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Report

Current Scientific Literature on Tarnished Plant bug, *Lygus lineolaris* (Palisot de Beauvois) Ecology in Mississippi and Critical Information Needs

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Abstract: Implementing a successful integrated pest management program requires understanding basic ecologic patterns of the tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois). As the primary pest of cotton in Mississippi and across the mid-south, *L. lineolaris* is a highly polyphagous mirid that moves among host plants throughout the year. Most major crops in this area, as well as many common weeds, are considered host plants and contribute to the population.

Keywords: tarnished plant bug, ecology, taxonomy

Introduction

Tarnished plant bug (TPB), *Lygus lineolaris* (Palisot de Beauvois), is a highly polyphagous mirid that is a common pest of fruit, nut, fiber, nursery, and vegetable crops in many agricultural areas. Tarnished plant bug range is documented to extend from Alaska, east to Newfoundland, and south to Guatemala (Schwartz and Foottit 1998). Reduction of insecticide applications in cotton, *Gossypium hirsutum* L, as a result of Boll Weevil eradication and introduction of Bt-cotton to control other key pests have made *L. lineolaris* the primary pest of cotton in Mississippi and the mid-south (Williams 2013). Damage to cotton plants is a result of *L. lineolaris* feeding on leaf buds, flowers, and fruit (Pack and Tugwell 1976).

Taxonomic History

The taxonomic history of TPB can be confusing at times since its variable appearance has caused it to appear with variable nomenclature in the literature. Tarnished plant bug was first described as *Capsus lineolaris* by Palisot de Beauvois (1818), and again described by Say (1832) as *Lygus oblineatus*. The first report of TPB as a pest was by Harris (1841), referring to it as *Phytocoris lineolaris*. Uhler (1872) first used the currently accepted name *Lygus lineolaris*. Tarnished plant bug was again described as *Capsus flavonatus* Provancher (1872), and again as *Capsus strigulatus* Walker (1873). Uhler (1886) synonymized *L. lineolaris* and *L. oblineatus* with the European plant bug, *Lygus pratensis* (L.); Knight (1917) further recognized TPB in North America as two subspecies: *L. pratensis* var. *oblineatus* and *L. pratensis* var. *rubidus*. Slater and Davis (1952) returned TPB to Uhler's *L. lineolaris*, which is the currently accepted placement. Kelton (1955) moved TPB to the genus *Liocoris*, though this placement was not accepted

(Kelton 1975, Schwartz and Foottit 1998). The variety of specific epithets used across the literature makes organizing and collecting historical accounts of TPB difficult.

Ecology

Understanding the basic interactions that occur between *L. lineolaris* and the environment is essential to formulating an effective IPM plan in Mississippi. *Lygus lineolaris* is well known to be highly polyphagous, with hundreds of host plants reported across the literature (Cleveland 1982, Anderson and Schuster 1983, Snodgrass et al. 1984b, a, Young 1986, Womack and Schuster 1987, Robbins et al. 2000, Esquivel and Mowery 2007, Parys and Snodgrass 2014). Here in the mid-south (Arkansas, Louisiana, and Mississippi), Snodgrass et al. (1984a) reported 169 host plant species, representing 36 families. The majority of *L. lineolaris'* recognized host plants are ephemeral, with subsequent generations moving through a variety of plants as the year progresses (Cleveland 1982, Anderson and Schuster 1983, Snodgrass et al. 1984b, Fleischer and Gaylor 1987, Stewart and Gaylor 1991).

Movement and behavior of *L. lineolaris* amongst host plants is poorly understood in the literature. Young reproductive females traveled the furthest on a flight mill and are the most likely to colonize new host plant patches (Stewart and Gaylor 1991, 1994). Two *L. lineolaris* were collected in light traps at lighthouses off the New Jersey coast, indicating that sustained flight distances of at least 5.15 km are possible (MacCreary 1965). The majority of *L. lineolaris* flights (between 88-90%) are less than 2 meters above ground with very few occurring above 18 feet (Ridgway and Gyrisco 1960, Stewart and Gaylor 1991).

Movement from other crops and other hosts

Movement of *L. lineolaris* into cotton fields is a reflection of the surrounding landscape, with various crops, cultivated non crop hosts, and wild hosts contributing to the population (Snodgrass et al. 1984b). With a high diversity of wild and cultivated hosts, populations of *L. lineolaris* increase throughout the growing season moving from host to host until plants are killed by frosts (Cleveland 1982).

Maize, *Zea mays* L., has been planted across Mississippi in increasing acreages as cotton acreage has declined (NASS 2013). *Lygus lineolaris* readily uses maize as a host plant, can serve as a host for > 3 weeks, and has the potential to produce up to 12,000 individuals/acre (Abel et al. 2010). Movement of *L. lineolaris* from maize into cotton occurs as the maize matures through the R2-R3 stages when silks begin to desiccate (Kumar and Musser 2009). *Lygus lineolaris* moving out of desiccating crops and wild host plants lay eggs in edge rows of cotton, and further disperse into the field (Kumar and Musser 2009, 2010). Adult *L. lineolaris* that have developed on corn plants can be separated from those that develop on other identified through stable carbon isotope analysis (Jackson et al. 2012).

Soybeans, *Glycine max* L., are also widely planted across the Mississippi delta and have increased in acreage in recent years (NASS 2013) . Populations of *L. lineolaris* use soybeans for a single generation, with adults moving out of the field at the end of flowering (Snodgrass et al. 2010). Snodgrass et al. (2010) estimated that there were 3,543 individuals/acre, indicating that a large number of *L. lineolaris* are utilizing soybeans as a host.

Stable carbon isotope analysis can reliably separate *L. lineolaris* that have developed on plants utilizing the Calvin pathway (C3) versus plants dicarboxylic acid pathway (C4) for photosynthesis (Jackson et al. 2012). Cotton, soybeans, wheat, and several major weeds all utilize the C4 pathway, while corn and pigweed (*Amaranthus* spp.) both utilize the C3 pathway (Jackson et al. 2010, 2012). Using carbon and nitrogen ratios together allowed differentiation of L. lineolaris that fed on corn versus those that fed on pigweed (Jackson et al. 2012). Later season collections of L. lineolaris in cotton fields indicated that development occurred on C3 hosts, and that reproduction was likely occurring in the cotton fields (Jackson et al. 2010).

Efforts have been made in the southwestern US to quantify landscape factors affecting a similar species of plant bug, *Lygus hesperus* Knight (Carriere et al. 2006, Carriere et al. 2012, Sivakoff et al.

2013). Bostanian et al. (2014) modeled mirid nymphs (including *L. lineolaris*) in northeastern vineyards, optimizing monitoring efforts in grape crops. While these models are certainly relevant to current research goals, they do not reflect the complexity of habitats found in agricultural areas throughout the mid-south. The only study in the mid-south examining influences of surrounding habitats observed a positive relationship between *L. lineolaris* and corn acreage, and a negative relationship with cotton acreage, but failed to examine non-crop influences (Allen and Luttrell 2009).

Sampling Strategies

Effectively and accurately sampling *L. lineolaris* populations is a challenge that is well addressed, but not answered in the literature. Historically, a wide range of techniques have been used for sampling *Lygus* spp. including sweeping, drop cloths, vacuuming, traps of various types, as well as visual inspection (Mukerji 1973, Prokopy et al. 1982, Kharboutli and Allen 2000, Villavaso 2005, Wade et al. 2006, Musser et al. 2007, Blackmer et al. 2008). Musser et al. (2007) provided a review of various sampling methods used in cotton fields across the mid-south, including sweep nets, drop cloths, whole plants, and visual examination of plant tissues. Sweep net data, while a common insect sampling method, can have significant variations amongst samplers (Musser et al. 2007, Spurgeon and Cooper 2011).

Ongoing research on potential pheromones for monitoring *Lygus* spp. is scattered throughout the literature. Scales (1968) first reported that male *L. lineolaris* are attracted to captive females, indicating the presence of a sex related pheromone. These captive females can be exploited to build inexpensive traps for monitoring, but require frequent maintenance (Slaymaker and Tugwell 1984). Chemical analysis of *L. lineolaris* glands and volatiles were examined for many years, with no resulting reliable pheromone blend released (Blumenthal 1978, Aldrich et al. 1988, Chinta et al. 1994, Dickens et al. 1995, Chinta et al. 1997). Scott and Snodgrass (2000) again worked with virgin females in cages, concluded that there was an aggregation pheromone present in males in addition to a sex specific pheromone in females. Byers et al. (In Press) recently published pheromone blends for both *L. hesperus* and *L. lineolaris*. A pheromone for *Lygus rugulipennis* Poppius has recently been identified and commercialized for use in Europe (Innocenzi et al. 2004, Innocenzi et al. 2005).

Discussion

While recent pushes to quantify *Lygus* populations in other parts of the country are important, the habitats that have been explored to date are vastly different from what is encountered across the mid-south. Host plants in the state of Mississippi and across the mid-south vary in time, space, and area (NASS 2013). This variation, or habitat heterogeneity, effects plant-insect interactions on scales much larger than a single agricultural field: current and future research should reflect this knowledge.

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