Distribution of the Little Fire Ant *Wasmannia auropunctata* (Roger) in Hawaii: A partnership of K-12 schools, the University of Hawaii, and the Hawaii Department of Agriculture

Daniel S. Gruner, University of Hawaii at Manoa

Introduction

Biological invasion, or the establishment and spread of non-native (alien or exotic) species, is the most important, pervasive and insidious threat to the conservation of biological diversity in the Hawaiian Islands (Howarth 1985). Social insects in particular have huge potential for destruction in Hawaii because there are no representatives in the native fauna (Wilson 1996). Recently, a new threat to the native Hawaiian fauna has been collected from the vicinity of Hilo, island of Hawaii (Conant and Hirayama 2000). The little fire ant (*Wasmannia auropunctata*) is a slow-moving, small (<2mm) golden or reddish brown ant with a painful sting that can produce large red welts. Native to South America but now widely distributed, *Wasmannia* has negative impacts on diverse systems all over the globe (Fabres and Brown Jr 1978, Lubin 1984, Wetterer et al. 1999). This ant could pose significant problems to our economy, health and environment if it is allowed to spread unabated.

Early indications are that this species is not yet widely established in the islands. Immediate action must be taken to identify the total current range of this species, increase public awareness of its potential economic and biological importance, and take steps towards control or eradication. However, the small size and cryptic habits of the ant have allowed it to elude detection for as many as five years since introduction. If abatement efforts are to succeed, we must recruit help from the general public in order to map the distribution of the ant on a very fine scale.

This report describes outreach efforts aimed towards K-12 students and teachers in the spring of 2000. The goal was to: 1) educate students and teachers about invasive species in general, the little fire ant in particular, and the threat these species pose to island ecosystems, while supporting Hawaii Content and Performance Standards of the Department of Education; and 2) train students to collect ants, and use these data to delineate the current distribution of *Wasmannia auropunctata* on the island of Hawaii.

Methods

Under the auspices of the National Science Foundation GK-12 initiative through the UH EECB Program, I initiated a public awareness program in multiple K-12 schools in the district of East Hawaii. In class exercises, I stressed two important conceptual areas: 1) the wonders of the basic natural history, ecology and evolution of Hawaiian plants and animals, and 2) the conservation problems, alien species in particular, faced by this unique biota.

In the first of two sessions, students were guided through interactive slide discussions of native versus introduced plants and animals, and important concepts were defined. Following the slide presentation, class exercises involved a hands-on inquiry into the mode of colonization of a suite of plants in Hawaii, introduced and native. We encouraged students to think about how plants and animals arrived in the islands, and the time scales involved in natural versus human-aided establishment.

The second session opened with individual students brainstorming all they know about ants and their biology. The class then built a concept map on the chalkboard. Building from this

awareness of their knowledge of ants, students were led through another interactive slide presentation on ant biology, diversity, and social behavior. Students were shown examples of common ants in Hawaii, and distinguishing features of *Wasmannia auropunctata* were discussed in detail. Gruner and Jones then led students on an excursion on the school grounds. Students were trained to collect ants using chopsticks baited with peanut butter that were laid out before class. As homework, students collected ants in a location of their choice. Gruner and N. Reimer (Hawaii Department of Agriculture) identified all ants in student collections to species and assembled a Geographical Information Systems (GIS) map of species distributions.

Results

In late spring of 2000, we visited 9 classes at 4 schools in East Hawaii. 118 student collections were returned, and additional, larger collections were made with students at each of the four schools. One new locality for *Wasmannia auropunctata* was identified in the Waiakea Uka district of Hilo (Figure 1). The Hawaii Department of Agriculture is working with the student and her family to delineate and possibly eradicate this population. From conversations with this family, it was determined that they purchased fish-tailed palms (*Caryota* sp.) from an infested nursery. Furthermore, they donated plants to a neighbor, and the property of that neighbor also was infested (P. Conant, personal communication).

A total of 21 species were collected at peanut butter baits (Table 1). The most common species was *Solenopsis papuana*, which was found in over half of the collections (Table 1, Figure 2). This ant is a close relative of the tropical fire ant *Solenopsis geminata*, which was also encountered frequently (Figure 2). Unlike the tropical fire ant, *S. papuana* is not known to sting people. Because of its strong sting, the tropical fire ant is familiar to many people in Hawaii (D. Gruner, personal observation) and is often confused with the smaller, lighter colored little fire ant *Wasmannia auropunctata*. The second most common species was *Tetramorium simillimum* (Table 1, Figure 2). Rounding out the top five most abundant ants were *Solenopsis geminata*, *Anoplolepis gracilipes* (longlegged ant), and *Monomorium floricola.*

The students also collected one unidentified species (tentatively identified as a species of *Leptothorax*) that is a new record for the Hawaiian Islands, and one unidentified species of *Solenopsis* is a new record for the island of Hawaii (N. Reimer, personal communication).

The locality data and number of ant species at each location was mapped with ARCView GIS software (ESRI). Many of the collection records could not be mapped unambiguously. Twenty records were excluded from use with detailed maps because location data provided by students was missing, too general or else ambiguous. Furthermore, detailed street address baseline data is not consistently available for areas outside of Hilo on East Hawaii Island. Thus, only 49 of 118 (42%) of the collections could be matched to existing geographic locality data (Figure 1). A larger proportion can be mapped to more general geographic locations, but this scale of geographic data may not useful for relocating very small populations of *Wasmannia auropunctata*. In future class exercises, students will be urged to provide detailed street address data to facilitate mapping.

Discussion

Current and future student collections and identifications (verified by myself and experts) will be used to develop an extensive GIS map of the distribution of *Wasmannia auropunctata*. This effort is already successful in its infancy, but much work remains. With an increased understanding of the distribution and abundance of this ant, state personnel can design and

implement a control or eradication program to curtail its spread. It is hoped that K-12 teachers and students will come away with a greater ecological and evolutionary understanding of the Hawaiian biota. Greater sensitivity to the problem of alien species in general may prevent future introductions and create an early warning network of informed citizens. Community support and involvement with conservation issues is crucial to their ultimate success, as evidenced by the ongoing *Miconia calvescens* eradication efforts throughout the islands.

There was one new record for *Wasmannia auropunctata* out of 122 samples examined (including the 4 schoolyard collections). This is a small population in the Waiakea Uka Heights district of Hilo. This is not a large number unless one considers how many locations remain to be sampled. If this encounter ratio of less than 0.8% is true islandwide, then there are many populations yet to be discovered. One hypothesis for the ants introduction and spread is that there is a close association of the ants with fish-tail palms (*Caryota* spp.) (P. Conant, personal communication). This new record supports the hypothesis. The owner did purchase a palm from an infested nursery, and then inadvertently spread the ant when giving a palm to a neighbor.

When these exercises were initiated in the spring of 2000, Gruner knew little more about Hawaii ant species identifications than the average citizen. A great deal of time was spent identifying student ant collections with keys. This experience was most valuable because Gruner can now identify the ants found by students or others, including new species such as the greatly feared red imported fire ant (*Solenopsis invicta*). However, the amount of time spent identifying all the species calls for a new direction in classroom activities. Students will identify ants in the classroom under the tutelage of Gruner or other well-trained students, but they will not attempt to identify all ants to species. Instead, they will use a simple key developed by Ellen VanGelder at the USGS-Biological Resources Division. This key follows a step-by-step elimination of all ants that are not *W. auropunctata*. All ants that may be *W. auropunctata* then will be given to Gruner or another expert for final species determinations.

The two new species found in the first survey are useful new records. It is unlikely that either of these species will constitute a large problem to the environment, economy or human health. However, both new species are comparable in size and color to the little fire ant. This will complicate the identification key created for the classrooms. The new *Solenopsis* species should fall out before the end of the key, but there are now at least 2 species that might be easily confused with *W. auropunctata* to the unpracticed eye: *Leptothorax* sp undet 1, and *Tetramorium simillimum*. As noted previously, *Tetramorium simillimum* appears quite common, so this challenge will arise repeatedly. This ant is quite similar to *Wasmannia auropunctata* in color and size, but unlike the little fire ant, it moves very quickly while still alive. Thus, careful observations of live ants before they are preserved may aid students in identification of *W. auropunctata*. The behavior of *Leptothorax* sp undet 1 is unknown, since only dead specimens have been carefully observed in Hawaii. This species is slightly larger than *W. auropunctata* (~2mm), but it has a similar color and shares a pair of quite long, sharp epinotal spines.

The relative abundance of species found by peanut butter baiting may not reflect the true abundance of ant species on East Hawaii Island. It is well known that baits can create biases in species abundance and diversity data. The peanut butter baits used in this study selectively attract ants to protein and oils, whereas some ants prefer carbohydrate-based foods, at least during a portion of their life cycle (Holldobler and Wilson 1990). Approximately half of the ants known from Hawaii Island were collected in these samples. Especially noteworthy is the complete absence of subfamily Ponerinae, although at least 5 species are known from Hawaii Island. This may reflect biological reactions to peanut butter versus carbohydrate baits, or it may reflect true

differences in distribution due to, for instance, climatic differences around the island. These alternatives cannot be distinguished with the current data.

For the purpose of identifying populations of *Wasmannia auropunctata*, the ultimate goal of this study, peanut butter is effective bait (P. Conant, personal communication). Furthermore, peanut butter is easily obtained or found in almost all households. This benefit to an outreach program may outweigh the benefits of using more efficient baits that are less easily obtained or distributed.

Future effort will be directed at reaching as many classrooms as possible in the next year. It is hoped that more students can be reached by eliminating efforts to identify all ants to species. By involving students with the identification of *Wasmannia auropunctata* as a classroom activity, students will be more involved with the process of inquiry. Gruner also will continue to develop the curriculum so that it may be posted on the web and used by teachers statewide. As it is common practice for horticulturists to transfer their stock among islands, the little fire ant may be established in small populations on other islands in the chain. Thus, a logical extension of this project is to start student surveys on other islands, which is already happening on Maui thanks to the efforts of the Harbinger Insitute. Experience dealing with the little fire ant in this way will help prepare for a dynamic rapid-response effort if other pests, such as the red imported fire ant, make their way to the islands in the future.

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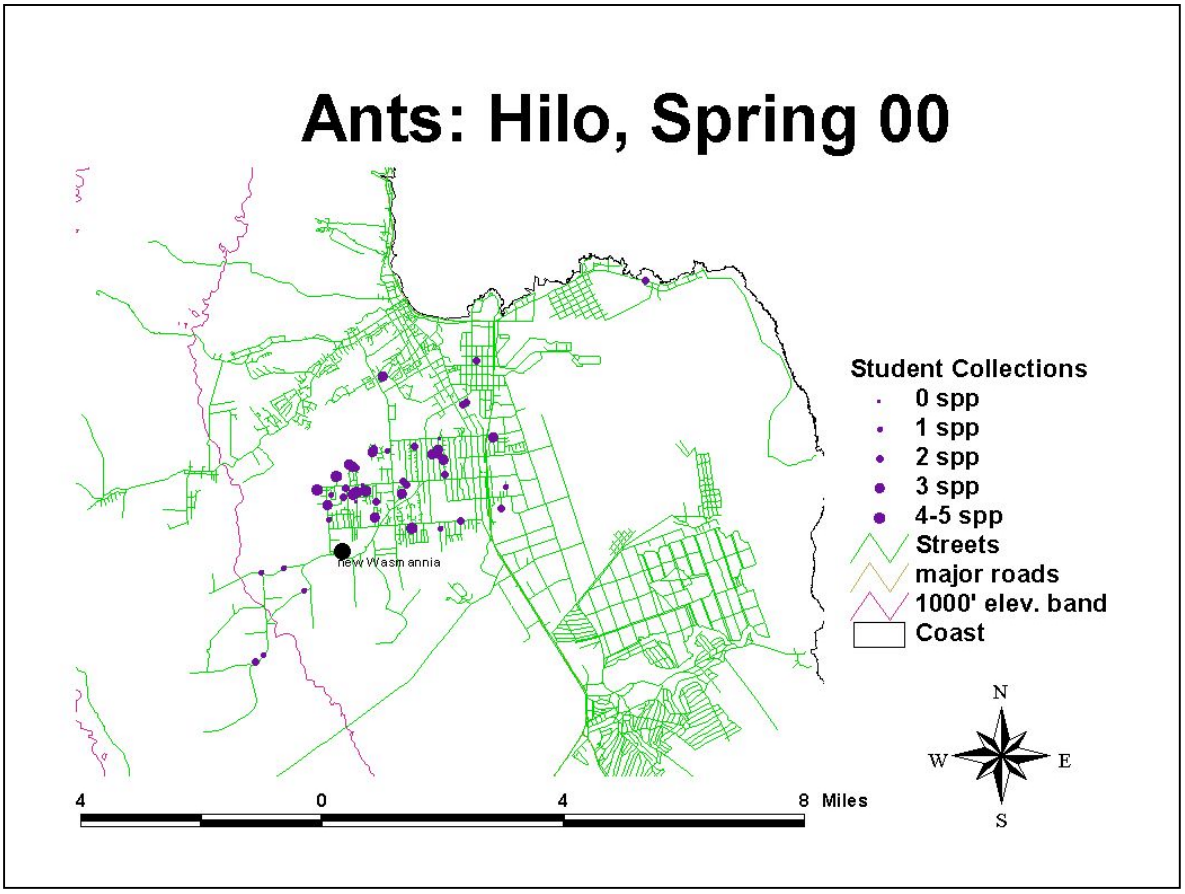

Figure 1: Geographical Information Systems (GIS) map of ants of the greater Hilo area. This data represents only a portion of student data (49/118) because baseline street data for Keaau and Puna were not available. The new locality of *Wasmannia auropunctata* is in black. The size of this point does not represent number of species collected as with the other points on the map.

Table 1: Ant species collected at peanut butter baits by 118 students in 9 classes, 4 schools, spring 2000, East Hawaii Island.

Genus	species	author	common name	frequency	percentage
Subfamily Dolichoderinae					
Tapinoma	*melanocephalum*	(Fabricius), 1793	tiny yellow house ant	1	0.8
Technomyrmex	*albipes*	(F. Smith), 1861		1	0.8
Subfamily Formicinae					
Anoplolepis	*gracilipes*	(F. Smith, 1857)	longlegged ant	24	20.3
Paratrechina	*bourbonica*	(Forel), 1886		5	4.2
Paratrechina	*vaga*	(Forel)		5	4.2
Plagiolepis	*alluaudi*	Emery, 1894	little yellow ant	2	1.7
Subfamily Myrmicinae					
Cardiocondyla	*nuda*	(Mayr), 1866		5	4.2
Monomorium	*floricola*	(Jerdon), 1851		18	15.3
Monomorium	*monomorium*	Bolton, 1987		14	11.9
Monomorium	*pharaonis*	(Linnaeus), 1758	pharaoh ant	8	6.8
Pheidole	*fervens*	F. Smith, 1858		17	14.4
Pheidole	*megacephala*	(Fabricius), 1793	bigheaded ant	7	5.9
Solenopsis	*geminata*	(Fabricius), 1804	fire ant	27	22.9
Solenopsis	*papuana*	Emery, 1900		67	56.8
Solenopsis	sp undet 1			3	2.5
Tetramorium	*bicarinatum*	(Nylander), 1847	Guniea ant	11	9.3
Tetramorium	*insolens*	(F. Smith)		2	1.7
Tetramorium	*simillimum*	(F. Smith), 1851		32	27.1
Tetramorium	*tonganum*	Mayr, 1870		1	0.8
Wasmannia	*auropunctata*	(Roger, 1863)	little fire ant	1	0.8
Leptothorax (?)	sp undet 1			3	2.5

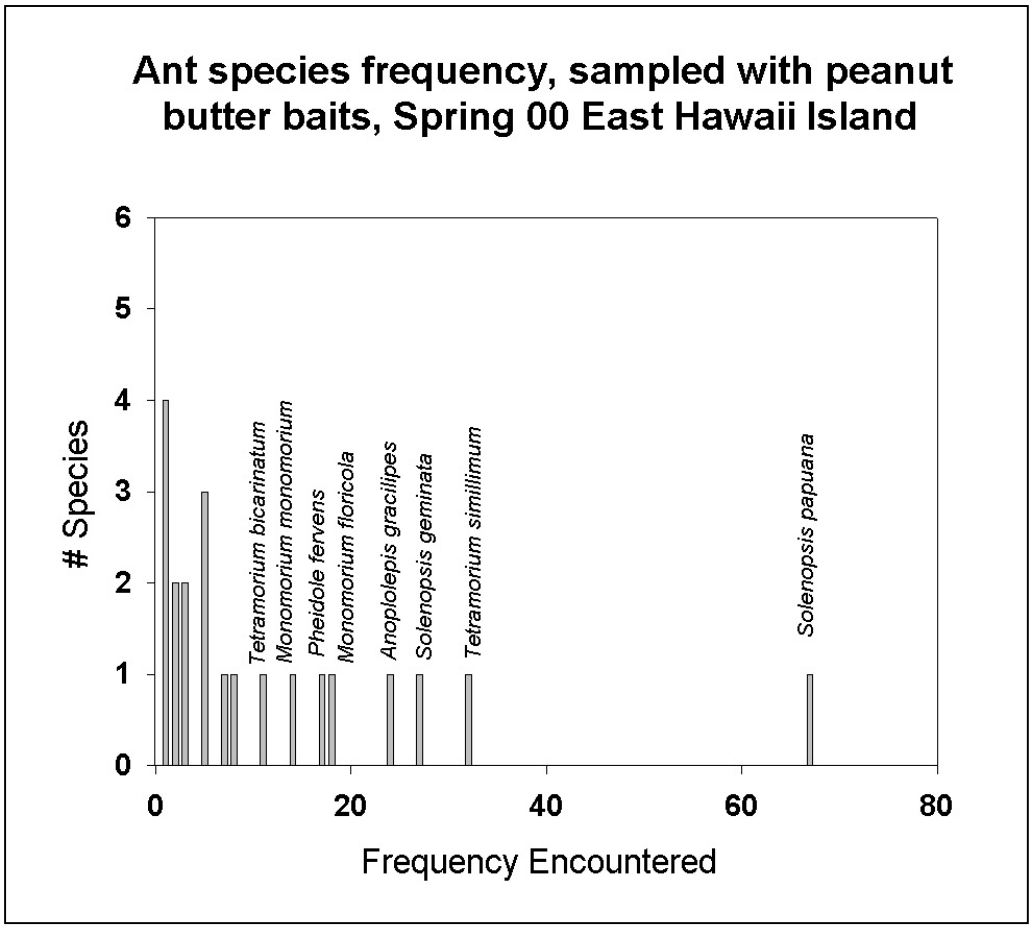

Figure 2: Frequency of ant species collected by students in 118 samples. The eight most common species are listed by scientific name.