**Thoughts on 2018 research on the Spotted lanternfly, *Lycorma delicatula*,in Berks County PA**

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From field research I have been doing this year the Spotted lanternfly, *Lycorma delicatula*, is an insect of ecotones. Locally we have four distinct ecosystems: urban, suburban, rural and forest. Three of these ecosystems are primarily ecotones: urban, suburban and rural. To this point the three most common food plants in order of preference appear to be *Ailanthus altissima*, *Vitis sp.* and *Celastrus orbiculatus*. *Acer saccharinum*, an ornamental tree common near where I live, appears to be another food source when *A. altissima* and *Vitis sp*. are not available.

Urban ecosystems tend to be fragmented with few if any forested areas more than 100 yards across. Mostly, they are a series of vacant lots, small hedgerows between properties, utility right-of-ways and similar disturbed areas where plants grow. Additionally, there are domesticated trees planted by municipal authorities and landowners. Manmade surfaces abound where SLF eggs can be deposited and vehicles to transport SLF across the landscape. The distances between parts of the ecotone appear to be easily traversed by SLF without human help since they are often short. Therefore, this appears to the most highly infested of the four local ecosystems.

Suburban ecosystems are less fragmented than urban areas but have similar characteristics in having vacant lots, disturbed areas between properties and utility right-of-ways with few deeper forested areas. Landowners and local government bodies plant domesticated plants, like urban governments, but on larger tracts of land. The largest difference is that there tends to be more space between buildings and larger patches of land where plants can grow with fewer manmade surfaces and vehicles. Still the distance between parts of this ecotone are relatively short.

Rural ecosystems have more open space and larger blocks of trees, yet with the same patchwork of hedgerows, abandoned tracts of land, utility right-of-ways and similar as urban and suburban ecosystems. The biggest differences are that the hedgerows can be deeper/longer, there are small forests scattered across the landscape with many fewer vehicles and manmade surfaces and the distances between parts of the ecotone are further.

Forested ecosystems tend to be large areas of deep forests with longer and fewer edges even though roads, trails and utility right-of-ways run through them. This is critical because most of the plants that the SLF feeds on appear to be ecotone plants, not plants of the deep forest. I seldom find *A. altissima*, *Vitis sp*. and *C. orbiculatus* more than a few yards deep in forests, except where an ecotone was created by geological features, fallen trees or human disturbance. I have yet to find SLF on any of the forest trees beyond the edges of an ecotone. Therefore, this appears to be the least heavily infested of the local ecosystems I have investigated.

Each of these ecotones has different challenges in SLF control. Urban areas have closely spaced ecotones separated by roads of varying width and utility acting as minor boundaries for SLF spread and more people which apparently enhance SLF spread. Suburban and rural areas have decreasing numbers of roads with decreasing traffic loads and fewer people making the spread of SLF slower. Forested areas are the slowest for the spread of SLF because there are fewer people to facilitate its spreading and food sources tend to be further apart.

To determine which woody plants are susceptible to SLF predation, analysis of the nutritional content of their sap needs to be done. Use *Ailanthus altissima* as a baseline since from observation it is the plant with the heaviest infestation and the one it feeds on in its original home. First test qualitatively for overall sap components of *A. altissima*. Then test quantitively for total sugars, proteins, fats, specific sugars and micronutrients. Compare this data to data from either specific species SLF may be using as an energy source or members of their families. Using sugar content as the primary test of plant desirability it can be assumed plants with the highest sugar content are preferred food.

Another part of this is to run the same quantitative tests on the waste SLF produces on *A. altissima* to determine the amount of sugar and/or other nutrients in the waste, comparing it to the same from other potential food sources. The higher the sugar content in the waste, potentially the higher the sugar content in the tree because apparently the excess sugar will be in the waste produced by the SLF.

A more complex and accurate predictor of plant preference is the analysis of the utility a plant has for the SLF. Utility is the amount of benefit an organism derives from a specific resource. U = (pU-c)/T. Utility = (potential Utility-cost)/Time. Potential utility is the maximum utility which can be obtained with no cost. Costs can be related to the sugar concentration of the sap (either too low or too high to use without additional energy expenditure), a different primary sugar than *Ailanthus*, sap viscosity and potential toxins in the sap which need to be dealt with, hardness of the bark, thickness of the bark or noxious/toxic chemicals in the bark. Time can either be by life stage from egg to senescence, end of a (the) reproductive cycle or a discrete unit of time such as minutes, hours or days. Environmental factors such as air temperature, bark temperature, humidity, amount of direct/indirect sunlight on the food source, state of the food source – bud break, full growth, dormancy and the amount of rain – flood, drought and time from most recent rainfall may change the utility values. The higher the quality of the food and the greater ease of access, the more utility it has. Hence, the higher the U value, the more energy for growth and reproduction.

This may have a gender component as it is generally accepted that in most species males have a much lower reproductive cost than females. Therefore, males may be able to use a resource of lower quality or less of a high-quality resource than females because of their lower breeding cost. If this is true, then it helps ensure his progeny and the reproductive viability of the species by reserving either higher quality resources or more of a higher quality resource for females to maximize their reproductive success.

Egg laying is an aspect which is confounding me. There appear to be mixed strategies of single females laying eggs and covering them relatively far from other females such as different trees/surfaces and group egg laying either contiguous to or near each other. This becomes more complicated because it appears that one SLF female may lay eggs close to the eggs of another female with the second female covering both sets of eggs. Then there are the eggs which are not covered which adds another dimension to the puzzle. The large communal egg masses are much less common than egg masses randomly scattered on a single tree or across the landscape on a variety of plants and surfaces. So far, I have found eggs on white birch, black birch, pignut, choke cherry, wild grape, silver maple, box elder, oak sp. and most commonly *Ailanthus*.

All the egg laying strategies can be reduced to game theory in the same way determining food sources is. The biggest mistake is to assume that what we see in this area is not reflective of where the SLF originated. Egg masses scattered around a landscape may ensure lower egg predation in the home habitat. Whereas, egg masses on a food source ensures that hatching nymphs have a readily available food source. Large masses of eggs in a small area may ensure that if egg predation occurs, some of the eggs will survive. The problem with assigning values to variables such as predation and proximity to food is that we do not know what the conditions are in the original habitat. When the SLF became established here the variables changed. What was a good strategy in Asia, may be a neutral or negative strategy here. Or, the strategy is good here for different reasons than in Asia. The scattering of the eggs across the landscape in Asia may have avoided predation, but here allows for the efficient movement of multiple generations of SLF across our landscape. The one constant is that the egg laying and other survival strategies are rapidly evolving to meet the new challenges offered by our ecology as it is different than the home ecology of the SLF.

*Ailanthus* has been isolated from the SLF since the mid-1700’s when seeds were brought from China to Paris. Next the tree went to London before coming to Philadelphia after the end of the American Revolutionary War in 1784. As often happens, when a defense is no longer needed it will either cease to exist or exist at a very low level. It will be exciting to watch the changes in *Ailanthus* over time with the reintroduction of this threat to it and the possibility that the tree by itself will control the SLF by bringing back or reinventing defense mechanisms to this specific threat. \*

A final point is that the SLF was introduced in this country only a few generations ago, perhaps four generations, but most probably several more. What will happen in the next several years is hard enough to guess. What may happen beyond that is beyond our ability to comprehend at the present time. That the SLF we are seeing are derived from one to a few parents is important. The fewer parents the more limited the gene pool. This means that the SLF does not have the full genetic toolbox of where it came from to deal with multiple new challenges such as predators, disease and foods (which may be toxic) in its new home. There lays our greatest hope – that the SLF will encounter a challenge which will either control it or hopefully eradicate it.

# \*The wild (European) parsnip *Pastinaca sativa* L. apparently decreased its defenses when introduced to the European North American colonies in the early 1600’s due to the lack of a principal herbivore - the parsnip webworm, Depressaria pastinacella. Defenses built back up with the accidental reintroduction of *D.* pastinacella in the late 1800’s. (Increase in toxicity of an invasive weed after reassociation with its coevolved herbivore, Arthur R. Zangerl and May R. Berenbaum, PNAS October 25, 2005 102 (43) 15529-15532.)