Saproxylic Hemiptera Habitat Associations

Michael D. Ulyshen[1,*], James L. Hanula[2], Robert L. Blinn[3], and Gene Kritsky[4]

Abstract - Understanding the habitat requirements of organisms associated with dead wood is important in order to conserve them in managed forests. Unfortunately, many of the less diverse saproxylic taxa, including Hemiptera, remain largely unstudied. An effort to rear insects from dead wood taken from two forest types (an upland pine-dominated and a bottomland mixed hardwood), three tree species (*Liquidambar styraciflua* [Sweetgum], *Pinus taeda* [Loblolly Pine], and *Quercus nigra* [Water Oak]), and two wood postures (standing snags and fallen logs) in South Carolina produced 435 Hemiptera belonging to eight families and 14 species. The most common (>25 individuals) species were *Lyctocoris stalii*, *Systelloderes inusitatus*, *Lasiochilus fusculus*, *Mezira granulata*, *Calisius contubernalis* (a new state record), and *Catonia* sp. *Lyctocoris stalii* and *Systelloderes inusitatus* were almost exclusively captured in the upland and bottomland forest, respectively. *Systelloderes inusitatus* and *Mezira granulata* were recovered only from logs. *Catonia* sp. only emerged from *P. taeda* logs. Among the less common species, all but two of the 21 specimens of *Peritropis saldaeformis* were collected from snags. Similarly, all four specimens of *Calliodis temnostethoides* collected emerged from the crowns of snags. These findings strongly indicate that saproxylic Hemiptera are unevenly distributed among forests, tree species, and wood postures in the southeastern United States. A wide variety of dead wood is clearly necessary to maintain this fauna.

Introduction

Much effort has been made in recent years to better understand the habitat requirements of saproxylic organisms (i.e., directly or indirectly dependent on dead or dying wood) with the aim of conserving them in managed forests. Most research has focused on beetles, whereas less diverse taxa remain largely unstudied. For example, only a small proportion of saproxylic insects belong to the order Hemiptera (e.g., Howden and Vogt 1951, Pechuman 1937, Savely 1939), and these organisms have received very little attention from researchers. Exceptions include several studies carried out in Europe and Alaska demonstrating the habitat associations and vulnerabilities of the mycophagous family Aradidae (Goßner et al. 2007, Hjältén et al. 2006, Johansson et al. 2010, Jonsell et al. 2005, Siitonen and Martikainen 1994). Aside from information gleaned from specimen labels (e.g., Taylor and Gil 2009), however, virtually nothing is known about the habitat associations of these organisms in the southeastern United States. We recently sampled saproxylic insect communities in two forest types (an upland pine-dominated forest and a bottomland hardwood-dominated forest), three tree species (*Liquidambar styraciflua* L. [Sweetgum], *Pinus taeda* L. [Loblolly Pine],

[1]USDA Forest Service, Southern Research Station, Starkville, MS 39759. [2]USDA Forest Service, Southern Research Station, Athens, GA 30602. [3]Department of Entomology, North Carolina State University, Raleigh, NC 27607. [4]Department of Biology, College of Mount St. Joseph, Cincinnati, OH 45233. [*]Corresponding author - mulyshen@fs.fed.us.

and *Quercus nigra* L. [Water Oak]), and two wood postures (standing snags and fallen logs) in South Carolina (Ulyshen and Hanula 2009). Although beetles were the original focus of the project, hemipterans were also collected, providing a rare opportunity to better understand the habitat associations of these poorly understood members of the dead wood fauna.

Methods

As discussed in detail in Ulyshen and Hanula (2009), the project took place on the Department of Energy Savannah River Site (SRS), a National Environmental Research Park on the upper Coastal Plain Physiographic Province of South Carolina. The SRS consists primarily of pine-dominated forests growing on relatively dry upland sites and hardwood-dominated forests on mesic bottomland sites. One forest of each type was used in this study, separated by about 25 km (within each forest type, sampling took place within an approximately 2-km-wide radius). On average, the upland forest was warmer than the bottomland forest (18.8 and 17.8 ºC, respectively), whereas relative humidity was on average lower there than in the bottomland forest (72.2% and 76.6%, respectively). The three tree species targeted in this study grow commonly in both forest types. *Liquidambar styraciflua* and *Q. nigra* grow most commonly on mesic sites dominated by mixed hardwoods, but also appear sporadically among pines on dry upland sites. Similarly, *P. taeda* is the dominant pine species in upland pine forests, but also grows at low densities in bottomland forests.

In both an upland pine-dominated forest and a bottomland mixed hardwood forest, wood samples were collected from three tree species (*L. styraciflua* vs. *P*. *taeda* vs. *Q. nigra*) and two tree postures (log vs. snag). There were three replicates. On 5–6 June 2006, 9 snags and 9 logs were created in the upland sites as well as in the bottomland sites, equally divided among *L. styraciflua*, *P. taeda*, and *Q. nigra* (i.e., three snags and logs of each species at each site). Snags were created by girdling the trees to a depth of 3 cm or more using a chainsaw and spraying full strength (53.8%) glyphosate into the wounds. To prevent the herbicide from traveling up the tree and possibly affecting insect colonization, a second girdle was created about 15 cm above the first before herbicide was applied. Only the lower girdle was treated.

Approximately 11 months later, in May 2007, we returned to collect sections from the three logs and snags of each species at each site. After felling the snags with chainsaws, we removed 0.5-m sections from the lower bole, middle bole, and upper bole of each snag and log. The position of each section was measured from the tree base (for details, see Ulyshen and Hanula 2009). We also collected three 0.5-m crown sections from major limbs or sometimes the upper-most portion of the main bole. The tops of all but one of the *L. styraciflua* snags had broken, so those crown sections had been in contact with the ground for an unknown length of time. The upper bole sections from these trees were taken directly below the point of breakage. All the other snags were intact. All bole and crown sections were labeled and transported to the laboratory by truck.

We recorded the diameter (measured at the center) and bark coverage (visual estimation) of each bole and crown section. We used these data to calculate the total surface area (not including ends) and bark surface area (product of surface area and visual estimate of bark coverage) sampled from each snag and log. Wood surface area did not vary significantly between forest types, among tree species or between wood postures, but bark surface area varied significantly among tree species, being lower for *P. taeda* than for *Q. nigra* and *L. styraciflua* (Ulyshen and Hanula 2009). There was also a significant interaction between tree species and posture due to *P. taeda* snags having less bark than *P. taeda* logs (Ulyshen and Hanula 2009).

Over a 20-week period, emerging insects were collected in the laboratory using rearing bags (Ulyshen and Hanula 2009). Hemipterans were identified to the lowest taxonomic level possible. Taxa not identified to species were assigned to morphospecies. Because none of the species was captured frequently enough to permit statistical analyses, the results are descriptive. Voucher specimens have been deposited in the Georgia Museum of Natural History (*Systelloderes inusitatus*) and in the NCSU Insect Museum (all other species).

Results and Discussion

In total, 435 hemipteran specimens were collected, belonging to eight families and 14 species (Table 1). The predatory lyctocorid *Lyctocoris stalii* (Reuter) was the most commonly collected species. It was almost exclusively captured in the upland forest, emerged from *Q. nigra* and *L. styraciflua* but not *P. taeda*, and was associated with both snags and logs (Table 1). The species was taken from all sampling positions, including the crowns of snags. Although *L. stalii* did not emerge from *P. taeda*, it was previously collected from pines infested with *Dendroctonus frontalis* Zimmermann (Southern Pine Beetle; Stein and Coster 1977). It is unclear why the species was so much more abundant in the upland forest.

The second most common species, the enicocephalid *Systelloderes inusitatus* (Drake and Harris), almost exclusively captured in the bottomland forest, was associated with all three tree species and entirely restricted to logs (Table 1). *Systelloderes inusitatus* was taken from all sampling positions, but was only rarely recovered from the upper bole (3 individuals) and crown sections (1 individual). Famous for their large mating swarms, *Systelloderes*, or “gnat bugs”, are predators found in leaf litter and under bark (Kritsky 1977). Their association with leaf litter may explain why they were recovered only from logs in this study. *Systelloderes inusitatus* was first collected beneath bark (Drake and Harris 1927), but how dependent they are on that habitat is not clear, nor is it clear why we found them so strongly associated with the bottomland forest.

Two aradid species were collected in this study. *Mezira granulata* (Say) was recovered from both forest types and all tree species, but occurred only in logs (Table 1). Conditions in snags may be too dry to favor the fungi used by *M. granulata*, as suspected for other log-favoring fungivores (Ulyshen 2011). In contrast, *Calisius contubernalis* Bergroth (Aradidae), reported from South Carolina for the first time, occurred in both forest types and was associated with both logs and snags (Table 1).

Other common (>25 individuals) species were the achilid *Catonia* sp. and the lasiochilid *Lasiochilus fusculus* (Reuter). The latter was fairly evenly distributed among forest types, tree species, and wood postures (Table 1). *Catonia* sp. occurred in both forest types, but was restricted to pine logs (Table 1). Nymphs of this genus are known to be associated with dead pines, feeding on fungus beneath bark (O'Brien 1971).

Among the less common species, all but two of the 21 specimens of the mirid *Peritropis saldaeformis* Uhler were collected from snags. This species and certain other Cylapinae are known to occur under bark, where they are predators, fungivores, or possibly both (Wheeler 2001, Wheeler and Wheeler 1994). Finally, although only four specimens of the anthocorid *Calliodis temnostethoides* (Reuter) were collected, all emerged from the crowns of snags, each from a different tree. Adult *C. temnostethoides* have been found in association with

Table 1. Abundance (logs/snags) of Hemiptera species by forest type (bottomland mixed hardwood and upland pine-dominated) and tree species (*Quercus nigra*, *Pinus taeda*, and *Liquidambar styraciflua*). Guild designations are as follows: F = fungivore, P = predator, O = omnivore, U = uncertain.

		Bottomland			Upland			
Species	Guild	*Q. n.*	*P. t.*	*L. s.*	*Q. n.*	*P. t.*	*L. s.*	Totals
Achilidae								
Catonia sp.	F[A]	0/0	18/0	0/0	0/0	10/0	0/0	28/0
Cixidia sp.	F[A]	0/0	0/0	0/0	0/0	0/3	0/0	0/3
Anthocoridae								
Calliodis temnostethoides (Reuter)	P	0/1	0/0	0/2	0/1	0/0	0/0	0/4
Cardiastethus assimilis (Reuter)	P	0/0	2/0	0/0	0/0	0/0	0/0	2/0
Orius insidiosus (Say)	O	0/0	0/0	0/0	0/0	0/2	0/0	0/2
Aradidae								
Calisius contubernalis Bergroth	F	9/3	0/0	5/3	2/11	0/0	0/0	16/17
Mezira granulata (Say)	F	16/0	0/0	0/0	10/0	1/0	13/0	40/0
Cicadellidae								
sp.	U	0/0	0/0	0/0	0/0	0/0	1/0	1/0
Enicocephalidae								
Systelloderes inusitatus (Drake and Harris)	P	1/0	28/0	68/0	0/0	3/0	0/0	100/0
Lasiochilidae								
Lasiochilus fusculus (Reuter)	P	0/0	4/3	2/1	19/0	4/0	22/0	51/4
Lyctocoridae								
Lyctocoris stalii (Reuter)	P	0/3	0/0	0/1	11/70	0/0	18/23	29/97
Miridae								
Fulvius imbecilis (Say)	U[B]	0/0	0/0	0/0	0/2	7/0	0/0	7/2
Peritropis husseyi Knight	U[B]	7/2	0/0	1/1	0/0	0/0	0/0	8/3
Peritropis saldaeformis Uhler	U[B]	0/10	0/0	0/1	2/7	0/0	0/1	2/19
Totals		33/19	52/3	76/9	44/91	25/5	54/24	284/151

[A]Refers only to nymphs.

[B]It remains unclear if cylapines are predators, mycophages or both (Wheeler 2001, Wheeler and Wheeler 1994).

dead leaf clusters on wind-thrown oaks (Lattin 1999). These findings suggest *C. temnostethoides* may be more active in the upper canopy.

Consistent with the results for beetles (Ulyshen and Hanula 2009), siricid wasps (Ulyshen and Hanula 2010), and parasitoids (Ulyshen et al. 2011) from the same study, saproxylic hemipterans are not distributed evenly among forest types, tree species or wood postures in the southeastern United States. A wide variety of dead wood is clearly necessary to maintain this diverse fauna.

Acknowledgments

We thank Scott Horn and Mike Cody for assisting with field work and the editor and two anonymous reviewers for comments that greatly improved the manuscript.

Literature Cited

Drake, C.J., and H.M. Harris. 1927. Three new species of Enicocephalidae. Ohio Journal of Science 27:102–103.

Goßner, M., H. Engel, and M. Blaschke. 2007. Factors determining the occurrence of flat bugs (Aradidae) in beech-dominated forests. Waldoekologie online 4:59–89.

Hjältén, J., O. Atlegrim, F. Sandström, R. Pettersson, and E.A. Rexstad. 2006. Occurrence of flat bugs (Heteroptera: Aradidae) in burned and unburned forests. Entomologica Fennica 17:130–135.

Howden, H.F., and G.B. Vogt. 1951. Insect communities of standing dead pine (*Pinus virginiana* Mill.). Annals of the Entomological Society of America 44:581–595.

Johansson, T., J. Hjältén, F. Stenbacka, and M. Dynesius. 2010. Responses of eight boreal flat bug (Heteroptera: Aradidae) species to clear-cutting and forest fire. Journal of Insect Conservation 14:3–9.

Jonsell, M., M. Schroeder, and J. Weslien. 2005. Saproxylic beetles in high stumps of spruce: Fungal flora important for determining the species composition. Scandinavian Journal of Forest Research 20:54–62.

Kritsky, G. 1977. Observations on the morphology and behavior of the Enicocephalidae (Hemiptera). Entomological News 88:105–110.

Lattin, J.D. 1999. Dead leaf clusters as habitats for adult *Calliodis temnostethoides* and *Cardiastethus luridellus* and other anthocorids (Hemiptera: heteroptera: Anthocoridae). Great Lakes Entomologist 32:33–38.

O'Brien, L.B. 1971. The Systematics of the Tribe Plectoderini in America North of Mexico (Homoptera: Fulgoroidea, Achilidae). University of California Press, Berkeley, CA. 79 pp.

Pechuman, L.L. 1937. An annotated list of insects found in the bark and wood of *Ulmus americana* L. in New York State. Bulletin of the Brooklyn Entomological Society 32:8–21.

Savely, H.E., Jr. 1939. Ecological relations of certain animals in dead pine and oak logs. Ecological Monographs 9:322–385.

Siitonen, J., and P. Martikainen. 1994. Occurrence of rare and threatened insects living on decaying *Populus tremula*: A comparison between Finnish and Russian Karelia. Scandinavian Journal of Forest Research 9:185–191.

Stein, C.R., and J.E. Coster. 1977. Distribution of some predators and parasites of the Southern Pine Beetle in two species of pine. Environmental Entomology 6:689–694.

Taylor, S.J., and S.A. Gil. 2009. State records, confirmations, and habitats of Aradidae (Hemiptera: Heteroptera) from Louisiana, USA. Florida Entomologist 92:199–207.

Ulyshen, M.D. 2011. Arthropod vertical stratification in temperate deciduous forests: Implications for conservation-oriented management. Forest Ecology and Management 261:1479–1489.

Ulyshen, M.D., and J.L. Hanula. 2009. Habitat associations of saproxylic beetles in the southeastern United States: A comparison of forest types, tree species, and wood postures. Forest Ecology and Management 257:653–664.

Ulyshen, M.D., and J.L. Hanula. 2010. Host-use patterns of *Eriotremex formosanus* (Hymenoptera: Siricidae) in South Carolina, USA. Entomological News 121:97–101.

Ulyshen, M.D., T. Pucci, and J.L. Hanula. 2011. The importance of forest type, tree species, and wood posture to saproxylic wasp (Hymenoptera) communities in the southern United States. Journal of Insect Conservation 15:539–546.

Wheeler, A.G., Jr. 2001. Biology of the Plant Bugs (Hemiptera: Miridae): Pests, Predators, Opportunists. Cornell University Press, Ithaca, NY. 507 pp.

Wheeler, Q.D., and A.G. Wheeler, Jr. 1994. Mycophagous Miridae? Associations of Cylapinae (Heteroptera) with Pyrenomycete fungi (Euascomycetes: Xylariaceae). Journal of the New York Entomological Society 102:114–117.