Pacific Invasive Ants Taxonomy Workshop
Suva, Fiji 26 – 28 June 2007

WORKSHOP MANUAL

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2007
FOREWORD

This manual is to be used by participants of the Pacific Invasive Ants Taxonomy Workshop organised by MAF Biosecurity New Zealand and the Secretariat of Pacific Community (SPC), June 2007, in Suva, Fiji, and is designed to complement the Lucid Key for The Pacific invasive Ants Identification, developed by Eli Sarnat (University of California, Davis).

Currently available keys to the ant fauna of the Pacific region do not include some invasive species that threaten the Pacific. It is vital that entomologists active in the Pacific are able to recognise these high impact invasive ants in order to facilitate the eradication of new detections and the prevention of further spread where they are present. Our aim is to provide a very simple and easy to use identification tool for the most important invasive and pest ant species of the Pacific region.

This workshop was made possible by New Zealand’s Pacific Security Fund, an interagency pool from various New Zealand government departments.

Trainers of the workshop:

- Eli Sarnat, M.S. (University of California, Davis)
- Dr. Disna Gunawardana (MAF Biosecurity New Zealand)
- Dr. Cas Vanderwoude (Vanderwoude Consulting Ltd. New Zealand)

Organizing Committee:

- Megan Sarty (MAF Biosecurity New Zealand)
- Warea Orapa (SPC)
- Caress Whippy (SPC)
- Roy Masamdu (SPC)
- Nacanieli Waqa (SPC)

Line Drawings and Images – Eli Sarnat M.S.

Manual preparation – Dr. Disna Gunawardana

All training materials used in the workshop will be held by SPC and we encourage their use outside the training workshop to promote invasive ant identification skills throughout the Pacific region.

For information on this training workshop please contact Nacanieli Waqa, Secretariat of the Pacific Community, Suva.
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Morphological Characters of an Ant

Fig. a. Ant side view with major characters labelled.

Fig. b. The front of an ant head with major characters labelled.
Pacific Invasive Ants Identification Key, based on workers
Taken from the Lucid Key for The Pacific Invasive Ants Identification, developed by Eli Sarnat June 2007.

1. **Number of waist segments:**
   One (Fig 1) or with hidden waist segment (Fig 2) ......................... 2
   Two (Fig. 3) ............................................................................ 7

![Fig. 1](image1)
![Fig. 2](image2)
![Fig. 3](image3)

2. **Petiole shape:**
   Raised (Fig. 4) .................................................................................. 3
   Flat (Fig. 5) or hidden (Fig. 2) ........................................................ 6

![Fig. 4](image4)
![Fig. 5](image5)

3. **Antennal scape length relative to head length:**
   More than 1 ½ times (Fig 6) ............................................................ 4
   Less than 1 ½ times (Fig 7) ............................................................ 5

![Fig. 6](image6)
![Fig. 7](image7)

4. **Many long thick hairs produced in pairs:**
   Present (Fig 8) ................................................ Paratrechina longicornis
   Absent (Fig 9) ................................................................. Anoplolepis gracilipes

![Fig. 8](image8)
![Fig. 9](image9)
5. **Many long thick hairs produced in pairs:**
   - Present (Fig 10) ........................................... *Paratrechina*
   - Absent (Fig 11) ........................................... *Linepithema humile*

   ![Fig 10](image1.png) ![Fig 11](image2.png)

6. **Hairs on dorsum of mesosoma and first gaster segment:**
   - Present (Fig. 12) ........................................... *Technomyrmex*
   - Absent (Fig. 13) ........................................... *Tapinoma*

   ![Fig 12](image3.png) ![Fig 13](image4.png)

7. **Propodeal Spine:**
   - Absent (Fig. 14) ........................................... 8
   - Present (Fig. 15) ........................................... 9

   ![Fig 14](image5.png) ![Fig 15](image6.png)

8. **Antenna club segments:**
   - Three (Fig. 16) ........................................... *Monomorium*
   - Two (Fig. 17) ........................................... *Solenopsis*

   ![Fig 16](image7.png) ![Fig 17](image8.png)
9. **Antenna club segments:**
   Three (Fig. 16) ................................................................. 10
   Two (Fig. 17) ......................................................... *Wasmannia auropunctata*

10. **Antenna scrobe:**
   Present (Fig. 18) ................................................................. 11
   Absent (Fig. 19) ................................................................. 13

11. **Head size relative to body size:**
   Large (Fig. 20) ................................................................. *Pheidole*
   (Major workers)
   Normal (Fig. 21) ................................................................. 12

12. **Steep ridge surrounding antenna insertions:**
   Present (Fig. 22) ................................................................. *Tetramorium*
   Absent (Fig. 23) ................................................................. *Pheidole*
   (Minor workers)

13. **Head size relative to body size:**
   Large (Fig. 20) ................................................................. *Pheidole*
   (Major workers)
   Normal (Fig. 21) ................................................................. 14

14. **Standing hairs on mesosoma:**
   Present ................................................................. *Pheidole*
   (Minor workers)
   Absent ................................................................. *Cardiocondyla*
Diagnostic Features of the main Pacific Invasive Ants:

*Anoplolepis gracilipes* – Yellow Crazy Ant

1. Large size, ~5mm
2. Antenna scape length greater than 1 ½ times head length
3. Antennal club absent
4. Yellow colouration
5. Slender body
6. Long thick hairs produced in pairs absent
7. Large eyes
8. Long neck connecting its body and head
9. One petiole segment
10. Monomorphic

Similar Species

- *Paratrechina longicornis*
- *Pheidole megacephala* (minor worker)

Differences (in blue)

<table>
<thead>
<tr>
<th>Features</th>
<th>A. gracilipes</th>
<th>Pa. longicornis</th>
<th>Ph. megacephala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>yellow</td>
<td><strong>dark</strong></td>
<td>yellow</td>
</tr>
<tr>
<td>Hairs</td>
<td>few, thin, not produced in pairs</td>
<td><strong>many, thick, produced in pairs</strong></td>
<td>many, thin, not produced in pairs</td>
</tr>
<tr>
<td>Waist segments</td>
<td>one</td>
<td>one</td>
<td><strong>two</strong></td>
</tr>
<tr>
<td>Propodeal spines</td>
<td>absent</td>
<td>absent</td>
<td><strong>present</strong></td>
</tr>
<tr>
<td>Size</td>
<td>large (~5mm)</td>
<td><strong>small (~2mm)</strong></td>
<td>small (~2mm)</td>
</tr>
</tbody>
</table>
**Solenopsis invicta** – Red Imported Fire Ant

1. Two waist segments: petiole and postpetiole
2. Antenna club with two segments
3. Propodeal spines absent
4. Median tooth present
5. Red color
6. Polymorphic

**Similar Species:**

*Solenopsis geminata*, *Solenopsis richteri*, *Tetramorium bicarinatum*

**Differences (in blue)**

<table>
<thead>
<tr>
<th>Features</th>
<th><em>S. invicta</em></th>
<th><em>S. richteri</em></th>
<th><em>S. geminata</em></th>
<th><em>T. bicarinatum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Median tooth</td>
<td>present</td>
<td>present</td>
<td>absent</td>
<td>absent</td>
</tr>
<tr>
<td>• Polymorphism</td>
<td>less extreme</td>
<td>less extreme</td>
<td>more extreme</td>
<td>absent</td>
</tr>
<tr>
<td>• Propodeal spines</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>• Antenna club</td>
<td>two</td>
<td>two</td>
<td>two</td>
<td>three</td>
</tr>
<tr>
<td>• segments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Antenna scrobe</td>
<td>absent</td>
<td>absent</td>
<td>absent</td>
<td>present</td>
</tr>
<tr>
<td>• Colour</td>
<td>red</td>
<td>dark</td>
<td>red</td>
<td>red with black</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>gaster</td>
</tr>
</tbody>
</table>
**Wasmannia auropunctata**

1. Minute (< 2mm)
2. Yellow in coloration
3. Waist with two segments: petiole and postpetiole
4. Antenna club with two segments
5. Propodeal spines present
6. Antenna scrobe present
7. Monomorphnic

**Similar Species**

- *Tetramorium simillimum*
- *Tetramorium tonganum*
- *Solenopsis papuana*

**Differences**

<table>
<thead>
<tr>
<th>Feature</th>
<th>W. auropunctata</th>
<th>T. simillimum</th>
<th>T. tonganum</th>
<th>S. papuana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antenna club segments</td>
<td>two</td>
<td><strong>three</strong></td>
<td><strong>three</strong></td>
<td>two</td>
</tr>
<tr>
<td>Propodeal spines</td>
<td>long</td>
<td><strong>short</strong></td>
<td>long</td>
<td><strong>absent</strong></td>
</tr>
<tr>
<td>Antenna scrobe</td>
<td>present</td>
<td>present</td>
<td>present</td>
<td><strong>absent</strong></td>
</tr>
<tr>
<td>Hairs</td>
<td>long &amp; thick</td>
<td><strong>short &amp; thick</strong></td>
<td>long &amp; thin</td>
<td>long &amp; thin</td>
</tr>
<tr>
<td>Eye facets</td>
<td>greater than ten</td>
<td>greater than ten</td>
<td>greater than ten</td>
<td>less than three</td>
</tr>
<tr>
<td>Raised ridge surrounding antenna</td>
<td>absent</td>
<td>present</td>
<td>present</td>
<td><strong>absent</strong></td>
</tr>
</tbody>
</table>
Other Pacific Invasive Ant Species

**Cardiocondyla**

*C. kagustuchi*  
*C. minutior*

*C. obscurior*

**Linepithema humile**

*L. humile*
**Monomorium**

*M. destructor*  
*M. floricola*

**Paratrechina**

*P. longicornis*  
*P. longicornis* (head)  
*P. vaga*  
*P. vaga* (head)
*Pheidole*

*P. fervens* (Major worker)  
*P. fervens* (Major-head)  

*P. fervens* (Minor worker)  
*P. fervens* (Minor-head)  

*P. megacephala* (Major worker)  
*P. megacephala* (Major-head)
**Solenopsis**

- *S. geminata* (Major worker)
- *S. geminata* (Major worker-head)
- *S. papuana*
- *S. papuana* – head

**Tapinoma**

- *T. melanocephalum*
- *T. melanocephalum* (head)
**Technomyrmex**

*T. albipes*

*T. albipes (head)*

**Tetramorium**

*T. bicarinatum*

*T. bicarinatum (head)*

*T. simillimum*

*T. simillimum*

*T. tonganum*

*T. tonganum (head)*
Key to subfamilies of Pacific Invasive Ants, based on workers.

1. **Gaster attached to mesosoma (alitrunk)**
   With one (Fig 1) or with a hidden waist segment (Fig 2) ………………...2

   With two waist segments (Fig. 2) …………………………...Myrmicinae
   (Solenopsis, Wasmannia auropunctata, Tetramorium, Pheidole, Monomorium)

2. **Sting**
   Well developed, usually extended and visible. Gaster with a distinct impression between the first and second segments. (Fig 4)…….Ponerinae
   (Not included in this work book)

   Sting absent …………………………………………………………...3

3. **Tip of the gaster**
   With a circular opening which is often fringed with hairs……Formicinae
   (Fig. 5) (Paratrechina, Anoplolepis gracilipes)

   Slit-like, never with a fringe (Fig. 6) …………………………Dolichoderinae
   (Linepithema humile, Tapinoma melanocephalum, Technomyrmex)

Figures 1,2,3,5 & 6 – Eli Sarnat
Figure 4 – after Shattuck, S.O. 1999. Australian ants: Their biology and identification. Monographs on Invertebrate Taxonomy.
Specimen Preparation Techniques for Identification

For short term storage, ants can be placed in 70-75% ethyl alcohol. If ants are to be used in molecular tests, those specimens should be stored in 95% ethyl alcohol.

For detailed study and long-term storage, ants should be point-mounted on insect pins. Pointing allows specimens to be easily manipulated while being examined with a microscope and is essential for viewing fine details such as sculpturing and pilosity. In all cases, ants, even large species, should be placed on points and not directly pinned.

Pinning of specimens:

- Individual points can be either hand-cut from strips of stiff, white, acid-free paper, or punched with a specially designed hand-punch or purchased from Entomological suppliers.
- The glue used to attach ants to the points should be water-soluble to allow for later removal if needed.
- Stainless steel insect pins of size 3 can be used to hold the points.
- Individual ants should be glued to the tip of the point with just enough glue to hold them securely but not so much that the lateral or upper surfaces are obscured.
- Specimens should be mounted upright, horizontal and with the point extending from the ant’s right side.
- Place the ant at the very tip of the point with the point covering the first segment of the middle and hind legs nearest the body.
- Try to (very) gently pull the legs downward so that the outer surface of the body can be seen in side view.

Labelling

Once the specimens are properly mounted, the final step is to add labels. Labels should be the standard type used in entomology 12mm X 8mm.

Label should include as a minimum;

- Location (state and nearest named place)
- Date
- Collector’s name.

Additional information which should be included if available include the latitude, longitude and elevation of the collection site, a brief description of the habitat.

<table>
<thead>
<tr>
<th>New Zealand</th>
<th>AK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mt Eden, 100m SW One Tree Hill</td>
<td></td>
</tr>
<tr>
<td>37°30'S 144°13'E , On apple leaves</td>
<td>21 Mar 2007</td>
</tr>
<tr>
<td>S.H. Anthony</td>
<td></td>
</tr>
</tbody>
</table>

**FORMICIDAE**

*Solenopsis invicta*

Det. J. Brown                  2007

**Fig. 3. Locality label - placed below the ant on the same pin.**

**Fig. 4. Determination label – placed below the locality label.**

References:


Best practice guidelines for making an identification using Lucid Player

During an identification session with an interactive key, Lucid allows you to choose any character (i.e., a feature and its associated states) from the Features Available list at any time. However, “stepping” through the key in a structured and sensible way will make your task of identification more efficient. Below are recommendations for increasing your efficiency and decreasing the amount of time required for identifying an unknown specimen using Lucid Player.

Preliminary Notice regarding ordering of taxa in Entities Remaining

The Lucid Player is designed so that, as you choose states, the taxa left in Entities Remaining are ordered so that the taxa that best match the chosen states are at the top. Note that this ordering will ONLY HAPPEN if you choose Lists at the bottom of the Entities Discarded panel. This ordering will NOT happen if you are viewing the default of Trees.

Familiarity with the specimen

First, become familiar with the characteristics of the specimen you wish to identify. If you are also familiar with the Lucid key that you will use, then you may already know many of the specimen's characteristics. Briefly reviewing these characteristics before you start will make it easier for you to proceed through the identification.

Note and use distinctive features

In any key, some taxa may possess particularly distinctive features and/or states. Use of these may allow the taxon to be keyed out in a very few steps. At the very least, starting with any particularly distinctive or striking features your specimen may possess for the first features you select may quickly reduce the list of Entities Remaining.

Answer easy features first

Browse the list of Features Available and address easy features first. The principles of dichotomous keys, in which the couplets must be answered in a preset order, are very familiar to most key users who often automatically apply these principles to a matrix key. Although Lucid3 lists the features of a key in an initial sequence in the opening window, this does not mean that the features must be selected in that order. You can select any feature from any position in the list. (Note that in some keys, where
positive dependencies are used, you may be forced to answer specific questions (features) before others become available.)

Most Lucid3 keys will have a wide variety of features, ranging from those dealing with obvious and simple features to those dealing with features that are minute, obscure, or difficult to interpret. Always start by browsing the list of Features Available for obvious features that you can quite quickly answer, as opposed to getting stuck on the first one. Lucid software is designed to overcome problems associated with difficult and obscure features.

It's okay to skip features

In looking through the features, you may not be sure which state of a feature to choose, or a feature or state may not be clear on your specimen. Skipping the feature entirely in such cases is always an option.

Use illustrated feature notes

As you work through the list of Features Available, you may find some features or feature states that you do not understand. If so, review any explanatory notes and illustrations that may be associated with the features and states. In fact, it is a good idea to check the notes and illustrations before using any feature for the first time, and to become familiar with these for all the features.

Choosing multiple states

You can always choose multiple states (more than one state of a feature) if you are uncertain which state is the correct one to choose for a particular specimen. Lucid software is designed to allow you to choose as many states as you require from any one feature (if, e.g., your specimen is in between two states, or exhibits two or more states). Within the program's logic, these states will be connected by an “or” link. This will cause Lucid to search for all taxa with any of the states you select. As a general rule, if you are unsure which of two or more states your specimen has, then choose them all. That way, you can be sure that your target taxon will remain in Entities Remaining. (Note that in the Lucid3 Player users can choose the matching method option of “all states” rather than the usual default of “any states”. See Help for more information.)
Finding the best feature to address next

When you have dealt with all the obvious features, use Lucid's “Best” function to suggest the best remaining feature that will give you the most efficient next step. The Best algorithm will assess which of the remaining features and states available will best reduce the list of *Entities Remaining*. The Lucid Player has two “Best” modes: "Find Best" and "Sort Best."

Find Best – In the Lucid3 Player, clicking the *Find Best Feature* button will cause the Player to move to and open the best available feature. *Find Next Best Feature* and *Find Previous Best Feature* buttons on the toolbar allow navigation through the Features list, if you have difficulty addressing the first feature nominated. If the list of entities in *Entities Remaining* changes after choosing a feature as suggested by Best, you should click the *Find Best Feature* button again to recalculate the next best feature to address.

Sort Best – Sort Best will reorder the *Features Available* list so that features are sorted from best to worst. After a Sort Best, scan the top of the list for features that you can answer most easily. (Note that Sort Best only works using List View, as a tree representation of features cannot be sorted.)

Other Lucid Player tools

You may find other Lucid3 tools helpful while navigating feature choices, such as "View Shortcut Features," "Prune Redundant Features," and "Calculate Differences." Explanations about how to use these functions are available through the Lucid Help menu.

What if no taxa remain?

This will happen sooner or later in one of your Lucid sessions. If no taxa are listed in the *Entities Remaining* window, then it simply means that no taxa in the database match the selection of states you have made. Several explanations are possible, but some of the most common are:

- You have made an error in one or more states that you have selected. This is the most likely error for any situation in which no taxa remain.

- The taxon may be undescribed or not one of those in the key. In this case Lucid cannot identify the specimen because its features are not represented in the key's data tables.

- The key author may have made an error when constructing the key. This is unlikely, but it can happen. If, after carefully checking all the features and states and checking that the specimen you are attempting to identify would be
expected to be included in the key, then a key construction error may be present.

Whichever of the above situations is suspected, you must very carefully review your chosen features and determine which ones you are uncertain about. Try unselecting uncertain states one by one to see what effect each has. One or more taxa may move back into the *Entities Remaining* window. In difficult cases, you may need to “play” with the key, adding or deleting states progressively to try to find the best matching taxon.

**What if several taxa remain?**

Never assume that you will always end up with one taxon remaining. Some taxa in the key may be very hard to differentiate, except when using difficult or obscure features. Sometimes, after you have addressed all the features, you may have a short list of taxa remaining instead of just one taxon. You are still much closer to an identification than you otherwise would have been. You may then have to carefully check your specimen against associated information (descriptions, images, etc. for the remaining taxa) or refer to more advanced or specialist reference sources.

In some cases, if you have a short list of taxa remaining, but have not addressed all the features, it may be easier to check your specimen against information associated with these remaining taxa. This can sometimes be a faster way to make an identification, than trying to find a feature that will discriminate among the remaining taxa.

If your taxon does not look similar to any of the taxa remaining, you can use the same strategy described above, of unselecting states one by one, or “playing” with the key, to find the best matching taxon.

**Checking the result**

Once you have made a preliminary identification, check the other information (such as notes, descriptions or images) provided for the taxon. Getting a possible name for a taxon from a key is not the end of an identification. You may have made errors, or your specimen may be a taxon that is not in the key. In these cases, the key may have provided you with the wrong name. The associated information will often give you a good indication as to whether the answer is correct.
Useful References and web sites for Pacific Ants Identification


Ants of New Zealand.
http://www.landcareresearch.co.nz/research/biocons/invertebrates/ants/key/

Australian ants on line.

Global Invasive species database
http://www.issg.org/database/welcome/

Japanese Ants Image database.
http://ant.edb.miyakyo-u.ac.jp/E/index.html
Glossary

**Antenna club:**
Enlarged segments that form a club-like structure at the end of the antenna. They can be composed of two, three or four segments.

**Antenna scrobe:**
An impression following some length of the head used to hold part or the entire antenna.

**Formicidae:**
The family to which all ants belong

**Gaster:**
The end section of the ant connected to the mesosoma by the waist.

**Median tooth:**
Tooth in the middle of the apical margin of the clypeus, usually with another tooth on either side

**Myrmicinae:**
One of the ant (Formicidae) subfamilies

**Myrmicines:**
Ants belonging to the subfamily Myrmicinae

**Petiole:**
Waist segment connecting the mesosoma to the postpetiole (Myrmicinae) or the gaster (Forminicane and Dolichoderinae).

**Polymorphic:**
Workers occurring in different sizes. In *Pheidole*, there is a distinct large worker caste (referred to as majors or soldiers) and a distinct minor worker caste (referred to as minors). In *Solenopsis invicta, S. geminata and Monomorium destructor* the castes are less distinct, with wide range of sizes from very small to very large.
Polymorphism:

See polymorphic

postpetiole:

Waist segment connecting the petiole to the gaster (Myrmicinae).

Propodeal spines:

Spines that originate on the propodeum.

Raised ridge surrounding antenna:

A diagnostic structure of *Tetramorium* that circles the antenna insertions with an elevated ridge.

Scape:

Antenna segment number one. Single antenna segment between funiculus and head. In ants it is very long, giving the antenna an "elbow-like" appearance.

Waist segments:

The segment (petiole) or segments (petiole and postpetiole) occurring between the mesosoma and gaster.
Appendix 1

THE FIRE ANTS (SOLENOPSIS) OF FLORIDA
(HYMENOPTERA: FORMICIDAE)


INTRODUCTION: Solenopsis is a worldwide genus of ants, perhaps most notorious for pugnacious members of the subgenus Solenopsis, or fire ants. This subgenus is restricted to the New World and contains 5 species occurring in the United States. Presently, only 2 species of the subgenus Solenopsis are known to occur in Florida: Solenopsis invicta Buren, the red imported fire ant, and S. geminata (Fabricius), the tropical or native fire ant. S. xyloni McCook, the southern fire ant, was reported only once from extreme northwest Florida (Smith, 1933) before the invasion by S. invicta. The other U.S. members of the subgenus are S. richteri Forel, the black imported fire ant, known in the United States only from northern Alabama and northern Mississippi (Buren, 1972), and S. aura Wheeler, known only from the southwestern states (Creech, 1950). Two other subgenera of Solenopsis (Euopilphtha, Diplomorphophtera) are present in the United States, but are smaller in size and relatively innocuous to man. The fire ants of Florida were treated by Denmark (1962) in Entomology Circular No. 3, but since that time some changes, especially in nomenclature, have been made. Because existing keys to the subgenus Solenopsis are often misleading and based on invalid characters, a new key to the Florida species is given.

IDENTIFICATION: The huddled taxonomy of the genus Solenopsis, the "crux myrmecologorum" (Creech, 1939), was partially clarified by Buren (1972). He discusses the taxonomy of 6 species in South and North America, and demonstrated that 2 species of imported fire ants (richteri, invicta) were present in the United States as a result of at least 2 separate introductions from South America. The 3 species reported to occur in Florida, S. invicta, S. xyloni, and S. geminata, are usually thought to be polymorphic, but a size continuum is actually represented. The terms major, media, minor, and minimum are used for convenience only. The term major arbitrarily refers to the largest workers present in a colony.

1. PETIOLE with 2 nodes (Fig. 1, 2); ANTENNA 10-SEGMENTED, with a very distinct 2-segmented apical club (Fig. 1, 3, 4, 5); CYLPEUS with 2 longitudinal ridges or keels which extend forward into teeth (Fig. 3, 4, 5); PROPODEUM without spines or teeth (Fig. 1, 6, 7, 8, 9, 10) ................................................ (Genus Solenopsis) 2

2. WITHOUT ABOVE COMBINATION OF CHARACTERS .............................. OTHER ANTS

3. USUALLY LARGER ANTS, 1.45-6.6 MM; SECOND AND THIRD FUNICULAR JOINTS OF ANTENNAE AT LEAST 1 TIME LONGER THAN WIDER (Fig. 4) .......................... (Subgenus Solenopsis) 3

4. SMALLER ANTS, 1.5-2.2 MM; SECOND AND THIRD FUNICULAR JOINTS OF ANTENNAE BROADER THAN LONG ........................................ Subgenera Euopilphtha and Diplomorphophtera

5. MAJOR WITH DISPROPORTIONATELY LARGE HEAD (Fig. 11), the OCCIPITAL LOBES PRONOUNCED (Fig. 3); ALL SIZE WORKERS WITH ELEVATED CARINAE (RIDGES) ON EITHER SIDE OF THE BASAL FACE OF THE PROPODEUM (Fig. 6, 7); MesoPELVIAN FANGS IN WIDE RANGE OF LENGTH (Fig. 12), MEDIOLYTE TOOTH ABSENT (Fig. 3, 4) .................................................. S. geminata (Fabricius)

6. MAJOR WITH MEDIUM-SIZED HEAD WITH THE OCCIPITAL LOBES ONLY MODERATELY ENLARGED (Fig. 3, 12); ALL SIZE WORKERS WITHOUT ELEVATED CARINAE ON BASAL FACE OF PROPODEUM (Fig. 6, 7, 9, 10); MESOPELVIAN FANGS IN WIDE RANGE OF LENGTH (Fig. 13, 14); MEDIOLYTE TOOTH ABSENT (Fig. 3, 4) .................................................. 4

7. PETIOLE USUALLY WITH DISTINCT ANTERO-VENTRAL TOOTH (Fig. 10); MESOPELVIAN FINELY SCULPTURED (Fig. 9); MEDIAL CYLPEAL TOOTH ABSENT; IN MAJOR, ANTELLAR SCAPES EXTENDING HALF WAY BETWEEN INSERTION AND OCUPITAL LOBES (Fig. 15), MEDIOLYTE SCALPELously SCULPTURED (Fig. 3, 4); MEDIAL CYLPEAL TOOTH ABSENT (Fig. 3, 4) .................................................. S. xyloni McCook

8. PETIOLE USUALLY WITHOUT A DISTINCT TOOTH, AT MOST A SLIGHT KNOB PRESENT (AS IN FIG. 2); MESOPELVIAN SCALPELously SCULPTURED (Fig. 1, 8); MEDIAL CYLPEAL TOOTH USUALLY PRESENT (Fig. 5) .................................................. S. invicta Buren

IN GENERAL, S. geminata and S. xyloni have more erect hairs than S. invicta, especially in the major workers. Generally S. invicta builds higher, more conical mounds than the 2 native species, but this varies considerably with soil type and moisture conditions. Coloration varies considerably in all 3 species, from red to black in S. geminata, from yellow to reddish brown in S. xyloni, and from reddish brown to dark brown in S. invicta. The dark brown color variety of S. invicta has sometimes been called the "intermediate brown" by writers who believe this color form represents hybrids between S. invicta and S. richteri. However, the dark variants occur throughout the known range of S. invicta, both in the United States and in South America, and since the ranges of the 2 species barely overlap (Fig. 15), intermediate color forms cannot be explained by hybridization.

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**DISTRIBUTION:** S. GEMINATA WAS REPORTED THROUGHOUT THE STATE (SMITH, 1930, 1933; WHEELER, 1932). S. CYLINDRICA HAS BEEN REPORTED ONLY FROM THE PANHANDLE, BUT MAY STILL EXIST IN ISOLATED AREAS IN EXTREME NORTHERN FLORIDA. BOTH S. GEMINATA AND S. CYLINDRICA ARE NOW ABSENT FROM LARGE AREAS WHERE THEY WERE ONCE ABUNDANT BECAUSE OF DESTRUCTION OF S. INVICTA AND INSECTICIDE TREATMENTS. S. INVICTA IS REPORTED FROM ALL COUNTIES EXCEPT DIXIE, GILCHRIST, AND MONROE, AND THE ENTIRE STATE IS NOW UNDER QUARANTINE REGULATIONS (USDA, 1976).

**BIOLOGY:** THESE SPECIES OF ANTS BUILD NESTS WHICH MAY, IN THE CASE OF S. INVICTA, BE UP TO 60 CM TALL AND 60 CM IN DIAMETER AT THE BASE. THE COLONIES MAY BE EXTREMELY LARGE; NESTS OF S. INVICTA MAY CONTAIN UP TO ONE-QUARTER MILLION WORKERS. NEW COLONIES ARE USUALLY STARTED BY QUEENS AFTER BREEDING FLIGHTS. COLONIES MAY ALSO BE ESTABLISHED BY TRANSPORTATION OF PORTIONS OF COLONIES IN NURSERY STOCK OR CAGE DIRT. ALL 3 SPECIES ARE HIGHLY PREDACIOUS BUT ALSO FEED ON SUGAR, HONEYDEW, OR CARRION. S. INVICTA IS MORE AGGRESSIVE AND MORE PUGNACIOUS THAN THE 2 NATIVE SPECIES. SEVERAL STUDIES HAVE SHOWN THAT S. INVICTA DISPLACES THE 2 NATIVE SPECIES (WHITCOMB ET AL., 1972; ROE, 1973; NAYES, 1974). ECOLOGICAL DISTURBANCES (INSECTICIDE TREATMENTS, ROAD BUILDING, ETC.) FAVOR REINFESTATION BY S. INVICTA OVER ALL OTHER ANTS, INCLUDING THE 2 NATIVE FIRE ANTS.

**ECONOMIC IMPORTANCE:** ALL 3 SPECIES STING, INJECTING VENOM WHICH CAUSES FIERCE ITCHING, PUSTULES (ESPECIALLY S. INVICTA), AND SOMETIMES MORE SEVERE REACTIONS INCLUDING ANAPHYLACTIC SHOCK. IN SEVERE CASES, MEDICAL ASSISTANCE IS NOT RECEIVED, THE INDIVIDUAL MAY DIE (LOFQOLD AND MORE ET AL., 1970). ALL 3 SPECIES, ESPECIALLY S. INVICTA DUE TO THE LARGER COLONY SIZE, CAUSE PROBLEMS IN LAWNS, PASTURES, AND ROADWAYS. ECONOMIC LOSSES HAVE BEEN ATTRIBUTED TO THE 3 SPECIES, PARTICULARLY S. INVICTA, IN THE HARVESTING OF SOYBEANS, HAY, AND OTHER CROPS, DEATH OF YOUNG LIVESTOCK, AND SMALL GAMEBIRDS. NURSERY STOCK, SOILS, LOGS, ETC., FROM AREAS INFESTED WITH S. INVICTA, MUST BE CERTIFIED ANT-FREE TO BE SHIPPED TO NON-INFESTED AREAS. TWO CHEMICALS ARE CURRENTLY REGISTERED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY FOR CONTROL OF IMPORTED FIRE ANTS. MIREX, A DELAYED TOXICANT, FORMULATED IN A CARRIAGE GRIT-SOYBEAN OIL BAITS CONTAINING 0.3% MIREX, IS APPLIED BY AIRCRAFT AT A RATE OF 1.25 LB/ACRE (BULK RATE). MIREX BAITS, FORMULATED TO CONTAIN 0.15% MIREX, MAY BE APPLIED AT A RATE OF 2.5 LB/ACRE (BULK RATE) WITH GROUND EQUIPMENT. CHLORDANE, A CONTACT TOXICANT, MAY BE APPLIED AS A DRENCH TO NURSERY STOCK OR APPLIED AS GRANULAR MATERIAL OR A DUST FOR TREATING LAWNS, ROADWAYS, AND OTHER NON-FOOD OR FORAGE PRODUCING AREAS AT A RATE OF 1.5 LB/ACRE (ACTUAL TOXICANT).

**LITERATURE CITED:**

- Denmark, H. A. 1962. A key and illustrations of Solenopsis geminata (F.) and Solenopsis geminata geminata (Fabricius) in Florida. J. Florida Ent. Soc. 44:311-319.

Fig. 2. *Solenopsis geminata*. Two node of petiole between thorax and gaster (abdomen) (140X). SK: slight knob.

Fig. 3-4. *Solenopsis geminata*. Fig. 3. Head of major worker (25X). Fig. 4. Head of minor worker (46X). AC: antennal club, CT: clypeal teeth, ST: second and third funicular joints.

Fig. 5. *Solenopsis invicta*. Head of minor worker (46X). AC: antennal club, CT: clypeal tooth, MCT: medial clypeal tooth.

Fig. 6-7. *Solenopsis geminata*. Propodeum of minor worker at 156X (Fig. 6) and major worker at 32x (Fig. 7). CA: carinae.

Fig. 8. *Solenopsis invicta*. Propodeum of minor worker (120X). ME: mesopleuron.
Fig. 9. Mesopleural area and propodeum (9×). ME: mesopleuron; MF: mesopleural flange.

Fig. 10. Propodeum (PR) and first petiolar node showing anterovinginal tooth (AT) (101×).

Fig. 11. S. geminata head and alitrunk of major

Fig. 12. S. invicta head and alitrunk of major

Fig. 13-14. Solenopsis geminata; variation in mesopleural flange. Fig. 13. 99X. Fig. 14. 226X

Fig. 15. Present distribution of S. invicta based on USDA (1976), and S. richteri based on Burken (1972) and unpublished records. Distribution of S. geminata and S. xyloni in imported fire ant infested areas based only on recent collections (Wojcik, unpublished; Bass and Hays, 1976; Carroll, 1970; Naves, 1974; Roe, 1973). Distribution of S. geminata and S. xyloni from areas not infested with the imported fire ant based on old records from Smith, 1936; Warren and Rouse, 1969; and Young and Howell, 1964.
A KEY AND ILLUSTRATIONS OF *SOLENOPSIS GEMINATA* (F.) AND *SOLENOPSIS RAEVSSIMA RICHTERI* FOERL

H. A. Denmark

Two fire ants, *Solenopsis Geminata* (F.) and *Solenopsis Raevssima Richteri* Forel, found in the southern United States are often misidentified by the layman. Both species build mounds, although the latter species usually builds larger mounds in loam or clay soils. Both species have a vicious sting, but the latter species causes a pustule to form a few hours after being stung. *S. Geminata* is found in all parts of Florida. *S. Raevssima Richteri* is found mainly in the northwestern and also several central counties, and continues to spread throughout Florida. There are external or morphological differences as illustrated in Fig. 1 and Fig. 2. The carina is present on both minor and major workers of *S. Geminata*, but the large head of the major worker is easier to see.

**Major Workers**

Head large and bifurcated (Fig. 1a) .......................................................... *Geminata*

Head medium size and only slightly bifurcated (Fig. 2a) .......................... *Raevssima Richteri*

**Minor Workers**

Epinotum with carina (elevated ridge) on either side (Fig. 1b) .................. *Geminata*

Epinotum without carina (elevated ridge) (Fig. 2b) ................................. *Raevssima Richteri*

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**Fig. 1**

**Fig. 2**
Appendix 3

Texas Fire Ant Identification: An Illustrated Key

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Texas has more than 260 species of ants, only a few of which are household or garden
pests (see FAPFS010 for identification of non-fire ant pest ants). Many native ants, including
native fire ant species and some harmless introduced ant species, are potential or known
competitors of the red imported fire ant, Solenopsis invicta Buren (Hymenoptera: Formicidae).
Fire ant mounds or nests differ from many native competitor ant species because they have no
central openings. Worker fire ants leave the colony using underground tunnels that open to the
surface away from the mound.

There are six known species of fire ants (Solenopsis species of the geminata group) in the
United States, five of which are found in Texas. Of these, four are native species and the fifth is
the accidentally introduced red imported fire ant. Another imported species, the black imported
fire ant (Solenopsis richteri) does not live in Texas. Although the four native species are called
fire ants, they are much less aggressive and numerous than the imported species.

The first question is whether you have fire ants. If the ants are aggressive, at least 3 mm
long, and rapidly run up any object placed into their nest, they are probably fire ants. If they try
to bite and sting the object, then it is a good bet they are fire ants. To confirm, look at the region
between the epinotum and gaster (see figure below), and if two nodes (petiole and postpetiole)
are present and the antennal club is two-segmented, then they are fire ants.

Identifying the specific species of fire ant is easier if you have access to a microscope and
a good light source because many of the features used to identify fire ants to species are small
and hard to see. To use this identification key, examine at least six to ten major workers (the
larger, wingless worker ants in a colony) because the characters used for identification might not
be fully developed in all individuals of the colony; they are easiest to see on the major workers.
Examining only one worker may lead to an incorrect identification. To use the identification key,
begin at the top and compare the options in the first pair of statements and illustrations to the
specimen(s) you have. Choose the figure and statement that matches the specimen(s) you have
and then proceed down the key until the ant is properly identified.

A technical identification key to all species of fire ants in North and South America was
published by J.C. Trager in 1991 (Journal of the New York Entomological Society 99 (2): 141-
198). A very useful older work that includes numerous scanning electron pictures was published
by A. Hung, M.R. Barlin, and S.B. Vinson in 1977 (Texas Agricultural Experiment Station
Bulletin No. 1185). An updated, more detailed identification guide is being prepared by Jerry
Cook, who is also studying specimens possibly representing a new species of native fire ant
found around Corpus Christi, Texas. This potential new species would be identified as a tropical
fire ant (Solenopsis geminata) in the key below.

Red imported fire ant (Solenopsis invicta Buren): Only the red imported fire ant has a median
eylepal tooth and a striated mesepimeron (see figures); although these may be difficult to see at
first. Other characters that might help in the identification include: 1) the antennal scape nearly
reaches the vertex, 2) the post-petiole is constricted at back half, and 3) the petiolar process is
small or absent. The red imported fire ant is widespread in the eastern two-thirds of the state and has also been found around El Paso.

**Tropical fire ant** (*Solenopsis geminata* [Fabricius]): The most distinguishing characteristic of this species is the relatively larger, parallel-sided head with a deep, median, lengthwise groove down the middle of the vertex. Other features that might help in the identification include: 1) smaller or absent petiolar process (also not found in the red imported fire ant) and 2) this antennal scape goes only about halfway to vertex. Tropical fire ants were once widespread in the eastern half of the state and central Hill Country, but are being quickly replaced by red imported fire ants.

**Southern fire ant** (*Solenopsis xyloni* McCook): Of all the native fire ants, the southern fire ant looks the most like the red imported fire ant. The southern fire ant can be identified by its brown to black color, well-developed petiolar process, and no median clypeal tooth. The southern fire ant is widespread throughout the eastern, southern, and southwestern parts Texas.

**Desert fire ants** (*Solenopsis aurea* Wheeler and *Solenopsis amblychaeta* Wheeler): Both of these species are yellowish-red to reddish-yellow (whereas all other fire ants are light to dark brown) and have a well-developed petiolar process. Both species are found in desert areas in western Texas.
Identification Guide to the Major Workers of the Fire Ants of Texas

Fire Ants

1) Petiole and postpetiole both present
2) Antenna with 10 segments
3) Antennal club of 2 segments
4) No spines on propodeum
5) Over 2 mm in length

(Tropical fire ant
Solenopsis geminata)

1) Vertex of head with deep groove
2) Mandibles without teeth and entirely black
3) Antennal scape shorter, reaching halfway to vertex

1) Vertex of head indented, not with a deep groove
2) Mandibles with distinct teeth
3) Antennal scape longer, over half length to vertex

(Desert fire ants
Solenopsis aurea
Solenopsis amblychila)

1) Clypeal teeth distinct
2) Clypeal ridge distinct
3) Vertex dull, with numerous hairs

1) Clypeal teeth reduced
2) Clypeal ridge reduced
3) Vertex shiny, with few hairs

Gaster light colored, yellowish to reddish yellow

Gaster dark colored, dark brown to black

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fireantfap6013.2002rev
June 2002 revision
For more information regarding fire ant management, see Extension publications B-6043, Managing Red Imported Fire Ants in Urban Areas; B-6056, Managing Red Imported Fire Ants in Agriculture; B-6099, Broadcast Baits for Fire Ant Control; or L-5170 The Texas Two-Step Method Do-It-Yourself Fire Ant Control for Homes and Neighborhoods. Also visit our web site at http://fireant.tamu.edu.

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Fire Ant Plan Fact Sheet 6013
fireant/fgpfs6013.2002rev
June 2002 revision