and McKinnon 1983). The single individual we found was collected on a small (~0.5 m wide), spring-fed stream in February.

Hebrus burmeisteri Lethierry and Severin, 1896

Only a single individual of this species was previously recorded from the state, in Saltillo, east of UMFS (Wilson 1958). The individual we collected was from a mesocosm in June.

Hesperocorixa brimleyi (Kirkaldy, 1908)

Only two individuals had previously been collected from the state, both in Tishomingo County (Wilson 1958). Our single individual was collected from a 110 L mesocosm and is likely the westernmost record of this species, which ranges along the Atlantic Coast of the United States (Hungerford 1948).

Hesperocorixa lucida (Abbott, 1916)

New state record. This species is distributed in eastern North America from Massachusetts and Ontario south to Florida, with few records west to Texas and Arkansas (Hungerford 1948; Epler and Denson 2017). Two individuals were collected from large (1300+ L) mesocosms, with a third from a fishless pond.

Trichocorixa macroceps (Kirkaldy, 1908)

The documented distribution of this species is along the Atlantic and Gulf coasts, along with the Great Lakes region (Hungerford 1948). Mississippi records are from the southern part of the state (Wilson 1958), with our record among the furthest 'inland' across its range (including the Great Lakes as a coast). This species was locally common in a swamp and found in five additional ponds.

Acknowledgements

Jason Bohenek, Tyler Breech, Lauren Eveland, Christina Hoffman, Rachel Kroeger, Bianca Martinez, Brandon McDaniel, Sarah McNamara, Zachary Mitchell, Kevin Potts, and Reed Scott helped collect and process insects. Richard Brown and Terence Schiefer facilitated the deposition of voucher specimens at the Mississippi Entomological Museum. Collecting was approved by the Mississippi Department of Wildlife, Fisheries, and Parks (permits 0624141, 0521162, 0525171, and 0502182). Some mesocosms housed vertebrates, which was approved by the University of Mississippi's Institutional Animal Care and Use Committee (protocols 14-027 and 18-011). This is publication number 10 of the Center for Biodiversity & Conservation Research at the University of Mississippi.

Disclosure statement

The authors declare no conflicts of interest.

Funding

The support was provided by the University of Mississippi, University of Mississippi Field Station, and the Henry L. and Grace Doherty Foundation.

ORCID

Matthew R. Pintar http://orcid.org/0000-0003-0165-3882
William J. Resetarits http://orcid.org/0000-0002-0197-1082

References

Abell, R.A. (2000), *Freshwater Ecoregions of North America: A Conservation Assessment*, Washington, DC: Island Press.

Balian, E.V., Segers, H., Lévèque, C., and Martens, K. (2008), *Freshwater Animal Diversity Assessment*. Dordrecht, The Netherlands: Springer.

Binckley, C.A., and Resetarits, W.J. (2005), 'Habitat Selection Determines Abundance, Richness and Species Composition of Beetles in Aquatic Communities', *Biology Letters*, 1, 370–374.

Binckley, C.A., and Resetarits, W.J. (2007), 'Effects of Forest Canopy on Habitat Selection in Treefrogs and Aquatic Insects: Implications for Communities and Metacommunities', *Oecologia*, 153, 951–958.

Drake, C.J., and Harris, H.M. (1928), 'Concerning Some North American Water-Striders with Descriptions of Three New Species', *The Ohio Journal of Science*, 28, 269–276.

Drake, C.J., and Hottes, F.C. (1925), 'Four Undescribed Species of Waterstriders (Hemip.-Gerridae)', *The Ohio Journal of Science*, 25, 46–50.

Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.H., Soto, D., Stiassny, M.L.J., and Sullivan, C.A. (2006), 'Freshwater Biodiversity: Importance, Threats, Status and Conservation Challenges', *Biological Reviews*, 81, 163–182.

Dunn, C.E. (1979), 'A Revision and Phylogenetic Study of the Genus *Hesperocorixa* Kirkaldy (Hemiptera: Corixidae),' *Proceedings of the Academy of Natural Sciences of Philadelphia*, 131, 158–190.

Elkins, D., Sweat, S.C., Kuhajda, B.R., George, A.L., Hill, K.S., and Wenger, S.J. (2019), 'Illuminating Hotspots of Imperiled Aquatic Biodiversity in the Southeastern US', *Global Ecology and Conservation*, 19, e00654.

Epler, J.H. (2006), *Identification Manual for the Aquatic and Semi-Aquatic Heteroptera of Florida*, Tallahassee, FL: Florida Department of Environmental Protection.

Epler, J.H., and Denson, D.R. (2017), 'New Records of Corixidae and Micronectidae (Insects: Heteroptera: Corixoidea) from Florida, with a Checklist of All Species Known from the State', *Entomological News*, 126, 410–414.

Hungerford, H.B. (1948), 'The Corixidae of the Western Hemisphere', *The University of Kansas Science Bulletin*, 32, 5–827.

Keiser, E.D. (1999), *Salamanders of the University of Mississippi Field Station*, Oxford, MS: University of Mississippi.

Keiser, E.D. (2001), *Turtles of the University of Mississippi Field Station*, Oxford, MS: University of Mississippi.

Keiser, E.D. (2008), *Frogs of the University of Mississippi Field Station*, Oxford, MS: University of Mississippi.

Keiser, E.D. (2010), *Snakes of the University of Mississippi Field Station*, Oxford, MS: University of Mississippi.
Keiser, E.D. (2014), *Lizards*, Oxford, MS: University of Mississippi.
King, J., McBride, A., and Lago, P.K. (2002), *A Field Guide to the Butterflies Common to the University of Mississippi Field Station*, Oxford, MS: University of Mississippi.
Knight, L.A. (1996), *A History and General Description of the University of Mississippi Biological Field Station*, Oxford, MS: University of Mississippi.
Lago, P.K., and Testa, S. (1989), 'The Aquatic and Semiaquatic Hemiptera and Coleoptera of Point Clear Island, Hancock County, Mississippi', *Journal of the Mississippi Academy of Sciences*, 34, 33–38.
Maguire, B. (1963), 'The Passive Dispersal of Small Aquatic Organisms and Their Colonization of Isolated Bodies of Water', *Ecological Monographs*, 33, 161–185.
Menon, R., and Holland, M.M. (2012), 'Study of Understory Vegetation at the University of Mississippi Field Station in North Mississippi', *Castanea*, 77, 28–36.
Noss, R.F., Platt, W.J., Sorrie, B.A., Weakley, A.S., Means, D.B., Costanza, J., and Peet, R.K. (2015), 'How Global Biodiversity Hotspots May Go Unrecognized: Lessons from the North American Coastal Plain', *Diversity and Distributions*, 21, 236–244.
Omernik, J.M. (1987), 'Ecoregions of the Conterminous United States', *Annals of the Association of American Geographers*, 77, 118–125.
Omernik, J.M., and Griffith, G.E. (2014), 'Ecoregions of the Conterminous United States: Evolution of a Hierarchical Spatial Framework', *Environmental Management*, 54, 1249–1266.
Penn, G.H., and Ellis, L.L. (1949), 'Notes on Aquatic Hemiptera from Lafayette and Marshall Counties, Mississippi', *The Florida Entomologist*, 32, 158–159.
Pintar, M.R., and Resetarits, W.J. (2017), 'Prey-Driven Control of Predator Assemblages: Zooplankton Abundance Drives Aquatic Beetle Colonization', *Ecology*, 98, 2201–2215.
Pintar, M.R., and Resetarits, W.J. (2017), 'Tree Leaf Litter Composition Drives Temporal Variation in Aquatic Beetle Colonization and Assemblage Structure in Lentic Systems', *Oecologia*, 183, 797–807.
Pintar, M.R., and Resetarits, W.J. (in press), 'Aquatic Beetles (Coleoptera) of the University of Mississippi Field Station, Lafayette County, Mississippi, USA', *The Coleopterists Bulletin*.
Polhemus, J.T., and McKinnon, C.N. (1983), 'Notes on the Hebridae of the western hemisphere with descriptions of two new species (Heteroptera: Hemiptera)', *Proceedings of the Entomological Society of Washington*, 85, 110–115.
Polhemus, J.T., and Polhemus, D.A. (2007), 'Global Diversity of True Bugs (Heteroptera; Insecta) in Freshwater', in *Freshwater Animal Diversity Assessment*, eds. E. V Balian, C. Lévêque, and K. Martens, Dordrecht: Springer, pp. 379–391.
Resetarits, W.J., Pintar, M.R., Bohenek, J.R., and Breech, T.M. (2019), 'Patch Size as a Niche Dimension: Aquatic Insects Behaviorally Partition Enemy-Free Space across Gradients of Patch Size', *The American Naturalist*, 32, 776–793.
Schneider, D.W., and Frost, T.M. (1996), 'Habitat Duration and Community Structure in Temporary Ponds', *Journal of the North American Benthological Society*, 15, 64–86.
Sites, R.W., and Polhemus, J.T. (1994), 'Nepidae (Hemiptera) of the United States and Canada', *Annals of the Entomological Society of America*, 87, 27–42.
Smith, C.L., and Polhemus, J.T. (1978), 'The Veliidae (Heteroptera) of America North of Mexico - Keys and Check List', *Proceedings of the Entomological Society of Washington*, 80, 56–68.
Strayer, D.L., and Dudgeon, D. (2010), 'Freshwater Biodiversity Conservation: Recent Progress and Future Challenges', *Journal of the North American Benthological Society*, 29, 344–358.
Tinerella, P.P., Taylor, S.J., and McPherson, J.E. (2009), 'New Records and a Checklist of Aquatic True Bugs (Heteroptera: Nepomorpha) from Illinois', *Journal of the Kansas Entomological Society*, 82, 293–299.
Wilson, C.A. (1958), 'Aquatic and Semiaquatic Hemiptera of Mississippi', *Tulane Studies in Zoology*, 6, 115–170.