ASSESSMENT OF EFFECTS OF SOLENOPSIS PAPUANA ON ARTHROPODS IN OAHU FORESTS

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Background

*Solenopsis papuana* is the most widespread and abundant invasive ant species in the upland forests of both mountain ranges on Oahu. While other more conspicuous ant species often occur in exposed, drier microsites such as ridgetops with short-statured vegetation, *S. papuana* is the only species that can commonly be found under the canopy in the interior of mesic to wet forests, and appears to be nearly ubiquitous above elevations of roughly 1000 ft. Although concern about the ecological effects of this species has been raised for many years, almost no research has been conducted on any aspect of its biology or ecology. I am directing a graduate student in a study of the ecological effects of *S. papuana* on the ground arthropod communities in forests under conservation management. A secondary goal is to attempt to measure effects of *S. papuana* on reproduction in native *Drosophila* flies in the field.

FY15 progress and results

During fiscal year 2015, graduate student Sumiko Ogura-Yamada was hired to conduct the research on this project. Initial work included scouting of various locations in the Waianae and Koolau mountains for presence and abundance of *S. papuana*, in order to determine suitable sites to establish experimental plots. These locations included Palikea, Ekahanui, Kaluua, Puu Hapapa, Pahole and Kahanahaiki in the Waianae Mountains, and the Manoa Cliff restoration site in the Koolau Mountains. Distributional maps of *S. papuana* presence and absence at these localities are shown in the Appendix. These surveys revealed a surprisingly wide range in incidence and/or density of *S. papuana* among sites. *Solenopsis papuana* was sparsely distributed at Palikea, but was nearly ubiquitous at sites like Ekahanui and Puu Hapapa.
Based on these surveys, it was determined to establish six pairs of plots at Ekahanui, Puu Hapapa, Pahole and Kahanahaiki. Each plot pair would serve as a replicate test of the effect of ant suppression on arthropod community composition, wherein ants would be suppressed with pesticide in one of the plots in the pair (treatment), and the other plot in the pair would remain unaltered (control). Arthropod sampling before and after treatment would be used to infer effects of ants on arthropod communities.

Methods for effective treatment and monitoring of *S. papuana* were developed at Lyon Arboretum and Pahole NAR. This included determination of an attractive food bait for the purpose of monitoring, determination of attractiveness and efficacy of pesticidal ant baits for the purpose of suppressing *S. papuana* in experimental plots, and determination of an effective bait station design to limit non-target impacts of the ant suppression treatment.

Four common ant bait attractants were compared: spam, peanut butter, corn syrup, and corn syrup and tuna blend. Spam and peanut butter were both found to be highly effective attractants for this species; peanut butter was chosen as the preferred bait for monitoring and distribution mapping because of its ease of use and lower cost compared to Spam. Five commercial pesticidal ant baits were also evaluated for attractiveness to *S. papuana*: Maxforce Complete (hydramethylnon active ingredient), Amdro (hydramethylnon), Extinguish Plus (hydramethylnon and methoprene), Siesta (metaflumizone), and Advion (indoxacarb). Amdro and Siesta were found to be the most attractive two baits. Amdro has the added advantage of the broadest label language of all of the baits tested, including provisions for use in forested natural areas.

Tests of bait station design indicated that a design used previously for Argentine ants, consisting of a pvc tube capped on both ends with small entry holes in each cap, was ineffective for attracting *S. papuana* to baits housed within. *Solenopsis papuana* forages much less actively than the Argentine ant, and the station design likely inhibited effective bait discovery and recruitment for this smaller, slower-foraging species. A station design that allowed more direct access from the soil and leaf litter proved to be much more effective. This consisted of a single pvc end cap sheltering the bait from above, and fitted with a fine mesh screen over the open bottom which allows access to *S. papuana* but appears to exclude nearly all other arthropods. These stations are staked to the ground with metal wire to keep them upright to exclude rain and maintain the contact between the screened bottom and the ground.

Initial tests of pesticidal bait efficacy indicated that of the two most attractive baits, Siesta was relatively ineffective in controlling *S. papuana*, most likely because of the bait’s rapid activity: large numbers of dead ants were typically found in Siesta bait stations within a few hours, which may limit sharing of the bait throughout *S. papuana* colonies. In contrast, Amdro was found to be effective both when broadcast and when presented within bait stations. This result is now being tested more formally in a series of replicated plots at Pahole NAR, in which efficacy of Amdro is being compared with Siesta. Per HDOA consultation, these tests do not exceed the minimum area threshold that necessitates an Experimental Use Permit. So far, after one month, Amdro bait has resulted in substantially greater reduction in ant numbers compared to Siesta (Figure 1). The initial bait efficacy tests also provided important information on the spatial scale of control. The range of effectiveness of baits (Amdro) for suppressing *S. papuana* appears to be
only approximately 1-2 meters, whether Amdro is broadcast or presented in stations. This is again likely due to the short foraging range and generally low level of activity in this species.

Figure 1. Mean number of ants at peanut butter baits cards in plots treated with Amdro ant bait, Siesta ant bait, and no ant bait (control), after approximately one month. Each treatment group replicated with three plots at Pahole NAR.

The above findings were used to select the methods used in the field plots designed to assess the ecological effects of *S. papuana* on arthropod communities. As mentioned, six pairs of plots were established at four locations in the Waianae mountains. Five of the plot pairs are 20 m by 20 m in dimension, while the sixth pair (one of the two pairs at Ekahanui) is 10 m by 10 m because of restrictive topography. In each plot pair, one was randomly selected as the treatment plot. In each treatment plot, a total of 81 bait stations were installed, with one station every 2.5 m in a grid pattern (25 stations were installed in the 10x10 m plot at Ekahanui). The control plot in each pair received no treatment. Amdro bait was first placed in bait stations from 4/18/15 to 5/7/15, after the initial pre-treatment arthropod sampling. On an approximately 4-6 week interval, ant numbers are monitored and Amdro bait is replaced in the plots. At each of the first three intervals post initial placement, bait station locations were also shifted 1.25 m such that every point within each treatment plot was eventually located no more than 1.25 m from a bait station. This was done to address the short range of efficacy mentioned above. This methodology appears to be working well for suppressing ants in the treatment plots: changes in ant abundances over the first 3 months after treatment are shown in Figure 2.
Figure 2. Changes in ant abundances over time in treatment and control plot pairs. Abundances expressed as percentage of the maximum recorded abundances in each plot.
From 4/19/15-5/7/15, pre-treatment arthropod sampling was conducted in all 12 plots. This included five pitfall traps per plot (open for seven days each), five leaf litter samples per plot, and four vegetation sweeping samples per plot. Most of these 168 samples have been sorted to order, and lower-level identification has begun.

A captive lab colony of *Drosophila crucigera* has been established in Dr. Ken Kaneshiro’s *Drosophila* rearing lab, using six wild-caught individuals provided by Dr. Karl Magnacca. Two individuals of *D. inedita* failed to lay eggs in the lab. *Drosophila crucigera* will be used as a surrogate for listed *Drosophila* species, to investigate potential impacts of *S. papuana* on *Drosophila* reproduction under realistic field conditions. Approximately 50 first-generation adults have been reared, and in the next phase we will attempt to rear a generation of flies in the lab from egg to adult using rotting *Pisonia* branch pieces as oviposition substrate and larval feeding substrate. If successful, this method will be used to place similar branch pieces inoculated with *Drosophila* eggs and/or larvae into field cages in the plots, to test if ant presence affects rates of adult emergence.

FY16 plans

In the second year of this project, we will complete the field efficacy test comparing Amdro and Siesta ant baits at Pahole. We will continue suppressing ants and monitoring their numbers in the treatment field plots by visiting the plots about every 4-6 weeks to replace Amdro bait in the bait stations, for a period of one year after initial bait placement. Post-treatment arthropod monitoring will be conducted at one year post-treatment, and possibly at approximately 6-8 months post treatment to sample during the wet season. Work will continue to attempt to successfully rear *Drosophila crucigera* on *Pisonia* host branch material, and test their emergence rates under field conditions as described above.
Appendix. Distributional maps of *Solenopsis papuana* presence and absence at areas scouted for potential plot locations. Red dots indicate peanut butter bait cards that attracted *S. papuana*, and black dots indicate cards that did not attract *S. papuana*.

Areas surveyed at Ekahanui are 2D site and Palai Gulch.