the insect. All the while, we as researchers make incremental observations about this dynamic continuum, in an attempt to understand and appreciate the full interaction.

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Impact of Plant Xylem Chemistry on Leafhopper Vectors of Diseases Caused by *Xylella fastidiosa*

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Xylophagous leafhoppers are vectors for numerous economically-important diseases such as Pierce's disease (PD) of grapevines, citrus variegated chlorosis, plum leaf scald, phony peach disease and leaf scorch of almond and many other tree and landscape species. *Xylella fastidiosa* (Xf) is the causal agent for these xylem-limited diseases. *Homalodisca coagulata*, also known as the glassy-winged sharpshooter (GWSS), is endemic to the southeastern United States where it is the most important vector for Xf diseases. Adult GWSS may feed on the xylem fluid of hundreds of plant species; however, successful nymphal developmental occurs on only a subset of the adult hosts. The distribution of this highly polyphagous leafhopper is in part due to host plant nutritional quality. Xylem fluid is 95 to 99% water with an osmolarity of 10 to 40 mM. The major constituents are amino acids, organic acids and sugars; inorganic ions comprise most of the remaining osmolarity.

Characteristics of GWSS that enable it to subsist on such a nutrient-poor diet include: 1) high feeding rates (10 to 100x body weight per day); 2) >99% assimilation efficiency of ingested organic compounds; 3) ammonotelism, and; 4) the seasonal and diurnal selection of host plants with superior nutrient content. Other xylophagous leafhoppers such as *H. insolita* and *Cuerna costalis* also share the above adaptations. Feeding rate of GWSS on most host plants is highest during midday, at a time when plant nutrient content and xylem tensions are also at their maximum. The majority of organic nitrogen transported in xylem fluid of many woody plants is in the form of the amides (asparagine and/or glutamine). Host selection and feeding of GWSS has been correlated with the amides or the ratio of the amides to total amino acids. In *Vitis* genotypes, glutamine accounts for 65 to 90% of the total amino acids in xylem fluid, and insect abundance and feeding have been correlated to the ratio of glutamine to proline concentrations.

Nymphs, particularly the early instars, develop more successfully on xylem fluid with low amide concentrations and proportionally higher concentrations of many of the more dilute amino acids that are deemed 'essential' for insect development. We have established that adult GWSS can efficiently use nitrogen and carbon from high amide concentrations, whereas young developing nymphs cannot. Female GWSS can consume more nutrients and produce more eggs on high amide diets, yet oviposition on these same hosts may result in up to 100% mortality from malnutrition of developing nymphs.

Malnutrition of nymphs and parasitoid-mediated reductions in oviposition success are key mortality factors for GWSS, with potential for manipulation to suppress vector populations and Xf diseases. Many of the important interactions, their critical timing, and identification of the host plants in mediating them remain to be elucidated. We do not fully understand the cues involved or the behavioral decisions female GWSS make in response to host plants during feeding and oviposition. These decisions involve movement and directly determine egg parasitism, oviposition success and nutrition of young nymphs and are critical to GWSS survival and fitness. We have developed a conceptual model of the critical choices facing GWSS females, their implications to leafhopper fitness and the potential environmental cues and response behaviors involved at each juncture in the processes. This heuristic device will be discussed.

Via host plant selection, feeding and the accompanying behaviors, xylem fluid chemistry plays a pivotal role by affecting egg quantity and distribution and ultimately the success of leafhopper (and GWSS) eggs through parasitism. For example, GWSS that deposit a high number of eggs on a high quality nymph host may potentially increase survival of nymphs, but also increase the rate of egg parasitism. Conversely, GWSS that scatter eggs across a number of lower quality hosts in time and space may potentially decrease egg parasitism but result in increased mortality of nymphs from malnutrition. Thus, opposing selection pressures may affect the feeding-oviposition behavior of GWSS. Necessary movements between feeding and ovipositional hosts or during feeding and oviposition may result in increased exposure of GWSS life stages to predation, or inability to locate either suitable ovipositional or feeding hosts.

To illustrate the conflicting requirements, in Florida, crape myrtle, *Lagerstroemia indica* L., appears to be the most frequently used mid-summer host of adult GWSS (highest abundances and consumption rates), yet GWSS oviposition is relatively low on this host. Adjacent hedges of *Euonymus japonica* have the highest concentrations of GWSS eggs that we have recorded, yet adults confined on this host feed very little. The ideal scenario for sustained GWSS population growth appears to be the close proximity of high quality GWSS ovipositional/developmental hosts to adult feeding hosts. These two conflicting requirements for population growth of GWSS (quality adult feeding hosts and ovipositional and/or developmental hosts) make it imperative to study host species and assemblages of host plants for their relative value and impact on GWSS. Such data may lead to pivotal decisions regarding removal or addition of key plant species, developing tactics such as trap crops (addition of plants to a landscape), cropping systems, crop/landscape systems or deployment of resistant hosts that suppress GWSS and/or Xf populations. Basic understanding of insect nutrition and behavior at the tissue, plant, and habitat levels, provide the critical information necessary to initiate a synthesis that will lead to practical applications for manipulation and suppression of vector populations and ultimately to disease suppression.