MANAGEMENT OF PEST ANTS IN NURSERIES

Prepared by

C. Vanderwoude
Hawai‘i Ant Lab
Pacific Cooperative Studies Unit, University of Hawai‘i
16 E. Lanikaula St Hilo
Hawai‘i 96720

Endorsed by

Big Island Association of Nurserymen
Hawai‘i Export Nursery Association
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of pest ants in nurseries</td>
<td>1</td>
</tr>
<tr>
<td>Background</td>
<td>5</td>
</tr>
<tr>
<td>Project funding and execution</td>
<td>5</td>
</tr>
<tr>
<td>Biosecurity impacts of pest ants</td>
<td>5</td>
</tr>
<tr>
<td>Regulatory requirements</td>
<td>5</td>
</tr>
<tr>
<td>Export certification</td>
<td>6</td>
</tr>
<tr>
<td>Fundamental approach to managing pest ants</td>
<td>6</td>
</tr>
<tr>
<td>IPM – combining physical, management biological and chemical solutions</td>
<td>6</td>
</tr>
<tr>
<td>Physical factors</td>
<td>7</td>
</tr>
<tr>
<td>Nursery design and layout</td>
<td>7</td>
</tr>
<tr>
<td>Habitat reduction</td>
<td>8</td>
</tr>
<tr>
<td>Management factors</td>
<td>8</td>
</tr>
<tr>
<td>Stock and goods inward</td>
<td>8</td>
</tr>
<tr>
<td>Work flow, production flow</td>
<td>8</td>
</tr>
<tr>
<td>Choosing battle lines</td>
<td>8</td>
</tr>
<tr>
<td>Biological solutions</td>
<td>8</td>
</tr>
<tr>
<td>Chemical treatment options</td>
<td>9</td>
</tr>
<tr>
<td>Whole of nursery</td>
<td>9</td>
</tr>
<tr>
<td>(Nursery NOT currently infested with ants)</td>
<td>9</td>
</tr>
<tr>
<td>Whole of nursery</td>
<td>9</td>
</tr>
<tr>
<td>(Nursery IS currently infested with ants)</td>
<td>9</td>
</tr>
<tr>
<td>Protecting stock</td>
<td>10</td>
</tr>
<tr>
<td>Appendix 1. Ant survey methods</td>
<td>12</td>
</tr>
<tr>
<td>Survey to target Little Fire Ants</td>
<td>12</td>
</tr>
<tr>
<td>Survey to target all ant species</td>
<td>13</td>
</tr>
<tr>
<td>Appendix 2. Control options in nurseries: baits and residual sprays</td>
<td>14</td>
</tr>
<tr>
<td>Baits, barriers and contact sprays</td>
<td>14</td>
</tr>
<tr>
<td>Bait them first, then blast them</td>
<td>14</td>
</tr>
<tr>
<td>Baiting basics</td>
<td>14</td>
</tr>
<tr>
<td>Barrier treatments</td>
<td>15</td>
</tr>
<tr>
<td>Dealing with ants around food plants</td>
<td>16</td>
</tr>
<tr>
<td>Controlling ants in vegetation</td>
<td>16</td>
</tr>
<tr>
<td>Appendix 3. An improved spreader for ant baits</td>
<td>18</td>
</tr>
</tbody>
</table>
BACKGROUND

Over the last few years, quarantine requirements for exporters of potted plants, flowers and foliage have become more and more stringent. It is easy to understand that moving plant pests from one location to another is detrimental to the nursery industry but what about pests we have not previously thought of as plant pests? Many insects can hitch a ride with a potted plant, and while they may not harm the plant itself, introducing these pests to new locations can potentially cause other impacts.

Ants are one of these pests. They often do not harm the plants they live in, but some species can cause huge economic and ecological damage when they are introduced to new locations. One such species, the Red Imported Fire Ant (*Solenopsis invicta*) is such a threat that the USDA has specific quarantine requirements for producers moving plants from within the RIFA quarantine zone to locations outside this zone. These requirements include mandatory treatment of stock and potting medium.

Fortunately, Hawai‘i does not have Red Imported Fire Ants. However, there are several other ant species present in Hawai‘i that are subject to restrictions for movement of stock between islands and interstate.

This manual is a guide to current best-practice nursery management options that minimize the impacts of these ant species to export operations.

PROJECT FUNDING AND EXECUTION

USDA Farm Bill

The project has been funded by the **USDA Animal and Plant Health Inspection Service** through section 10201 of the 2008 Farm Bill. One of the priorities of the implementation strategy is to “safeguard nursery production”, and this project was funded under that priority.

Hawai‘i Ant Lab

**The Hawai‘i Ant Lab** is part of the Pacific Cooperative Studies Unit of the University of Hawai‘i. Their charter is to prevent the entry of invasive ant species into Hawai‘i, develop technologies to manage those ant species already present and work to eradicate them where feasible. The Hawai‘i Ant Lab is the lead group in this project, working with the Hawai‘i Department of Agriculture and Dr Arnold Hara of the UH College of Tropical Agriculture and Human Resources.

Participating agencies

Two key industry groups have participated in the development of this manual. The Big Island Association of Nurserymen and the Hawai‘i Export Nursery Association have both endorsed and supported the project.

BIOSECURITY IMPACTS OF PEST ANTS

Shipments of potted plants, foliage, or flowers that are infested with ants are subject to certain quarantine requirements depending on where they are being transported. As a producer, this could affect your business through seized shipments, liability issues, penalties and monetary losses.

REGULATORY REQUIREMENTS

Intra-island (local sale)

Most pest ants are not “regulated species” and therefore there are no regulatory restrictions on the local sale of plants infested with ants. There is one exception to this – Little Fire Ants (*Wasmannia auropunctata*). This is a regulated species under Hawai‘i Revised Statutes (HRS150A) and Hawai‘i Administrative Rules (HAR chapter 4-72). Knowingly moving material infested with LFA is an offense under these laws.

Inter-island sale

The movement of potted plants, foliage, flowers and propagative material from one island to another within the State of Hawai‘i is regulated by the Hawai‘i Department of Agriculture Plant Quarantine Branch. All shipments must either be inspected by an HDOA inspector, or shipped from a nursery certified by the HDOA. In addition to other quarantine pests, inspectors will check for Little Fire Ants. Infested material can not be shipped until it has undergone quarantine treatment. The shipment may be re-inspected at the destination island by HDOA inspectors located there.

Mainland USA

The provisions relating to inter-island shipments apply, and additionally, State laws or regulations in
the receiving state also apply. In most cases, agriculture or quarantine staff in the receiving State inspect incoming shipments also. At this point, detection of any pest ants may trigger a seizure, destruction of the shipment, or return to the origin port.

Hawai‘i Revised Statutes HRS150A can be viewed online:
http://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0150A/HRS_0150A-.htm

Hawai‘i Administrative Rules HAR can be downloaded here:

EXPORT CERTIFICATION

Producers can opt for HDOA nursery certification. This allows growers to export without inspections of individual shipments, and is based on phytosanitary inspections of the benches and/or growing area of stock bound for export. HDOA Plant Quarantine officers will conduct at least two inspections every year to determine whether the export section of the nursery meets required standards. For more information about nursery certification, contact your local HDOA office or go to http://hawaii.gov/hdoa/pi/pq/export.

FUNDAMENTAL APPROACH TO MANAGING PEST ANTS

Integrated Pest Management or IPM is a pest management approach that utilizes all available pest management methods to keep pest populations below pre-determined threshold levels. Each pest management technique must be environmentally sound and compatible with producer objectives. IPM has several components that work together to allow the grower to develop the most efficient and effective pest management strategy:

1. Setting pest thresholds,
2. Survey and scouting,
3. Developing a multi-pronged pest management strategy,

Setting Pest Thresholds

Often, the presence of some pests in a production system causes no economic harm, and sometimes, the presence of even one pest individual is too many. In the case of pest ants as a quarantine problem means the pest threshold must be zero. Where pest ants are causing other problems like farming scale insects or mealybugs, the presence of small, scattered colonies may not actually be causing any real economic damage.

Knowing what pest loads are present, and the identity of the species is therefore an important factor in deciding whether to take action or not. The best way to get this information is through regular scouting or pest surveys.

Survey and Scouting

Regular survey and scouting are essential in any integrated pest management system. Surveying for ants is not difficult and there are three good methods of doing so. In Hawai‘i, where it is warm all year round, these surveys should be conducted several times a year (at least twice).

1. Visual Searching
Pick up random pots at regular intervals and look underneath each pot. Check out both the underside of the pot and that part of the bench where they have been sitting. Any ants scurrying away can be caught using a piece of scotch tape. Simply press the tape down onto the ant and stick it onto a piece of paper. A more thorough inspection entails taking the pot to a solid bench and slapping it down sideways (not enough to damage the plant, but sufficient to dislodge any ants crawling on foliage). If plants are pot-bound, removing them from their pot and tapping the rootball onto the bench will also dislodge any ants living in the potting medium.

2. Survey for Little Fire Ants
There is a protocol for survey of Little Fire Ants in the Appendices on page 12. This entails placing chopsticks or popsicle sticks smeared thinly with some peanut butter into shady spots around the nursery. Intervals of 20-30 ft are ideal. Leave the chopsticks for about 60 minutes, and place them into zip-lock bags. It is helpful to use several bags – one for each part of the nursery because that way it will...
be possible to narrow down the location of any problem ant species.

3. Complete ant survey
Different ant species are attracted to different kinds of food items. Some like sweet things, other prefer proteins and some like oils. A survey for all ant species means it is necessary to use three different kind of baits. This can be done by modifying the Little Fire Ant survey to use different bait types. Instructions for this can be found on page 13. After the survey, they can then be sent to the Department of Agriculture for identification.

Pest identification

Ants are unusual in a pest management context because there is no one-size-fits-all solution. Each ant species has a unique biology and often solutions need to be tailored to suit each individual species. For this reason, knowing which ant species are present in your production system is very important. We have over 50 ant species in Hawai‘i, and most of these are not nursery pests. Only a handful pose problems for the nursery industry. A brief description of the main pest species can be found on page 20. Fortunately, there are many identification resources available to growers. The Hawai‘i Ant Lab, Hawai‘i Department of Agriculture and the College of Tropical Agriculture and Human Resources (CTAHR) are all too pleased to provide identification of any ant species you might find during your scouting and survey activities. There is an illustrated key to all ant species in Hawai‘i on page 24. Once you know the identity of the ant species in your nursery, you are in a much better position to develop a plan of action.

The presence of some ant species may pose no biosecurity or regulatory issues at all, and it is then up to you to determine if they are causing any impacts to your stock. Other ant species can pose substantial problems, especially for inter-island and interstate exports. The most serious of these is the Little Fire Ant. However, interstate agriculture agencies are becoming increasingly cautious about the presence of any ant species.

The nursery “industry” in Hawai‘i is very diverse and ranges from large, high-volume wholesale enterprises, smaller retail establishments that sell direct to the public, to hobbyists who grow plants and sell them at farmers markets and other venues. Your nursery layout has probably “evolved” over the years as your business grows, shrinks, or changes according to market demands. The gradual changes to nursery layout over time result in three key design elements that hamper pest management.

The first is the lack of a clear boundary between the growing area and neighboring properties. Ants do not respect boundaries, and without a clear buffer between your business and neighbors, it can be difficult to manage pest ants. You may be very successful at eliminating an ant problem in your business, but if those ants can re-infest your property from neighboring land, all your efforts could be wasted. If at all possible, establish a cleared buffer around your enterprise. Wider is better, but at a minimum, this should be 6 feet or better. This buffer can be utilized as a “fire-break” between you and the ants beyond.

The second common design element many nurseries have, is the use of wind-breaks or planted areas through the nursery or adjacent to greenhouses or growing areas. These windbreaks often contain palms and other tropical trees. While they may look attractive and serve a useful purpose, they are also a harborage for pest ants and other plant pests. Often it becomes very difficult to manage ant populations when windbreaks are close to growing areas.

A final aspect of nursery layout that can hamper pest management is the presence of “fallow” areas – growing beds or shade-houses containing old pot-bound stock, accumulations of supplies and equipment that are not being used, and unused space in general. This build-up of “stuff” that might be useful one day, unused growing beds or shade-houses are a haven for pest ant populations to establish and develop. Because these areas do not get much attention, they serve as a quiet place for pest populations to build-up unnoticed.

So, wherever possible, change your layout so you have a cleared buffer around your operation, remove unnecessary windbreaks and other vegetation, and keep unused areas of the nursery as tidy as possible. These simple changes will greatly reduce the cost and time needed to manage pest ants in your operation.
HABITAT REDUCTION

The previous section deals with changing the basic layout of a nursery operation to reduce the amount of effort needed to manage nursery pests. It goes hand-in-hand with reducing available habitat. Nursery operations can be frantic and diverse as you respond to market demands. Growing a number of different products with market demands that ebb and flow often results in an accumulation of equipment and supplies necessary for each aspect of your business. One day you need a 1000 1 gallon pots and next week demands change and the left-over pots sit somewhere gathering moss. And... pest ants. Accumulations of pots, cinder, peat and other supplies that are left idle until they are needed, provide excellent habitat for pest ants to establish and spread. Often these piles of unused items are left adjacent to growing beds, shade-houses etc where they pose the biggest threat to your growing stock.

Wherever possible, keep these items organized, and if possible in some central location away from production areas. Spaces around shade houses etc should be clear of equipment, supplies and dunnage. Not only does this prevent ants from sneaking in to your stock, it will make managing these pests much easier and more cost effective.

MANAGEMENT FACTORS

STOCK AND GOODS INWARD

One of the main pathways for pest ants to enter your nursery is through goods moving into the nursery production system from elsewhere. Items such as stock, pots, potting media, landscaping material, items for resale etc, all potentially harbor pest ants. Any materials coming onto the property should be first held in a quarantine area and inspected or surveyed to ensure they are ant free. Refer to the survey protocols at the end of this manual for appropriate methods. Plants being purchased or returns from customers or landscaping projects can also potentially become infested while they are outside your nursery. These should also be quarantined and surveyed.

Trucks, machinery and employees’ vehicles can also harbor ants. Again, ensure a designated car park is used for these vehicles and either survey regularly, or better yet, treat with barriers sprays every 4-6 weeks.

WORK FLOW, PRODUCTION FLOW

A defined work flow is also important, especially when you have production or growing areas you use to harvest cuttings and other propagule material. It’s a good idea to chart out how things move around within the nursery and keep these flows well-defined. As stock moves from one part of the production line to the next, there are different risks of contamination. If there is a pest problem that becomes too difficult or expensive to control, it may be possible to design a management plan in which some areas early in the production chain receive less treatment with control gradually strengthened as the product approach their final stages.

CHOOSING BATTLE LINES

Nursery enterprises are sometimes very large and can span many acres. Treating these larger enterprises can be costly and time consuming. An alternative might be to choose your battle lines and leave certain parts of the property untreated. This approach can work well, especially when planned in conjunction product work flows. The important thing is to have pest-free plants at the end of the production chain, and sometimes it is possible to do this without the need to treat the entire operation.

BIOLOGICAL SOLUTIONS

For many insect pests, the introduction of natural predators or pathogens is the most effective and least costly solution. There are thousands of very successful biocontrol programs that save agriculture millions, even billions of dollars per year. However, most insect pests are solitary – they live out their lives with little or no contact with other insects (except for mating). This means a natural predator, for example, can reduce the pest problem one insect at a time.
Ants are one of the few insect families that live together in a social colony. Each ant has a specific task, and most foraging ants (the ones we actually see) are the older workers assigned to the high-risk task of finding food. A large portion of the colony stays out of sight. All the workers are sterile daughters of a queen. The workers protect the queen and normally she is very difficult to find.\(^1\) If some workers are killed during foraging, by a natural predator for example, the queen simply lays more eggs to replace those lost workers.

Research of potential biocontrols against Little Fire Ants is in its infancy and to date, no potential candidates have been identified and tested. The history of biological control efforts against ants in general has met with mixed success. Three or so species of phorid fly have been released in southern USA to combat the Red Imported Fire Ant (not the Little Fire Ant). They appear to have established well, however, the impact on the Red Imported Fire Ant population has been only slight. Other agents that have been researched for their effect on Red Imported Fire ants include several species of protozoa and a species of fungus. This work has been progressing for some years but at this time has not resulted in a miracle cure. However, together, all the biocontrols will reduce the total Red Imported Fire Ant population somewhat, but not eliminate them.

---

**CHEMICAL TREATMENT OPTIONS**

---

**WHOLE OF NURSERY (NURSERY NOT CURRENTLY INFESTED WITH ANTS)**

If there are no ants of quarantine concern present in the nursery, it is good practice to keep it that way. This avoids having problems at a later time. There are two activities that a grower should do:

1. Regular surveys of the nursery
2. Bait or chemical treatment of the nursery boundary.

**Surveys**

There are three ways that ants can enter the nursery system: purchase of infested plants, potting media or other items, ants traveling on cars and trucks driven by staff, customers and delivery vehicles, and ants spreading from a neighboring property. Good nursery quarantine procedures, hygiene, and designated parking can reduce the risk of the first two pathways, but natural spread from an adjoining property is more difficult. It is important to conduct regular surveys of high-risk areas within the nursery such as car parking areas, quarantine areas and the nursery boundaries. This can be done quickly and easily using the survey procedures on page 12 of this manual. The recommended frequency of this survey type would be 2-4 per year, with at least one survey conducted over the entire property. These survey activities should be backed up by regular treatments around the boundaries and the car parking areas.

**Prophylactic treatment**

Prophylactic treatment refers to treating an area for a pest although it “probably” is not infested. It’s a good approach to take because ant infestations, when colonies are just starting to spread, can be very difficult to detect with a survey. These treatment types can be done using baits or spraying residual pesticides. Baits are preferable, less expensive and easier to apply.

---

**WHOLE OF NURSERY (NURSERY IS CURRENTLY INFESTED WITH ANTS)**

If ants of quarantine concern have infested the nursery, there are two options open to the grower. The first option is to eradicate the ants from the entire nursery, the other option is to eradicate the ants from those sections of the nursery that are most critical – the export benches, packing and processing areas.

Treating an entire nursery is preferable because there is greater certainty that any plants sold or moved from the nursery are ant free. Depending on the type of operation being carried out, either baits, chemical sprays or both can be used. Baits tend to be least expensive, take less time to apply and are more effective over larger areas. An additional benefit is that far less insecticides are used because baits are directly targeted at the ant rather than being applied everywhere.

However, some operations are better suited to treatment by residual insecticides.

---

\(^1\) Some ant species, for example Little Fire Ants, can have many queens within each colony.
Although it is preferable to have an ant-free nursery, and therefore ant-free plants, there may be times when the grower has stock that is infested. Plants and the potting medium can be treated prior to sale or export to ensure they are ant-free. There are three main methods for treating plants: dip, drench and spray with an insecticide; adding controlled release chemicals to the potting media before use, and heat treatment immediately prior to shipment. Each has advantages and disadvantages.

### Dip/drench/spray options

Ants can nest and live in either the potting medium, or the foliage of potted plants (sometimes both). Therefore the entire plant needs to be treated. The most common products available for this are Talstar Select®, (which contains bifenthrin) and Sevin®, (which contains carbaryl).

#### Sevin®

Sevin is a trade name and a number of products are registered under that name. It contains the active ingredient carbaryl. Treatment recommendations are for Sevin RP4®, (EPA reg. 264-335) which is labeled for this purpose. Sevin can be used both as a soil drench and a foliar spray. It provides short-term control provided the foliage and medium is thoroughly treated. Foliage sprays are mixed at a rate of 1.5 oz per gallon and soil drench rate is 0.75 oz per gallon. Make sure the potting medium is already moist and drench with at least 1/5 the pot volume of pesticide mix. Alternatively, immerse them in a bath of pesticide mix for about 30 minutes, allow to drain and return spent mix to the bath.

#### Talstar Select®

This product (EPA reg. 279-3155) is registered for use in nurseries by licensed applicators only. It can be used as both a spray and a drench for potted plants, however the rate depends on the bulk density of your potting medium. Talstar®, applied at this rate provides up to six months control of insects in the potting mix. To calculate your bulk density, use a measuring jug and fill it exactly to the one quart mark with your potting mix compacted as you would for a potted plant. Dry the measured amount in an oven turned on low until no water remains and the mix is perfectly dry. Weigh the dry mixture using a postal scale or good kitchen scale. The chart below shows how many ounces Talstar®, to add to 100 gallons of water. If you use a measuring jug that is oven-proof, you could weigh the jug before filling it and subtract the container weight after weighing.

For both Sevin® and Talstar®, there may be equivalent generic versions available at your chemical supplier.

<table>
<thead>
<tr>
<th>Weight of 1 quart dried medium (oz)</th>
<th>ounces Talstar Select® per 100 gallons water</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.9 or less</td>
<td>2.4</td>
</tr>
<tr>
<td>7.0-11.5</td>
<td>4.8</td>
</tr>
<tr>
<td>11.6-16.1</td>
<td>7.2</td>
</tr>
<tr>
<td>16.2-20.7</td>
<td>9.6</td>
</tr>
<tr>
<td>20.8-25.3</td>
<td>12.0</td>
</tr>
<tr>
<td>25.4-30.0</td>
<td>14.4</td>
</tr>
</tbody>
</table>

Each pot needs to be drenched with at least 1/5 of the pot volume for treatment to be effective.

#### Potting media treatment

It is possible to “pre-treat” the potting medium of nursery stock. Granular products such as Talstar Nursery® and generic equivalents are available and can be used without the need for an applicator license. These products can be dosed to exclude ants for period exceeding two years. Again, the bulk density of the potting medium determines how much Talstar® will be needed. Also, more product is required as the desired length of protection increases. Use the table below to calculate how many pounds need to be added to each cubic yard of potting medium.

<table>
<thead>
<tr>
<th>Weight of 1 quart dried medium (oz)</th>
<th>lbs Talstar per cu. yard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 mth</td>
</tr>
<tr>
<td>6.9 or less</td>
<td>1.0</td>
</tr>
<tr>
<td>7.0-11.5</td>
<td>2.0</td>
</tr>
<tr>
<td>11.6-16.1</td>
<td>3.0</td>
</tr>
<tr>
<td>16.2-20.7</td>
<td>4.0</td>
</tr>
<tr>
<td>20.8-25.3</td>
<td>5.0</td>
</tr>
<tr>
<td>25.4-30.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

#### Heat treatment

Dr Arnold Hara and his team at the Komohana Extension Center (UH College of Tropical Agriculture and Human Resources) have developed novel heat

---

2 This product can not be used on plants already potted-up. It must be added to the potting mix before use.
treatment systems that can eliminate most, if not all living ants from potted plants. The system relies on heating the plant and pot to a temperature hot enough to kill ants but not hot enough to harm the plants. Dr Hara can be contacted through his web page here: http://www.ctahr.hawaii.edu/haraa/

Hot water dip tank for treating nursery plants

Hot water spray room for treating nursery plants

3 Image provided by Dr Arnold Hara, CTAHR

4 Image provided by Dr Arnold Hara, CTAHR
APPENDIX 1. ANT SURVEY METHODS

SURVEY TO TARGET LITTLE FIRE ANTS

Little Fire Ants are the main ant species of quarantine concern for nurseries on the Big Island. A survey to identify if these are present in your nursery is fairly quick and easy using lures. Ants are always foraging around looking for sources of food. By placing the right type of food item at regular intervals, a foraging ant will quickly find it and soon the other ants in the colony join her in retrieving the food. By using lures, the ants come to you, rather than you having to search for them. The best lure for LFA is peanut butter, because they need the oils and proteins to feed the queens and the larvae.

You will need the following items:

1. Smooth peanut butter
2. Wooden coffee stirrers are best, or use chopsticks (cut in half)
3. Quart sized zip-lock bags
4. Road-marking spray paint (optional)

Conducting the survey

The chopsticks can be rather hard to find after they are distributed around the nursery, so its best to mark them using spray paint (red is a good color) so they can be easier to find. Once painted, smear the lightest amount of peanut butter onto the chopsticks or coffee stirrers and place them at approximately 15 foot intervals in a rough grid pattern through the area to be surveyed. Leave them out for one hour or so, then go back and retrieve them. Place any chopsticks with ants on them into a zip-lock bag.

Ideal spots to place lures include the following:

- The base of plant benches
- On the media of potted plants
- The bases of trees
- In the crowns of palms or at the bases of older leaves on bananas,
- At the edges of buildings (especially the northern and eastern sides)
- Near or under piles of tree trimmings, stacks of old pots, cracks or splits in weed matting
- Under trees in wind breaks

You can divide the nursery area into sections and place all the chopsticks from one section into the same zip-lock bag. Don’t forget to write the location onto each zip-lock bag. Once you have collected all the lures, place the bags in the freezer overnight and bring them to an entomologist for identification. Your local Hawai‘i Department of Agriculture office can arrange to have them identified. Alternatively, send them directly to the Hawai‘i Ant lab.

A typical Little Fire Ant lure - chopstick with peanut butter placed in a shady area on the ground

Little Fire Ant lure deployed on a banana plant
Tips for a better survey

- LFA like shady moist places – always try to place the lures away from the sun
- If you have a banana patch or palm trees, place at least some lures in these. The best location is where the older leaves join onto the stem, as well as in the trash at the base of the plant. There is an image in the presentation showing the best spot.
- LFA are VERY small, a uniform orange color, and walk fairly slowly. If the ants you see are black, or fast moving, or are more than one color, they probably are not LFA.

Little Fire Ants are

- Very small – probably the smallest ant you have seen
- An orange-red color all over
- Very slow moving unless disturbed
- Will often fall from the chopstick as you pick it up

Images of Little Fire Ants on lures

SURVEY TO TARGET ALL ANT SPECIES

Every ant species has their own preferred types of food. Peanut butter works well for ants that like proteins or oils, but some ants prefer sweet foods and other ant species like only proteins. In order to survey for all ant species, it is necessary to place a wider variety of lures.

The survey method for Little Fire Ants is quick and easy. It can be modified to capture a wider variety of ant species by placing a wider variety of food types. For this type of survey, you will need the additional items:

- Cane sugar or karō syrup
- A can of tuna or similar fish

Using one part cane sugar or karō, blend with 3 parts warm water to make a light sweet liquid. Blend the canned fish in a separate container with enough water to make a thin slurry (like a fish smoothie). Prepare 1/3 of the chopsticks by placing the unpainted ends in the sugar mixture for at least an hour. Do the same for the fish mix, and prepare the peanut butter sticks as usual. The watery sugar mix and the fish mix will soak into the chopsticks and they can be lightly patted dry to make them easier to handle.

Now conduct your survey as before, but place the different lure types in an alternating pattern: one peanut butter, then a sugar lure, then fish. Collect them as before. The fish lures will become unpleasant to handle if left unfrozen, so please make sure to leave them in the freezer until just before bringing them in for identification.
APPENDIX 2. CONTROL OPTIONS IN NURSERIES: BAITS AND RESIDUAL SPRAYS

The array of pesticides on the shelf at your local garden exchange or hardware store can be mystifying. There are dozens of different proprietary products available and it can be very difficult to know which is the right one for your situation. Some are liquids, some are granules, they can be in small bottles or huge bags, in ready to use spray bottles or concentrates... So, which one do you buy?

BAITS, BARRIERS AND CONTACT SPRAYS

Pesticides for ant control can be divided into three main types: baits, barrier treatments, and contact sprays. Each of these work differently and it’s important to know which is which.

Ant baits

are an attractive food laced with a toxin (usually a very small amount). Most baits for outside use are in a granular form to make them easier to spread. Liquid baits are mostly used inside a home in bait stations. Ants harvest baits and take it back to the nest where it shared with the rest of the colony. Once the toxin takes effect most or all of the ants are killed. Different ant species prefer different food types so it’s important to match up the bait with the ant species you are trying to control. Baits are the recommended first-line treatment because they are very effective and also minimize the use of pesticides.

Barrier treatments

can come in a spray form or a granule, and can be applied to the soil, hard surfaces or vegetation. They contain a toxin that has a residual effect and can stay active for a month or even longer. Once they are deployed, any ants that wander across a treated surface will come into contact with the chemical and die.

Contact sprays

are used to directly spray a target pest. They are useful for spraying spiders, flies or other bugs that you discover in your home. Often contact sprays are sold in pressurized aerosol cans which can be aimed at the offending insect or spider.

BAIT THEM FIRST, THEN BLAST THEM

The best way to manage Little Fire Ants around the nursery is to use a dual approach of baiting and barrier treatments. It’s important to use them properly because even small differences to your application method can lead to big differences in results. First, NEVER apply a bait and a barrier treatment at the same time. Why?... Well, baits work when ants bring them back to the colony and share them with all the workers (and also to tell the others where to get more bait). If a worker ant is carrying some bait back to the nest and crosses over a barrier treatment, she will die before being able to get back to the colony. One treatment will cancel out the other and you will be wasting your hard-earned cash.

So, bait first and give the baits enough time to have an effect – around 2 weeks is good. Then, apply barrier treatments. Continue to repeat this sequence for 3-4 months or until ant numbers drop to a level you are comfortable with. At this point, increase the amount of time between treatments to 1 month (bait, then apply the barrier treatment a month later, followed by baiting a month after that etc.).

BAITING BASICS

• Read the label
• Do not use old bait
• Treat in dry weather
• Treat your entire property

Always read the label directions for the product you intend to use. The label is a legal document and specifies what you can and cannot do. It will also list any precautions you should take and any personal protective equipment you should wear while mixing or applying the product.

The baits most suitable for control of Little Fire Ants all look very similar – small yellow granules around % inch in size. The granules are actually corn grits which have been infused with vegetable oil and a toxin. They are most easily spread using a small
fertilizer spreader. Instructions for improving the performance of these inexpensive spreaders can be found in the appendices.

Once the bottle has been opened, the baits will quickly deteriorate and become rancid, so its best to use the whole container rather than storing left-over bait for next time. Bad bait will not be attractive to ants and they will not feed on it. Most baits come in different pack sizes, so buy the size that is sufficient to treat your property once. This way your bait will always be fresh.

Rainfall makes the bait soggy and unattractive to ants. Try to pick a dry day for applying baits. In places where this is difficult, a dry period of around 4 hours after treatment should be sufficient time for ants to find the granules and take them to the nest. After a day or so, the baits are no longer effective even without rainfall.

One mistake a lot of people make is to only spread bait in places where they have seen ants. It is very important to treat your entire property because Little Fire Ants have lots of small nests and often we do not know where they all are. So, walk over the entire property and systematically apply the bait to every section.

The Hawai`i Ant Lab has tested several bait products available in Hawai`i. Some are good and others, not so good.

- **Amdro®** is sold at most garden exchanges, hardware stores and chemical supply companies, under several different names. This product seems to be consistently effective and is very popular.
- **Probait®** is sold at chemical supply companies, and is similar to Amdro®. Usually it is sold in larger jugs. This product is also a consistent performer.
- **Maxforce Complete®** is sold at chemical supply companies and has a very attractive bait matrix. It is a little more expensive than other products but we have found it to be extremely effective.
- **Extinguish Plus®** is also available at some locations. It is moderately attractive and not as effective as other products.
- **Advion® fire ant bait** is sold as a professional use only product. We have found performance of this product to be rather inconsistent.

Sometimes it is effective and at other times performs poorly.

- **Tango®** is a new product recently registered in Hawai`i. It is a concentrate intended to be mixed with a bait matrix of your choosing. A recipe for mixing this bait is appended to this manual. This matrix forms a gel so it can be applied into trees and other vegetation.

### BARRIER TREATMENTS

- **Read the product label**
- **Do not mix barrier treatments and bait treatments**
- **Use a different spreader when using granular baits**
- **Apply to wet soil or when rain is expected**
- **Make a wide band – 3-6 feet wide**

Always read the label directions for the product you intend to use. The label is a legal document and specifies what you can and can not do. It will also list any precautions you should take and any personal protective equipment you should wear while mixing or applying the product.

Barrier treatments are insecticides that are sprayed or sprinkled around areas where ants are to be excluded. As ants and other insects crawl over the treated areas, they come into contact with the toxin and are killed. Barrier treatments usually have a residual activity and can provide protection for months.

Granular barrier treatments are the easiest to apply because there is no mixing required. This also makes it a bit safer because you will not be handling concentrated chemicals. The easiest way to spread granular barrier treatments is with a simple fertilizer spreader, just like baits. However, it is good practice to have 2 spreaders – one for use with baits and the other for the barrier treatment (mark each one with a marker pen so you know which is which). If you use the same spreader for both jobs, it is possible you might taint the baits with traces of the barrier granules. The ants could be repelled by the smell of the barrier granules and not feed on the bait. A reminder here that it is not a good idea to apply a barrier treatment at the same time as a bait because, the ants carrying the baits back to the nest will be killed and the colony might
survive. Always apply the barrier treatment around 2 weeks after you have applied baits.

The chemicals in barrier treatments need to stick to the soil particles for them to work and the best time to apply these products is when the ground is wet or rain is expected soon. This helps the binding process needed for the chemicals to work. If the soil is dry when you want to apply these products, you can wet the ground with a garden hose or sprinkler after applying the treatment. Generally around Hilo, this will not be necessary!

The more ground you treat, the better the effect of a barrier treatment. However, if you want to limit your use of chemicals, you can just sprinkle or spray those parts of your lot where you want the most protection such as around the home and the lawn areas used by people or pets. A barrier treatment around your home should be at least 3 feet wide and preferably 6 feet.

#### DEALING WITH ANTS AROUND FOOD PLANTS

Many pesticides are not registered for use on food plants. This is because the Environmental Protection Agency has very strict guidelines for registering pesticides to be used on crops. Therefore, there are less products available for treating ants in food crops, and often a product will be registered for one crop but not another. Usually the “popular” crops have more products available, but unfortunately for growers in Hawaii, the crops and fruits we grow here are often not on product labels. Chemical companies are required to carefully test their products for residues in each crop they wish to list on their labels, and each test can be very expensive. Many crops and fruits grown here in Hawaii are not grown anywhere else in the USA and the cost of testing these is too great to make it economically worthwhile.

There are several bait products available in Hawaii registered for use on a broad range of crops. These are listed below. However, be sure to read the label carefully to make sure your crop or fruit is listed. You can download many product labels mentioned in this fact sheet by going to the LittleFireAnts.com industry web page (http://www.littlefireants.com/index_files/Page3284.htm) or the Hawaii Pesticide Information Retrieval System (HPIRS) maintained by University of Hawaii College of Tropical Agriculture and Human Resources at Manoa (http://state.ceris.purdue.edu/doc/hi/statehi.html). Bait available for use on or near food plants include the following:

- **Extinguish PRO®** is a bait containing methoprene. It should not be confused with **Extinguish PLUS®** which is not registered for food plants. In standard palatability testing conducted by Hawai‘i Ant Lab, this product was not attractive to little fire ants. Although the active ingredient is effective, if ants do not feed on the bait, the product will not work. Further testing with different rates of the active ingredient showed that the ants appeared to be repelled by higher rates of methoprene.

- **Esteem Fire Ant Bait®** is another bait registered for use on many food plants. It contains pyriproxyfen as the active ingredient. Like Extinguish®, ants seem to be repelled by the bait and do not feed on it to any great extent.

- **Tango®** (see above) is registered for use on and under food plants also. It contains methoprene as well, but a lower rate than Extinguish®. This product appears to be very effective and safe.

#### CONTROLLING ANTS IN VEGETATION

**Safety precautions for all pesticides**

**ALWAYS** read the label of the product you buy very carefully to make sure your plant species and situation is listed.

*Follow ALL safety directions on the label.*

**ALWAYS** make sure to keep other people and pets away from the treated plants until they are completely drv

Little Fire Ants often nest in the foliage and branches of trees. These may not be well controlled with standard bait applications because the tree-dwelling ants do not always forage on the ground. Most baits are granular and so can not be applied to trees. Tango® gel baits can be applied to trees so this is virtually the only effective bait option in trees.

16 | Page
The other option for controlling little fire ants in trees is to spray the trees with pesticides. Good general-use pesticides for spraying foliage are products containing carbaryl as most proprietary products containing this active ingredient are registered for many food plants as well as ornamental plants. Gardens in Hawaii often contain a mixture of food and ornamental plants so these products can be used for both. Carbaryl does not have a residual effect so its important to thoroughly wet the entire plant, making sure you observe any withholding periods for fruits and vegetables listed on the label.

There are other products that can be used on ornamental plants only. Products containing bifenthrin often have instructions for spraying ornamental plants. Bifenthrin is a residual insecticide which means it continues to be effective on ants that walk over treated surfaces for some weeks after application.

These products come in a concentrate form which need mixing with water in a spray tank, or in a ready-to-use form where you simply connect your garden hose to the container. When spraying plants, make sure to thoroughly wet cracks, crevices, moss and other places where ants hide.

Choose a calm day with little or no wind for spraying foliage. Be very careful to always wear the protective equipment recommended on the label and be especially careful when spraying tall plants that the spray doesn't drift onto yourself or into a neighbour's property. Always spray away from yourself and make sure the wind is blowing away from you so that the spray does not drift back. Even if the label does not specify it, Hawaii Ant Lab recommends wearing eye protection (safety glasses, goggles etc), a chemical resistant hat, and a mask whenever spraying vegetation taller than 5 feet.
APPENDIX 3. AN IMPROVED SPREADER FOR ANT BAITS

Often people tell me they spread ant baits like Amdro™, Esteem™, Maxforce™ and others by placing little clumps around where they see the ants. Little Fire Ants have very small nests but there might be thousands of them all around your house. By spreading the bait in just a few places, you might knock out the nests nearby but leave many nests untreated. Its always best to spread the bait as evenly as you can over your entire house-lot.

The easiest and cheapest way to do this is to buy a home fertilizer spreader. Home Depot normally carry the Scott™ brand for around $15, but there are others on the market that are very similar. They all seem to have 2 major drawbacks:

- the bait “clumps” in the hopper and does not spread evenly. This happens because the agitator built into the hopper is designed for heavier granules like fertilizer and will not agitate the ant bait enough to keep it flowing.

- The spreaders have an adjustable opening that lets you set how much product comes out. This is held open by a spring-loader trigger which needs to be held down the whole time you are applying the bait. After a few minutes, my “trigger finger” begins to hurt from the strain.

Here are some ways you can modify these cheaper spreaders to make them easier to use. You don’t need many tools, and its fairly simple⁵.

---

⁵Thanks to Jason Reberger who first showed me these tricks a few years ago.

---

A Scott™ “Handy Green” fertilizer spreader. Similar spreaders are also available.

---

IMPROVING THE AGITATOR

The agitator is the orange plastic “T” shaped device in the bottom of the hopper. This can easily be pulled out. Wrap a small cable tie around the stem and tighten the tie as tightly as possible. Then cut it down so an inch or so is left sticking out. The cable tie should wrap around the stem in an anti-clockwise direction when viewed from above so when it is in the hopper, it is wrapped the way shown in the figures below.

Cut the cable tie down to leave a one inch end. Cut the tie after placing it onto the stem so it will be easier to tighten.
Cable tie ready to be placed onto the agitator stem.

modified agitator in place and ready for use

Screw holding the trigger permanently open.

SOME CAUTIONS

1. With the opening in the hopper open all the time, be careful not to let bait dribble out of the spreader until you are ready to start.

2. Any modifications are probably going to void the manufacturer's warranty.

3. You do all this at your own risk. I'm not responsible for any damage you may cause to or by the spreader...

4. The spreader shown in this fact sheet is for demonstration purposes only and is not an endorsement or recommendation.

Now you are ready to go. Happy ant killing!

LOCKING THE TRIGGER

Hold the trigger open at your desired setting. Usually #1 is sufficient, but a better position is half way between #1 and #2. Then drill a small pilot hole and drive a self tapping screw through the assembly so the trigger remains open.

---

6. Set the trigger at 2 then manually hold the trigger so the opening on the hopper is bigger than #1 and smaller than #2 while drilling the pilot hole.
APPENDIX 4. TARGET SPECIES BIOLOGY

LITTLE FIRE ANTS

Scientific name:
The scientific name for this species is *Wasmannia auropunctata*. Around the world it is also known as the "cocoa tree ant" and the "electric ant".

Origins:
Little Fire Ants (LFA) are originally from south America, east of the Andes. It has been spreading around the world for over 100 years.

Known distribution:
USA (Florida), Caribbean islands, west Africa, Israel, Papua New Guinea, Solomon Islands, New Caledonia, French Polynesia, Hawai‘i (Big Island and Kauai), Australia, Galapagos, Guam.

On the island of Hawai‘i, it is common and widespread from Kalapana to Laupahoehoe up to an elevation of 2000 ft and sparsely distributed in Kailua-Kona on the west coast. A small population has been found near Kailihiwai Bay. A small infestation was discovered on Maui in Waihee but this has been eradicated.

Biology:
Little Fire Ants are a rainforest species, and nest on the ground, in leaf litter and in vegetation. They have many small inter-connected nests rather than one main colony. Instead of a single queen, Little Fire Ant colonies have many queens – each laying eggs. This results in a virtual blanket of nests reaching from the ground to the canopy. They prefer sites that are shaded, warm and moist. and generally avoid full sunlight.

Nurseries and potted plants (especially under shade) are a perfect habitat for this species. Each potted plant can contain one or more nests in the potting medium, under the pot and in the plant being grown. Often nursery benches are supported by cinder blocks and the gaps between these blocks also host other colonies. Each potted plant, when moved, can start a new infestation at its destination.

The predominant sources of food for this species are the sugars produced by scales, mealybugs and other hemiptera like whiteflies and aphids. Little Fire Ants “ranch” these plant pests, moving them to new locations and protecting them from their natural enemies.

Impacts:
The association between Little Fire Ants and homopteran plant pests can cause damage to the host plants and reduce productivity of fruiting trees and reduced growth of ornamental plants. Additionally, Little Fire Ants have a painful sting, and infested sites often have many millions of these ants per acre. Ants foraging on vegetation often fall to the ground and on people or pets. It is common for people in infested areas to suffer repeated stings on the neck, shoulders and torso.

Domestic pets can be blinded by repeated stings on their eyes. Once Little Fire Ants become well established in a new location, they will invade homes in search of food and new nesting sites. In these situations, people are often stung in their beds and children often become victims.

By this stage of development, it is almost impossible to eradicate them and residents are forced into a continuing cycle of repeated applications of baits and pesticides. Some people choose to move to uninfested locations in order to avoid this problem.

WHITE-FOOTED ANTS

Scientific name:
The scientific name for the White Footed Ant is *Technomyrmex difficilis*. This ant was previously identified as *Technomyrmex albipes* until 2007. It is also known as the “Black House” ant around the world.

Origins:
Native to Southeast Asia, White Footed Ants have spread throughout the world mainly through the transport of cargo and other commodities.

Known distribution:
USA (Florida, South Carolina, Georgia, Louisiana, Hawaii), Antigua, Nevis, Puerto Rico, St. Croix and St. Thomas. In Hawaii WFA is currently known from Maui, Oahu and Kahoolawe. This species is a part of group of *Technomyrmex* species that look almost identical to one another, so it is probable this species may be established on other Hawaiian Islands.

Biology:
Little Fire Ants are a rainforest species, and nest on the ground, in leaf litter and in vegetation. They have many small inter-connected nests rather than one main colony. Instead of a single queen, Little Fire Ant colonies have many queens – each laying eggs. This results in a virtual blanket of nests reaching from the ground to the canopy. They prefer sites that are shaded, warm and moist. and generally avoid full sunlight.

Nurseries and potted plants (especially under shade) are a perfect habitat for this species. Each potted plant can contain one or more nests in the potting medium, under the pot and in the plant being grown. Often nursery benches are supported by cinder blocks and the gaps between these blocks also host other colonies. Each potted plant, when moved, can start a new infestation at its destination.

The predominant sources of food for this species are the sugars produced by scales, mealybugs and other hemiptera like whiteflies and aphids. Little Fire Ants “ranch” these plant pests, moving them to new locations and protecting them from their natural enemies.

Impacts:
The association between Little Fire Ants and homopteran plant pests can cause damage to the host plants and reduce productivity of fruiting trees and reduced growth of ornamental plants. Additionally, Little Fire Ants have a painful sting, and infested sites often have many millions of these ants per acre. Ants foraging on vegetation often fall to the ground and on people or pets. It is common for people in infested areas to suffer repeated stings on the neck, shoulders and torso.

Domestic pets can be blinded by repeated stings on their eyes. Once Little Fire Ants become well established in a new location, they will invade homes in search of food and new nesting sites. In these situations, people are often stung in their beds and children often become victims.

By this stage of development, it is almost impossible to eradicate them and residents are forced into a continuing cycle of repeated applications of baits and pesticides. Some people choose to move to uninfested locations in order to avoid this problem.
White Footed Ants (WFA) will nest in almost any location inside and outside of the house including under roofs, cardboard boxes, compost piles, potted plants, outdoor furniture, etc... but trees seem to be ideal. Colony sizes can range from 400,000 to 3 million individuals. Because of the enormous size of the colonies, large amounts of food are essential to sustain the populations. WFA will feed on a wide variety of food sources including sugary substances and dead insects.

Unlike many other ant species, WFA do not share food with the rest of the colony. This makes control with baits very difficult because only about half of the colony will be killed (those ants that foraged on and ate the bait). The sterile female worker ants lay unfertilized eggs ("trophic eggs") which are used as a food source for the non-foraging ants in the colony.

Like other "tramp ant" species, WFA spread rapidly through movement of infested material such as household waste, plant material, potted plants, etc. They have enormous reproductive capabilities and new colonies within an area are founded via swarming as well as budding (a subsection of the colony moves to a new location with a queen to begin a new colony).

Impacts:
White Footed Ants (WFA) do not bite or sting. They are considered a pest primarily due to their sheer numbers, which can seem never ending. WFA are also known to tend homopteran plant pests such as scale insects, aphids and mealy bugs and feeding on the sweet sugary honeydew produced by these insects. It has been documented that this association has contributed to the spread of several serious plant diseases around the world. Because WFA are very attracted to sweets they are considered a major nuisance in homes, gardens, greenhouses, and orchards.

As its name suggests, this species was originally from south America with its native range centered on the Paraná river catchment which spans Brazil, Paraguay and Argentina.

Known distribution:
Argentine ants have been widely distributed by human commerce during the early part of the 20th century and are now found worldwide, including Europe, USA, South America, Australia, Africa and Asia as well as many islands in the Pacific.

It is a common species on all the islands of Hawai‘i and is usually found at mid-high elevations. At lower elevations, it is out-competed by Big-Headed Ants.

Biology:
This species prefers a Mediterranean climate with warm dry summers and cool wet winters. However, in the absence of competition from other ant species, it can establish and thrive in warmer and cooler climates.

Impacts:
Argentine ants are a serious ecological pest, disrupting native ecosystems and is also a structural pest – often invading homes and urban buildings.

Scientific name:
The scientific name for Argentine Ants is Linepithema humile. Until about 20 years ago it was known as Iridomyrmex humilis. Worldwide it is known as the Argentine Ant.

Origins:
ARGENTINE ANTS

SINGAPORE ANTS

Scientific name:
The scientific name for the Singapore Ant is Monomorium destructor. It is also commonly known as the “destructive trailing ant” and “mizo-hime-arī” (Japan) around the world.

Origins:
Singapore Ants are native to India, Japan, Malaysia and Sri Lanka and are easily spread around the world through commerce and trade.

Known distribution:
Australasia-Pacific, North America, South America, Africa, Laysan, French Frigate Shoals, Hawai‘i. In Hawaii it is currently known to be established on Hawaii, Kauai and Oahu.

Biology:
Singapore Ant will nest in a variety of places but appear to be unable to establish themselves in undisturbed
habitats such as forested areas. They are often found in urban areas as well as irrigated gardens, orchards, and rural areas. Singapore Ants spread quickly over long distances through human transportation of infested materials but will spread short distances through budding.

They forage on a variety of food sources from dead and live insects to sugary honeydew from plant sucking insects and nectar.

Impacts:

Singapore Ants are more of a pest in urban environments and as a house pest. Although they will forage on sugars and proteins the biggest problem is the destruction of electrical and phone lines. "Foragers gnaw holes in fabric and rubber goods, remove rubber insulation from electric and phone lines, and damage polyethylene cable" (Global Invasive Species Database). They can destroy or damage electrical lines in houses and cars which can lead to electrical fires.

BIG-HEADED ANTS

Scientific name:

The scientific name for the Big Headed Ant is *Pheidole megacephala*. It is also known as the “brown house-ant”, “coastal brown-ant”, “lion ant”, and “Grosskopfameise” (German) in other parts of the world.

Origins:

The Big Headed Ant is believed to be native to southern Africa.

Known distribution:

It is widely distributed throughout the temperate sub-tropical and tropical regions of the world.

Biology:

Big Headed Ants get their name from the “major caste” of worker ants (often called soldiers) which have extremely large heads compared to the rest of their bodies. The smaller “minor caste” (small foraging ants) will forage on almost anything from sweet sugary liquids, dead insects, and plant seeds. They bring the food back to the nest where it is shared throughout the colony.

Colonies generally have multiple queens which can lay hundreds of eggs each day. The transportation of infested materials is known to distribute BHA over long distances, but they can also spread locally via budding and swarming depending on the climate.

The Big Headed Ant (BHA) can establish its self practically anywhere. Colonies may be found in agricultural areas, coastal areas, forest (natural and planted), wetlands, range/pastures, as well as urban/residential areas.

Impacts:

In urban/residential areas they often cause considerable damage to telephone and electrical lines in homes and buildings.

PENNANT ANTS

Scientific name:

The scientific name for the Pennant Ant is *Tetramorium bicarinatum*. It is also known as the “Bicolored Pennant Ant”, “Guinea Ant”, or “Penny Ant”. The name Guinea Ant is also commonly used for a close relative *Tetramorium guineense*.

Origins:

The Pennant Ant is native to the Indo-Pacific region of the world.

Known distribution:

This is a cosmopolitan species commonly found around the world and is one of the most widespread species of ants globally. In Hawaii it is most likely established on all of the major islands.

Biology:

Colonies of Pennant Ants are usually small to moderate in size and occur in urban environments, yards, gardens, green/shade houses. Nests can have multiple queens and workers can vary in color and size. It is believed that inseminated queens can found new colonies without the aid of worker ants. Pennant Ants
are generalists in their diet and will feed on almost anything.

Impacts:

Although they are not considered to be a major pest, they can be a nuisance around the home and garden because of their ability to sting if provoked.
APPENDIX 5. KEY TO IDENTIFYING ANTS IN HAWAI’I

Glossary of Terminology

- Antennal Scrobes: A depressed area on the front of the head where the antenna lie when in rest.
- Anepisternum: The area of the mesothorax.
- Appressed: Laying flat against the body (i.e., appressed setae).
- Carina: A ridge, usually long. Common on the head of an ant and marks where the antenna scape rests against the head.
- Clypeus: The part of the face that is directly above the mandibles (“upper lip”).
- Clypeal Tooth: A pointed projection(s) on the clypeus. May be difficult to see.
- Coxa: The very first segment of the leg.
- Dorsal: On the top surface.
- Dorsal view: Looking down, from above (opposite of ventral).
- Frontal: The view showing the “face” of the ant (opposite of posterior).
- Gaster: The “butt” of the ant.
- Mandibles: The “jaws” of the ant.
- Mesonotum: The middle part of the thorax.
- Metanotum: The upper and front portion of the propodeum.
- Occiput (Occipital): The back of the head. Behind where the ocelli are located on queen and reproductive ants.
- Petiole: The waist of the ant. May consist of 1 or 2 segments or may be completely absent.
- Posterior: The rear, or the view from the rear (opposite of frontal).
- Post petiole: The second segment of the waist (if present).
- Profile view: The view of an ant that shows the body, legs, gaster to the right and head to the left.
- Propodeum: The rear section of the thorax where the petiole (waist) connects.
- Propodeal Spines: Spines (usually 2) that arise from the rear of the thorax (propodeum).
- Reticulate: Consisting of a network of veins that looks like a net or covered in fine bumps.
- Setae: A thick, bristle-like hair.
- Scape: The first segment of the antenna (long).
- Suture: A line made by the connecting of 2 or more exoskeletal plates such as the separation between the mesonotum and propodeum.
- Tarsus: The segments of the leg that comes after the tibia.
- Tergites: Dorsal plate-like segments (i.e., gastric tergites).
- Tibia: 3rd leg segment; segment after the femur.
- Thorax: The “body” of the ant.
- Ventral: On the underside.
- Ventral view: Looking from the bottom upwards (opposite of dorsal).
Morphological characteristics of an ant

**HEAD (frontal view)**

- frontal carina
- scrobe
- eye
- scape
- clypeus
- mandibles

**Body and legs**

- occiput
- pronotum
- mesonotum
- propodeum
- petiole
- post-petiole
- gaster
- femur
- tibia
- tarsi

Original artwork by Neila Monansolo Vanderwoude
KEY TO SUB FAMILIES OF ANTS IN HAWAII

1 2-segmented petiole, very large bulging eyes (1a) .......................................................... Pseudomyrmecinae
   \( \text{Pseudomyrmex gracilis} \)

2-segmented petiole (1b), eyes normal, reduced or absent ........................................ 5 Myrmicinae

1-segmented petiole or none apparent (1c)................................................................. 2

2 Distinct weak constriction between 1st and 2nd gastral tergites, sting present
and usually visible (2a) ........................................................................................................ 3

Profile of gaster without constriction, sting never present (2b) ..................... 4

3 Last segment of gaster with a row of small spines along outer and trailing
edge (3a) ................................................................................................................................. Cerapachynae
   \( \text{Cerapachys biroi} \)

Last segment of gaster smooth in profile (3b) ...................................................... 50 Ponerinae

4 Tip of gaster with a circular opening, often fringed with a circlet of hairs (4a) .... 35 Formicinae

Tip of gaster with a slit-like opening or no obvious opening, not
fringed with a circlet of hairs (4b) .................................................................................... 43 Dolichoderinae
5 Antennal club 3-segmented (5a). ................................................................. 6
Antennal club 2-segmented (5b). ................................................................. 9
No distinct antennal club and/or with 6 antennal segments or less (5c) ........ 10

5a 5b 5c

6 Propodeum with a distinct pair of spines (6a). ........................................ 7
Propodeum smooth and without a spine (6b). ........................................... 11 (Monomorium spp)

6a 6b

7 Pronotum rounded and clearly higher than propodeum (7a) ................. 17 (Pheidole spp)
Pronotum and propodeum on the same horizontal plane (7b) .................... 8

7a 7b

8 Antennal scrobes present, (sometimes weakly defined) body sculpturing striate (8a) ........................................................................................................ 19 (Tetramorium spp)
Antennal scrobes absent, body sculpturing not striate (8b) ....................... 23 (Cardiocondyla spp)

8a 8b

9 Propodeum with a distinct pair of spines (9a). ...................................... Wasmannia auropunctata
Propodeum without spines (9b) ............................................................... 28 (Solenopsis spp)
10 Head heart-shaped, mandibles short (10a)...................................................... *Pyramica membranifera*
   Head heart-shaped, elongated mandibles (10b)...................................................... 32 (*Strumigenys sp*)

11 Head finely reticulate, giving a uniform dull appearance ................................. 12
   Head smooth and shiny ......................................................................................... 14

12 Head and thorax uniformly yellow ........................................................................ 13
   Head and thorax uniformly dark brown, rear visible gastral tergite
   with large shiny and hairless area on dorsal surface............................................ *Monomorium indicum*

13 Head, thorax and petiole with pairs of short stiff setae...................................... *Monomorium pharoanis*
   Head, thorax and petiole with fine hairs (not erect)............................................ *Monomorium bicolor gp*

14 Eyes very small, consisting of < 5 facets (14a).................................................. *Monomorium sechellense*
   Eyes larger, with > 5 facets (14b)........................................................................ 15

15 Propodeum smoothly convex in profile (15a)..................................................... *Monomorium liliuokalanii*
   Propodeum with distinct dorsal and posterior planes (15b)................................. 16
16 Bicolored - head and gaster both distinctly darker than thorax

Monomorium floricola

Uniformly colored, sometimes gaster slightly darker than head and thorax

Monomorium destructor

17 Head and pronotum sculptured in dorsal view (17a)

Pheidole moerens

Head and pronotum smooth and shiny in dorsal view (17b)

18 Ventral surface of post-petiole distinctly convex (18a)

Pheidole megacephala

Ventral surface of post-petiole straight or slightly convex (18b)

Pheidole fervens

19 Petiole rounded in profile (19a)

20 Petiole blocky in profile (19b)

Tetramorium insolens

Top surface of petiole wave-like (19c)

20 Dorsal surface of entire body thickly covered with long hairs, slight upward

sweep of propodeal spines. Antennal scrobes smooth and shiny (20a)

Tetramorium lanuginosum

Dorsal surface of entire body with sparse long hairs, propodeal spines

straight. Antennal scrobes reticulate (20b)

Tetramorium tonganum
21 Large, total length > 3 mm, ........................................................... *Tetramorium bicarinatum*
Smaller, total length < 3 mm........................................................... 22

22 Antennal scrobes weakly defined, reticulation between the inner edge of scrobe and the eye similar in frontal view (22a)........................................................................ *Tetramorium caldarium*
Antennal scrobes distinct, reticulation between the inner edge of scrobe and the eye different in frontal view (22b)............................................................ *Tetramorium simillimum*

23 Propodeal spine short in profile (23a)........................................... 24
Propodeal spine moderate-long in profile (23b)............................... 25

24 Rounded forward-facing tooth on lower surface of petiole (24a) .......... *Cardiocondyla kagutsuchi*
Sharp forward-facing tooth on lower surface of petiole (24b) ............ *Cardiocondyla venustula*

25 Dorsal profile of thorax interrupted by a distinct notch between the mesonotum and metanotum (25a)........................................................... 26
Dorsal profile of thorax relatively smooth and without a notch between the mesonotum and metanotum (25b)........................................................... *Cardiocondyla minutior*
26 Post-petiole with a ventral “keel” that runs the entire length of post-petiole (26a) ................................................................. *Cardiocondyla emeryi*

   Ventral surface of post-petiole rounded and without a “keel” (26b) .................. 27

27 Entire gaster distinctly darker than thorax ....................................................... *Cardiocondyla obscurior*

   Entire gaster except first gastral tergite the same color as thorax ................. *Cardiocondyla wroughtonii*

28 Small, less than 2 mm, antennal segments between scape and club narrow, wider than high (28a) ........................................................................................................... 29

Larger, > 2 mm, width of antennal segments between scape and club
the same or longer than wide (28b) ........................................................................... 31

29 Body uniformly dark in color ............................................................................ *Solenopsis papuana*

   Body uniformly light in color or bicolored .......................................................... 30

30 Post-petiole larger than petiole in profile view (30a) ....................................... *Solenopsis globularia*

   Post-petiole the same size or smaller than petiole in profile view (30b) ........... *Solenopsis* sp HI01

31 Central clypeal tooth absent (31a), mandibles with three teeth or smooth
(31b), lower portion of mesonotum often with a forward-facing tooth or flange (31c), majors with dis-proportionally large heads ....................................................... *Solenopsis geminata*

   Central clypeal tooth present (31d), mandibles with four teeth (31e), lower
portion of mesonotum never with a forward-facing tooth or flange (31f) head
of major workers proportionally the same size as in minors, .............................. *Solenopsis invicta*

   *(not present in Hawaii)*
32 Antenna (including the scape) composed of 4 segments (32a).…………………….……. Strumigenys emmae
Antenna (including the scape) composed of 6 segments (32b).……………………….…. 33

33 Mandibles armed with 1 tooth in addition to a forked terminal tooth ............... 34
Mandibles armed with 2 teeth in addition to a forked terminal tooth (33b) ....... Strumigenys rogeri

34 Pronotum covered with curved “woolly” non-erect hairs……………………..……. Strumigenys godeffroyi
Pronotum with sparse erect hairs........................................................................... Strumigenys lewisi
FORMICINAE

35 Small, total length <3 mm ................................................................. 36

Total length 3 mm or more................................................................... 38

36 Body color brown, antenna consisting of 9 segments including the scape (36a) ... *Brachymyrmex sp nr obscuria*

Body color yellow, antenna with 10 or more segments (36b) ....................37

36a

36b

37 Dorsal surface of thorax with pairs of erect setae (37a).................................40

Dorsal surface of thorax without pairs of erect setae (37b)......................... *Plagiolepis alluaudi*

37a

37b

38 Face in frontal view covered with thick hairs (38a)........................................... 39

Face in frontal view not covered with thick hairs (38b) fine hairs may be present 41

38a

38b

39 Antennal scape long, more than 1.5 times the length of head. (39a) ............ *Paratrechina longicornis*

Antennal scape less than 1.5 times length of head (39b) .............................. 40

39a

39b
40 Lower section of mesonotum with appressed setae, not shiny .................. *Nylanderia bourbonica*
Lower section of mesonotum glabrous and shiny................................. *Nylanderia vaga*

41 Antennal scape long, more than 2 times the length of head (41a).................. *Anoplolepis gracilipes*
Antennal scape less than 1.5 times the length of head (41b)...................... 42

42 Mesonotum convex in dorsal view, without teeth or spines on propodeum (42a). *Camponotus variegatus*
Mesonotum concave in dorsal view, propodeum armed with blunt tooth (42b)... *Lepisiota sp.*
43 Rear face of propodeum distinctly concave (43a).................. Ochetellus glaber
Rear face of propodeum flat or convex (43b)..............................44

44 Petiole reduced or absent, forward face flat or indistinct (44a) ............. 45
Petiole well defined, taller than wide (44b) .................................. Linepithema humile

45 Gaster with 4 plates on the upper surface (5th tergite ventral), no setae on
dorsal surface of thorax (45a) ......................................................... 46 (Tapinoma spp)
Gaster with 5 plates on the upper surface (45b), sparse setae often found
on dorsal surface of thorax ............................................................47 (Technomyrmex spp)

46 Head and thorax distinctly darker than gaster............................... Tapinoma melanocephalum
Head, thorax and gaster uniformly colored.................................. Tapinoma sessile
47 Occipital region of head above the eye with one or two erect setae (47a)  
this feature is best seen in profile view.................................................................48

Occipital region of head without erect setae (47b) ..............................................49

48 Tarsus of hind leg lighter in color than tibia....................................................... Technomyrmex difficilis

Tarsus of hind leg the same color as the tibia....................................................... Technomyrmex pallipes

49 Scape short, extending to the rear margin of head when viewed in profile,
body color black (49a)......................................................................................... Technomyrmex albipes

Scape longer, clearly extending beyond rear margin of head when viewed
in profile, body color brown or dark brown (49b) .............................................. Technomyrmex vitiensis
50  Rear and front face of petiole distinct and well-defined (50a) ........................................ 51  
    Rear face of petiole broadly attached to gaster (50b) .................................................. Amblyopone zwaluwenburgi

51  Mandibles broadly triangular in frontal view (51a).................................................. 52  
    Mandibles long and slender in frontal view (51b) .......................................................... Leptogenys falcigera

52  Eyes absent or not obvious .............................................................................................. 53  
    Eyes present but may be small ...................................................................................... 55

53  Ventral process of petiole with an acute angle (54a)................................................ Ponera swezeyi
    Ventral process of petiole a simple lobe (54b) ............................................................. 54
54 Small, < 2 mm total body length ................................................................. *Hypoponera sp. H01*
Larger, > 3 mm total body length ............................................................. *Hypoponera zwaluwenburgi*

55 Lower anterior tip of first gastral segment with a forward-facing process (55a) ... *Hypoponera opaciceps*
Lower anterior tip of first gastral segment smooth in profile and without a forward-facing process (55b) ................................................................. *Hypoponera punctatissima*
**APPENDIX 6. LINKS AND CONTACTS**

**Hawai`i Ant Lab**
Pacific Cooperative Studies Unit, University of Hawai`i
16 E. Lanikaula St, Hilo HI 96720
Ph: (808) 315 5656
Web page [www.littlefireants.com](http://www.littlefireants.com)

**CTAHR Research Extension Center**
875 Komohana St Hilo, HI 96720
Ph: (808) 981 5199
Web page [www.ctahr.hawaii.edu](http://www.ctahr.hawaii.edu)

**Big Island Association of Nurserymen**
P.O. Box 4365, Hilo, HI 96720
Web page [http://hawaiiplants.com](http://hawaiiplants.com)

**Hawai`i Export Nursery Association**
P.O. Box 11120, Hilo, Hawaii 96721
Phone (808) 969-2088

**Hawai`i Department of Agriculture**
16 E. Lanikaula St Hilo, HI 96720
Ph: (808) 974 4140

**Hawai`i Pesticide Information**

**Search for product MSDS**
[http://www.cdms.net/LabelsMsds/LMDefault.aspx](http://www.cdms.net/LabelsMsds/LMDefault.aspx)

**Pesticide toxicology information**
[http://extoxnet.orst.edu/ghindex.html](http://extoxnet.orst.edu/ghindex.html)

**USDS Animal and Plant Health Inspection Service (APHIS)**