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 variuos 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.

CONTENTS

Morphological Characters of an Ant

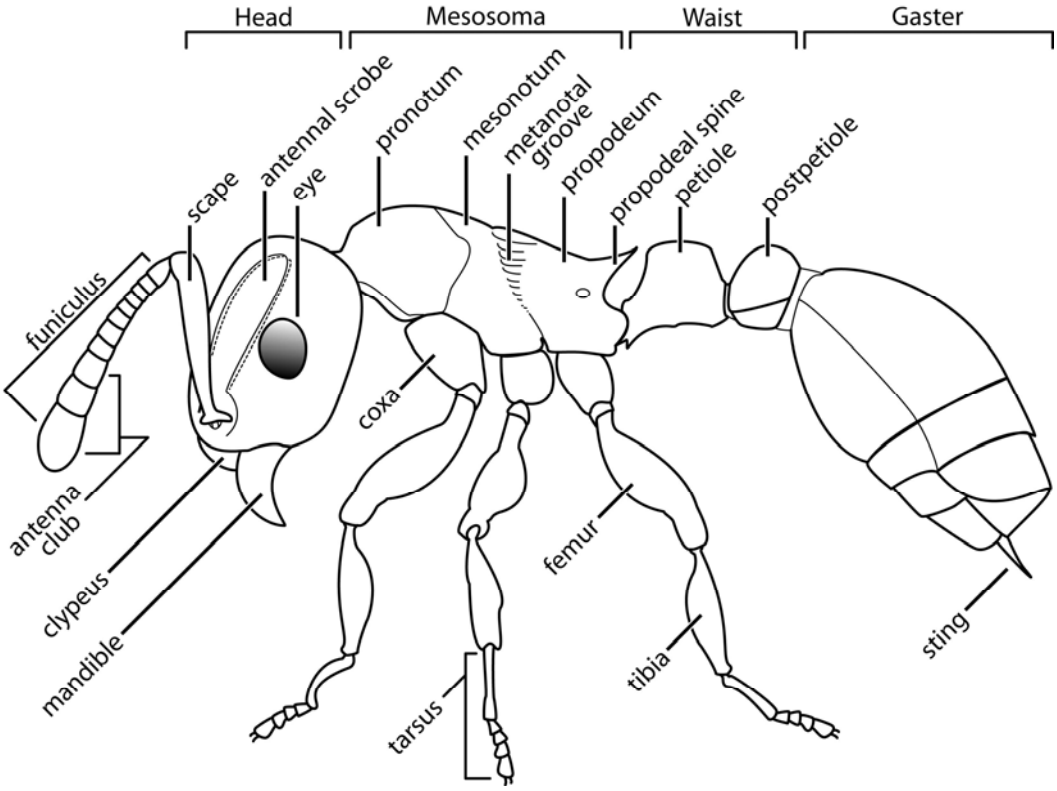


Fig. a. Ant side view with major characters labelled.

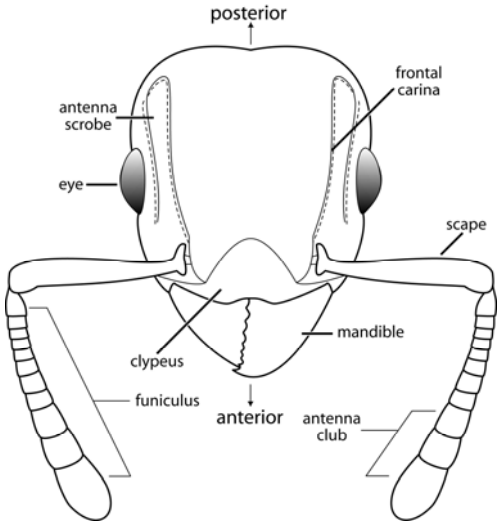


Fig. b. The front of an ant head with major characters labelled.

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

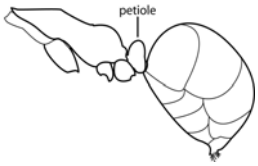


Fig. 1

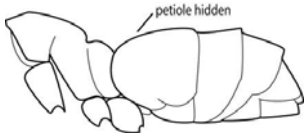


Fig. 2

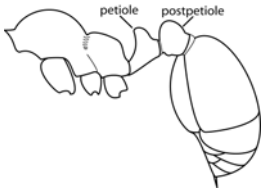


Fig. 3

2. Petiole shape:

Raised (Fig. 4) …….. 3
Flat (Fig. 5) or hidden (Fig. 2) …….. 6

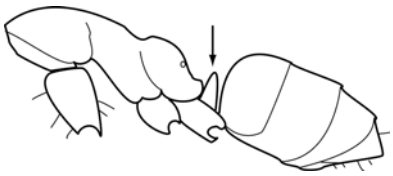


Fig. 4

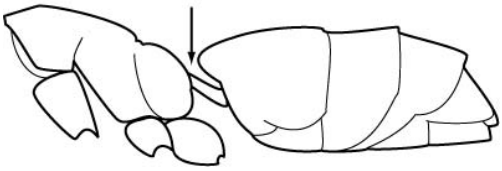


Fig. 5

3. Antennal scape length relative to head length :

More than 1 ½ times (Fig 6) ……. 4
Less than 1 ½ times (Fig 7) ……..... 5

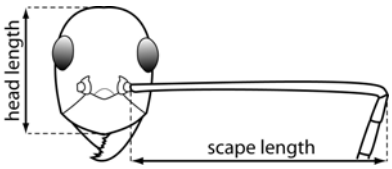


Fig. 6

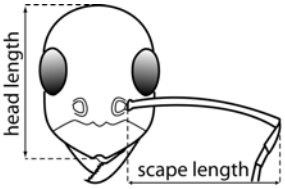


Fig. 7

4. Many long thick hairs produced in pairs :

Present (Fig 8) …… *Paratrechina longicornis*
Absent (Fig 9) …….. *Anoplolepis gracilipes*

Fig. 8

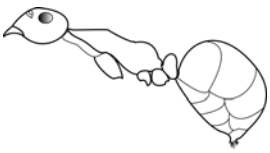


Fig. 9

5. **Many long thick hairs produced in pairs:**
Present (Fig 10) …… *Paratrechina*
Absent (Fig 11) …….. *Linepithema humile*

Fig. 10

Fig. 11

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

Fig. 12

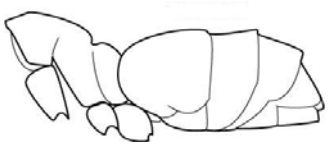


Fig. 13

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

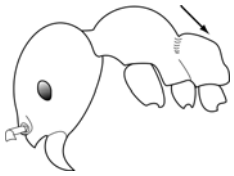


Fig. 14

Fig. 15

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

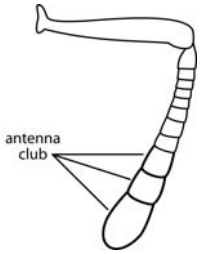


Fig. 16

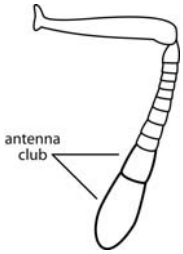


Fig. 17

9. Antenna club segments:

Three (Fig. 16) …….. 10

Two (Fig. 17) …… *Wasmannia auropunctata*

10. Antenna scrobe:

Present (Fig.18) …….. 11

Absent (Fig. 19) ……. 13

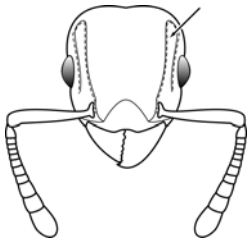


Fig. 18

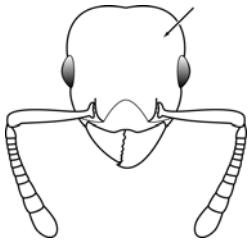


Fig. 19

11. Head size relative to body size:

Large (Fig. 20) …….. *Pheidole* (Major workers)

Normal (Fig. 21) …….. 12

Fig. 20

Fig. 21

12. Steep ridge surrounding antenna insertions:

Present (Fig. 22) …….. *Tetramorium*

Absent (Fig. 23) …… *Pheidole* (Minor workers)

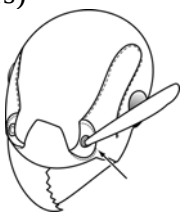


Fig.22

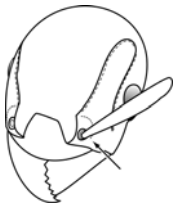


Fig. 23

13. Head size relative to body size:

Large (Fig. 20) …….. *Pheidole* (Major workers)

Normal (Fig. 21) …… 14

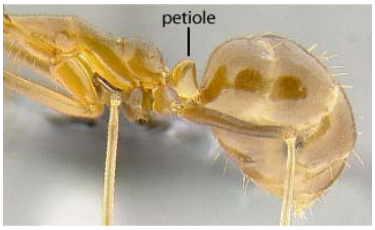
14. Standing hairs on mesosoma:

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

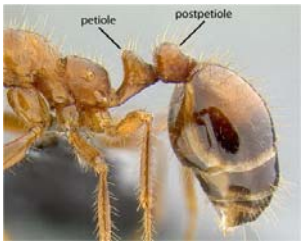
Similar Species

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

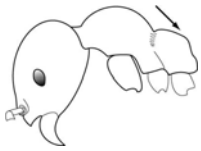
Differences (in blue)

Features	*A. gracilipes*	*Pa. longicornis*	*Ph. megacephala*
• **Color**	yellow	**dark**	yellow
• **Hairs**	few, thin, not produced in pairs	**many, thick, produced in pairs**	**many**, thin, not produced in pairs
• **Waist segments**	one	one	**two**
• **Propodeal spines**	absent	absent	**present**
• **Size**	large (~5mm)	**small (~2mm)**	**small (~2mm**

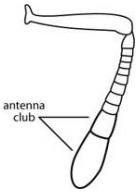
Solenopsis invicta – Red Imported Fire Ant



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

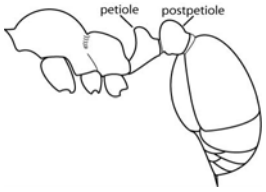


Propodeal spines absent



Two segmented club

Median tooth present



Waist with two segments: petiole and postpetiole

Similar Species:

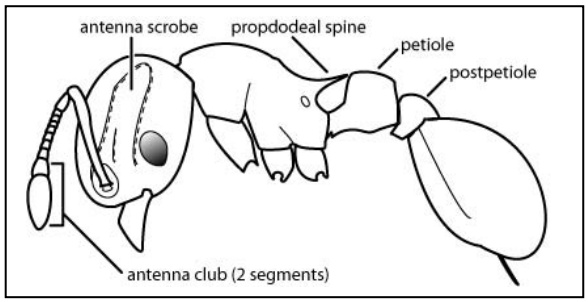
Solenopsis geminata , *Solenopsis richteri* , *Tetramorium bicarinatum*

Differences (in blue)

Features	***S. invicta***	***S. richteri***	***S. geminata***	***T. bicarinatum***
• **Median tooth**	present	present	**absent**	**absent**
• **Polymorphism**	less extreme	less extreme	**more extreme**	**absent**
• **Propodeal spines**	absent	absent	absent	**present**
• **Antenna club segments**	two	two	two	**three**
• **Antenna scrobe**	absent	absent	absent	**present**
• **Colour**	red	**dark**	red	red with **black** gaster

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. Monomorphic



Similar Species

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

Differences

Feature	*W. auropunctata*	*T. simillimum*	*T. tonganum*	*S. papuana*
• **Antenna club segments**	two	**three**	**three**	two
• **Propodeal spines**	long	**short**	long	**absent**
• **Antenna scrobe**	present	present	present	**absent**
• **Hairs**	long & thick	**short** & thick	long & **thin**	long & **thin**
• **Eye facets**	greater than ten	greater than ten	greater than ten	**less than three**
• **Raised ridge surrounding antenna**	absent	**present**	**present**	absent

Other Pacific Invasive Ant Species

Cardiocondyla

C. kagustuchi

C. minutior

C. obscurior

Linepithema humile

L. humile

Monomorium

M. destructor

M. floricola

Paratrechina

P. longicornis

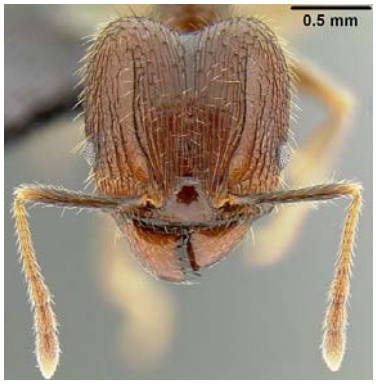
P. longicornis (head)

P. vaga

P. vaga (head)

Pheidole

P. fervens (Major worker)

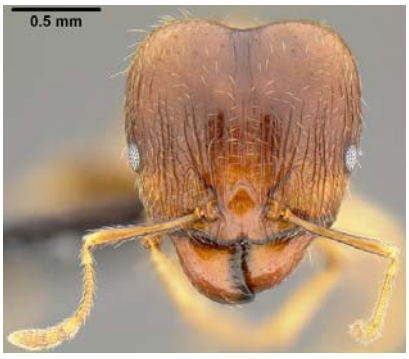


P. fervens (Major- head)

P. fervens (minor worker)

P. fervens (minor –head)

P. megacepahala (Major worker)



P. megacephala (major –head)

Solenopsis

S. geminata (Major worker)

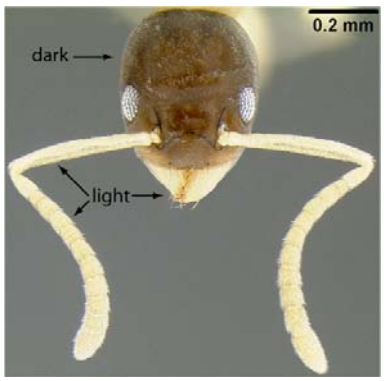
S. geminata (Major worker-head)

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*)

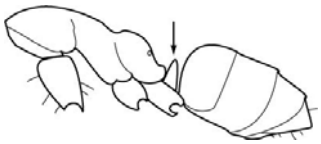


Fig.1

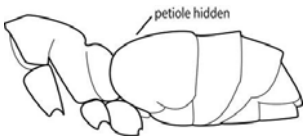


Fig.2

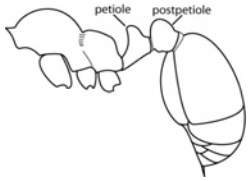


Fig. 3

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

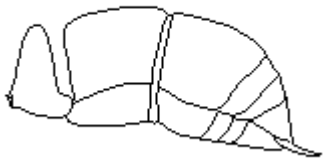


Fig. 4

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)*

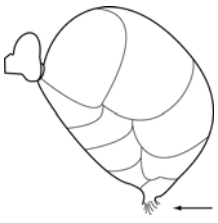


Fig.5

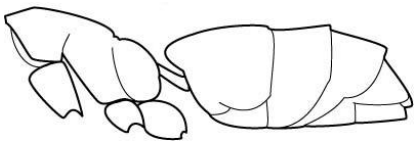


Fig. 6

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.

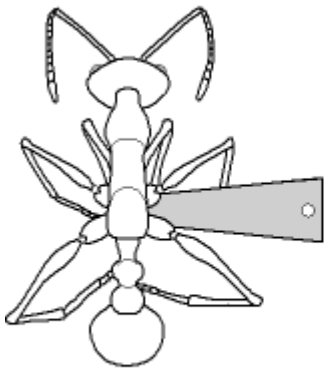


Fig.1.
Top view of an ant mounted on a triangular point

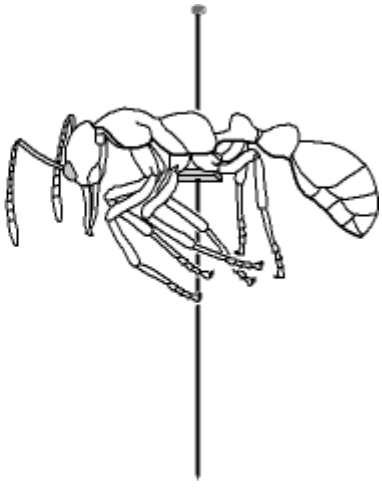


Fig.2.
Side view of an ant mounted on a triangular point.

(Figures taken from: Shattuck, S.O. 1999. Australian ants: Their biology and identification. Monographs on Invertebrate Taxonomy. p17)

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.

New Zealand AK
Mt Eden, 100m SW One Tree Hill
$37^0$30'S $144^0$13'E , On apple leaves
21 Mar 2007
S.H. Anthony

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

FORMICIDAE

Solenopsis invicta

Det. J. Brown 2007

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

References:

Shattuck, S.O. 1999. Australian Ants: Their biology and identification. Monographs on Invertebrate Taxonomy. Pp 226

Walker, A.K. & Crosby, T. K., 1988. The preparation and curation of insects. DSIR Information Series 163. Wellington. Pp.91

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.

CPHST's Identification Technology Team Document (Release 1 – May 25, 2006)

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Australian ants on line.
http://www.ento.csiro.au/science/ants/default.htm

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

ENTOMOLOGY CIRCULAR NO. 173
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FLA. DEPT. AGR. & CONSUMER SERV.
DIVISION OF PLANT INDUSTRY

THE FIRE ANTS (SOLENOPSIS) OF FLORIDA (HYMENOPTERA: FORMICIDAE)[1]

D. P. WOJCIK[2], W. F. BUREN[3], E. E. GRISSELL[4], AND T. CARLYSLE[5]

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 WITH 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), TH 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. AUREA WHEELER, KNOWN ONLY FROM THE SOUTHWESTERN STATES (CREIGHTON, 1950). TWO OTHER SUBGENERA OF SOLENOPSIS (EUOPHTHALMA, DIPLORHOPTRUM) 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 MUDDLED TAXONOMY OF THE GENUS SOLENOPSIS, THE "CRUX MYRMECOLOGORUM" (CREIGHTON, 1930), WAS PARTIALLY CLARIFIED BY BUREN (1972). HE DISCUSSED 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); CLYPEUS 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
1'. WITHOUT ABOVE COMBINATION OF CHARACTERS . . . . . OTHER ANTS
2. USUALLY LARGER ANTS, 1.6-6 MM; SECOND AND THIRD FUNICULAR JOINTS OF ANTENNAE AT LEAST 1 1/2 TIMES LONGER THAN BROAD (FIG. 4) . . . . . (SUBGENUS SOLENOPSIS) 3
2'. SMALLER ANTS, 1.5-2.2 MM; SECOND AND THIRD FUNICULAR JOINTS OF ANTENNAE BROADER THAN LONG . . . . . SUBGENERA EUOPHTHALMA AND DIPLORHOPTRUM
3. MAJORS 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); MESOPLEURAL FLANGE BROKEN INTO VARIOUS PROJECTIONS (FIG. 13, 14); MEDIAL CLYPEAL TOOTH ABSENT (FIG. 3, 4) . . . . . S. GEMINATA (FABRICIUS)
3'. MAJORS WITH MEDIUM SIZED HEAD WITH THE OCCIPITAL LOBES ONLY MODERATELY ENLARGED (FIG. 5, 12); ALL SIZE WORKERS WITHOUT ELEVATED CARINAE ON BASAL FACE OF PROPODEUM (FIG. 8, 9, 10); MESOPLEURAL FLANGE ENTIRE OR ABSENT, NOT BROKEN INTO JAGGED PROJECTIONS (FIG. 1, 9); MEDIAL CLYPEAL TOOTH PRESENT OR ABSENT 4
4. PETIOLE USUALLY WITH DISTINCT ANTERO-VENTRAL TOOTH (FIG. 10); MESOPLEURON FINELY SCULPTURED (FIG. 9); MEDIAL CLYPEAL TOOTH ABSENT; IN MAJOR, ANTENNAL SCAPES EXTENDING HALF WAY BETWEEN POINT OF INSERTION AND OCCIPITAL LOBES . . . S. XYLONI MCCOOK
4'. PETIOLE USUALLY WITHOUT A DISTINCT TOOTH, AT MOST A SLIGHT KNOB PRESENT (AS IN FIG. 2); MESOPLEURON DENSELY SCULPTURED (FIG. 1, 8); MEDIAL CLYPEAL TOOTH USUALLY PRESENT (FIG. 5); IN MAJOR, ANTENNAL SCAPE NEARLY REACHING OCCIPITAL LOBE . . . . 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 BROWNS" 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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OTHER CHARACTERS WHICH HAVE BEEN USED IN KEYS ARE INVALID. THE RELATIVE ANTENNAL LENGTH, THE DEGREE OF CURVATURE OF THE MANDIBLES, AND THE NUMBER OF MANDIBULAR TEETH VARIES WITH WORKER SIZE. THE ABSENCE OF MANDIBULAR TEETH, USED AS A KEY CHARACTER FOR S. GEMINATA, IS AGE DEPENDENT, THE TEETH BEING WORN DOWN WITH USE. CREIGHTON (1930, 1950) USED THE TERM "MESOSTERNAL SPINE" FOR THE MESOPLEURAL FLANGE. THIS TERM IS INCORRECT MORPHOLOGICALLY AND MOREOVER A TRUE SPINE-LIKE PROCESS ONLY OCCURS IN S. GEMINATA RUFA (JERDON), A SUBSPECIES APPARENTLY LIMITED TO THE OLD WORLD AND THE PACIFIC OCEANIC ISLANDS. THE REDDISH FORM OF S. GEMINATA WHICH OCCURS IN THE UNITED STATES DOES NOT HAVE THIS SPINE.

DISTRIBUTION: S. GEMINATA WAS REPORTED THROUGHOUT THE STATE (SMITH, 1930, 1933; WHEELER, 1932). S. XYLONI HAS BEEN REPORTED ONLY FROM THE PANHANDLE, BUT MAY STILL EXIST IN ISOLATED AREAS IN EXTREME NORTHERN FLORIDA. BOTH S. GEMINATA AND S. XYLONI ARE NOW ABSENT FROM LARGE AREAS WHERE THEY WERE ONCE ABUNDANT BECAUSE OF PRESSURE FROM 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 MOUNDS 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; MOUNDS OF S. INVICTA MAY CONTAIN UP TO ONE-QUARTER MILLION WORKERS. NEW COLONIES ARE USUALLY STARTED BY MATED QUEENS AFTER MATING FLIGHTS. COLONIES MAY ALSO BE ESTABLISHED BY TRANSPORTATION OF PORTIONS OF COLONIES IN NURSERY STOCK OR FILL DIRT. ALL 3 SPECIES ARE HIGHLY PREDACEOUS 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; NAVES, 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 FIERY ITCHING, PUSTULES (ESPECIALLY S. INVICTA), AND SOMETIMES MORE SEVERE REACTIONS INCLUDING ANAPHYLACTIC SHOCK. IN SEVERE CASES, IF MEDICAL ASSISTANCE IS NOT RECEIVED, THE INDIVIDUAL MAY DIE (LOFGREN ET AL., 1975). ALL 3 SPECIES, ESPECIALLY S. INVICTA BECAUSE OF THE LARGER COLONY SIZE, CAUSE PROBLEMS IN LAWNS, PASTURES, AND ROADSIDES. 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 CORNCOB GRIT-SOYBEAN OIL BAIT CONTAINING 0.3% MIREX, IS APPLIED BY AIRCRAFT AT A RATE OF 1.25 LB/ACRE (BULK RATE). MIREX BAIT, 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 FOR NURSERY STOCK OR APPLIED AS GRANULAR MATERIAL OR A DUST FOR TREATING LAWNS, ROADSIDES, AND OTHER NON-FOOD OR FORAGE PRODUCING AREAS AT A RATE OF 1.5 LB/ACRE (ACTUAL TOXICANT).

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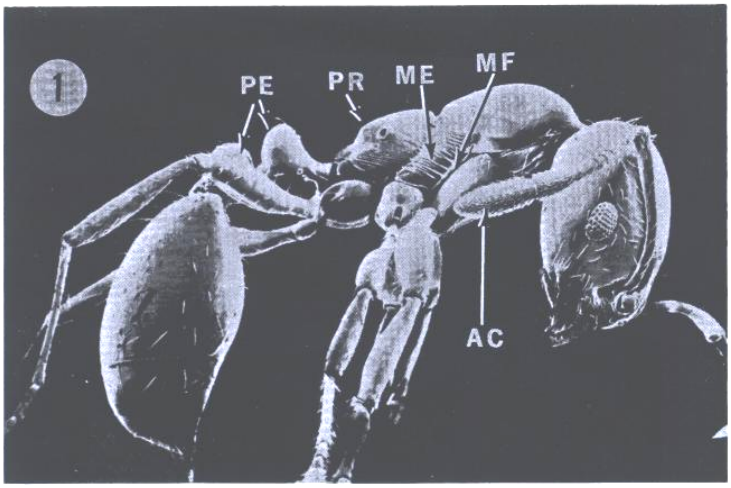


FIG. 1. SOLENOPSIS INVICTA. MEDIA WORKER (260X). AC: ANTENNAL CLUB, ME: MESOPLEURON, MF: MESOPLEURAL FLANGE, PE: PETIOLE, PR: PROPODEUM.

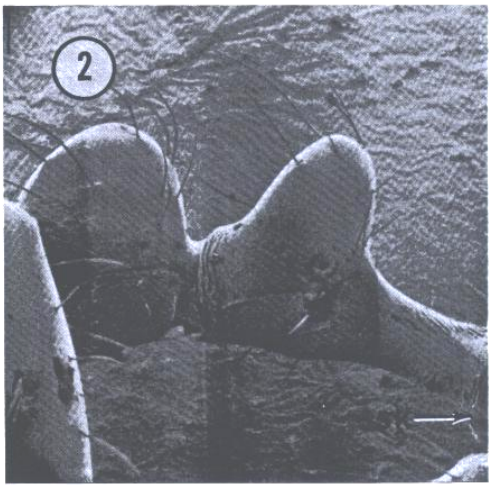
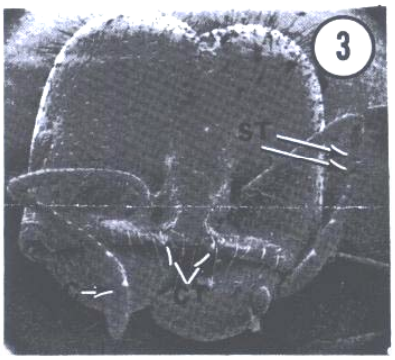


FIG. 2. SOLENOPSIS GEMINATA. TWO NODE OF PETIOLE BETWEEN THORAX AND GASTER (ABDOMEN) (140X). SK: SLIGHT KNOB.



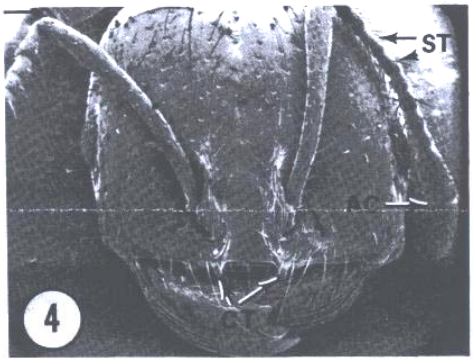


FIG. 3-4. SOLENOPSIS GEMINATA. FIG. 3. HEAD OF MAJOR WORKER (25X). FIG. 4. HEAD OF MINOR WORKER (46X). AC: ANTENNAL CLUB, CT: CLYPEAL TEETH, ST: SECOND AND THIRD FUNICULAR JOINTS.

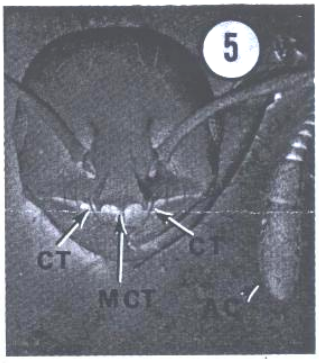
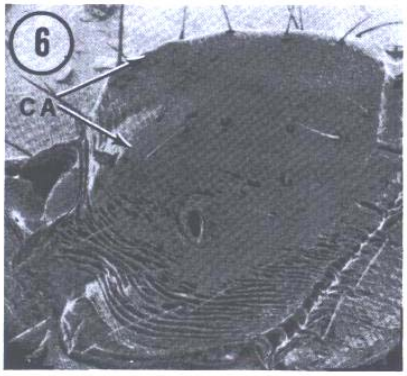


FIG. 5. SOLENOPSIS INVICT HEAD OF MINOR WORKER (46X). AC: ANTENNAL CLU CT: CLYPEAL TOOTH, MCT: MEDIAL CLYPEAL TOOTH.



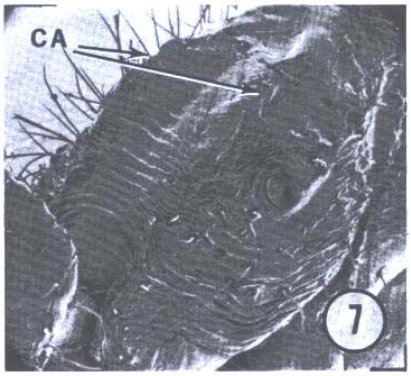


FIG. 6-7. SOLENOPSIS GEMINATA. PROPOSEUM OF MINOR WORKER AT 156X (FIG. 6) AND MAJOR WORKER AT 82X (FIG. 7). CA: CARINAE.

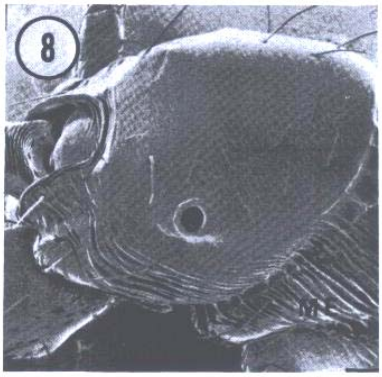
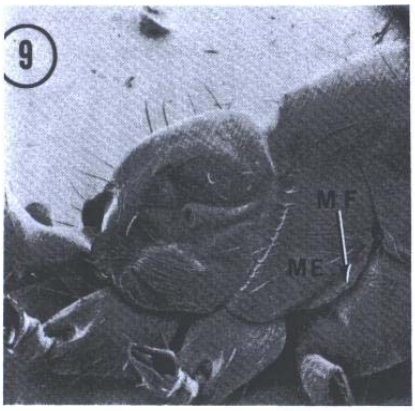


FIG. 8. SOLENOPSIS INVICTA. PROPODEUM OF MINOR WORKER (128X). ME: MESOPLEURON.



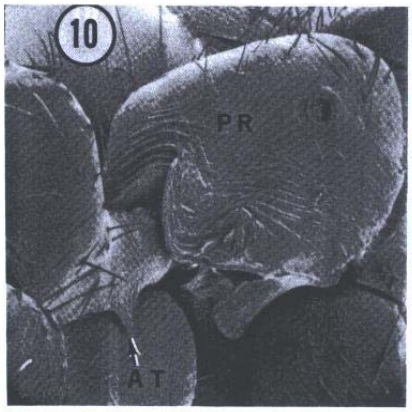


FIG. 9-10. SOLENOPSIS XYLONI.

FIG. 9. MESOPLEURAL AREA AND PROPODEUM (94X). ME: MESOPLEURON, MF: MESOPLEURAL FLANGE.

FIG. 10. PROPODEUM (PR) AND FIRST PETIOLAR NODE SHOWING ANTEROVENTRAL TOOTH (AT) (101X).

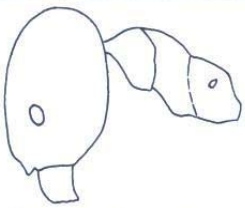


FIG. 11. S. GEMINATA HEAD AND ALITRUNK OF MAJOR

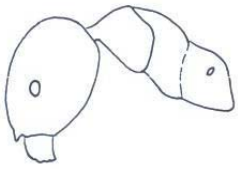
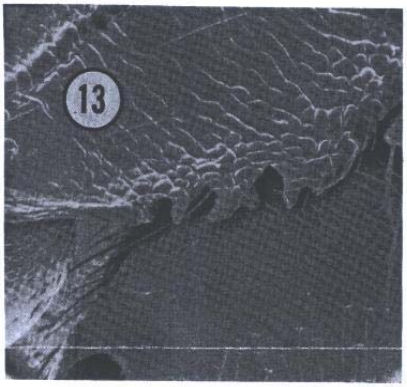


FIG. 12. S. INVICTA HEAD AND ALITRUNK OF MAJOR



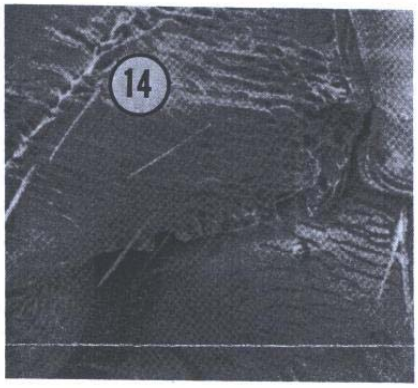


FIG. 13-14. SOLENOPSIS GEMINATA. VARIATION IN MESOPLEURAL FLANGE. FIG. 13. 199X. FIG. 14. 228X

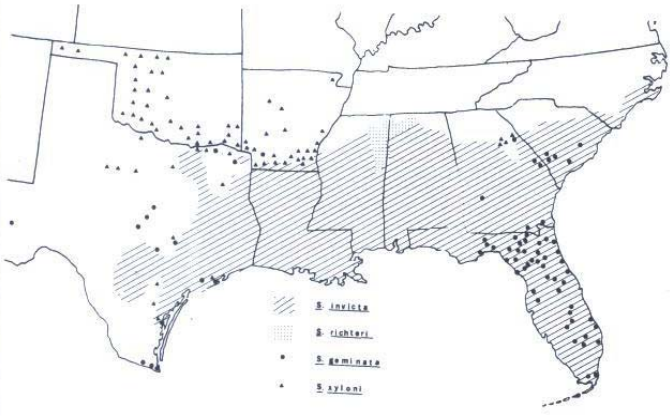


FIG. 15. PRESENT DISTRIBUTION OF S. INVICTA BASED ON USDA (1976), AND S. RICHTERI BASED ON BUREN (1972) AND UNPUBLISHED RECORDS. DISTRIBUTION OF S. GEMINATA AND S. XYLONI IN IMPORTED FIRE ANT INFESTED AREAS BASED ONLY ON RECENT COLLECTIONS (WOJCIK, UNPUBLISHED; BASS AND HAYS, 1976; CARROLL, 1970; NAVES, 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.

Appendix 2

ENTOMOLOGY CIRCULAR NO. 3
JULY 1962

FLA. DEPT. OF AGR.
DIV. OF PLANT INDUSTRY

A KEY AND ILLUSTRATIONS OF SOLENOPSIS GEMINATA (F.) AND SOLENOPSIS SAEVISSIMA RICHTERI FOREL[1]

H. A. DENMARK

TWO FIRE ANTS, SOLENOPSIS GEMINATA (F.) AND SOLENOPSIS SAEVISSIMA 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. SAEVISSIMA 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) . . . . . SAEVISSIMA RICHTERI

MINOR WORKERS

EPINOTUM WITH CARINA (ELEVATED RIDGE) ON EITHER SIDE (FIG. 1B). . . . . GEMINATA
EPINOTUM WITHOUT CARINA (ELEVATED RIDGE) (FIG. 2B). . . . . SAEVISSIMA RICHTERI

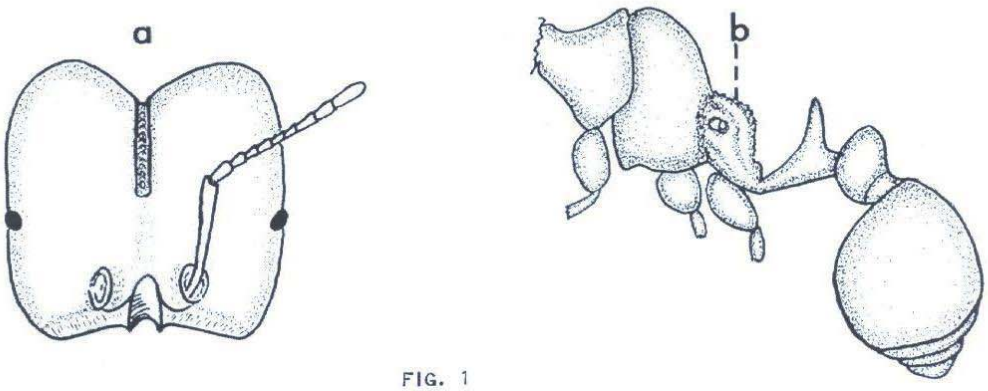


FIG. 1

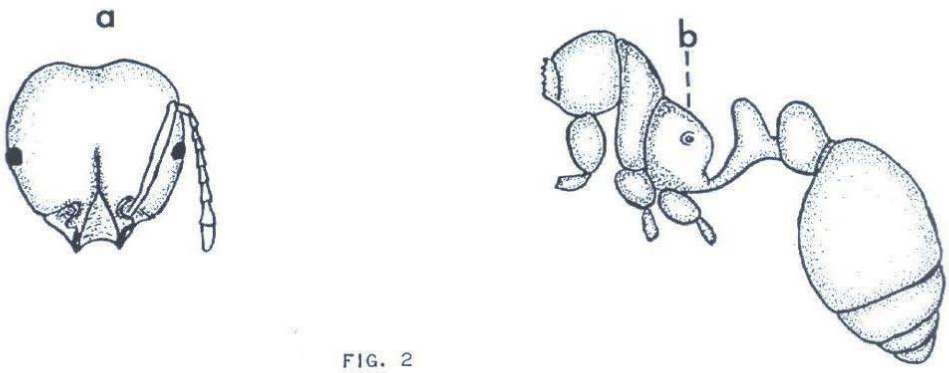


FIG. 2

Appendix 3

Texas Fire Ant Identification: An Illustrated Key

Jerry L. Cook, Stephen F. Austin University,
Sean T. O'Keefe, , and S. Bradleigh Vinson, Department of Entomology, Texas A&M University, College Station, TX

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.

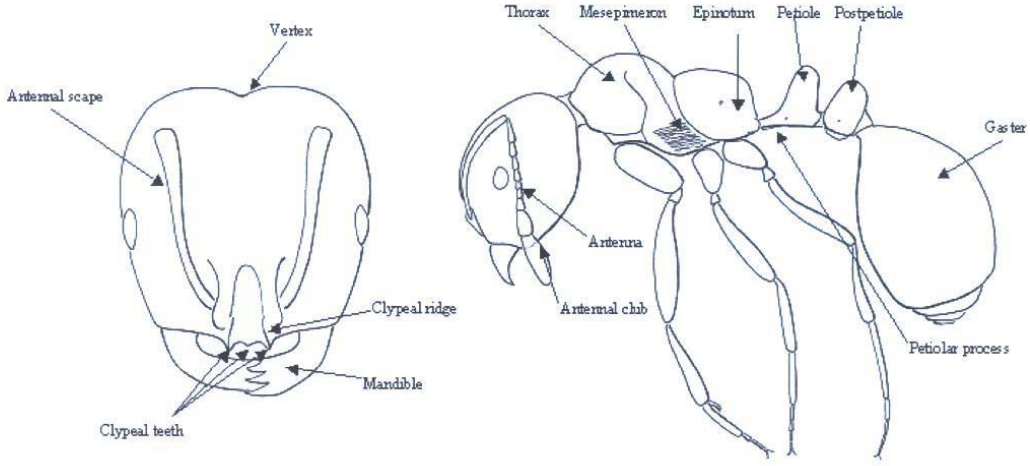
Red imported fire ant (*Solenopsis invicta* Buren): Only the red imported fire ant has a median clypeal tooth and a striated mesepimeron (see figures); although these may be difficult to see at first. Other characters that might help in the identification include: 1) the antennal scape nearly reaches 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 amblychila* 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

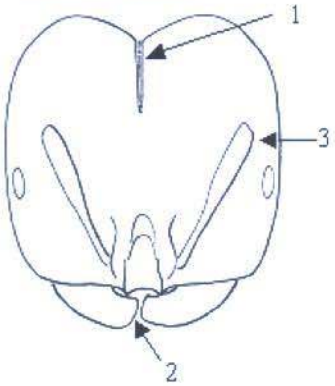
(Non fire ants have one or more of the following differences)

1) Postpetiole absent
2) Antenna with 12 segments
3) Antennal club with 3 segments
4) Have spines on the propodeum
5) Are either under 2 mm or over 7 mm

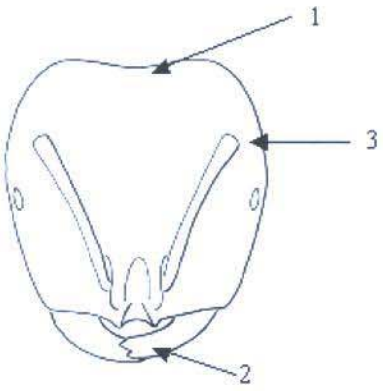
1) Vertex of head with deep groove
2) Mandibles without teeth and entirely black
3) Antennal scape shorter, reaching halfway to vertex

Tropical fire ant

Solenopsis geminata



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



Gaster light colored, yellow-red to reddish yellow

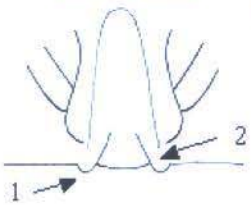
Gaster dark colored, dark brown to black

Next Page

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

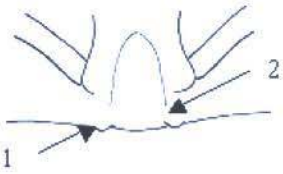
Solenopsis aurea

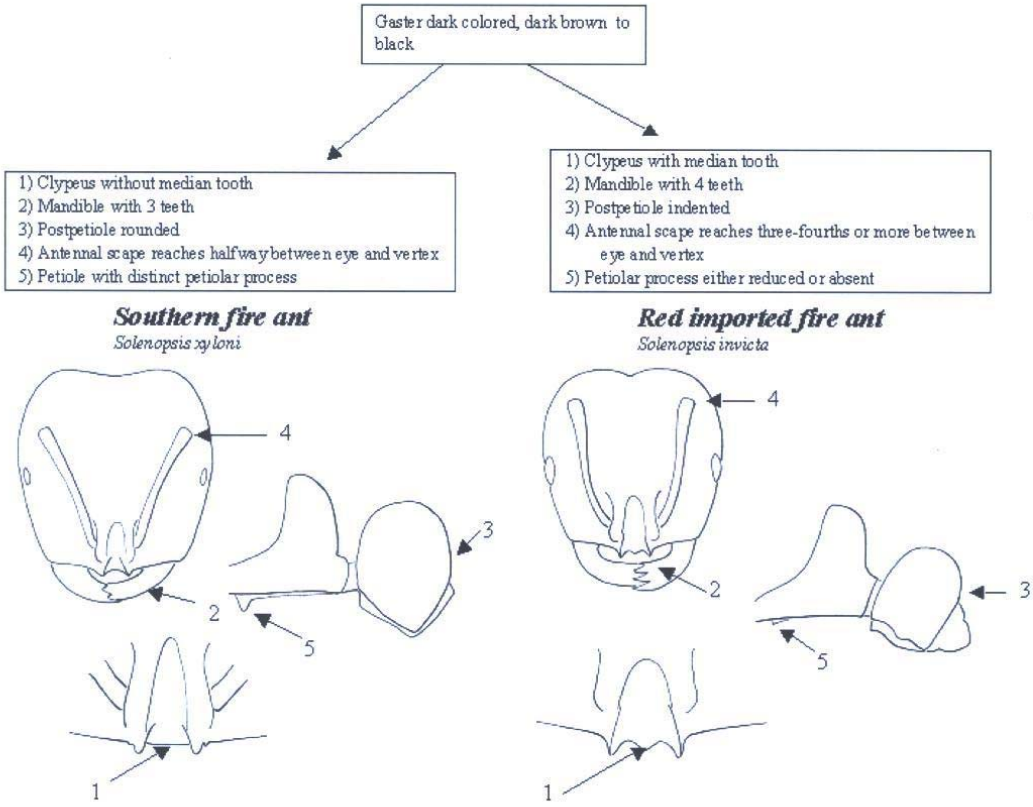
Desert fire ants



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

Solenopsis amblychila





For more information regarding fire ant management, see Extension publications B-6043, *Managing Red Imported Fire Ants in Urban Areas*; B-6076, *Managing Red Imported Fire Ants in Agriculture*; B-6099, *Broadcast Baits for Fire Ant Control*; or L-5070 *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.