Strategies for Evaluating Non-Target Effects in Arthropod Biological Control

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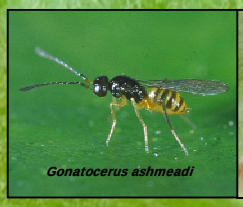
ABSTRACT

Examining possible non-target effects of biological control agents is becoming a more common requirement for many biological control programs targeting arthropod pests. Currently, for classical biological control of weeds, the Wapshere method provides an excellent means for eliminating possible natural enemies that could cause harm to non-target plants. However a rigorous, reliable, and broadly applicable testing standard for arthropod biological control is currently lacking. No-choice and choice testing strategies are a common way to test for possible non-target effects of new biological control organisms. However, these lab studies are often carried out in small testing arenas where the study organism is forced onto the host which may be adequate for determining physiological host range but may seriously overestimate its ecological host range in nature. Our research involves the use of rigorous testing strategies utilizing standard Petri dish test arenas, coupled with larger-scale entire plant test arenas in no-choice and choice comparisons. As retrospective studies in ongoing biological control programs can yield valuable information on non-target impacts, we chose the glassy-winged sharpshooter (GWSS), *Homalodisca coagulata* Say (Hemiptera: Cicadellidae), classical biological control program in California as model for our non-target studies. We are examining the possible non-target impacts of the self-introduced *Gonatocerus ashmeadi* Girault and the recently introduced *G. fasciatus* Girault (Hymenoptera: Mymaridae), egg-parasitoids of the GWSS, and three sharpshooters native to California, U.S.A.: (1) the smoke-tree sharpshooter (STSS), *Homalodisca liturata* Ball; (2) blue-green sharpshooter (BGSS), *Graphocephala atropunctata* (Signoret); and (3) green sharpshooter (GSS), *Draeculocephala minerva* Ball (all Hemiptera: Cicadellidae). Our study, along with the use of small-scale Petri dish studies and larger-scale full plant studies are supplemented with sentinel plants and habitat surveys to determine the invasiveness of GWSS parasitoids. Since very little is known regarding the native sharpshooters and their native natural enemies, this research, in part, also focuses on surveying and classifying the native parasitoid fauna of the native sharpshooters.

MEET THE PLAYERS

THE INVASIVE SPECIES

INTRODUCED BIOLOGICAL CONTROL AGENTS EXAMINED



POSSIBLE NON-TARGET SPECIES INVESTIGATED

STRATEGIES EMPLOYED

CHOICE & NO-CHOICE TESTS

Petri Dish

Full Plant

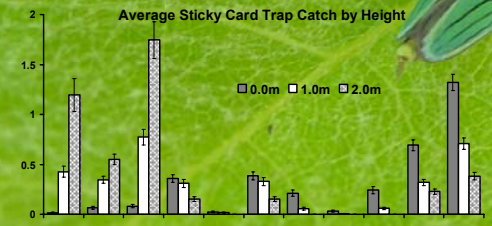
NON-TARGET HABITAT MONITORING

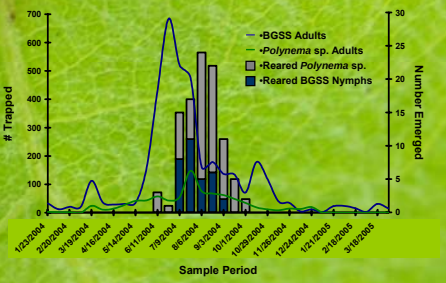
Sticky & Malaise Traps, Host Plant Samples

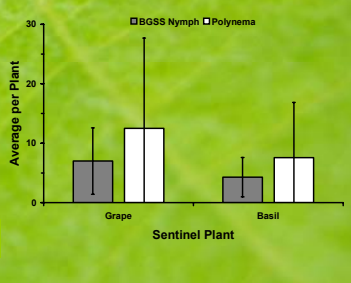
Sentinel Plants

EXOTIC PARASITIOD FORAGING CHARACTERISTICS

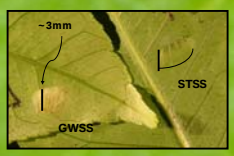
Height by Direction







EGG & OVIPOSITION CHARACTERISTICS OF NON-TARGETS



IDENTIFICATION OF NATIVE NON-TARGET NATURAL ENEMIES

Newly discovered BGSS egg parasitoids *Ufens* **spp., STSS egg parasitoids**

G. latipennis

Polynema sp.

DISCUSSION

Results of laboratory choice & no-choice tests with *G. ashmeadi* and *G. fasciatus* are currently being tabulated for STSS and BGSS. Preliminary data shows neither parasitoid will parasitize BGSS eggs, but will parasitize STSS eggs. In fact, STSS egg masses were attacked equal to the GWSS control in no-choice tests at both scales, and with no preference for either host egg in choice tests at both scales. Furthermore, *G. ashmeadi* emerging from STSS eggs were smaller and less fecund than those developing from GWSS eggs. We would speculate these 'runts' may have an overall reduced fitness, and that STSS eggs may ultimately be a dead-end host for *G. ashmeadi*; given a substantial availability of GWSS eggs, these parasitoids may not severely impact the native *Ufens* spp. parasitoid complex. However, if these parasitoids were to establish in the xeric habitats where STSS is most prolific, and cause an increase in interspecific competition experienced by *Ufens* spp., then we might expect a drastic impact on the natural enemy fauna of STSS in desert regions. This may in turn cause an upset in STSS population dynamics, e.g., the establishment of exotic parasitoids in the fragile ecosystems of the desert oases at Joshua Tree National Park, where the STSS and *Ufens* spp. coexist in a delicate balance, could have dire consequences. Ultimately, we feel that *G. ashmeadi* and *G. fasciatus* are unlikely to physiologically withstand the harsh environment in the desert southwest of California, but the possibility of such interactions is worth consideration.

This retrospective investigation defines an approach that attempts to include not only the physiological and ecological limitations of the exotic agents introduced, but also includes the temporal and spatial elements in determining possible non-target effects. Many of these assessments can be employed prior to release and can be maintained, post-introduction, to effectively monitor the control program. Foraging, flight, searching characteristics and other behaviors can be assessed pre-introduction and the most probable non-targets can be assessed via oviposition, habitat & temporal characteristics. Additionally, surveys in the home range can be conducted to account for possible impacts to the native non-target natural enemy complex. If fortunate, a native natural enemy may be discovered that could be manipulated to control the target invasive species.

In conclusion, via choice & no-choice testing at two scales, parasitoid behavioral studies in the field, non-target habitat monitoring & natural enemy classification, and by determining oviposition, egg, & habitat characteristics of the possible non-target species, we are obtaining information vital to assessing the possible risk posed by these exotic natural enemies of the GWSS and helping to formulate a comprehensive strategy for predicting potential non-target impacts for future biological control endeavors.