GOBIERNO DE CHILE
FUNDACION PARA LA
INNOVACIÓN AGRARIA

INFORME TECNICO

"Visita a Chile de un experto internacional en taxonomía y biología de termitas de importancia económica"

CODIGO: FIA – CO – C – 2007 – 2 – F - 002

OCTUBRE 2007

(7)

GOBIERNO DE CHILE
FUNDACIÓN PARA LA INNOVACIÓN AGRARIA
MINISTERIO DE AGRICULTURA

CONTENIDO DEL INFORME TÉCNICO

Fecha de entrega del Informe
2 DE NOVIEMBRE DE 2007
Nombre del coordinador de la ejecución
Renato Ripa Schaul
Firma del Coordinador de la Ejecución

1. ANTECEDENTES GENERALES DE LA PROPUESTA
Nombre de la propuesta
Visita a Chile de un experto internacional en taxonomía y biología de Termitas de importancia económica.
Código
FIA-CO-C-2007-2- F - 002
Entidad responsable
INIA La Cruz
Coordinador(a)
Dr. Renato Ripa Schaul
Fecha de realización (inicio y término)
29 septiembre al 18 de octubre de 2007

2. RESUMEN DE LA PROPUESTA

Resumir en no más de ½ página la justificación, actividades globales, resultados e impactos alcanzados con la propuesta.

Dada la creciente importancia que las termitas en el país, el INIA La Cruz, ha realizado estudios principalmente de la termita subterránea (*Reticulitermes flavipes*) y de la termita de los muebles (*Cryptotermes brevis*), con el fin de determinar su distribución y manejo. Las investigaciones han permitido evaluar la efectividad de las metodologías de control de estos insectos plaga, particularmente de la termita subterránea, principalmente en el área urbana. Por otra parte, en el curso de estos estudios fueron encontradas termitas infestando frutales (paltos, cítricos, entre otros) y parronales, observando gran deterioro de las plantas atacadas. Además, se han realizado detecciones recurrentes de una especie de termita afectando plantaciones de eucaliptos y pinos al sur de la Región del Bío Bío, con la consecuente preocupación del sector forestal.

En este contexto, es muy importante la realización de una prospección de las especies de termitas que han sido detectadas afectando frutales y plantaciones forestales, con el fin de sugerir trabajos futuros que incluyan la implementación de medidas de manejo adecuadas tendientes a minimizar el problema.

Con la colecta realizada, se logró tener una amplia visión de la distribución de las especies de termitas presentes en Chile continental. Este aspecto resulta de alta relevancia para el manejo de esta plaga ya sea en la áreas urbanas, rurales y forestales.

Además este proyecto permitió conocer el estado de avance del daño de la termita en el área forestal. De acuerdo a las estimaciones de los profesionales del rubro, las pérdidas de árboles maderables alcanzan alrededor de un 10% de las plantaciones de *Eucalyptus nitens*, en sectores atacados por esta termita, cifra que si bien no es muy elevada, es preocupante, ya que hace algunos de años no superaba el 5% (CPF 2007, com. pers).

En el área del manejo integrado de plagas urbanas, agrícolas y forestales un aspecto muy relevante es la identificación correcta de la especie – plaga, ya que este conocimiento permite aplicar acciones de manejo adecuadas para cada especie.

3. ALCANCES Y LOGROS DE LA PROPUESTA

Problema a resolver, justificación y objetivos planteado inicialmente en la propuesta

Debido a la creciente importancia que las termitas han adquirido en la zona central del país en los últimos años, el INIA a través de su Centro Regional de Investigación La Cruz, ha realizado estudios principalmente de la termita subterránea (*Reticulitermes flavipes*) y de la termita de los muebles (*Cryptotermes brevis*), con el fin de determinar su distribución y manejo. Las investigaciones previas han permitido además, evaluar la efectividad de las metodologías de control de estos insectos plaga particularmente de la termita subterránea, principalmente en el área urbana (INIA-FNDR 2005). Un punto importante de destacar ha sido el creciente interés a nivel de Gobierno Regional de Valparaíso por resguardar sectores históricos y de vivienda del ataque de termitas (*C. brevis*), principalmente en la zona patrimonial de Valparaíso, donde esta plaga ha causado daño económico importante.

Por otra parte, en el curso de estos estudios fueron encontradas termitas infestando frutales (paltos, cítricos, entre otros) y parronales, observando gran deterioro de las plantas atacadas Además, se han realizado detecciones recurrentes de una especie de termita afectando plantaciones de eucaliptos y pinos en la IX y X regiones, con la consecuente preocupación del sector forestal ya que potencialmente podría convertirse en una plaga de importancia económica (CPF 2007, com. pers).

En este contexto, se hace necesario realizar la prospección de las especies de termitas que han sido detectadas afectando frutales y plantaciones forestales y evaluar el nivel de daño producido, con el fin de sugerir medidas de manejo adecuadas tendientes a minimizar el problema planteado.

Establecer características biológicas y de comportamiento de las especies de termitas asociadas a sistemas agrícolas, forestales y sectores urbanos.

1. Colectar e identificar taxonómicamente ejemplares de especies de termitas asociadas a parronales, cítricos y paltos y áreas urbanas en la zona norte, centro y sur del país.
2. Describir las características biológicas y de comportamiento relevantes para el manejo de la plaga
3. Realizar jornadas de capacitación y divulgación de la metodología de identificación y manejo de termitas a profesionales y técnicos del ámbito agrícola, forestal y urbano.

Objetivos alcanzados tras la realización de la propuesta

Fueron alcanzados todos los objetivos propuestos.

Resultados e impactos esperados inicialmente en la propuesta

1. Catastro de especies de termitas asociadas a especies frutales, forestales y parronales de la zona Norte y Centro Sur de Chile.

2. Profesionales, técnicos y ayudantes de investigación de los ámbitos agrícola, forestal y urbano capacitados en la identificación y técnicas de manejo de termitas.

3. Metodología práctica de reconocimiento de especies de termitas a través del daño, residuos y estructuras corporales de insectos.

Resultados obtenidos

Descripción detallada de los conocimientos y/o tecnologías adquiridos. Explicar el grado de cumplimiento de los objetivos propuestos, de acuerdo a los resultados obtenidos. Anexar el informe final del consultor.

Con la colecta realizada, se logró tener una amplia visión de la distribución de las especies de termitas presentes en Chile continental. Este aspecto resulta de alta relevancia para el manejo de esta plaga ya sea en la áreas urbanas, rurales y forestales.

Además este proyecto permitió conocer el estado de avance del daño de la termita en el área forestal. De acuerdo a las estimaciones de los profesionales del rubro, las pérdidas de árboles maderables alcanzan alrededor de un 10% de las plantaciones de *Eucalyptus nitens*, en sectores afectados por esta termita, cifra que si bien no es muy elevada, es preocupante, ya que hace un par de años no superaba el 5% (CPF 2007, com. pers.). De allí la preocupación de este sector por capacitarse en el conocimiento de estos insectos, para poder realizar un manejo adecuado, antes que se convierta en un problema económico de gran magnitud, como ocurre actualmente en las áreas urbanas con algunas especies de termita.

En el área del manejo integrado de plagas urbanas, agrícolas y forestales un aspecto muy relevante es la identificación correcta de la especie – plaga, ya que este conocimiento permite aplicar acciones de manejo adecuadas para cada especie. En el caso particular de las termitas, como las especies presentes en Chile presentan características físicas y de comportamiento muy diferentes, cada una requiere de metodologías particulares para su manejo.

Estos resultados muestran el cumplimiento cabal de los objetivos de la propuesta, que serán de gran utilidad para el desarrollo de futuros trabajos en esta área.

Se adjunta Informe final del consultor (ANEXO 1)

Resultados adicionales

Describir los resultados obtenidos que no estaban contemplados inicialmente.

Publicación de los resultados obtenidos en Revista internacional.

Aplicabilidad

Explicar la situación actual del sector y/o temática en Chile (región), compararla con las tendencias y perspectivas presentadas en las actividades de la propuesta y explicar la posible incorporación de los conocimientos y/o tecnologías, en el corto, mediano o largo plazo, los procesos de adaptación necesarios, las zonas potenciales y los apoyos tanto técnicos como financieros necesarios para hacer posible su incorporación en nuestro país (región).

Las termitas de madera seca (*Cryptotermes brevis*) y subterránea (*Reticulitermes flavipes*), han adquirido importancia en el quehacer nacional debido al daño causan, principalmente en la áreas urbanas donde se han establecido, lo anterior se relaciona con un impacto económico y social preocupante. Se debe resaltar que el daño aumenta en el tiempo si no se toman las medidas de prevención y control adecuadas. En este contexto el INIA La Cruz, ha realizado investigaciones tendientes a conocer esta plaga y de esta manera generar soluciones en materia del manejo junto con la educación a la población con la elaboración de material didáctico y técnico.

Por otra parte en el último tiempo, en algunas plantaciones forestales del Sur de la Región del Bío Bío, se han realizado recurrentes detecciones de termita de la madera húmeda (*Porotermes quadricollis*), en plantaciones de Eucaliptos y pinos, lo cual ha provocado preocupación en este rubro. En este sentido, se requiere generar información respecto al manejo de estos insectos, antes que las infestaciones alcancen mayores niveles de daño económico.

Los antecedentes indican que existe la necesidad de capacitar a profesionales y técnicos en monitoreo y la identificación de las especies, con el fin de evitar y/o limitar su dispersión, además se deben implementar estrategias de manejo. Dentro del ámbito del manejo y control de la termita de madera seca, madera húmeda y subterránea, uno de los principales problemas que se presentan es la detección de los focos. Visualmente durante una inspección es posible encontrar evidencias de la presencia de termitas, tales como madera dañada, alas adheridas a telarañas o en el suelo, fecas acumuladas cerca del lugar afectado y en algunas oportunidades pequeños orificios en la madera. Sin embargo, muchas veces el daño no es visible o no existen evidencias de este, como es el caso de los bosques en pie y es allí donde se requiere la utilización de equipos especializados de detección, no destructivos como un equipo detector de emisiones acústicas (EA), que captan el sonido causado por las termitas al arrancar las fibras de madera, captándolo mediante un transductor, señal que luego es amplificada y filtrada. Otra tecnología desarrollada en Australia, es el emisor y detector de microondas el cual funciona en forma similar a un radar, enviando una señal de microonda, la que detecta el movimiento de termitas en el interior de estructuras.

La utilización de tecnologías eficientes de detección tienen como consecuencia un mejor control de la plaga y por lo tanto una disminución del impacto económico que puede llegar a causar esta plaga, el cual varía entre un 5 y un 20% del total de US$ 1.5 billones utilizados anualmente en Estados Unidos en el control de insectos que destruyen la madera, sólo en el área urbana. En nuestro país, no existen estudios que muestren el impacto económico de las especies de termita encontradas en las áreas urbanas. Sin embargo, es necesario destacar que se han encontrado severos daños en construcciones de 5 a más de 20 años de antigüedad, lo cual confirma que estos insectos se encuentran en plena actividad, lo que es un índice de la urgente necesidad de su control.

Por lo anterior, los conocimientos el intercambio de información y la capacitación realizada resultan muy importantes ya que pueden ser aplicados permanentemente en las investigaciones que desarrolla el INIA V Región, y en sus proyectos futuros, en esta plaga urbana y forestal, en la cual la incorporación de técnicas de detección y la realización de un manejo integrado proporciona ventajas ambientales y económicas.

Esta iniciativa, desarrollada con el apoyo financiero del FIA, responde a la necesidad de intercambiar conocimientos e incorporar la experiencia de investigadores de nivel internacional, en el estudio y manejo de las termitas tanto en área urbana como forestal y eventualmente agrícola. Nuevas propuestas de incorporación de conocimiento, como la aquí se informa, requerirá de apoyo financiero para su realización, lo que incrementará las oportunidades de éxito en la postulación de futuras investigaciones y de las ya desarrolladas, las cuales se traducirán en un aporte a la innovación tecnológica de nuestro país.

Detección de nuevas oportunidades y aspectos que quedan por abordar

Señalar aquellas iniciativas que surgen como vías para realizar un aporte futuro para el rubro y/o temática en el marco de los objetivos iniciales de la propuesta, como por ejemplo la posibilidad de realizar nuevas actividades.

Indicar además, en función de los resultados obtenidos, los aspectos y vacíos tecnológicos que aún quedan por abordar para ampliar el desarrollo del rubro y/o temática.

Los antecedentes indicados señalan la necesidad de implementar estrategias de monitoreo de los focos de termitas, de diferentes especies de termita, identificados en áreas urbanas, rurales y forestales con el fin de evitar y/o limitar su dispersión, y aplicar medidas de manejo.

Por otro lado es importante considerar la existencia de medidas preventivas para el manejo de esta plaga, mediante el conocimiento del comportamiento de estos insectos, lo que permite generar condiciones menos favorables para su desarrollo.

En este contexto existen varios aspectos que deberían se abordados en futuras investigaciones, como:

- Detección de colonias de termitas de madera seca y húmeda por medio de instrumentos específicos (emisión acústica y/o radar).
- Detección y monitoreo de colonias de termita de madera húmeda asociadas a plantaciones de eucaliptos y pinos en el sur del país .
- Caracterización de condiciones ambientales desfavorables para termita de madera seca y húmeda
- Transferencia a los usuarios de las metodologías de manejo desarrolladas.
- Asesoramiento en el manejo de termitas de madera seca y subterránea en el área Patrimonial de Valparaíso y termitas de madera húmeda en las plantaciones de eucaliptos y pinos de la zona Centro Sur del país.

Por otro lado, y muy importante es la interacción con investigadores especialistas en el tema, la que será un nuevo apoyo a la investigación desarrollada.

4. ASPECTOS RELACIONADOS CON LA EJECUCIÓN DE LA PROPUESTA

Programa Actividades Realizadas

Nº	Fecha	Actividad
1	30 septiembre	Llegada a Chile, posterior traslado a Quillota , V Región.
2	1 octubre	Reunión con investigadores INIA La Cruz. Coordinación de actividades.
3	2 octubre	Viaje a Copiapó
4	3 octubre	Visita a Parronal (Empresa Tres Soles), Copiapó.
5	4 octubre	Viaje a Caldera, colecta de individuos de termita
6	5 octubre	Viaje Copiapó – Carrizal Bajo y Huasco Bajo, colecta de individuos de termita
7	6 octubre	Visita y colecta de especimenes de termita en Parque Nacional Fray Jorge. Regreso a la V Región
8	8 octubre	Visita áreas urbanas en Quillota. Colecta de material.
9	9 octubre	Visita áreas rurales en La Cruz. Colecta de individuos de termita.
10	10 octubre	Viaje a Los Ángeles
11	11 octubre	Visita a plantaciones forestales en Mulchén y Collipulli. Colecta de material.
12	12 octubre	Charla a profesionales del Área Forestal. En CPF- Regreso a V Región.
13	16 octubre	Visita casco histórico de Valparaíso. Fotos.
14	17 octubre	Charla a profesionales de Municipios y personal de INIA La Cruz. En auditorio, La Cruz.
15	18 octubre	Capacitación personal del laboratorio de INIA La Cruz, en identificación de especies de termitas (a nivel de género)

Detallar las actividades realizadas, señalar las diferencias con la propuesta original.

La visita se inició con la recepción del Dr. Krecek, por las autoridades del INIA La Cruz, Director Sr. Robinson Vargas M. y Subdirector de investigación y desarrollo Sr. Fernando Rodríguez A., instancia en la cual se revisó el programa de las actividades a realizar durante su estadía.

Luego se preparó el material de colecta y de difusión necesario para las actividades.

Posteriormente se dio inicio a las actividades de colecta de termitas, con un viaje hacia Copiapó (2 de octubre de 2007).

3 de octubre de 2007: Visita a los patronales de la Empresa Agrícola Tres Soles (propietario: Sr. Alfonso Prohens), ubicada al interior de la comuna de Tierra Amarilla, en la Región de Atacama. Esta actividad fue coordinada por el Sr. Alfonso Momberg, agrónomo zonal de Subsole, con quien se realizó el recorrido de un sector de patronales, plantados en el año 1952, var. Thomson seedles (Foto 1), afectados por termitas de madera seca de la especie *Cryptotermes brevis* (Walker) (Foto 2). Estas plantas se encuentran actualmente en producción. Se colectó individuos pertenecientes a las castas de obreros y soldados (2 muestras), colocados en alcohol al 85%. Además se guardó muestras de madera con daño, madera con individuos vivos y muestras de fecas encontradas en las maderas atacadas (Fotos 3 y 4).

Foto 1. Parronal Thomson seedles. Copiapó

Foto 2. Soldado y obreras *Cryptotermes brevis*

Foto 3. Daño Termita en Parronal Thomson seedles. Copiapó

Foto 4. Daño Termita en Parronal Thomson seedles. Copiapó

En el lugar además fueron revisados numerosos árboles y arbustos que se encontraban en los alrededores, con el fin de colectar nuevas muestras, es así que se colectó en alcohol (85%) individuos de *C. brevis* encontrados en Eucalipto (*Eucalyptus globulus*), en Molle o Huingán (*Schinus polygamus*), Acacio rey o capense (*Acacia capense*), pimiento del Perú (*Schinus molle*) y durazno (*Prunus persica*), logrando colectar 5 muestras.

En la localidad de Los Loros (Tierra Amarilla), en el sector San Antonio, se encontró daño y presencia de individuos vivos de *C. brevis* en ramas secas de Chañar (*Geofforea decorticans*), en Pimiento del Perú y en Sauce Chileno (*Salix humboldtiana*), completando un total de 3 muestras.

4 de octubre de 2007: se realizó un viaje hacia Caldera, en esta cuidad se visitó la iglesia principal "San Vicente de Paul" (foto 5), en el lugar se constató daño en bancas (foto 6) y guardapolvos de la construcción con daño de *C. brevis*. Al ingresar al patio interior se observó un árbol de damasco muerto (*Prunus armeniaca* L.), al cortar una rama, se verificó la presencia de colonias de *C. brevis*, de las cuales se colectó muestra de individuos vivos en trozos de madera y en alcohol (fotos 7 y 8). En el mismo sitio se colectó además la misma especie de termita atacando ramas secas en un gomero (*Ficus elastica*) y un hisbisco (*Hibiscus sp.*), obteniendo 3 muestras.

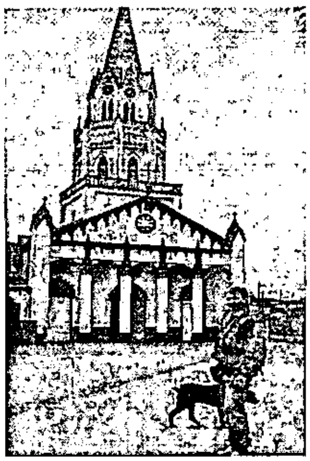


Foto 5. Iglesia San Vicente de Paul. Caldera

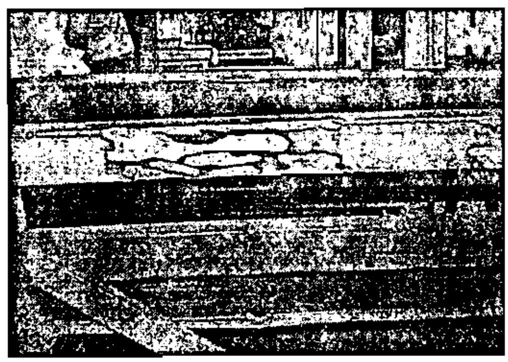


Foto 6. Daño Temitas en bancas Iglesia San Vicente de Paul. Caldera

Foto 7. Daño en damasco. Iglesia San Vicente de Paul. Caldera

Foto 8. *Cryptotermes brevis* en damasco. Caldera

Sector San Pedro, camino a Puerto Viejo fueron colectadas 2 muestras de termita *C. brevis* en madera de roble y en una especie arbustiva del desierto.

En el sector Pabellones, cerca de Copiapó se colectó individuos de *C. brevis* en Acacio (*Acacia caven*). (Foto 9) 1 muestra.

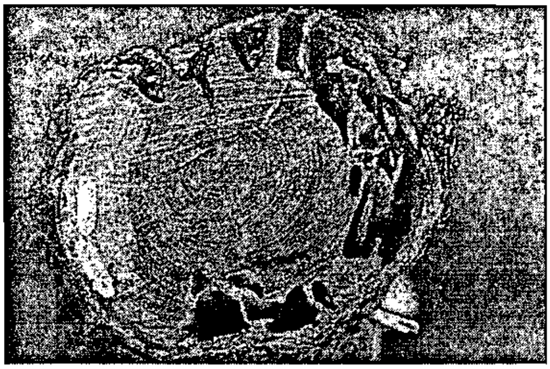


Foto 9. Acacia caven con daño de termita. Paballones. Copiapó

5 de octubre de 2007: viaje Copiapó a Carrizal bajo, accediendo por el norte. Se colectó individuos de termita chilena, *Neotermes chilensis* (Blanchard) (Foto 10), encontrados en un cactus seco (Fotos 11 y 12) (*Eulyghnia breviflora*). 1 muestra.

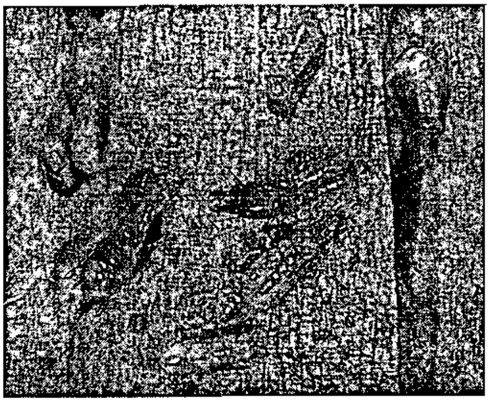


Foto 10. Soldado y obreras Neotermes chilensis

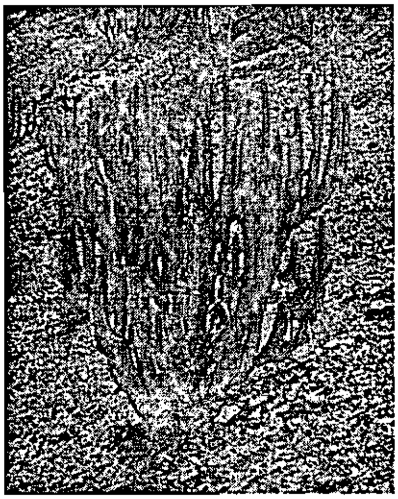


Foto 11. Cactus (Eulyghnia breviflora). Camino a Carrizal Bajo

Foto 12. Daño termita en cactus. Camino a Carrizal Bajo

En Carrizal Bajo, se observó daño de termita de los muebles, *C. brevis*, en numerosas casas y estructuras (foto 13), en la las bancas de la iglesia y en un tronco seco de un árbol, posiblemente de pimiento del Perú (foto 14). 1 muestra.

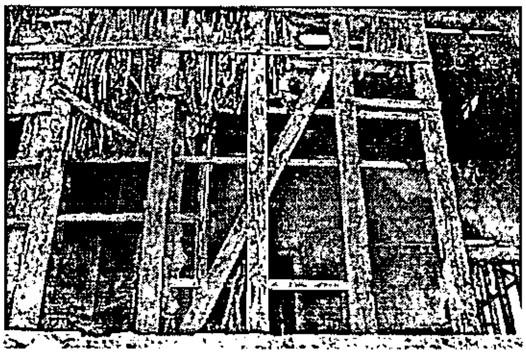


Foto 13. Daño termita en estructuras de vivenda. Carrizal Bajo

Foto 14. Daño termita en *Schinus molle*. Carrizal Bajo

Huasco Bajo, se observó daños de termita de los muebles (*C. brevis*), en postes utilizados como cercos, ventanas (foto 15) y pilares de una casa. Además se colectó muestras en los postes, en un peral seco (*Pirus communis*) y en un sauce muerto (*Salix humboldtiana*) (3 muestras), foto 16.

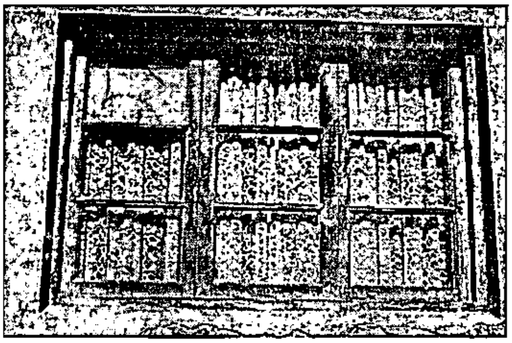


Foto 15. Daño en ventana vivienda. Huasco Bajo

Foto 16. Daño en *Salix humboldtiana*. Huasco Bajo

6 de octubre de 2007: Parque Nacional Fray Jorge, en este lugar se hizo contacto con el guarda bosques Sr. Mario Ortiz L., con quien se realizó un recorrido por el bosque Valdiviano y se colectó termita chilena (*N. chilensis*) en troncos muertos de Olivillo (*Aectoxicum punctatum*) (fotos 17, 18 y 19). 2 muestras.

Foto 17. Troncos caídos de *Aectoxicum punctatum.* con daño de termita. P.N. Fray Jorge

Foto 18. Daño termitas en *Aectoxicum punctatum.* P.N. Fray Jorge

Foto 19. Daño termitas en *Aectoxicum punctatum.* P.N. Fray Jorge

8 de octubre de 2007: Las actividades de estas visitas fueron coordinadas por la Ing. Agrónoma Sra. Paola Luppichini y la Sra. Patricia Véliz, del INIA LA Cruz. Se realizó un recorrido por el centro de la ciudad de Quillota, ya que allí existe un foco de la especie de termita *C. brevis*. En la oportunidad se pudo observar daño en pilares, ventanas y algunos techos de viviendas y locales comerciales. No se colectó muestras. Además se detectó presencia de termitas vivas en un Falso acacio (*Robinia pseudoacacia*), del cual se obtuvo una muestra.

Se visitó un foco de termita subterránea (*Reticulitermes flavipes*) (foto 20) ubicado en el Sector de La Palma, en el lugar se pudo observar viviendas, postes, estacas y árboles atacados esta termita. Se colectó individuos de esta especie de termita encontrados en trocos secos de Álamo (*Populus nigra* var *italica*) ubicados cerca de una vivienda muy afectada. una muestra.

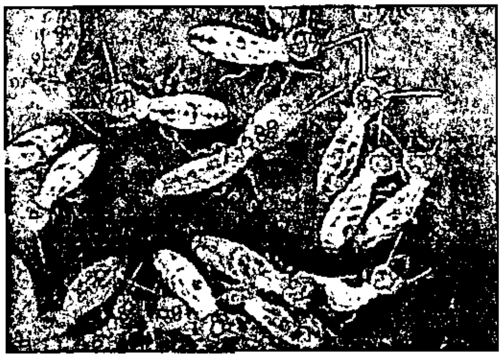


Foto 20. Soldado y obreras *Reticulitermes flavipes*

9 de octubre de 2007: El Dr. Krecek asistió a una reunión almuerzo con el Director del Centro Regional de Investigación, INIA La Cruz, Dr. Robinson Vargas, en la cual se realizó un pequeño resumen de las primeras actividades y resultados de esta visita y se dio a conocer las actividades de la segunda parte de la consultoría.

La salida a terreno se realizó en el sector Pocochay, en La Cruz con un recorrido por una plantación de eucaliptos (*E. globulus*), en este lugar se colectó individuos de *N. chilensis* (termita chilena) presentes en tocones de eucaliptos, en Molle (*Schinus latifoluis*) y en acacio (*A. caven*). 3 muestras.

Se programó inicialmente la visita a un huerto de cítricos que presentó ataque de termita subterránea, sin embargo se contactó al administrador del lugar y señaló que ya no existía daño de estas termitas debido a la aplicación de insecticida y posterior arranque de las plantas afectadas (fotos 21 y 22). Esta actividad fue sustituida por la visita a la plantación de eucaliptos.

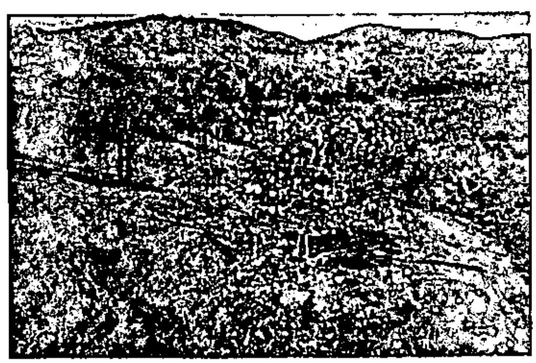


Foto 21 y 22. Cítricos desfoliados y cloróticos con daño de termita subterránea en el cuello. Quillota 2005

11 de octubre de 2007: Las actividades de estas visitas fueron coordinadas por el Sr. Osvaldo Ramírez G., gerente de CPF S.A. (Controladora de Plagas Forestales S.A.) y profesionales la Forestal Mininco S.A., con quienes se realizó una pequeña reunión con el fin de conocer el itinerario del recorrido y algunos aspectos de la detección de termitas realizada en predios forestales de las Regiones VIII y IX.

Predio Monte Verde, de propiedad de la empresa Mininco S.A., ubicado en la Comuna de Mulchén, VIII Región. El recorrido se inició en una plantación de Eucaliptos (*Eucalyptus nitens*) del año 1994, se observó grandes colonias de termita de madera húmeda, *Porotermes quadricollis* (Rambur) (foto 23) en trozos de pino (*Pinus radiata*) que quedaron de la plantación precedente (foto 24). Se cortó un eucalipto ubicado en un sector donde se encontró colonias de *P. quadricollis* (foto 25), el cual presentaba daño en el exterior, sin embargo, al realizar cortes transversales se pudo ver claramente galerías en la madera , construidas por las termitas (fotos 26 y 27), el daño se extendía hasta los 4 m de altura. Se realizó la colecta de individuos vivos de termitas en ambas especies arbóreas. Colecta de individuos, 2 muestras.

Foto 23. *Porotermes quadricollis* en *Pinus radiata*. Mulchén

Foto 24. Trozo de *Pinus radiata* con ataque de termitas. Mulchén

Foto 25. Corte de *Eucalyptus nitens* con daño de termita. Mulchén

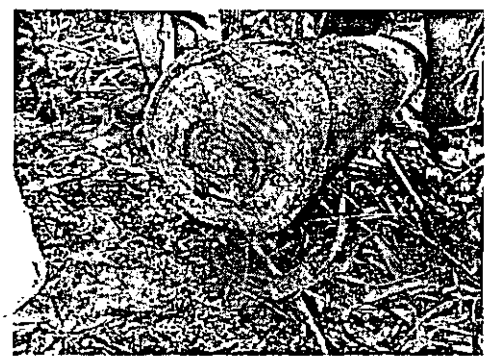


Foto 26. Daño de termita en tronco de *Eucalyptus nitens*. Mulchén

Foto 27. Daño de termita en tronco de *Eucalyptus nitens*. Mulchén

Predio Pan Grande, Plantación de *E. nitens* (foto 28) y *P. radiata*, de propiedad de la empresa Mininco S.A., ubicado en la Comuna de Collipulli, IX Región. Durante la visita se colectó individuos de termita (*P. quadricollis*) presentes en un tocón de roble (*Nothofagus oblicua*) y aromo (*Acacia dealbata*) (foto 30). Además se encontró colonias numerosas de *P.quadricollis* en tocones de *E. nitens*, cosechados en 1999 (foto 29). Colecta de individuos, 3 muestras.

Foto 28. Vista plantación *Eucalyptus nitens*. Collipulli

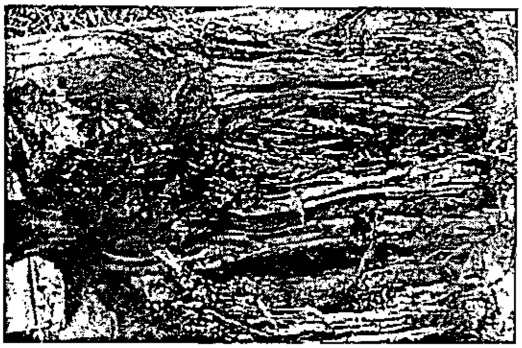


Foto 29. Tocón *Eucalyptus nitens* con daño de termitas. Collipulli

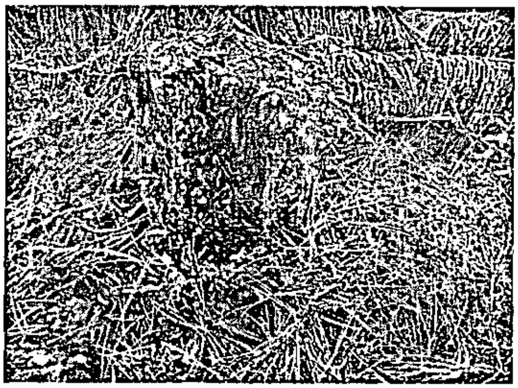


Foto 30. Tocón *Acacia dealbata* con daño de termitas.Collipulli

De acuerdo a la propuesta inicial el recorrido contemplaba la visita a la IX y X Regiones debido a detecciones recurrentes de una especie de termita que está afectando plantaciones de eucaliptos y pinos en esos lugares. Sin embargo, de acuerdo a los últimos monitoreos realizados por profesionales de CPF S.A. y Mininco S.A., el mayor número de hallazgos daño de termita se han concentrado el sur de la VIII Región, principalmente en las plantaciones de *E. nitens*, esto ha provocado una preocupación del sector forestal ya que potencialmente podría convertirse en una plaga de importancia económica. De esta manera, los profesionales encargados estimaron más provechoso recorrer estos lugares que han sido de gran preocupación en los últimos meses.

Nº Total Muestras colectadas: 33

12 de octubre de 2007: se sostuvo una breve reunión con el Sr. Osvaldo Ramirez G., gerente de CPF S.A. quien realizó una breve reseña de la empresa, misión, visión, objetivos y socios en esta reunión participó el Dr. Renato Ripa S., el Dr. Jan Krecek y la Ing. Agrónoma Sra. Paola Luppichini B.

Posteriormente, se realizó un Seminario que contó con la participación del Dr. Renato Ripa S., y la Ing. Agrónoma Sra. Paola Luppichini B. del INIA La Cruz, con el tema "Impacto y control de las termitas" y el Dr. Jan Krecek de la Universidad de Florida con el tema "Taxonomía y biología de termitas neotropicales de importancia económica". El público asistente estuvo constituido por profesionales y técnicos de CPF S.A., Mininco S.A, Forestal Celco S.A., Masisa S.A., CMPC y particulares (Foto 31). Duración 2 horas, asistencia 15 personas (Lista asistencia, Anexo 3).

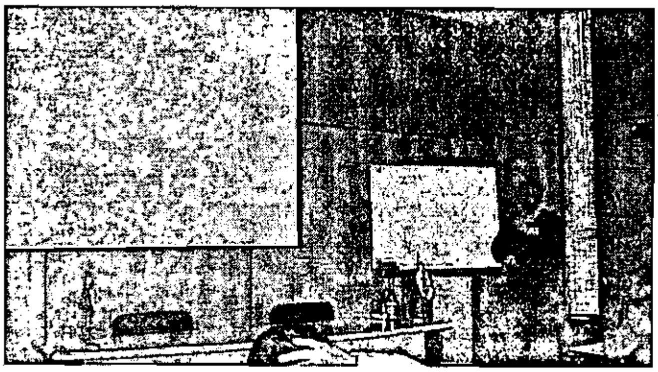
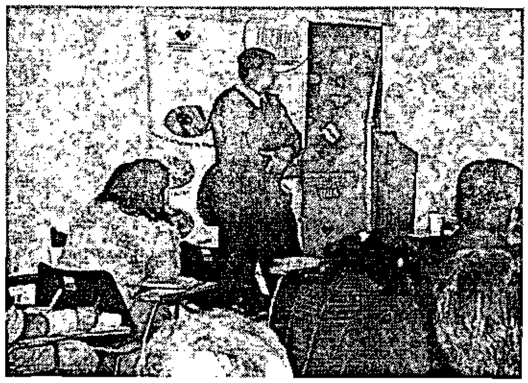


Foto 31. Charla en CPF S.A. Los Angeles

16 de octubre de 2007: visita al casco histórico de Valparaíso, fueron visitados diversos focos de termita de los muebles, *C. brevis*, identificados en este sector. Se puede destacar, por el gran daño que se observa, la casa parroquial de la Iglesia La Matriz donde ventanas, marcos de puestas y pisos se encuentran con profuso daño (foto 32).

Foto 32. Daño de termita en ventana casa parroquial iglesia La Matriz. Valparaíso

17 de octubre de 2007: En el auditorio del Centro Regional de Investigación del INIA La Cruz, se realizó la charla "Taxonomía y biología de termitas neotropicales de importancia económica", realizada por el Dr. Jan Krecek de la Universidad de Florida. En esta charla se incluyó la descripción de algunas técnicas simples, que permiten la identificación a nivel de género de termitas (fotos 33 y 34). El público asistente estuvo constituido por profesionales y técnicos de la Municipalidad de Viña del Mar, SAG, CONAMA y del INIA La Cruz. Duración 2 horas y media, asistencia 20 personas. (Lista asistencia, Anexo 3).



Fotos 33 y 34. Charla en INIA La Cruz. La Cruz

18 de octubre de 2007: Durante la mañana se analizó el manuscrito de la publicación que se proyecta realizar, con la información obtenida con esta visita y antecedentes sobre termitas en otros lugares del mundo, obtenidos por el Dr. Krecek y el equipo de la Universidad de Florida y por los profesionales del INIA Dr. Renato Ripa y Sra. Paola Luppichini, respecto a termitas en Chile.

El Dr. Krecek realizó un taller de identificación en laboratorio de especies de termitas (género), utilizando dibujos para la comparación de mandíbulas de obreras (foto 35) (ver anexo), forma de la cabeza de soldados (clave) y forma del pronoto. Este taller estuvo dirigido al personal del laboratorio de INIA La Cruz y tuvo una duración de 2 horas.

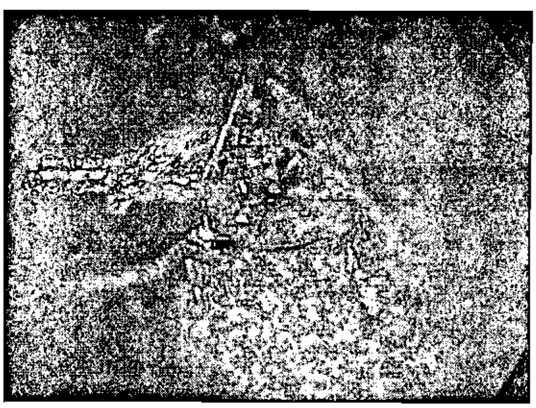


Foto 35. Mandíbulas de obrera de termita subterránea

En la propuesta se incluyó la entrega de un CD con la o las presentaciones realizadas durante la actividad. Debido a que dentro de este material presentado el Dr. Krecek existe información que aun no es publicada y es propiedad intelectual de la Universidad de Florida, se excusó de poder dejar el material para entregarlo al público asistente.

Contactos Establecidos

Presentar los antecedentes de los contactos establecidos durante el desarrollo de la propuesta (profesionales, investigadores, empresas, etc.), de acuerdo al siguiente cuadro:

Institución Empresa Organización	Persona de Contacto	Cargo	Fono/Fax	Dirección	E-mail
Agrícola Tres Soles	Conrado Grau	Administrador	52 - 523910	Sector Tres Soles. Interior, Tierra amarilla	cgrau@prohenscopiapo.cl
Subsole	Alfonso Momberg	Agrónomo Zonal	52 - 213971 9 - 3461068	Sector Tres Soles. Interior, Tierra amarilla	amonberg@subsole.cl
Subsole	Andro Vidal G.	Agrónomo	2 - 9406400 2 - 2421220 9 3207617	Luis Pasteur 5661. Vitacura. Santiago	avidal@subsole.cl
Controladora de Plagas Forestales S.A. (CPF S.A.)	Osvaldo Ramírez G.	Gerente	43 – 320017 43 - 320018	Camino Público Los Ángeles – Laja. Sector Curamávida s/n (km 2.5). Los Ángeles	oramirez@cpf.cl
Forestal Mininco S.A	Luis De Ferrari F.	Subgerente Gestión Ambiental y Protección Sanitaria	43 - 636202 43 - 312701 9 4414464	Av. Alemania Nº 751. Los Ángeles	luis.deferrari@forestal.cmpc.cl
Forestal Mininco S.A	Miguel Castillo S.	Jefe Depto. Protección Sanitaria	41- 2857340 41- 2373431	Los Canelos 79. San Pedro de la Paz. Concepción.	miguel.castillo@forestal.cmpc.cl

Forestal Mininco S.A	Marcelo Donoso M.	Supervisor Protección Sanitaria	43 - 636202 43 - 312701 9 8296506	Av. Alemania Nº 751. Los Ángeles	marcelo.donoso@forestal.cmpc.cl
CONAF	Mario Ortiz L.	Guarda Bosques en Parque Nacional Fray Jorge	9 6411015	Parque Nacional Fray Jorge	marioayuda@yahoo.es

Material elaborado y/o recopilado

Entregar un listado del material elaborado, recibido y/o entregado en el marco de la propuesta. Se debe entregar adjunto al informe un set de todo el material escrito y audiovisual, ordenado de acuerdo al cuadro que se presenta a continuación.

También se deben adjuntar fotografías correspondientes a la actividad desarrollada. El material se debe adjuntar en forma impresa y en versión digital.

Elaborado

Tipo de material	Nombre o identificación	Preparado por	Cantidad
Revista	Revista Tierra Adentro Nº 59 , 2004	Dr. Renato Ripa y Paola Luppichini	15
Afiches	Reconocimiento de especies de termitas	Dr. Renato Ripa y Paola Luppichini	35
Afiches	Reconocimiento de especies de coleópteros xilófagos en madera en servicio	Dr. Renato Ripa y Paola Luppichini	35
Clave	Clave de identificación taxonómica de termitas (características soldados).	Dr. Jan Krecek	5
Libro colección INIA	Termitas y otros insectos xilófagos en Chile: especies, biología y manejo.	Dr. Renato Ripa, Paola Luppichini, Dr. Jan Krecek, Dr. Michael Lenz y Jim W. Creffield.	10

Recopilado

Tipo de Material	Nº Correlativo (si es necesario)	Caracterización (título)
Artículo	1	Scheffrahn R.H., N-Y. Su, J. Krecek, A. van Liempt, B. Maharajh and G.S. Wheeler. 1998. Prevention of

		colony foundation by *Cryptotermes brevis* and remedial control of Drywood termites (Isoptera: Kalotermitidae) with selected chemical treatments. Journal of Economic Entomology. Vol. 91 nº 6. 1387 – 1396.
Artículo	2	Scheffrahn R.H., J. P.E.C Darlington, M.S. Collins, J. Krecek and N-Y. Su. 1994. Termites (Isoptera: Kalotermitidae, Rhinotermitidae, Termitidae) of the best Indies. Sociobiology. Vol. 24 Nº 2. 213 – 238.
Artículo	3	Scheffrahn R.H., J. Krecek, J.A. chase and N-Y. Su. 1998. *Cryptotermes abruptus*, a new drywood termite (Isoptera: Kalotermitidae) from southeastern Mexico. Florida Entomologist. Vol. 81 (2). 188 – 193.
Artículo	4	Krecek J. and R.H. Scheffrahn. 2003. *Neotermes phragmosus*, a new dampwood termite (Isoptera: Kalotermitidae) from Southeastern Cuba. Florida Entomologist. Vol. 86 (1). 73 – 79.
Artículo	5	Scheffrahn R.H., P. Buses, J.K. Edwards, J. Krecek B. Maharajh and N-Y. Su. 2001. Chemical prevention of colony foundation by *Cryptotermes brevis* (Isoptera: Kalotermitidae) in Attic modules. Journal of Economic Entomology. Vol. 94 Nº 4. 915 – 919.
Artículo	6	Scheffrahn R.H., J. Krecek and N-Y. Su. 2000. Redescription of dampwood termites *Neotermes jouteli* and *N. luykxi* (Isoptera: Kalotermitidae) from Florida, Cuba, Bahamas, and Turks and Caicos Islands. Annals of the Entomological Society of America. Vol. 93 Nº 4. 785 -794.
Dibujos	7	Esquemas para identificación de especies de termitas (a nivel de género) a través de las mandíbulas de los obreros.
Fotos	8 (en CD)	Lugares de colecta, daño de termitas, charlas de difusión

Programa de difusión de la actividad

En esta sección se deben describir las actividades de difusión de la actividad, adjuntando el material preparado y/o distribuido para tal efecto.

En la realización de estas actividades, se deberán seguir los lineamientos que establece el "Instructivo de Difusión y Publicaciones" de FIA, que le será entregado junto con el instructivo y formato para la elaboración del informe técnico.

Tipo de actividad realizada y objetivo principal
Charlas Técnicas

Objetivos

- Los objetivos de las charlas fueron los siguientes:
  1. Dar a conocer las especies de termitas presentes en Chile, su impacto económico y avances en el manejo y control.
  2. Profundizar en el conocimiento de la biodiversidad de termitas neotropicales, su importancia ecológica y económica.
  3. Transferir a profesionales, ayudantes de investigación y asesores, la experiencia práctica y en la identificación de especies de termitas, su biología, biodiversidad.

Fecha, orador y lugar de realización

12 de Octubre de 2007
Dr. Jan Krecek: "Taxonomía y biología de termitas neotropicales de importancia económica"
Dr. Renato Ripa. " Impacto y control de Termitas en Chile"
Auditorio de CPF S.A., en Los Ángeles, Región del Bío Bío
Se adjuntan mail – invitación enviado por Osvaldo Ramírez de CPF S.A. y Luis De Ferrari de Mininco S.A (Anexo 2). Además el listado de asistentes a la charla (Anexo 2).

17 de Octubre de 2007
Dr. Jan Krecek: ""Taxonomía y biología de termitas neotropicales de importancia económica"
Auditorio de INIA La Cruz, en La Cruz, región de Valparaíso.
Se adjunta mail – invitación enviado por INIA La Cruz (Anexo 2) y listado de asistentes a la charla (Anexo 3).

Destinatarios de la actividad
Se envió una invitación dirigida a profesionales, técnicos y ayudantes de investigación del INIA, profesionales del SAG y personal de municipios afectados por la plaga y a la Sociedad Chilena de Entomología a través de una invitación que se hizo llegar al Secretario Sr. José Mondaca.

Además la empresa CPF S.A., realizó una convocatoria orientada a profesionales y técnicos de empresas del rubro forestal de la zona Sur.

5. PARTICIPANTES DE LA PROPUESTA

CONSULTORES: Ficha de(l) Consultor(es)

Nombre	Jan
Apellido Paterno	Křeček
Apellido Materno	
RUT Personal o Nº de Pasaporte	33793754
Nacionalidad	Checa
E-mail	jfkr@ufl.edu
Nombre de la organización, empresa o institución donde trabaja	Universidad de Florida, USA.
Cargo o actividad que desarrolla	Investigador

6. EVALUACIÓN DE LA ACTIVIDAD DE DIFUSIÓN

a) Efectividad de la convocatoria (cuando corresponda)
La propuesta solicitó la visita de un experto internacional en el tema termitas.
b) Grado de participación de los asistentes (interés, nivel de consultas, dudas, etc)
En las charlas realizadas por el Dr. Krecek, el público asistente presentó un alto interés, especialmente vinculado a la identificación de las especies de termita, hábitos y formas de dispersión.
c) Nivel de conocimientos adquiridos por los participantes, en función de lo esperado (se debe indicar si la actividad contaba con algún mecanismo para medir este punto y entregar una copia de los instrumentos de evaluación aplicados)
La actividad no contó con mecanismo de medición para la actividad.
d) Problemas presentados y sugerencias para mejorarlos en el futuro (incumplimiento de horarios, deserción de participantes, incumplimiento del programa, otros)
No se presentaron problemas de origen técnico ni administrativo. En general el programa

se cumplió según lo establecido.

7. CONCLUSIONES FINALES DE LA PROPUESTA.

Se logró la colecta de 33 muestras de individuos de termitas de las cuatro especies de importancia económica, presentes en Chile continental, estas son: *Cryptotermes brevis* (termita de los muebles), *Neotermes chilensis* (termita chilena de la medra seca), endémica de nuestro país, *Porotermes quadricollis* (termita de madera húmeda) y *Reticulitermes flavipes* (termita subterránea).

A través de las charlas impartidas por Dr, Krecek y el Dr. Ripa, se logró la capacitación de 35 personas pertenecientes a diferentes estamentos de instituciones y empresas, municipios, en el conocimiento de las especies presentes en Chile y Centro América principalmente y de formas simples de identificación a través del tipo de daño, características del cuerpo y fecas.

Esta actividad permitió generar una voz de alerta en el rubro forestal respecto al potencial desarrollo de la termita, como plaga de importancia económica.

Cuatro integrantes del personal de apoyo en laboratorio y campo y un profesional del INIA La Cruz, fueron capacitados en la identificación de las especies de termita a nivel de género, a través de la observación de características de las mandíbulas de las obreras y forma de la cabeza y del pronoto y posición de mandíbulas de los soldados, todas observaciones bajo lupa.

La visita de profesionales como el Dr. Krecek es parte importante de la interacción con investigadores especialistas en el tema, que es de gran valor en el apoyo a las investigaciones realizadas y por desarrollar.

ANEXO 1

Informe final confeccionado por el consultor Dr. Jan Krecek, Universidad de Florida. U.S.A.

ANEXO 2

Mail - Invitación a charla de difusión:
- Enviada por CPF S.A. a: socios de la empresa y asesores de la zona.
- Enviada por INIA La Cruz a: todo – inia e invitados especiales.

ANEXO 3

Listado de participantes en las charlas:
- 12 de octubre de 2007, en CPF S.A. en Los Ángeles. Región del Bío Bío.
- 17 de octubre de 2007, en INIA La Cruz, en La Cruz, Región de Valparaíso.

ANEXO 4

Material Elaborado:
- Artículos Revista Tierra Adentro Nº 59, 2004.
- Impresión de Afiches:
    - Reconocimiento de las especies de termitas
    - Reconocimiento de coleópteros xilófagos en maderas en servicio
- Clave identificación de soldados de termitas.
- Portada Libro: Termitas y otros insectos xilófagos en Chile: especies, biología y manejo.

ANEXO 5

Material Recopilado:
- 6 Artículos científicos.
- Dibujos mandíbulas de termitas, para identificación de especies a nivel de género.

ANEXO 1

INFORME FINAL VISITA A CHILE

29 de septiembre al 18 de octubre de 2007

Dr. Jan Krecek
Universidad de Florida
3205 College Avenue
Fort Lauderdale
Florida. U.S.A.
jfkr@ufl.edu

El objetivo principal de mi visita y consulta en Chile en el mes de Septiembre 2007 fue en colaboración con especialistas Chilenos tratar confirmar la presencia de termita de madera seca *Cryptotermes brevis* (Walker) (Isoptera, Kalotermitidae) a fuera de las casas. Y de esta manera, en el caso positivo, confirmar la nuestra hipótesis sobre el origen zoogeográfico de esta extremadamente dañina especie, la cual actualmente esta responsable a los daños en el interior de las casas en algunas 70 países en todos los continentes, incluyendo Australia y Oceanía. Pero según muchas referencias en la literatura, la especie nunca se encuentra a fuera de las construcciones. Estos planes fueron implementados con las amplias discusiones sobre este y otros temas adicionales del interés mutuo con contrapartidas regionales, incluyendo dando las charlas sobre importancia económica y ecológica de termitas chilenos en comparación con la fauna Neotropical.

Actividades realizadas y resumen de resultados

Durante de los días del monitoreo de *Cryptotermes brevis* entre 4 y 8 Octubre en los Valles de los ríos Copiapó y Huayco, nosotros positivamente revisamos la presencia supuesta de esta especie que antes de este estudio era prácticamente desconocida en los lugares abiertos (a fuera de las casas) en el todo el Nuevo Mundo, excepto de una relativamente reciente colecta de Dr. Renato Ripa en parronal en Copiapó y de Dr. Jan Krecek en la ciudad de Lima, hace más de 20 años en un árbol muerto, en las cuales fue basada nuestra hipótesis del trabajo sobre la ocurrencia natural de esta especie en la parte del Norte del Chile y también probablemente en el sur y centro del Perú

En las tablas siguientes se resumen los datos principales sobre nuestros hallazgos:

Tabla 1. Plantas nativas hospederas de *Cryptotermes brevis* en Chile.

Nombre científico	Nombre común	Área nombre
Shinus molle	Pimiento del Perú	Tres Soles, Copiapó
Shinus polygamus	Molle	Tres Soles, Copiapó
Geoffroea decorticans	Chañar	Tres Soles, Copiapó
Salix humboldtiana	Sauce chileno	Huasco Bajo
Acacia caven	Espino	Pabellón, Tierra Amarilla
Atriplex sp.	Atriplex	San Pedro, área Caldera
Baccharis sp.	Chilca	San Pedro, área Caldera

Tabla 2. Plantas introducidas hospederas de *Cryptotermes brevis* en Chile Norte.

Nombre científico	Nombre común	Área nombre
Eucalyptus globulus	Eucalipto	Parronal Tres Soles, Copiapo
Vitis vinifera	Uva de mesa (var. Thompson seedless)	Parronal Tres Soles, Copiapó
Prunus persica	Durazno	Parronal Tres Soles, Copiapó
Acacia capense	Acacio capense	Parronal Tres Soles, Copiapó
Prunus armeniaca	Damasco	Caldera
Ficus elastica	Arbol del caucho, Gomero	Caldera
Hibiscus rosa-sinensis	Hibisco	Caldera
Pyrus communis	Peral	Huasco Bajo

En el área estudiada encontramos alta presencia de esta especie de termita. Entre las plantas hospederas, se encontró en 7 especies nativas y 8 cultivadas. En algunos casos encontramos la misma planta hospedera en diferentes localidades. Además se encontró *Cryptotermes brevis* en madera muerta de plantas vivas o completamente muertas, detectamos esta especies en varios casos en madera en el campo y también atacando los durmientes del roble en la localidad San Pedro, área Caldera.

Después de visitar regiones Norte del Chile trabajamos en el área de Los Ángeles en el Sur, donde localmente ocurren ataques significativos por *Porotermes quadricollis* (Rambur, 1842) (Termopsidae) en la silvicultura de pino y eucalipto.

Conclusiones

En base a los datos acumulados, se confirmó la presencia de *Cryptotermes brevis* fuera de las casas en 7 en total áreas naturales y seminaturales alrededor de los ríos Copiapó y Huasco y de esta manera, se confirmó por lo menos la parte de su patria original. También encontramos en la colaboración con el servicio forestal serios daños a la madera de árboles completamente vivos en algunos cultivos de el pino *Pinus radiata* y *Eucalyptus nitens* lo que representa una seria amenaza a la producción de madera en el futuro.

ANEXO 2

De: Osvaldo Ramirez Grez [mailto:oramirez@cpf.cl]
Enviado el: Martes, 02 de Octubre de 2007 12:20
Para: Arturo Otegui (Arturo Otegui); Claudio Goycoolea (Claudio Goycoolea); Fernando Bobadilla (Fernando Bobadilla); Gastón Gónzalez (mggonzalez@entelchile.net); Luis Cerda Martínez (Luis Cerda Martínez); Manuel Reyes (Manuel Reyes); Miguel Poisson (Miguel Poisson); Orlando Venegas (ovenegas@cpf.cl); Patricio Parra (Patricio Parra); Rocío Canales (Rocío Canales); Rolando Gomez (Rolando Gomez); Rosita Cifuentes (Rosita Cifuentes); Susana Espinoza (Susana Espinoza); Sergio Saez; 'Rodrigo Ahumada (rahumada@arauco.cl)'; 'Carlos Ramirez'; 'Luis De Ferari'; 'Miguel Castillo'
Asunto: Charla sobre termitas

Estimados Amigos:

A través de la presente me es grato invitarlos para el **día 12 de octubre a partir de 11:00 horas** a una charla sobre el tema **"Taxonomia y biologia de termitas de importancia económica"**, que dictará el Dr. Jan Krecek de la Universidad de Florida, que es traído al país por INIA La Cruz y que se llevará a cabo en el Auditórium de CPF-SA en la ciudad de Los Angeles.

Esperando contar con vuestra presencia, le saluda atentamente,

Osvaldo Ramírez

De: Luis de Ferrari Fontecilla (Forestal LA)
Enviado el: Jueves, 11 de Octubre de 2007 8:16
Para: Patricio Santibañez Carmona (Forestal LA); Daniel Contesse Gonzalez (Forestal SP); Juan Andres Celhay Schoelermann (FORESTAL LA); Pedro Pablo Bonnefoy Dibarrart (Forestal LA); Rolando Etcharren White (Forestal TC); Francisco Rodriguez Aspillaga (Forestal Viv); Marco Muñoz Quezada (Forestal LA); Marcos Urrutia Valenzuela (Forestal LA); Jaime Rodríguez Schafer (Forestal LA)
CC: Miguel Castillo Salazar (Forestal SP); Marcelo Donoso Montoya (Forestal LA)
Asunto: RV: TERMITAS

Estimados:
Como lo indica el correo adjunto, los invito para mañana (12 de octubre) a la charla sobre termitas en CPF, según lo indicado en correo adjunto.
Les recuerdo que estos insectos están presentes en nuestros bosques.
Saludos y creo interesante participar.
Luis De Ferrari F.

De: Osvaldo Ramirez Grez [mailto:oramirez@cpf.cl]
Enviado el: Jueves, 04 de Octubre de 2007 12:05
Para: 'RENATO RIPA S.'
CC: 'PAOLA LUPPICHINI'; Miguel Castillo Salazar (Forestal SP); Luis de Ferrari Fontecilla (Forestal LA)
Asunto: TERMITAS

Estimado Renato:

Te confirmo que estamos ok con la visita de Uds. por el tema de las termitas, para la próxima semana.

La idea es visitar el **jueves 11 de octubre**, fundos entre Collipulli y Mulchen con profesionales de Forestal Mininco con la presencia del problema, para lo cual te propongo nos juntemos ese día en nuestras oficinas en Los Angeles a primera hora, y el **viernes 12 de octubre** a partir de las 11:00 horas tener la charla "Taxonomía y biología de termitas de importancia económica" del Dr. Krecek en nuestro Auditórium, ya están cursadas las invitaciones.

Si hubiera cualquier cambio, por favor avísame, como asimismo si necesitas reservas de hoteles.

Saludos cordiales,

Osvaldo

Corina Donoso

De: Corina Donoso [cdonoso@inia.cl]

Enviado el: viernes, 05 de octubre de 2007 12:02

Para: 'jose.mondaca@sag.gob.cl'; 'laboratorio.valparaiso@sag.gob.cl'; 'rromero@sanantonio.cl'; 'aalvarado@municipalidad.quillota.cl'; 'Jorge.GonzalezValladares@munivina.cl'; 'medioambiente@munivalpo.cl'; 'narellano.5@conama.cl'; 'dennisnaveaogaz@yahoo.com'; 'sandraaliaga@gmail.com'; 'pcosta@e-casablanca.cl'

Asunto: Invitación Charla Dr. J. Krecek

stimados (as)

Centro Regional de investigación INIA La Cruz y FIA, tienen el agrado de invitar a usted a la Charla: "Taxonomía y ología de termitas de importancia económica", dictada por el Dr. Jan Krecek, de la Universidad de Florida, USA. Esta tividad, se realizará el día miércoles 17 de octubre de 2007, a las 10.00 hrs. en el auditorio de nuestro Centro, ubicado calle Chorrillos 86 La Cruz, V Región.

onfirmar asistencia:
no: 33 – 312366
nail: cdonoso@inia.cl

PAOLA LUPPICHINI

De: Corina Donoso [cdonoso@inia.cl]
Enviado el: Viernes, 05 de Octubre de 2007 12:26
Para: todo-inia@inia.cl
Asunto: RV: Invitación Charla Dr. J. Krecek

Estimados (as):

El Centro Regional de Investigación INIA La Cruz y FIA, tienen el agrado de invitar a usted a la Charla: "Taxonomía y biología de termitas de importancia económica", dictada por el Dr. Jan Krecek, de la Universidad de Florida, USA. Esta actividad, se realizará el día miércoles 17 de octubre de 2007, a las 10.00 hrs. en el auditorio de nuestro Centro, ubicado en calle Chorrillos 86 La Cruz, V Región.

Confirmar asistencia:
Fono: 33 – 312366
Email: cdonoso@inia.cl

ANEXO 3

GOBIERNO DE CHILE
MINISTERIO DE AGRICULTURA
INIA LA CRUZ

Listado de Asistencia

Nombre de la Reunión: "Taxonomía y biología de termitas de importancia económica" del Dr. Krecek
Fecha: 12 de octubre de 2007
Lugar Auditorium CPF , VIII Región

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15	Lucas "Ripa" A	Particular		33-311714	
16					
17					
18					
19					
20					

GOBIERNO DE CHILE
MINISTERIO DE AGRICULTURA
INIA LA CRUZ

Listado de Asistencia

Nombre de la Reunión: "Taxonomía y biología de termitas de importancia económica" del Dr. Krecek
Fecha: 17 de octubre de 2007
Lugar Auditorium INIA La Cruz , V Región

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17	Paola Luppichini	INIA La Cruz	pluppich@inia.cl	312366	[firma]
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19	Patricio Torres	INIA La Cruz	[illegible]	312366	[firma]
20	Elena Santa María	INIA La Cruz	esantamaria@inia.cl	9-8243668	[firma]

ANEXO 4

INSTITUTO DE INVESTIGACIONES AGROPECUARIAS

Termitas de importancia e...

Renato Ripa S.
Ingeniero Agrónomo, Ph.D.
rripa@lacruz.inia.cl

Paola Luppichini B.
Ingeniera Agrónoma
INIA La Cruz

Las termitas pertenecen al orden Isoptera (iso = igual; ptera = ala). Son insectos sociales que se caracterizan por trabajar como un grupo con el fin de enfrentar situaciones biológicas y ecológicas que muchos organismos no sociales deben sobrellevar por sí solos. Los niveles de organización, cohesión, cooperación interna, eficiencia y éxito biológico de los insectos sociales –de las termitas en particular– son fascinantes, y su estudio, un desafío.

Viven en colonias cuyo número puede llegar, en algunas especies, sobre el millón de individuos. Cada miembro cumple una tarea coordinada al interior de la colonia, que contribuye al desarrollo de una sociedad vigorosa, adaptable, eficiente y productiva (Thorne, 1998). Todas las especies del Orden constituyen sociedades estructuradas en castas, con la presencia permanente de machos y hembras, que podrán o no reproducirse, dependiendo a cuál casta, por presión de la sociedad, hayan sido derivados durante su desarrollo (Camousseight, 1999).

Un mundo de castas

En general, en las colonias de termitas hay tres castas principales que tienen claras diferencias morfológicas y de labores que realizan dentro de la colonia. Las castas se dividen en:

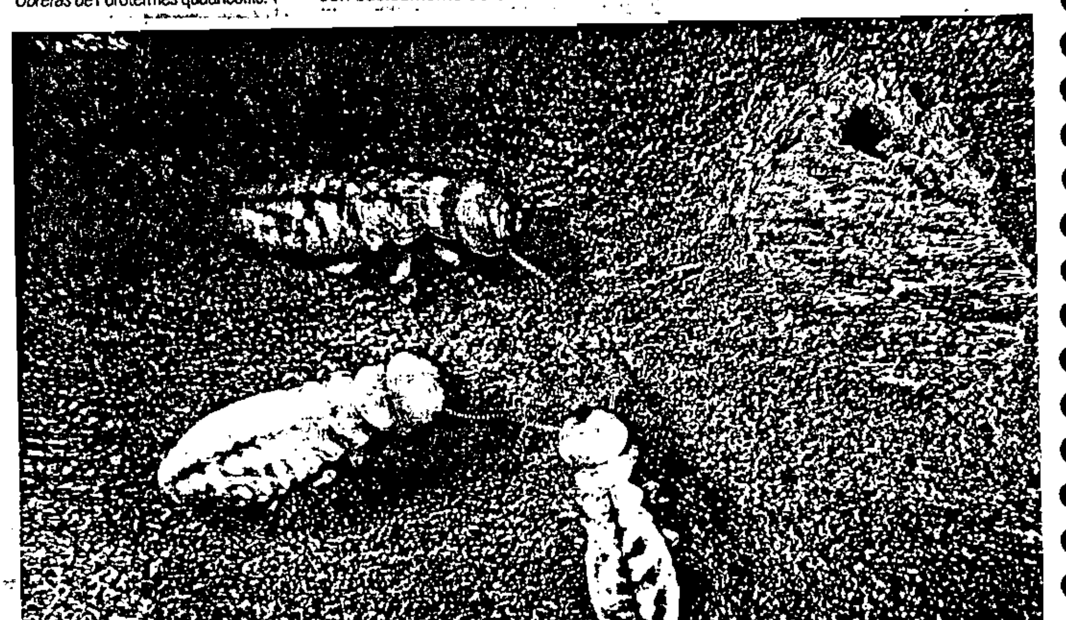
Alados: es la casta de los reproductores, macho y reina. Se caracterizan por tener la cabeza esférica, ojos compuestos laterales acompañados de un ojo simple u ocelo, antenas moniliformes (con forma de cuentas de collar) y armadura bucal de tipo masticador, con mandíbulas fuertemente esclerosadas (endurecidas). Los tres segmentos del tórax son casi iguales, con patas típicamente andadoras, de igual tamaño; alas generalmente el doble del largo del cuerpo, translúcidas, todas con una zona de quiebre en la base por donde se desprenden después del vuelo (enjambrazón) previo al encuentro sexual.

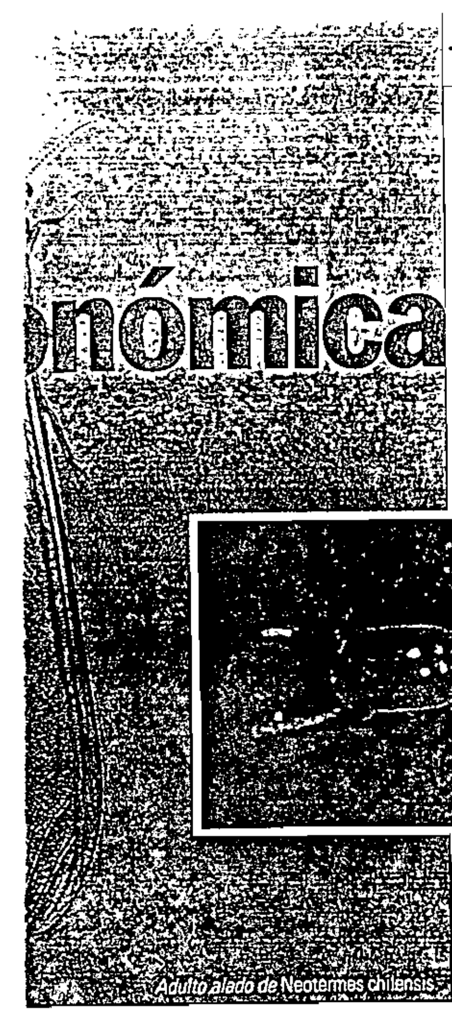
Obreras: individuos no reproductivos, que conservan durante toda su vida el aspecto de las primeras etapas de desarrollo juvenil. De color blanco-amarillento, con sólo las mandíbulas pigmentadas y esclerosadas, que les dan la dureza necesaria para triturar la madera. Son ciegas, sin vestigios de alas (ápteras) y sin diferenciación sexual.

Soldados: casta formada por individuos que alcanzan los primeros estadios del desarrollo juvenil pero, a diferencia de las obreras, la cabeza y las mandíbulas se hipertrofian y además presentan una llamativa coloración oscura, consecuencia del depósito de esclerotina. Son ciegos, ápteros y prácticamente sin diferenciación sexual. Esta casta es característica del Orden. Su proporción en la colonia es menor a la de las obreras. Sus funciones son básicamente defensivas.

Reproductores neoténicos: se refiere a termitas reproductoras que se desarrollan a partir de obreras, presentan vestigios de alas y no se dispersan. Su fecundidad es menor que la de los alados, pero pueden ser cientos por colonia, de modo que el impacto total en número de huevos puede ser mayor que el de la reina, derivada de un alado.

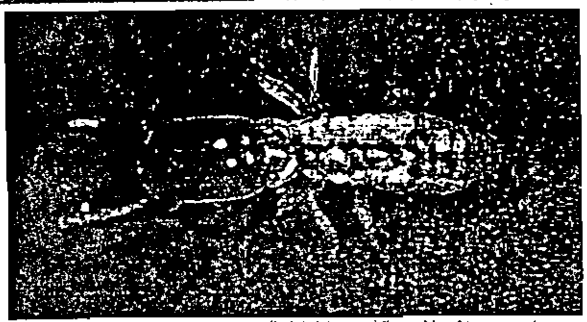
Obreras de Porotermes quadricollis.





Adulto alado de Neotermes chilensis

nómica en Chile



Soldado de termita subterránea, Reticulitermes flavipes.

Su relación con la madera

Desde el punto de vista alimentario, las termitas son absolutamente dependientes de la celulosa, principal componente de la madera, la que degradan con enzimas o microorganismos simbiontes específicos. Por ello las termitas no sólo atacan madera sino que también sus derivados, como papel, cartón, libros y, en general, todo elemento que tenga entre sus componentes este polisacárido (Thorne 1998). Además, desempeñan un importante rol en la descomposición de la celulosa y, en algunas zonas, en la descomposición de la materia orgánica (Artigas 1994).

En el mundo existen alrededor de 2.600 especies de termitas. De ellas 183 se encuentran asociadas al daño en construcciones y 83 producen daño significativo. El 80% de las especies económicamente importantes (147) corresponde a termitas subterráneas (Su et al. 2000).

Las familias

Hasta hace unos años en Chile existían sólo dos familias de termitas: Kalotermitidae y Termopsidae. Con la introducción de la termita subterránea, se agregó la familia Rhinotermitidae.

La familia Kalotermitidae representa uno de los grupos más primitivos de termitas. Las colonias típicamente viven en madera sólida y seca. Ésta es su habitáculo y fuente de alimento, por lo que se las denomina "termitas de la madera seca". En Chile se encuentran presentes las siguientes especies que pertenecen a este grupo:

Cryptotermes brevis o termita de los muebles, especie cosmopolita introducida a Chile, presente desde la 1ª hasta la 5ª Región, incluyendo el archipiélago Juan Fernández e Isla de Pascua.

Kalotermes gracilignathus o "termita de Juan Fernández", especie endémica restringida al archipiélago de Juan Fernández.

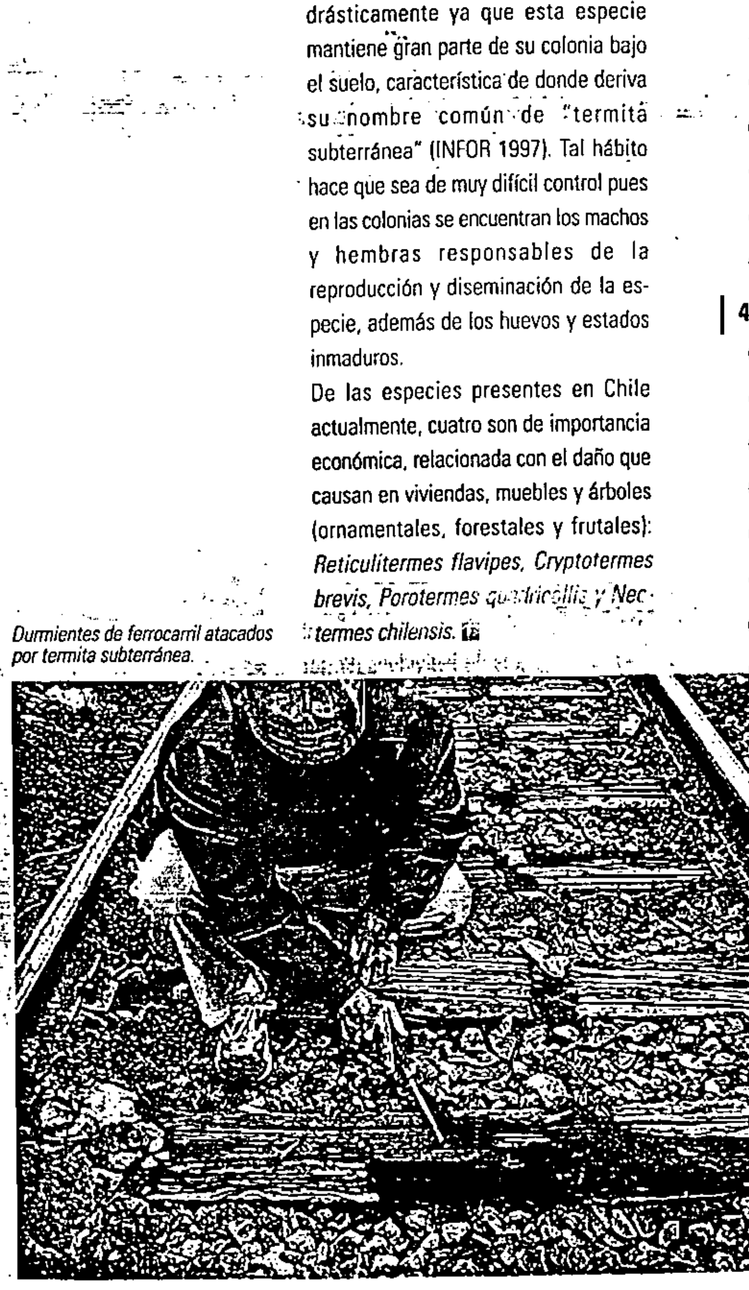
Neotermes chilensis, especie nativa (Camousseight 1999) que preferentemente desarrolla sus colonias en raíces de árboles, pudiendo extenderse hacia la parte alta del árbol si éste tiene partes secas (Artigas 1994).

La familia Termopsidae está representada en Chile por *Porotermes quadricollis* o "termes de la madera húmeda", especie característica de la zona sur del país.

La familia Rhinotermitidae incluye las termitas subterráneas. Con la llegada al país de *Reticulitermes flavipes*, detectada en 1986, el escenario ha cambiado drásticamente ya que esta especie mantiene gran parte de su colonia bajo el suelo, característica de donde deriva su nombre común de "termita subterránea" (INFOR 1997). Tal hábito hace que sea de muy difícil control pues en las colonias se encuentran los machos y hembras responsables de la reproducción y diseminación de la especie, además de los huevos y estados inmaduros.

De las especies presentes en Chile actualmente, cuatro son de importancia económica, relacionada con el daño que causan en viviendas, muebles y árboles (ornamentales, forestales y frutales): *Reticulitermes flavipes, Cryptotermes brevis, Porotermes quadricollis y Neotermes chilensis.*

Durmientes de ferrocarril atacados por termita subterránea.



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Paola Luppichini B.
Ingeniera Agrónoma
INIA La Cruz

Cómo reco

Termitas de la madera seca

Cryptotermes brevis **(Walker)**

Biología: son pequeñas, de cuerpo alargado, color claro, de hasta 5 mm de largo. Las alas miden hasta 8 mm de largo cada una (foto 1). Viven en madera seca, no tienen hábitos subterráneos. Se las encuentra preferentemente en regiones secas (Peters 1996; Shelton et al. 2000). Los adultos alados (foto 2) son de color claro con la cabeza color castaño y con ocelos (ojos simples). Sus alas son irisdiscentes (foto 3), cuerpo blando y color claro. Los soldados son escasos, de color crema pálido, de 4 a 6 mm de largo, con la cabeza achatada y oscura y mandíbulas relativamente pequeñas (foto 4). *C. brevis* es la especie de más amplia distribución en el mundo. Se ha encontrado en Asia, África, Australia, y en toda América. A diferencia de las termitas subterráneas, sus colonias son usualmente pequeñas, conteniendo tal vez unos cientos de individuos (Potter 1997).

La mayoría de las especies de termitas de madera seca sólo infestan árboles, pero otras son plagas económicamente importantes, ya que ubican sus colonias en estructuras como vigas, marcos de puertas y ventanas, postes y muebles. Dentro de estas últimas, *C. brevis* es considerada como una de las más destructivas a escala mundial (Peters 1996).

En las maderas atacadas por las termitas de madera seca (fotos 5 y 6) se observan pequeños orificios por los que, ocasionalmente, expulsan las fecas que pueden acumularse bajo dichas aperturas (Shelton et al. 2000). Las galerías formadas dentro de las estructuras atacadas son relativamente limpias y no existe restos de suelo a ellas (foto 7).

44

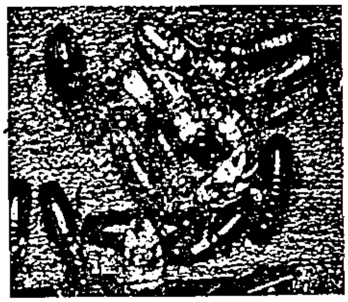


Foto 1. Obreras, soldado y adultos reproductores de Cryptotermes brevis.

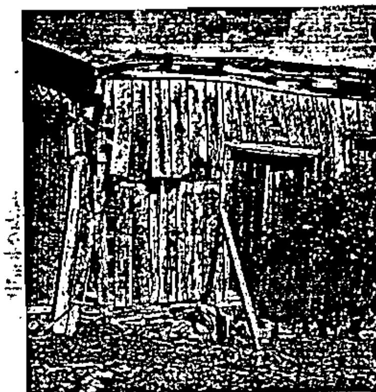


Foto 5. Viviendas con daño de Cryptotermes brevis.

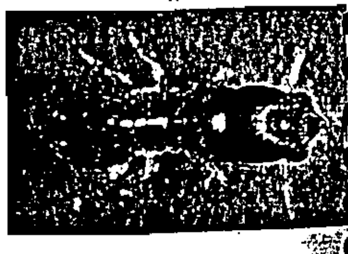
Ciclo de vida: las colonias son similares a otras termitas. Desarrollan individuos alados, reproductores, los cuales vuelan en gran número desde colonias maduras y establecen una nueva colonia en madera sólida. El período de vuelo o enjambrazón ocurre en horas del crepúsculo entre la primera y segunda quincena de diciembre. Estos vuelos ocurren al interior de las viviendas y en muchas ocasiones en los entretechos, donde pasan inadvertidos.

Foto 2. Adulto reproductor alado de Cryptotermes brevis.

Foto 3. Alas iridiscentes de adultos reproductores de Cryptotermes brevis.

En la especie *C. brevis*, la pareja fundadora alada establece la colonia sobre madera con ciertas características de madurez, humedad, espesor y ausencia de productos químicos o pinturas repelentes. Antes de copular, pierden las alas e inician la construcción de una pequeña cámara en la que se aparean y la hembra coloca 2 a 5 huevos pequeños, de color blanco brillante, los que la pareja cuida y mantiene limpios y libres de hongos. En laboratorio la incubación demora entre 75 y 81 días. Al término del primer año, a la pareja fundadora se han sumado sólo 3 a 4 individuos y aún no se ha producido ningún soldado (Artigas 1994). En otras especies durante los primeros

Foto 4. Soldado de Cryptotermes brevis.



ocer las termitas

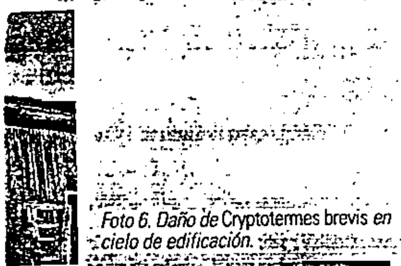


Foto 6. Daño de Cryptotermes brevis en cielo de edificación.

Los adultos alados miden 17 a 22 mm de largo, son de color castaño (ver foto superior en páginas 42-43). Los soldados, de color pardo a castaño, poseen una cabeza grande, abultada y aplanada en la región frontal (foto 8). En esta familia de termitas no existen las obreras verdaderas sino una casta diferente de pseudobreras que realizan el trabajo correspondiente a lo que hacen las obreras en otras familias (Edwards et al. 1986). Estas pseudobreras son de color blanco amarillento y miden entre 10 y 12 mm. El período de vuelo (enjambrazón) se produce desde enero hasta marzo, en especial durante las horas crepusculares y nocturnas (González, 1983). Sin embargo en la 5ª Región se ha observado que la enjambrazón ocurre preferentemente en marzo, y en menor escala hasta abril. Los días de mayor calor presentan los vuelos más intensos.

Su hábitat natural son ramas secas de espino, molle, tallos florales secos de

Foto 7. Viga con galerías de Cryptotermes brevis.

chagual, quillay y romerillo.

Ciclo de vida: la colonia se inicia a través de una pareja fundadora alada (rey y reina) que durante la enjambrazón abandonan su colonia original. La pareja elige dónde establecerse de acuerdo con las características de la madera, como madurez y humedad. Se ha observado parejas en el interior de grietas en la madera, en las cuales excavan una pequeña cámara. Posteriormente sellan la entrada con fragmentos de madera y material fecal líquido.

dos años de la nueva colonia, aparecen uno o dos soldados. Los alados pueden aparecer a partir del cuarto a sexto año. Las colonias antiguas establecidas pueden tener 2.000 a 3.000 individuos y 50 a 60 soldados.

En invierno la oviposición se detiene, en algunos casos hasta cinco meses, y luego continúa. De esta forma la colonia sigue creciendo y las nodrizas alimentan por regurgitación (alimentación estomodeal) a las ninfas en sus dos primeros estadios y a los soldados durante toda su vida. Una colonia adulta o madura llega a tener 300 individuos en relación de un soldado por cada 45 de las otras castas (Artigas 1994).

Neotermes chilensis **(Blanchard)**

Biología: se establecen en galerías al interior de madera, formando amplios espacios limpios. Se las puede encontrar además atacando maderas con una humedad moderada tanto en edificaciones como en árboles nativos. En estos últimos la colonia puede continuar desarrollándose hacia la parte alta del árbol, si tiene partes secas o muertas, y en raíces.

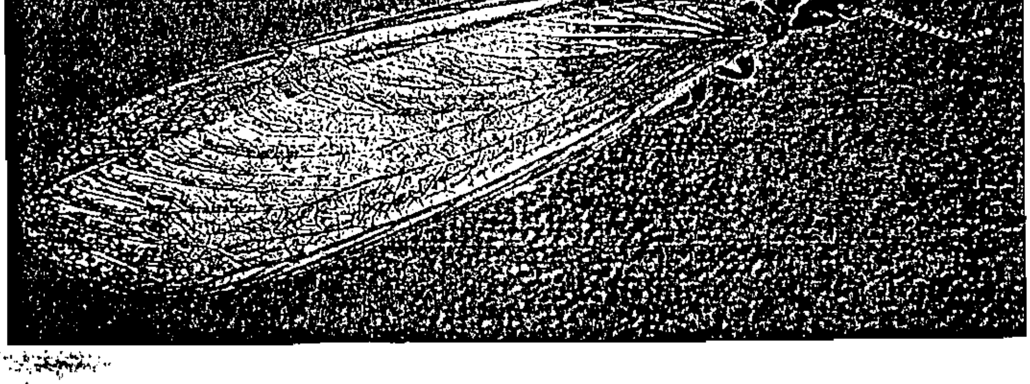
Termita de madera húmeda

Porotermes quadricollis **(Rambur)**

Dentro de las termitas de madera húmeda, la especie P. quadricollis es la de más amplia distribución en Chile. Se encuentra entre la 5ª y la 11ª Región (Artigas 1994; Camousseight 1999).

Biología: este grupo de termitas infesta maderas con alto contenido de humedad.

Foto 9. Adulto de Porotermes quadricollis.



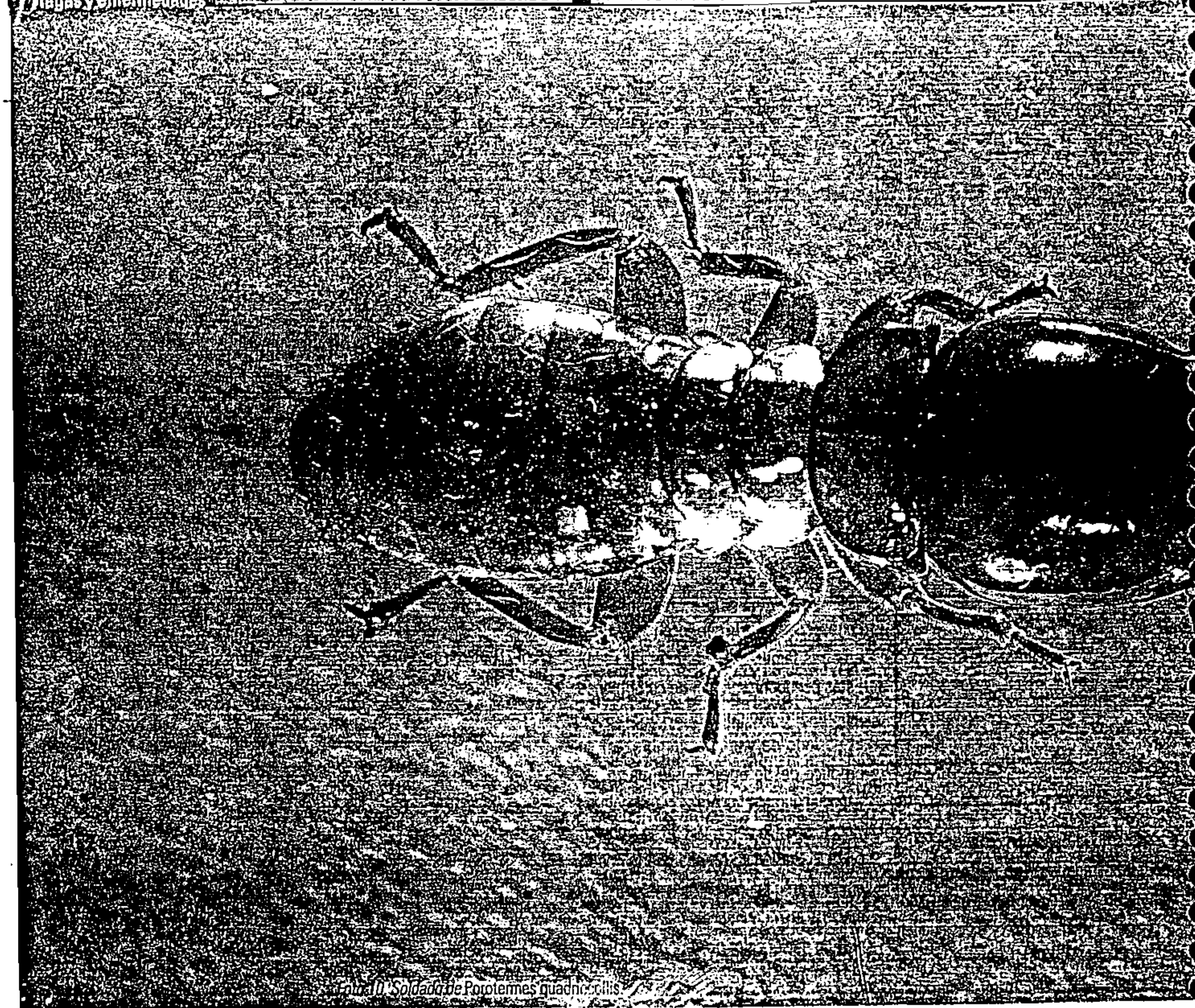


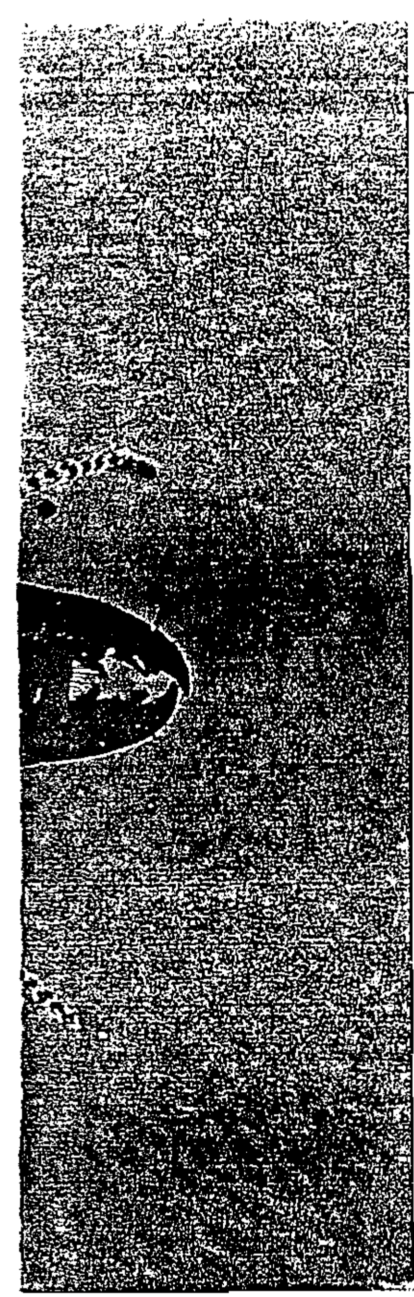
Foto 10. Soldado de Porotermes quadricollis.

Las colonias se ubican en el interior de la madera y no requieren estar en contacto con el suelo. Comúnmente se sitúan bajo la corteza de árboles, tocones, árboles muertos y en maderas afectadas por hongos y muy húmedas. Las estructuras, postes, maderas apiladas expuestas a la humedad del suelo y a la intemperie son objeto del ataque. La infestación en estructuras normalmente se produce cuando la madera está en contacto con el suelo o en áreas húmedas por causa de filtraciones (Potter 1997).

En ambientes húmedos, hacen galerías de mayor tamaño que otras especies de termitas. Consumen la madera y expulsan gran parte de las fecas hacia el exterior. Por lo general el daño no es visible, excepto cuando las paredes de la estructura atacada colapsan y se observan las extensas galerías. Si el ataque es severo se puede ver gran cantidad de fecas cercanas al lugar donde se concentran. Las galerías que dejan en las maderas son relativamente limpias y carecen de suelo (Camousseight 1999, Potter 1997).

Las obreras son insectos alargados, color claro, ligeramente aplastados, con cabeza castaño claro (ver foto inferior en página 42). El cuerpo de los alados mide hasta 9 mm y cada ala hasta 20 mm de largo (foto 9). Se distingue de otras termitas por la cabeza pequeña de las obreras, sin ocelos, ojos bien desarrollados ubicados detrás de la fosa antenal. Los soldados tienen la cabeza dorsoventralmente aplastada y mandíbulas fuertes con los ápices curvados hacia la línea media (foto 10).

Ciclo de vida: se reproducen en el interior de maderas en lugares con alta humedad, en galerías y celdas que corresponden a un patrón típico de la especie *P. quadricollis*. Los alados reproductores pierden las alas luego de copular. La pareja entra en una grieta en madera adecuada e inician la vida reproductiva, para lo cual construyen una pequeña galería. La actividad ovárica de las reinas se divide en dos períodos. El primero dura 25 días; en él se produce el depósito del 70 a 80% de la postura total. Las posturas van de 1 a 3 huevos por día. El macho y la hembra cuidan los huevos permanentemente, los mantienen limpios y con la humedad adecuada. A los 45 días los huevos eclosan.



Las ninfas son alimentadas por regurgitación por las nodrizas. En las colonias recién fundadas se diferencian algunos soldados a partir de la ninfa de tercer estadio (Artigas 1994).

Termita subterránea

Reticulitermes flavipes

Las termitas subterráneas tienen amplia distribución en el mundo: se las encuentra en los cinco continentes. En Chile están presentes en las regiones Metropolitana, 5ª Región y un foco detectado en la 6ª (Litueche).

Biología: son insectos de tamaño pequeño a mediano (4 a 5 mm), su cuerpo es alargado y frágil y destaca el hecho que viven en colonias organizadas en castas sociales. Entre las termitas existen individuos ápteros (sin alas) y alados. La forma alada es la casta reproductiva, compuesta por adultos fértiles, con ojos compuestos y coloración más oscura que las castas estériles. Las obreras y los soldados son individuos estériles y ápteros (foto 11), de color blanco, a excepción de la cabeza que está fuertemente quitinizada en los soldados.

Dado su hábito alimenticio, la termita subterránea es de gran importancia en ambientes naturales, ya que participa en la degradación de los componentes celulósicos y en su incorporación al suelo. Sin embargo, en ambientes urbanos constituye una plaga al ingresar a las viviendas y dañar las estructuras de madera, lo que genera pérdidas considerables.

El tamaño de las colonias varía según la especie. Existen algunas de cientos a miles de individuos e incluso ciertas especies alcanzan el millón de individuos en una misma colonia.

Las maderas que han sido atacadas por este insecto presentan en su interior gran cantidad de suelo, que ellas trasladan con el fin de mantener condiciones de humedad y temperatura para su desarrollo. Una característica del daño de la termita subterránea es la construcción de galerías de barro (foto 14, página 48) y fecas sobre la superficie de paredes, techos, pisos, vigas, etc.; por donde circulan en busca de alimento.

El período de vuelo (enjambrazón) se produce desde mediados de agosto hasta septiembre, en horas de mucho calor, alrededor del medio día.

Ciclo de vida: tienen una metamorfosis gradual, la que incluye huevo, ninfa y adulto. Por lo general, las hembras oviponen en forma aislada, es decir, no depositan los huevos en grupos. Una vez que la ninfa sale del huevo, las obreras la alimentan por algún tiempo. En mudas sucesivas se produce la diferenciación que dará origen a obreras, soldados e individuos alados. Este período de desarrollo puede durar 2 a 4 meses e incluso más, dependiendo de la disponibilidad de alimento, temperatura y vigor de la colonia. Los ejemplares reproductivos, alados (foto 15, página 48), abandonan la colonia durante la época de vuelo para formar nuevas colonias (foto 16, página 48). El período de vuelo (enjambrazón) se produce desde la segunda quincena de agosto hasta fines de septiembre, en los días de mayor calor. En el crepúsculo se observan cientos a miles de individuos alados, color café oscuro a negro. La enjambrazón puede apreciarse en el exterior e interior de las viviendas.

Cuando dos ejemplares alados han perdido sus alas y encontrado un ambiente propicio, cavan una pequeña cámara donde se aparean. Luego la hembra o reina deposita un número reducido de huevos. El cuidado de éstos y de los primeros ejemplares vivos es responsabilidad del macho (rey) y la reina. Posteriormente el cuidado y alimentación

Foto 11. Obreras y soldado de termita subterránea, Reticulitermes flavipes.
Foto 12. Daño de Reticulitermes flavipes, *en el piso bajo una maceta.*

Foto 13. Daño de Reticulitermes flavipes, *en pared exterior de una vivienda en Quintero.*

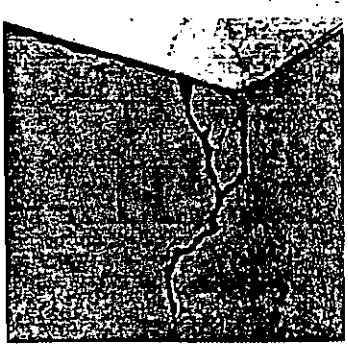


Foto 14. Tubos de suelo en parte alta de una habitación construidos por Reticulitermes flavipes.

de las ninfas son responsabilidad de las obreras (Thorne 1998).

Aunque, como se señaló, al inicio de una colonia la reina es capaz de oviponer sólo un reducido número de huevos, después de unos años puede producir más de mil huevos diarios. Existen especies tropicales con un potencial de reproducción mucho mayor. La reina que funda una colonia por lo general es muy longeva, en algunos casos puede llegar hasta 20 años. La función del rey es fecundar a la reina, lo que hace en varias oportunidades y también es muy longevo.

Foto 15. Adulto alado de termita subterránea, Reticulitermes flavipes.

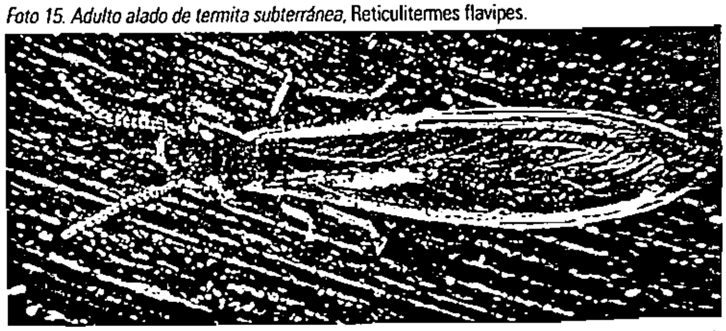


Foto 16. Tubos de suelo empleados para la salida de adultos alados de Reticulitermes flavipes *en poste de madera.*

Control de termitas

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INIA La Cruz

Termitas de la madera seca y la madera húmeda

Antes de dar cualquier paso, se requiere una inspección visual exhaustiva de las estructuras dañadas. Existen varias alternativas para el control, en general se dividen en tratamientos totales y localizados.

Los tratamientos totales consisten en la fumigación de la estructura o construcción completa, con gases letales como bromuro de metilo o Vikane (sulfuryl fluoride), o la aplicación de calor en forma de aire caliente (Scheffran et al. 1997). La fumigación requiere la evacuación de la construcción por 24 horas en el caso de Vikane y por 72 horas en el de bromuro de metilo. Respecto a este último, Chile tiene el compromiso de eliminar su uso para el año 2015. Se está tramitando la licencia para el uso urbano de las fosfaminas (Phostoxin) para este tipo de control (SAG 5ª Región).

Los tratamientos localizados incluyen el uso de calor, frío, químicos, electricidad y microondas, aplicados al área dañada en la que se encuentran los insectos.

Todos los tratamientos han mostrado efecto controlador sobre las termitas. No obstante, algunos de ellos tienen limitaciones como, por ejemplo, el uso de nitrógeno líquido en el caso de tratamientos con frío.

Métodos preventivos de control de termitas subterráneas

Barreras físicas: el uso de barreras físicas en el combate de las termitas subterráneas está dado básicamente por tratamientos antes de la construcción. Dentro de las más utilizadas se encuentran la utilización de arenas de granulometría uniforme, la malla metálica y los plásticos impregnados.

La granulometría de la arena ocupada no debe permitir que las termitas subterráneas pasen por espacios interfaciales. Los granos de arena tienen que ser de un tamaño suficientemente grande para que no puedan tomarlos con sus mandíbulas y moverlos. La obtención de estas arenas es difícil, de un costo relativamente alto, y el sistema no resulta muy efectivo.

En estudios de campo se ha demostrado que el empleo de mallas de acero inoxidable disminuye la actividad de varias de las especies de termitas estudiadas. Estas mallas poseen orificios muy pequeños que impiden su paso. Pueden ser usadas con mayor efectividad como una barrera horizontal continua, instalada antes de la construcción de una estructura (Su et al. 1998). Sus mayores desventajas son los costos, bastante elevados, y una compleja instalación.

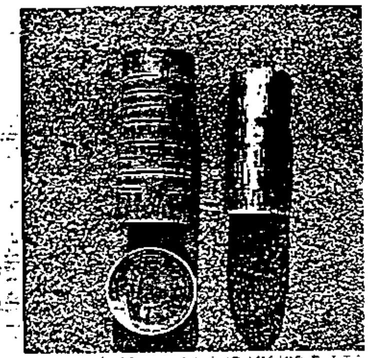


Foto 2. Estación de monitoreo y cartón corrugado.

Foto 1. Perforación de piso para la inyección de insecticida en el suelo.

Los plásticos impregnados con termiticidas repelentes impiden el avance de las termitas. Su utilización ha sido limitada por problemas de costos y de efectividad de la instalación.

Barreras químicas: las barreras químicas han sido ocupadas por muchos años, tanto en tratamientos preventivos como curativos (pre y post construcción) contra los ataques de termita subterránea. Los resultados comerciales y de investigaciones han demostrado que los insecticidas-termiticidas disponibles en el mundo logran efectividad durante períodos de 5 a 20 años.

Su duración depende en gran medida de las concentraciones aplicadas, de la calidad de la colocación del producto y del ambiente en cual están insertos. La mayoría de los productos usados se formulan para ser efectivos en una extensa gama de suelos y condiciones ambientales.

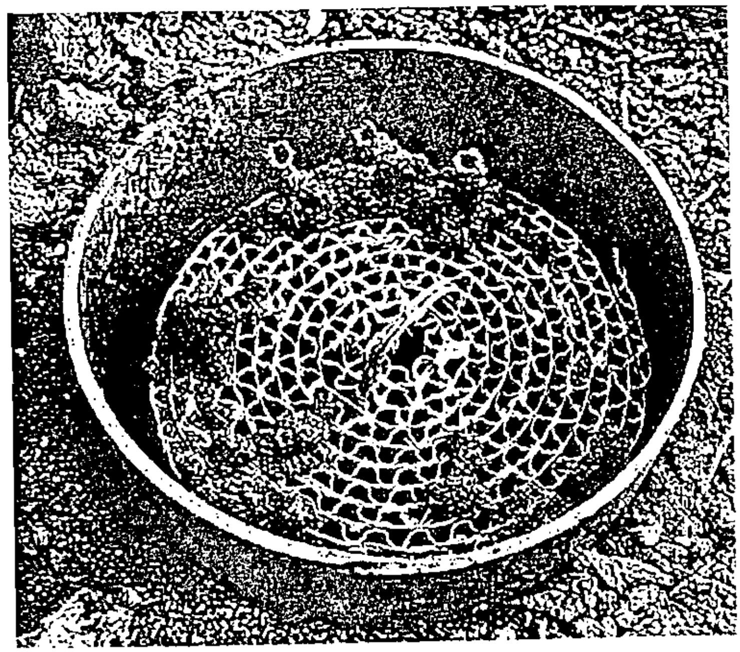


Foto 4. Estación de monitoreo activa.

Foto 3. Instalación de estaciones de monitoreo en módulo.

Los termiticidas convencionales se formulan como líquidos, por lo que forman barreras efectivas alrededor de muros y cañerías. Aunque su aplicación requiere de personal especializado en el manejo de insecticidas, el proceso es rápido, seguro y garantizado (foto 1, página 49). Se puede indicar que las barreras químicas son normalmente efectivas. Es el método de control más usado.

Métodos de control curativo contra termitas subterráneas

Dentro de las metodologías para el control o eliminación de termitas subterráneas, dos son las tecnologías de frecuente uso en post construcción.

Barreras químicas líquidas: son empleadas para proteger la estructura. Se coloca insecticida/termiticida en todas las áreas por donde las termitas podrían ingresar a la edificación. La instalación requiere de numerosas perforaciones en la estructura en contacto con el suelo: piso, radieres interiores y exteriores de las viviendas u otras estructuras afectadas. Se necesita introducir y depositar un volumen aproximado de termiticida de 5 litros por metro lineal tratado.

El trabajo de aplicación debe ser realizado por profesionales con experiencia, con el fin de asegurar una aplicación correcta y para evitar daños en cañerías, cerámicas, sistemas eléctricos y de calefacción.

Uso de cebos: este sistema contempla la instalación de estaciones en el suelo (patios) cada 3 a 5 metros y alrededor de estructuras afectadas. Las termitas subterráneas ubican las estaciones y se alimentan de madera dispuesta en ellas. En las estaciones activas, esto es en aquellas que presentan termitas vivas, se reemplaza la madera por un cebo de celulosa impregnado con un insecticida. Las termitas se alimentan del cebo, lo cual les causa una mortalidad retardada. Los cebos efectivos deben incorporar insecticidas de acción lenta con el fin de que puedan ser llevados a toda la colonia, utilizando el sistema de galerías. Mediante el hábito de la trofalaxis, que es la entrega "boca a boca" de material alimenticio de un insecto a otro, el producto se transfiere a los reproductores los restantes miembros de la colonia e no han estado en contacto directo n el cebo, causando una mortalidad neralizada. La técnica de cebos tóxicos en ejecutada reduce drásticamente las ntidades de insecticidas usados de rrera en aplicaciones preventivas al elo (Su, 1991).

ácticas culturales: medidas de evención consistentes en crear un nbiente menos favorable al desarrollo las termitas subterráneas. Algunas n:

- Reducir las fuentes de agua permaentes y estacionales, así como la umedad dentro de las viviendas. Las stalaciones de agua no deben tener traciones y la red de evacuación de guas lluvia tiene que ser adecuada.
- Disminuir el riego alrededor de onstrucciones, reemplazando por emplo las plantas por aquellas que requieren menor riego (suculentas).
- Es importante disminuir la oferta de celulosa en contacto con el suelo. Ello implica mantener sobre el nivel del terreno las estructuras de madera, pilares, enchapes, porches y leña, entre otras. Hay que remover troncos cortados y no dejar desechos o escombros de celulosa enterrados en el sitio.
- Eliminar las plantas colocadas muy cercanas a los muros de la vivienda.
- Evitar el traslado de maderas, escombros, leña, durmientes o suelo desde lugares sospechosos de presencia de termita subterránea.
- Utilizar madera tratada cuando se requiera que ésta quede en contacto directo con el suelo.

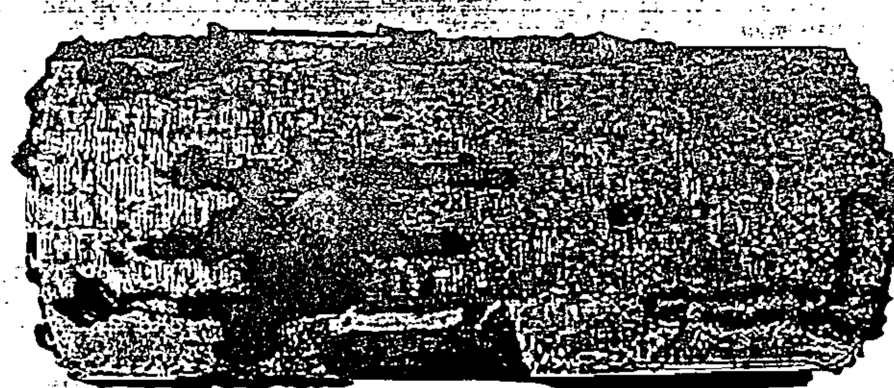


Foto 5. Cartón corrugado con termitas subterráneas extraído de estación de monitoreo.

ESTUDIO DE DISTRIBUCIÓN, MONITOREO Y CONTROL DE LA TERMITA SUBTERRÁNEA

Debido a la gran preocupación que ha generado entre los habitantes de la 5ª Región la presencia de termitas subterráneas durante los últimos años, el Centro Regional de Investigación La Cruz, con el apoyo financiero del Gobierno Regional de Valparaíso, formuló un programa para validar métodos de control de este insecto en las provincias de Quillota y Valparaíso.

La termita subterránea, *R. flavipes*, llegó a nuestro país entre unos 40 y 60 años atrás, posiblemente a la Región Metropolitana, desde donde se ha distribuido a la 5ª Región. En ambas zonas ha causado severos daños, principalmente a la madera de viviendas y otras construcciones.

El ataque a las casas se produce cuando hay una o más colonias de este insecto, pudiendo ser afectadas varias decenas de edificaciones a la vez.

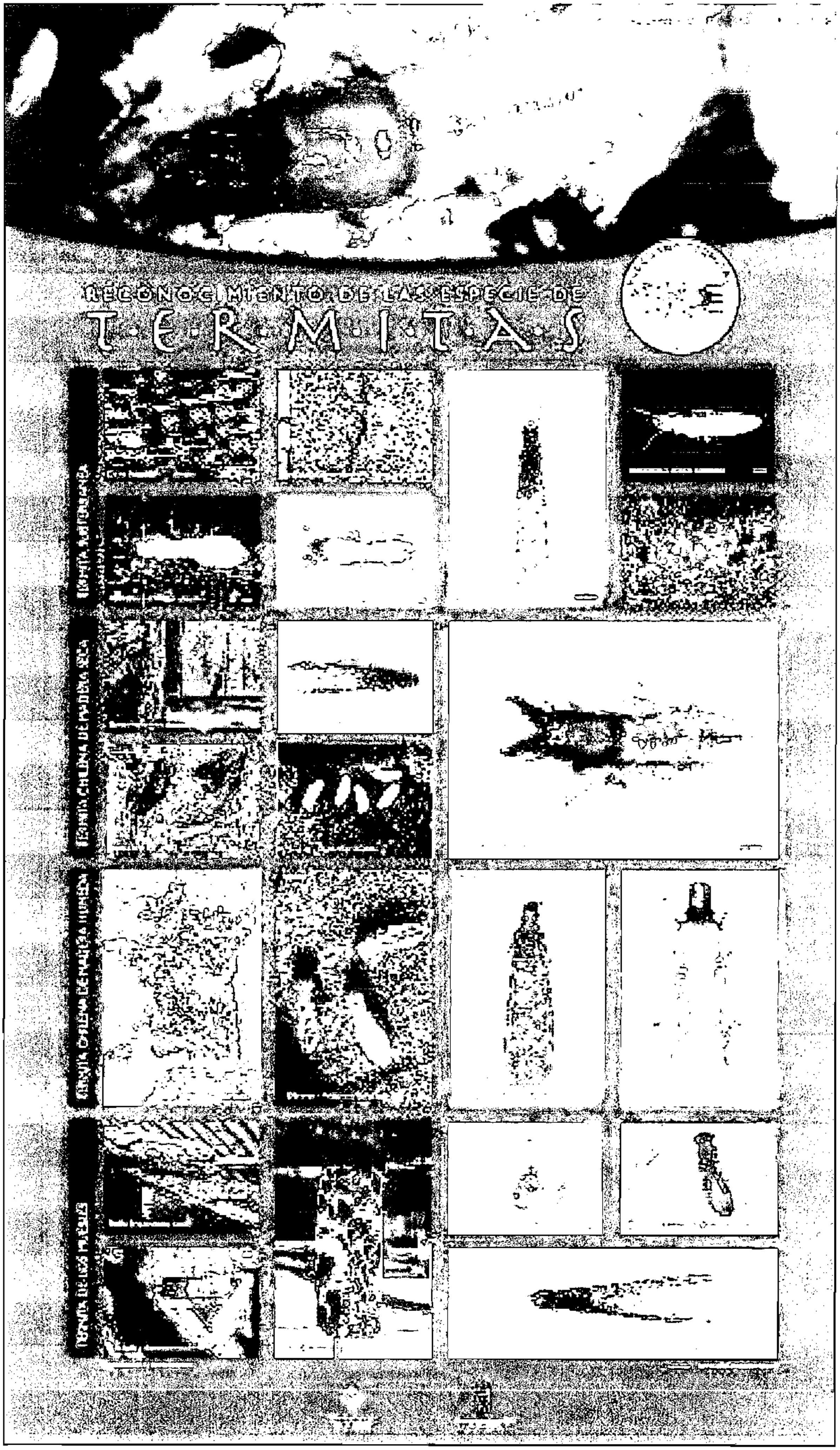
Los focos de termitas tienen su origen en el traslado a distintos lugares de materiales (madera y suelo) que contienen la plaga. Así la termita subterránea se instala y comienza a multiplicarse, alimentándose de la madera presente en el lugar. El daño no se observa sino hasta 5 ó 10 años después, cuando la colonia ya está compuesta por miles de individuos.

El objetivo general del programa fue identificar los focos de la plaga en la 5ª Región, mitigar su dispersión, evaluar las alternativas de control y transferir los resultados. Entre los objetivos específicos se contempla: evaluar la efectividad de los tratamientos de control aplicados al suelo y la madera; incorporar medidas preventivas; minimizar la dispersión de la plaga; capacitar a los usuarios en el reconocimiento de la plaga, identificar y prevenir el daño, y diferenciar de otros insectos xilófagos (que se alimentan de madera); generar información para ser entregada a la población, municipalidades, técnicos y profesionales del área de la construcción, empresas de construcción de viviendas y establecimientos educacionales, entre otros.

El programa comprende actividades de terreno, laboratorio y difusión. Entre las primeras, se pueden destacar: prospección de la distribución de la plaga, elección de sitios para módulos de tratamiento, colocación de las estaciones de monitoreo (fotos 2 y 3) en los módulos de tratamiento (Quillota y Valparaíso), evaluación de las estaciones de monitoreo (fotos 4 y 5), estimación del número y distribución de colonias de termita subterránea en cada módulo, aplicación de termiticida como barrera química, aplicación de cebos y evaluación de los métodos de control aplicados.

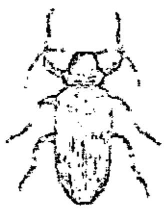
Las actividades de laboratorio comprenden: evaluación del efecto estomacal y de contacto de insecticidas, y evaluación de insecticidas mezclados con suelo.

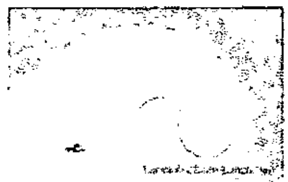
Por último, las actividades de transferencia y difusión contemplan la organización de seminarios y talleres; asesoría en la identificación de focos de la plaga; participación en seminarios y cursos relacionados con plagas urbanas y creación de afiches, manual, CD informativo y sitio web.


RECONOCIMIENTO DE LAS ESPECIE DE
TERMITAS
TERMITA SUBTERRANEA
TERMITA CHILENA DE MADERA SECA
TERMITA CHILENA DE MADERA HUMEDA

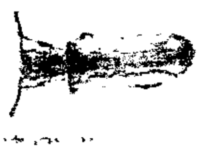
Al igual que las termitas, los coléopteros xilófagos atacan la madera generando pérdidas económicas importantes.

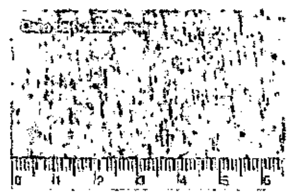
Anobiidae

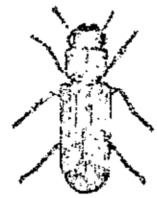




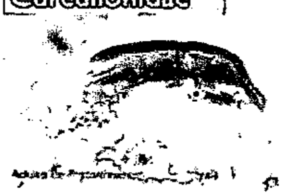
Lyctidae

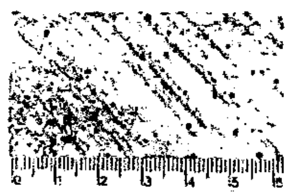






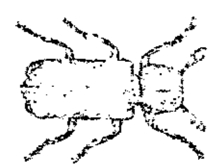
Curculionidae





Los coleopteros presentan un ciclo biologico compuesto por 4 estados diferenciados: huevo, larva, pupa y adulto.

Bostrichidae



CLAVE DE IDENTIFICACIÓN DE ESPECIES DE TERMITAS DE IMPORTANCIA ECONÓMICA PRESENTES EN CHILE

Jan Křeček

Clave de Isoptera de Chile indicada a continuación está basada (A) en la casta de soldados

A. Soldados.

1. Cápsula cefálica incluyendo mandíbulas alargada, casi rectangular u oval en su forma, no cortada o truncada, sin rugosidad o cavidad frontal, ligeramente pigmentada, mandíbulas muy alargadas, vive en madera húmeda, soldados frecuentes **2**

\- Cápsula cefálica con mandíbulas muy cortas, cuboide, truncada y muy oscura, frente notablemente cóncava, su parte anterior muy rugosa, mandíbula muy corta, vive en madera seca, casi únicamente en viviendas, soldados muy poco frecuentes .... *Cryptotermes brevis*

2. Mandíbulas izquierda y derecha sin dientes marginales, en la misma base una protuberancia redonda en ambas mandíbulas; mandíbula izquierda notablemente de forma sinuosa y el labro es más largo que ancho en su base y se estrecha hacia ápice..*Reticulitermes flavipes*

\- Ambas mandíbulas con dentición marginal en la mayor parte de su largo, incluyendo la mitad distal. La mandíbula izquierda no es sinuosa y el labro es ancho.. .**3**

3. Cápsula cefálica sin considerar mandíbulas, casi del mismo ancho que largo, levemente ovoide, las mandíbulas no convexas en la base y color casi negro uniforme en todo el largo. Pronoto de contorno semicircular .... *Porotermes quadricollis*

\- Cápsula cefálica (sin considerar mandíbulas) alargada, de contorno subrectangular. Ambas mandíbulas en la base son convexas lateralmente; base de mandíbula color castaño rojizo, parte distal de la mandíbula casi negra. Pronoto de contorno arriñonado..**4**

4. Cápsula cefálica robusta (~2,6 mm ancho), alta, mandíbulas muy convexas en la base, ojos notables, endémico de Chile continental. Mandíbulas en vista lateral son fuertemente curvadas arriba.. *Neotermes chilensis*

\- Cápsula cefálica mediana en su tamaño (~1,6 mm ancho), ligeramente comprimida dorso-ventralmente, mandíbula levemente convexa, ojos no visibles, endémico exclusivo del Archipiélago de Juan Fernández e Isla de Pascua, ausente en el continente. Mandíbulas en vista lateral paralelas con la base de la cabeza.. *Kalotermes gracilignathus*

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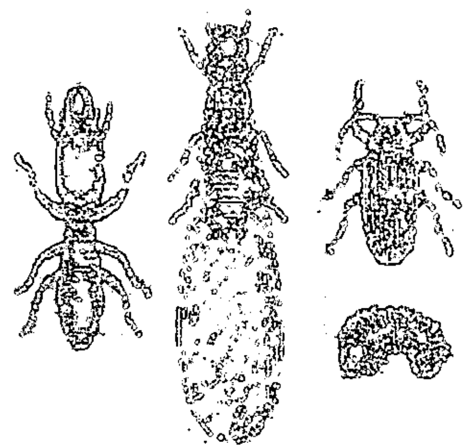
TERMITAS Y OTROS INSECTOS XILÓFAGOS EN CHILE: ESPECIES, BIOLOGÍA Y MANEJO



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TERMITAS Y OTROS INSECTOS XILÓFAGOS EN CHILE: ESPECIES, BIOLOGÍA Y MANEJO

INIA

portada (623x935x24b jpeg)

ANEXO 5

Prevention of Colony Foundation by *Cryptotermes brevis* and Remedial Control of Drywood Termites (Isoptera: Kalotermitidae) with Selected Chemical Treatments

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ABSTRACT A wooden trap-block bioassay, tested over 2 flight seasons, was found to be a suitable colonization platform for *Cryptotermes brevis* (Walker) dealates. A crevice designed into trap blocks was the preferred locus for nuptial chamber construction by dealates. Lone heterosexual pairs were found in 52% of chambers containing live termites. Of colonies containing brood, 80% were headed by lone heterosexual pairs. The broods in 4- or 6-mo-old *C. brevis* colonies were small, with ≤3 eggs, larvae, or a combination. In 1995, a choice test of disodium octaborate tetrahydrate (DOT) solution, chromium copper arsenate (CCA), and water-treated (control) trap blocks was exposed to swarming *C. brevis* alates. Four months after swarming ceased, live dealates and brood were recovered from nuptial chambers in control blocks, but not from DOT or CCA-treated blocks. These results indicated that DOT and CCA-treated wood surfaces were unpreferred substrates for colony foundation by *C. brevis*, but that these deposits were not toxic to dealates as demonstrated by their survival in neighboring control blocks. In 1996, no-choice tests were conducted using trap blocks partially treated with DOT solution or water (control). Live dealates, heterosexual dealate pairs, and brood were detected in all control treatments at 6 mo. The mean number of nuptial chambers and live termites was not significantly different among the control treatments. The number of nuptial chambers in all DOT treatments, however, was significantly lower compared with control blocks and no live termites were found in any DOT-treated blocks. These results demonstrate that partial DOT deposits deterred *C. brevis* dealates from colonizing blocks. Choice tests also were conducted in 1996. A silica gel–pyrethrin dust, spinosad suspension concentrate (SC), and DOT dust were applied to trap block tops and tested against control blocks. Significantly fewer nuptial chambers and live termites were found in silica gel-treated blocks compared with neighboring controls. Although the number of nuptial chambers was reduced significantly in spinosad-treated blocks compared with control blocks, there was no significant difference in the number of live termites. No live termites were detected in either DOT-dusted trap blocks or in adjacent control blocks, implying that dealates searching for colonization sites were intoxicated by DOT dust and unable to colonize neighboring control blocks. In remedial control tests, mature colonies of *C. brevis* and *Incisitermes snyderi* (Light) in naturally infested wood were exposed to single-point gallery injections of spinosad SC or surface applications of aqueous DOT. Infested wood members were bisected, and the resultant halves differentially treated with chemical or water. Member halves were destructively censused at 28–33 d and 97–109 d after treatment with spinosad and DOT, respectively. Spinosad-treated halves yielded 92–100% mortality in 8 of 9 wood members containing either *I. snyderi* or *C. brevis* infestations. Surface applications of DOT caused partial and sporadic mortality. Mortality ranged from 1 to 88% for *I. snyderi* and was significantly greater overall compared with water-injected halves, whereas mortality in *C. brevis* infestations treated with DOT ranged from 0 to 35%. Mortality in water-treated half members ranged from 0 to 9%. Results of remedial control tests demonstrate the advantages of intragallery applications over surface-only treatments for drywood termite infestations.

KEY WORDS *Incisitermes snyderi*, borates, spinosad, silica gel, incipient colonies

The overwhelming majority of termite alates that leave their colonies during dispersal flights do not survive to reproduce. Predation, climatic conditions, availability and suitability of nest sites, mate selection and fitness, and intraspecific competition are all factors that severely limit the number of imago pairs that will yield progeny (Nutting 1969). Drywood termite alates flying inside infested structures or those flying into structures from outdoor colonies may encounter conditions that are rather favorable for incipient colony development (Harvey 1934, Wilkinson 1962). The inhibition of termite colony foundation as a measure of efficacy of a given preventative treatment, however, remained unstudied.

Chemical treatments applied directly onto structural wood or other surfaces explored by dealates searching for a nest site might be useful in reducing or preventing initial infestations or recolonizations of drywood termites in buildings. Some of the early wood preservatives included liquids primarily derived from coal tar or water-soluble metal salts (Randall and Doody 1934a). To prevent infestation, wood was either impregnated under pressure before use in construction or surface-treated with toxicant sometime after construction. Inorganic sorptive dusts such as silica aerogel were shown to be lethal to alates of *Incisitermes minor* (Hagen) (Ebeling and Wagner 1959) and *Cryptotermes brevis* (Walker) (Minnick et al. 1972) in forced-exposure, nonflight bioassays. In these studies, chemical treatments were not exposed to natural dispersal flights. Nevertheless, various silica-gel-based dusts have been used commercially for local or building-wide prevention of drywood termites (Ebeling 1975, Scheffrahn and Su 1994). Most recently, products containing the boron salt, disodium octaborate tetrahydrate (DOT), have been marketed to the pest control industry for the prevention of drywood termites. Tim-bor (U.S. Borax, Valencia, CA), a popular DOT product, is recommended as a dust for preventative application (Anonymous 1995).

Established infestations of drywood termites require invasive treatments into their wood galleries. Fumigation has been used as such a method since the 1940s (Hunt 1949). Pentachlorophenol emulsion had been used as a wood soak for drywood termites (Ebeling 1975) until its outlaw. Arsenical dusts, chlorinated hydrocarbons, dimethyl bromide, chlorpyrifos, and other chemicals have been commercially available at various times for local gallery injection and, more recently, heat, cold, and electrocution have been marketed to the public for drywood termite control (Scheffrahn and Su 1994). For remedial control, Tim-bor is recommended as a liquid surface treatment or as a dust or liquid intragallery treatment (Anonymous 1995).

The exclusive wood-inhabiting nature of drywood termite colonies makes it difficult to quantitatively evaluate the efficacy of a given remedial control treatment applied in situ. Only recently has a study been conducted using direct mortality counts following the application of control treatments on naturally infested wood (Lewis and Haverty 1996). Furthermore, Scheffrahn et al. (1997) found that high-frequency acoustic emissions detection devices (Scheffrahn et al. 1993) could be used to nondestructively evaluate the efficacy of treatments against drywood termite infestations in situ.

The current article consists of 3 phases addressing the prevention and remedial control of drywood termites. The purpose of the 1st phase is to validate a method to induce the natural foundation of *C. brevis* colonies. The 2nd phase is an assessment of the efficacy of various wood surface treatments to prevent the foundation of *C. brevis* colonies by using the validated colony foundation bioassay. The 3rd phase is a technique to treat and destructively assess the efficacy of treatments for the remedial control of mature drywood termite infestations.

Materials and Methods

Trap Block Test, 1995. Seasoned, chromium copp arsenate (CCA)-treated (factory pressure-impr nated) construction-grade pine (*Pinus* sp.) boards (by 3.8 by 244 cm) were purchased from a local lu beryard. Only boards free of cracks, checks, and sa piness were selected. Visual inspection indicated t the CCA treatment completely penetrated the wo Untreated spruce (*Picea* sp.) boards (3.8 by 3.8 by 2 cm), also free of sap and defects, were surface-spray in the vertical position with an aqueous 100,000 p (wt:vol) solution of DOT (Tim-bor 98% anhydro dust) or water (control). *Picea* spp., *Pinus* spp., a practically all other woods used for construction a furniture are susceptible to colonization by polyp gous drywood termites such as *C. brevis* (R.H.S., published data). The spray treatments were appli twice (1-h interval) to runoff on all external boa surfaces by using a hand-held mist sprayer. Retenti of DOT solution was measured gravimetrically (w weight minus dry weight) for each board. After t boards were dry, 5 cm long ends of each treated boa were sawed off and discarded. The remaining boa were sawed into 8-cm lengths. Cut ends of sectio (top and bottom, Fig. 1) were not additionally treat

Paired wood-block bioassay units or trap blo were constructed from the same treatments. Each tr block consisted of 2 sections joined upright at th long sides with 2 rubber bands and separated at th juncture by a flat, 1.3 mm thick, wooden toothpi positioned 1 cm from their bottoms to create a crevi (Fig. 1). The trap blocks were designed to be attractive habitat for colony foundation postswarmed *C. brevis* dealates.

A windowless laboratory (5 by 8 m) served as alate dispersal venue. The room contained 20 wood doors that were heavily infested with mature *C. bre* colonies. The doors were collected from a vacant na hospital in Key West, FL, in July 1994. A water p which served as an alate monitoring trap, was plac near a 3.9-W fluorescent lamp, the only light source the room. Three days after the 1st alates were fou in the water trap (5 May 1995), 15 CCA-treated, DOT-treated, and 50 water-treated trap blocks w placed randomly 2.5 cm apart on a metal table top a choice test arrangement beneath the light. As s radic dispersal flights commenced, dealates were f quently observed crawling alone and in tandem on t trap blocks. Alates were counted in the water t every 1–3 d to monitor dispersal flight activity over t flight season. In October 1995, all 115 trap blocks w disassembled. The incipient colony status, includi location and number of nuptial chambers, contents each chamber (number and gender of live dealate and number and composition of brood (eggs and l vae) in each chamber was recorded.

A nuptial chamber is defined herein as an enclos composed of any combination of excavated wo existing wood partitions (i.e., block surfaces), a other construction materials (fecal pellets, anal sec tions, and frass) used by young dealates to buil

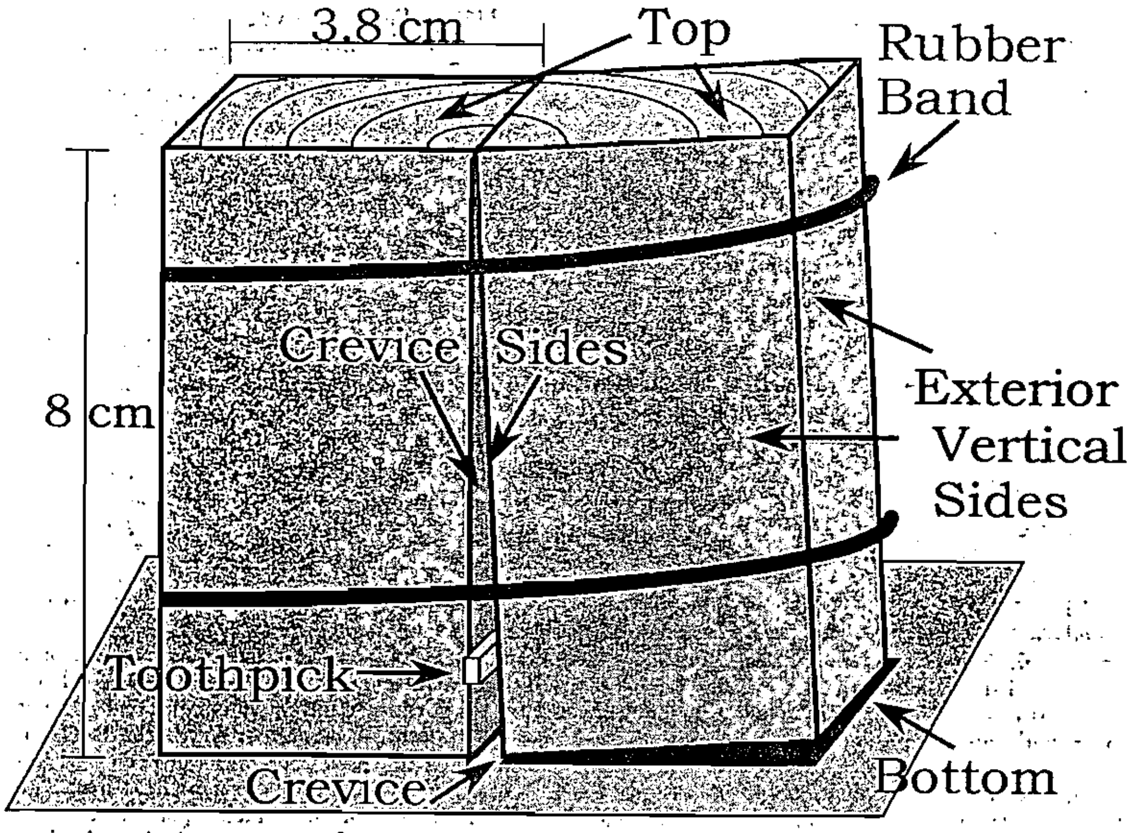

Fig. 1. Trap block bioassay used as a colonization platform for *C. brevis* dealates.

nesting enclosure. A nuptial chamber in a trap block marks a colonization attempt by dealates, whereas live dealates in a nuptial chamber indicate the absence of overt toxicity by block treatments. A nuptial chamber containing at least 1 live heterosexual dealate pair (king and queen) with or without brood is indicative of successful colony foundation in this study.

Trap Block Test, 1996. The same trap block design tested in 1995 was used in 1996. Because some treatments were arranged in a no-choice design and dislodgable chemicals (dusts) were tested in choice tests in 1996, treatments were segregated from each other in metal isolation trays (32 by 44 cm) from which dealates could not escape and contaminate neighboring treatments. In the no-choice experiments, *Picea* trap blocks were constructed from 3 different DOT and 3 different water-treated boards to result in the following treatments: trap blocks treated only on their 2 vertical crevice-facing sides, on all 6 vertical exterior sides except the 2 crevice-facing sides, or on all 8 vertical sides (Fig. 1). Board surfaces not designated for treatment were shielded with masking tape before spraying. Partial surface treatments were designed to simulate incomplete field applications. Boards were then weighed, sprayed 1 time only on designated surfaces to runoff with 150,000 ppm of DOT (Tim-bor) aqueous solution or water, and reweighed. Forty-two trap blocks were prepared for each treatment for a total of 252 U. Blocks were spaced 2.5 cm apart and segregated by treatment in trays.

Two dust treatments and a suspension concentrate were evaluated in a choice-test arrangement in 1996. A total of 126 untreated trap blocks was prepared for this test. The top surfaces (Fig. 1) of 21 blocks were covered with DOT (Tim-bor) dust at the label rate (15 mg/cm^2). Top surfaces of 21 blocks were treated with amorphous silica gel (40%) containing 1% pyrethrins, 10% technical piperonyl butoxide, and 49% inert ingredients (Drione dust AgrEvo, Montvale, NJ) at the label rate (0.49 mg/cm^2). Spinosad SC (Dow AgroSciences, Indianapolis, IN) was applied by dipping block tops in a 5,000-ppm aqueous suspension and weighing the deposit. DOT dust, silica gel dust, or spinosad-treated blocks each were alternated with 21 untreated blocks in trays in a checkerboard pattern with 2.5-cm spacings.

Before the1996 dispersal flight season, the choice and no-choice trays were arranged randomly beneath 6 3.9-W fluorescent lights in the same room containing *C. brevis*-infested doors used in 1995. Tray positions were transposed randomly on several occasions during the flight season. In 1996, the alate water trap was placed further away from the light source than in 1995 resulting in a lower catch (Fig. 2). In December 1996, the blocks were dismantled and a nuptial chamber census was taken as in the previous year. Additionally,

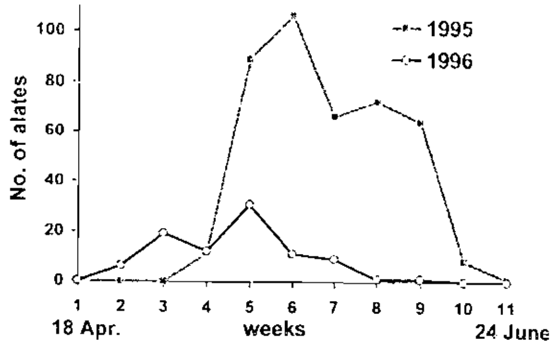

Fig. 2. Weekly water-trap catches of *C. brevis* alates emerging from infested doors. Water trap placed near light in 1995 and away from light in 1996.

the number of dead alates and dealates outside of nuptial chambers was counted in the isolation trays.

Trap block census counts from each year were analyzed separately with a Kruskal–Wallis test (PROC NPAR1WAY, SAS Institute 1989) to determine if the treated blocks differed in the number of nuptial chambers, live dealates, chambers containing males and females, and those containing brood. This nonparametric test was used because of the high frequency of blocks with no termite activity, especially those treated with DOT and CCA (see *Results*), and the consequent non-normal distribution of the data. Means were compared with a nonparametric multiple comparison test (Conover 1980). Separate chi-square analyses were conducted for 1995 and 1996 to determine if differences occurred in the location of nuptial chambers, number of chambers with males and females, and the number of chambers with brood.

Remedial Treatment of Mature Colonies. Limbs and trunks of Brazilian pepper, *Schinus terebinthifolius* Raddi, of varying dimensions and infested with single colonies (1 queen) of *Incisitermes snyderi* (Light), were collected in Deerfield Beach, Broward County, FL. All bark, naturally deciduous on dead wood, was removed from logs. Boards of varying dimensions and infested with *C. brevis* were removed from a house under renovation in Homestead, Dade County, FL. To delineate the foraging territory (i.e., inhabited portion) of each drywood termite infestation, both ends of each wood member were trimmed in a few-centimeter increments with a band saw until active galleries containing live termites were encountered. The dimensions of each wood member were measured. Each member was then sawed in half at the midpoint of its long axis. Gallery openings, exposed by sawing, were sealed with rubber putty (Handi-Tak, Pacer Technology, Rancho Cucamonga, CA) and each cut end was tightly covered with paraffin film (Parafilm, American National Can, Greenwich, CN). Paired half-members were left undisturbed for at least a few hours before treatment.

Two treatments were tested, a gallery injection of spinosad SC and a surface application of DOT. A 5,000-ppm aqueous suspension of spinosad SC was applied by single-point injection into 1 of the pai half-members. The treated member was chosen b coin toss. One hole (2 mm diameter) was drilled i the center of the member to a maximum depth of 4 unless the wood was of lesser thickness. If no gall was intersected, as detected by lack of drill bit jun the drilling step was repeated until a gallery was tersected. The spinosad suspension was slowly jected into the treatment hole with a 10-ml syrin fitted with a metal tube (1.85 mm o.d., 38 mm lon The tube was collared with a rubber septum that pressed onto the wood surface to minimize outfl during injection. The wood member was position horizontally during all phases of treatment and h dling. Injection volume was calculated to be 1% of t total wood member volume; however, 3 of the treat members accommodated only a lesser volume as th galleries filled prematurely and liquid began flowi from the injection hole. After injection, the hole w plugged to a depth of 1 cm with a 2-mm-diamet wooden dowel. Paired half members were inject identically with water. Five *I. snyderi* logs and 4 *brevis* boards were injected with spinosad–wat treatments.

For the surface treatments, an aqueous 100,000-p solution of DOT (Tim-bor) was sprayed with a ha sprayer to vertical runoff on all longitudinal surfa of the chosen half-member. After 1 h, the DOT plication was repeated. Members were weighed i mediately after spraying to determine DOT load. T other half-member of each matched pair was assign a water (control) surface treatment. Six *I. snyderi* l and 3 *C. brevis* boards were sprayed with DOT–wa treatments.

The spinosad and DOT-treated wood members a their paired control halves were stored horizont under room conditions and were destructively mantled at 28–33 d and 97–109 d after treatme respectively. Half-members were dismantled by ting each into 10 cm long sections and further sub viding each section by wood chisel and mallet until termites were removed from their galleries. Live, m ibund, and dead pseudergates (workers) of *I. snyd* and *C. brevis* were counted in each of the treatm and control half-members. The few moribund in viduals encountered (i.e., unable to right themsel when placed on their dorsa) were scored as de Median tests (PROC NPAR1WAY, SAS Institu 1989) were conducted separately for *I. snyderi* and *brevis* tests to determine differences in termite m tality between the treated and control half-memb

Results and Discussion

Trap Blocks as Colony Foundation Platforms. *brevis* is an ideal species for conducting colony fo dation and prevention studies because it is the o termite occurring solely in structural infestati worldwide (Scheffrahn et al. 1998) and alates attracted to artificial light. Therefore, all condition this study constitute a true field experiment. The fli behavior of *C. brevis* observed by us agrees with t

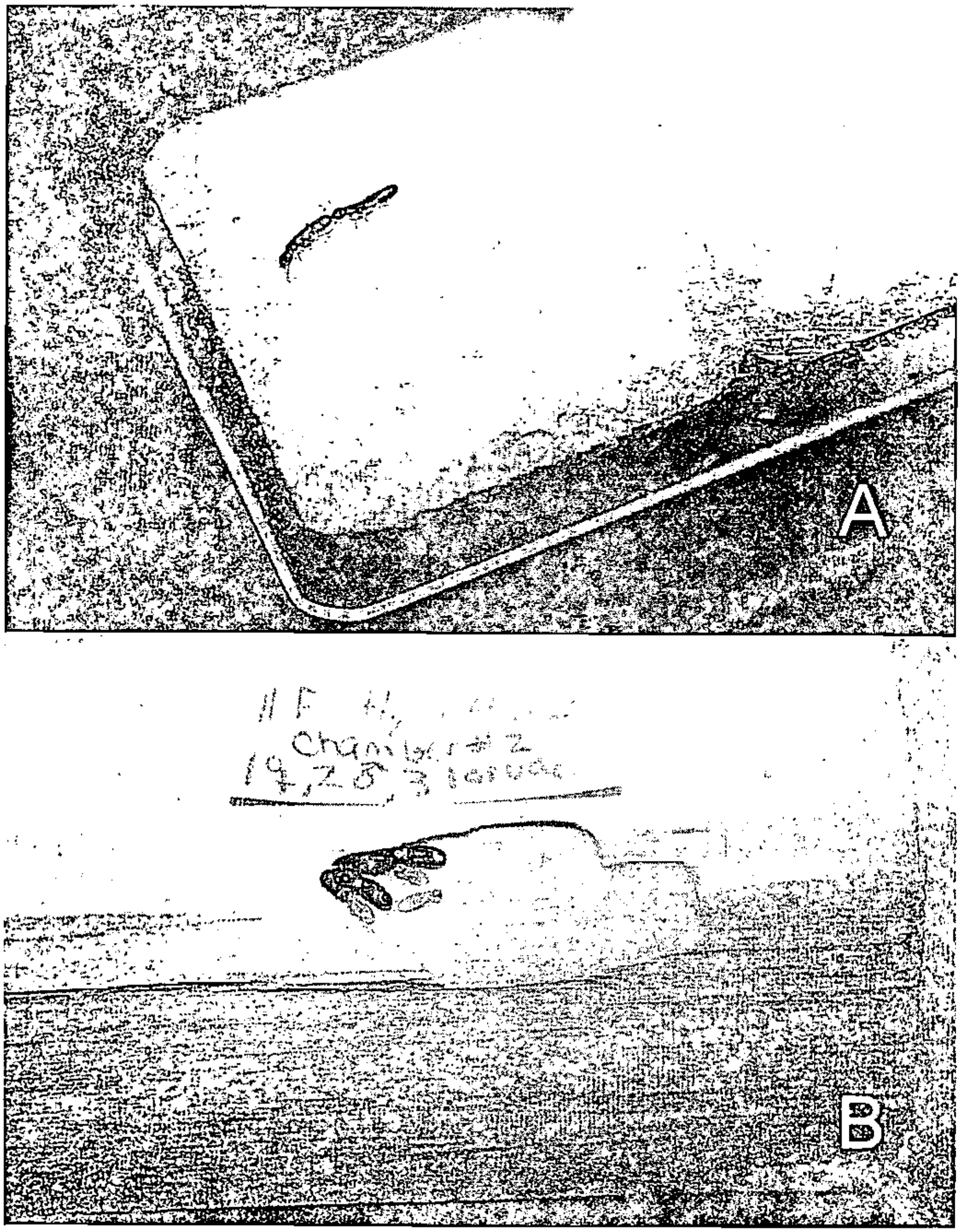

Fig. 3. (A) Tandem male–female pair of dealates investigating DOT-dust-treated trap block (shown ≈6 h after flight). (B) Incipient 6-mo-old *C. brevis* colony composed of 2 male and 1 female dealates and 3 larvae.

reported by Minnick (1973) who collected alates in light traps during crepuscular swarms in Florida in May and June. In 1995, the 1st alates were captured in the water trap during the 1st wk of May and flights continued through the end of June, whereas the 1996 flights commenced and ceased ≈2 wk earlier (Fig. 2). We observed the same sequence of postflight behavior on trap blocks that Minnick (1973) reported for dealates on wooden substrates in buildings, including surface palpitation and tandem investigation of substrata (Fig. 3A) lasting up to many hours.

The number and contents of nuptial chambers in the water-treated blocks in the 1995 choice test and the 1996 no-choice tests validated the trap block design as a suitable colonization platform for *C. brevis* and provided an insight into dealate behavior and incipient colony development (Tables 1–4). As expected of these cryptobiotic and thigmotactic insects,

Table 1. Location of nuptial chambers in 4-mo-old (1995) and 6-mo-old (1996) *C. brevis* colonies in water-treated trap blocks

Trap block location[a]	No. of nuptial chambers		No. chambers with ≥1♂ + ≥1♀		No. chambers with brood	
	1995	1996	1995	1996	1995	1996
Top	4	4	3	3	2	1
Crevice	29	167	27	60	9	19
Bottom	17	28	11	9	7	6
Exterior	0	9	0	5	0	5
χ^2 =	41.68	345.269	42.805	115.987	11.778	23.581
df =	3	3	3	3	3	3
P =	<0.001	<0.001	<0.001	<0.001	0.01	<0.001

[a] See Fig. 1.

the trap block crevice was the preferred locus for nuptial chamber construction during both years (Table 1). The bottom surface, forming a fortuitous crevice with the metal substrate, was the 2nd most used colonization locus. Although less common, nuptial chambers also were excavated parallel to the wood grain in exposed top surfaces, and across the grain in outer trap block surfaces, the latter of which represented the greatest block surface area. Individual trap blocks contained up to 5 nuptial chambers, with the majority of blocks (67%) containing only 1 or 2 chambers (Table 2). Lone heterosexual pairs headed 52% (74 of 143) of colonies containing live termites for 1995 and 1996 combined (Table 3). Of incipient colonies containing brood, 80% (39 of 49) were headed by lone heterosexual pairs, 16% had additional dealates occupying chambers with a heterosexual couple (Fig. 3B), and 2 broods (4%) lost 1 or both founding reproductives (Table 3). The broods in 4-mo-old *C. brevis* colonies were small, with the number of eggs or larvae being 3 or fewer; as expected, 6-mo-old colonies contained a higher proportion of larvae over eggs than the 4-mo-old colonies (Table 4). McMahan (1962) reported a mean of (1 egg and 3–5 larvae or pseudergates (>3 instar) from 4- to 6-mo-old *C. brevis* colonies composed of laboratory-paired dealates placed inside prepared termitaria. The somewhat higher fecundity reported by McMahan (1962) may have resulted from her experimental methods that eliminated intraspecific competition and precluded nuptial chamber construction by the young dealates. Harvey (1934) found broods consisting of only 1–2 eggs in 5- to 7- mo-old *I. minor* colonies from laboratory-paired dealates.

Preventative Treatments, 1995. After the conclusion of flight season, 817 dead *C. brevis* dealates were recovered within the zone occupied by the trap blocks but outside of nuptial chambers. No attempt was made to count the bodies and wings scattered about the room, but we estimate that 5,000-10,000 alates had flown during the 1995 experiment.

Disassembly of the trap blocks 4 mo after the last alate flight revealed a preponderance of nuptial chambers in the water-treated blocks with a mean of 1.02 chambers per block (Table 5). The DOT and CCA-treated blocks contained significantly fewer nuptial chambers with a mean of only 0.04 and 0 per block, respectively. The nuptial chambers in the water-treated blocks contained a total of 129 live dealates (2.58 per trap block), whereas no live dealates or brood were found in either the DOT or CCA-treated blocks (Table 5). After swarms, dealates were regularly observed crawling on all treatments. Therefore, we concluded that DOT solution and CCA-treated wood surfaces were unpreferred substrates for colony foundation by *C. brevis*, but that these deposits were not toxic to dealates as many apparently established viable colonies in neighboring control blocks. Results further suggested that if some wood members in an attic, wall void, or other structural entity were left untreated with DOT solution or CCA impregnation, these untreated members could be selectively chosen by dealates and successfully colonized. It was not determined, however, if dealates would be able to establish colonies in these treatments if not given a choice to infest control blocks, hence, the inclusion of the no-choice tests for DOT solution in 1996.

Preventative Treatments, 1996. After the conclusion of flight season, 3,468 dead *C. brevis* dealates were recovered outside the nuptial chambers but within the treatment confinement trays. As in 1995, no absolute

Table 2. Number of nuptial chambers per block in 4-mo-old (1995) and 6-mo-old (1996) *C. brevis* colonies in water-treated trap blocks

Nuptial chambers/block	No. of blocks	
	1995	1996
0	22	11
1	14	46
2	7	51
3	6	13
4	1	4
5	0	1

Table 3. Dealate gender composition and brood presence in 4-mo-old (1995) and 6-mo-old (1996) *C. brevis* colonies in water-treated trap blocks

Dealate gender	Total no. of colonies		Colonies with brood	
	1995	1996	1995	1996
1♂ + 1♀	27	47	17	22
>1♂ + 1♀	5	16	0	5
1♂ + >1♀	3	9	0	2
>1♂ + >1♀	6	5	1	0
♂ only (n = 1–4)	7	14	0	1
♀ only (n = 1 or 2)	1	2	0	0
None	0	1	0	1

Table 4. Brood composition in 4-mo-old (1995) and 6-mo-old (1996) *C. brevis* colonies in water-treated trap blocks

1995 No. of colonies	Brood composition		1996 No. of colonies	Brood composition	
	No. of eggs	no. of larvae[a]		No. of eggs	No. of larvae[a]
6	0	1	19	0	1
3	0	2	6	0	2
3	0	3	2	0	3
3	1	0	3	1	0
1	1	1	1	1	5
1	2	2	—	—	—
1	3	0	—	—	—
Totals 18	9	24	31	4	42

[a] Instars 1-3.

alate emergence counts were possible, but we estimate that 5,000-10,000 alates had flown during the 1996 experiment. Live dealates, heterosexual dealate pairs, and brood were only detected in no-choice water treatments (Table 6). Even under these seemingly favorable field conditions, successful colony foundation by dealate pairs of *C. brevis* was an uncommon event in 1996 as only 37% (77 of 208) of chambers contained live heterosexual pairs in the no-choice water treatments. A few times we observed dealates evicting and biting those already constructing chambers, suggesting that intraspecific competition for nest sites was reducing colonization success rates. Likewise, Harvey (1934) found only 7 dealate pairs of *I. minor* in an experimental wooden house exposed to caged alates flying from heavily infested utility poles. Given swarms within the proximity of untreated wooden structures, it seems inevitable that a few pairs will find suitable refugia for nuptial chamber construction and that 1 or 2 will go on to head mature and damaging colonies.

The mean number of nuptial chambers and live termites was not significantly different among the 3 no-choice water treatments (Table 6). The frequency of nuptial chambers in trap blocks was significantly lower in all DOT treatments compared with water-treated blocks and no live termites were found in any DOT-treated blocks. These findings confirm that trap blocks treated with aqueous surface deposits of DOT at ≈1 mg/cm^2 not only are unpreferred colonization sites as observed in 1995, but that DOT deposits also significantly deter colonization attempts (nuptial chamber construction) and prevent successful colony establishment. Furthermore, even partial treatment of trap blocks with DOT solution is sufficient, in the absence of untreated blocks, to inhibit successful colony foundation by *C. brevis*. We conclude that, at least in small-scale situations, dealates, upon detecting DOT on the surface of wood being explored as a possible colonization site, will reject the wood outright or be further deterred or intoxicated during some phase of nuptial chamber establishment.

Choice test results from 1996 are given in Table 7. Significantly fewer nuptial chambers and live termites were found in silica gel-treated blocks compared with neighboring untreated trap blocks. Although the number of nuptial chambers was reduced significantly in spinosad-treated blocks compared with water treatments, there was no significant difference in the number of live termites between the spinosad-treated and the water-treated blocks. No live termites were detected in either DOT-dusted blocks or in adjacent untreated trap blocks.

The choice tests not only identify treatments that prevent or reduce termite occupation of treated trap blocks, they also detect treatments that are toxic to dealates that would otherwise colonize neighboring control blocks. Like the 1995 choice tests with DOT solution and CCA impregnation, the silica gel dust and Spinosad SC deposits tested in 1996 did not prevent colonization of control blocks. This suggests that exploring dealates either avoided contact with the chemicals or such contacts were not always lethal. Choice test results with DOT dust, however, suggest that all dealates searching for colonization sites contacted lethal quantities of this voluminous dust (Fig. 3A) regardless of whether colonization sites were chosen on treated or untreated blocks. The practical conclusion of such a result is that deposits of DOT dust will not only protect underlying wood in a treated structure, but that the dust will kill dealates before they can colonize unprotected wood elsewhere. This premise assumes that dealates will search a sufficiently large area before selecting a nuptial chamber site. Frenetic searching is supported by our observations, along with

Table 5. Mean ± SE number per trap block of *C. brevis* dealates, nuptial chambers, and brood in 100,000 ppm DOT-treated, CCA-treated, or untreated blocks (choice design) infested May–June 1995 and disassembled October 1995

Treatment	No. of blocks	No. of nuptial chambers	No. of live dealates	No. of chambers containing	
				≥1♂ + ≥1♀	Brood
Water	50	1.02 ± 0.16a	2.58[a] ± 0.44a	0.82 ± 0.14a	0.36 ± 0.09a
DOT[b]	50	0.04 ± 0.03b	0 ± 0b	0 ± 0b	0 ± 0b
CCA[c]	15	0 ± 0b	0 ± 0b	0 ± 0b	0 ± 0b
χ^2 =		43.180	43.522	40.496	18.824
df =		2	2	2	2
P =		0.0001	0.0001	0.0001	0.0001

Means within a column followed by the same letter are not significantly different according to a Kruskal–Wallis test and a nonparametric multiple comparison test ($P > 0.05$, Conover 1980).

[a] Total of 72 males and 57 females.

[b] Mean surface retention (mg DOT/cm^2 ± SD) = 1.16 ± 0.19.

[c] Commercial pressure impregnation, full penetration.

Table 6. Mean ± SE number per trap block of *C. brevis* dealates, nuptial chambers, and brood in 150,000 ppm DOT-treate untreated blocks (no-choice design) infested April–June 1996 and disassembled December 1996

Treatment	Vertical sides treated[a]	No. of blocks	Nuptial chambers	Live dealates[b]	Chambers containing	
					≥1♂ + ≥1♀	Broo
Water	Crevice	42	1.79 ± 0.15a	2.38 ± 0.28a	0.71 ± 0.10a	0.24 ± 0
	Exterior	42	1.62 ± 0.17a	1.48 ± 0.33a	0.62 ± 0.14a	0.26 ± 0
	All	42	1.55 ± 0.11a	1.57 ± 0.28a	0.50 ± 0.10a	0.24 ± 0
DOT	Crevice[c]	42	0.81 ± 0.14b	0 ± 0b	0 ± 0b	0 ± 0l
	Exterior[d]	41[e]	0.39 ± 0.09c	0 ± 0b	0 ± 0b	0 ± 0l
	All[f]	42	0.40 ± 0.08c	0 ± 0b	0 ± 0b	0 ± 0l

Means within columns followed by the same letter are not significantly different according to a Kruskal–Wallis test and a nonparame multiple comparison test ($P > 0.05$, Conover 1980).
[a] See Fig. 1.
[b] Total of 129 males and 99 females for combined water treatments.
[c] Mean surface retention (mg DOT/cm^2 ± SD) = 1.11 ± 0.11.
[d] Mean surface retention (mg DOT/cm^2 ± SD) = 1.05 ± 0.30.
[e] Data missing for 1 block.
[f] Mean surface retention (mg DOT/cm^2 ± SD) = 0.86 ± 0.083.

those of Harvey (1934) for *I. minor* and Wilkinson (1962) for *Cryptotermes havilandi* (Sjöstedt), that report nuptial chamber site location and acceptance involves repeated forays over a wide area and for up to several hours.

Remedial Treatment of Mature Colonies. *Schinus* logs infested with *I. snyderi* ranged in length from 44 to 120 cm (trimmed) and in diameter from 3.75 to 8.25 cm, whereas *C. brevis*-infested boards ranged in length from 97.5 to 160 cm (trimmed), in width from 8.5 to 23 cm, and in thickness from 2 to 4 cm. Pseudergate populations in these wood members ranged from 186 to 927 (mean ± SD, 476 ± 284) for *I. snyderi* and 25–2,068 (647 ± 715) for *C. brevis*. Bisecting wood members infested with drywood termites did not appear to affect the vigor of resident pseudergates. The dismantling procedure resulted in some termite mortality; however, handling mortality, as observed in untreated halves, was minimal (0–9.1%, Tables 8 and 9). Dead termite bodies are never encountered in healthy termite colonies because of the necropha habits of healthy nestmates.

The technique of bisecting infested wood memb and differentially treating the resultant halves has t advantage of imposing in situ chemical and cont treatments on nestmates of the same colony. Previo studies that employed destructive sampling of natu infestations treated by arsenical dusts (Harvey 19 Randall and Doody 1934b) and nonchemical metho or fumigation (Lewis and Haverty 1996) did not i clude control treatments for natural infestations. A though colony bisection will result in an uneven d tribution of the colony population within an infest member, the proportions of pseudergates amo paired halves were mostly distributed over a 1:1–1 ratio in the current study. Only 1 of the 18 bisect members yielded an extremely unbalanced pseud gate population split as noted below (log 4, Table 8 Single-point gallery injections of relatively sm amounts of spinosad (AI) yielded 92–100% mortali

Table 7. Mean ± SE number per trap block of *C. brevis* dealates, nuptial chambers, and brood in top surface-only treated and untrea blocks (choice design) infested April–June 1996 and disassembled December 1996

Treatment	No. blocks	Nuptial chambers	Live dealates	Chambers containing	
				≥1♂ + ≥1♀	Broo
Silica gel dust[a]	21	0.19 ± 0.09	0.38 ± 0.22	0.10 ± 0.07	0.05 ± 0
Water	21	0.71 ± 0.16	1.29 ± 0.31	0.48 ± 0.11	0.24 ± 0
	χ^2=	6.9913	6.1821	7.2889	3.03
	df=	1	1	1	1
	P=	0.0082	0.0129	0.0069	0.081
Spinosad SC[b]	21	0.24 ± 0.12	0.57 ± 0.32	0.14 ± 0.08	0.10 ± 0
Water	21	0.67 ± 0.13	0.86 ± 0.33	0.19 ± 0.09	0
	χ^2=	6.8908	0.8976	0.1674	2.05
	df=	1	1	1	1
	P=	0.0087	0.3434	0.6825	0.15
DOT dust[c]	21	0.19 ± 0.09	0	0	0
Water	21	0.29 ± 0.10	0	0	0
	χ^2=	0.5125	0	0	0
	df=	1	1	1	1
	P=	0.4741	1.0	1.0	1.0

[a] Deposit rate = 0.49 mg/cm^2.
[b] Mean deposit rate (mg spinosad/cm^2 ± SD) = 0.31 ± 0.072.
[c] Deposit rate = 15 mg/cm^2.

Table 8. Mortality of drywood termite pseudergates in wood members that were bisected, one-half injected with 5,000 ppm of spinosad SC, the other half injected with water, and dismantled after 28–33 d

Unit no.	Spinosad-treated halves		Water-treated halves		Analysis of % mortality		
	Total no. pseudergates	% dead	Total no. pseudergates	% dead	χ^2	df	*P*
			I. snyderi in *Schinus* logs[a]		6.00	1	0.0143
1	434	95.6	177	0			
2	429	100.0	421	0			
3	126	100.0	417	0			
4	9	0	918	0			
5	604	99.2	203	0			
			C. brevis in structural boards[b]		7.00	1	0.0082
1	118	100.0	148	0			
2	215	100.0	289	0			
3	309	96.1	1,759	0			
4	907	91.8	606	1.2			

[a] Mean (n = 5) injection rate ± SD = 48.0 ± 4.5 mg (AI)/liter of wood volume.
[b] Mean (n = 4) injection rate ± SD = 40.6 ± 11.2 mg (AI)/liter of wood volume.

in 8 of 9 wood member halves containing either *I. snyderi* or *C. brevis* infestations compared with negligible mortality in all water-injected halves (Table 8). These data support previous findings that showed that spinosad SC deposits yielded high mortality of *I. snyderi* and *C. brevis* pseudergates in laboratory choice bioassays, and gallery injection with spinosad SC significantly suppressed or eliminated *C. brevis*-generated acoustic emissions in structural infestations (Scheffrahn et al. 1997). Failure to affect control of *I. snyderi* in 1 *Schinus* member (log 4, Table 8) appeared to be the result of injection into inactive galleries. The 9 pseudergates found in the spinosad-treated half were in a small gallery located in its distal end and may have represented a 2nd colony that we did not observe when cutting the limb in the field. Only unoccupied galleries were found between this small group and the 918 pseudergates in the water-treated half. If an acoustic emissions device were used (Scheffrahn et al. 1997), this unoccupied gap might have been detected before treatment.

The surface application of aqueous DOT caused partial and sporadic mortality in some treated members; however, overall mortality was significantly different ($P = 0.0270$) or not significantly different ($P = 0.4561$) from control halves in *I. snyderi* and *C. brevis* infestations, respectively (Table 9). These results validate previous laboratory and field studies with *C. brevis* demonstrating the limited mortality caused by aqueous DOT treatments applied to the surface or injected at 50 cm spacings (Scheffrahn et al. 1997). The manufacturer recommends that surface spray treatments at 3.3–4.4 mg of DOT/cm^2 (a retention we could not achieve in *C. brevis* treatments because of runoff) be combined with injections of 100,000- or 150,000-ppm solutions of DOT into galleries until the solution pours out of neighboring surface damage (Anonymous 1995). We chose to test only the DOT surface treatment because the label is vague on the requirement of injection if wood is <10 cm thick (Anonymous 1995). Also, many pest control operators in Florida and California apply DOT only to surfaces

Table 9. Mortality of drywood termite pseudergates in wood members that were bisected, 1-half surface-treated with 100,000 ppm of DOT, the other half surface-treated with water, and dismantled after 106–109 d

Unit no.	DOT-treated halves		Water-treated halves		Analysis % mortality		
	Total no. pseudergates	% dead	Total no. pseudergates	% dead	χ^2	df	*P*
			I. snyderi in *Schinus* logs[a]		4.889	1	0.0270
1	163	4.3	60	3.3			
2	88	76.1	132	2.3			
3	177	1.1	43	0.0			
4	80	16.3	302	1			
5	119	88.2	153	7.8			
6	103	28.2	83	2.4			
			C. brevis in structural boards[b]		0.56	1	0.4561
1	14	28.6	11	9.1			
2	48	35.4	42	2.4			
3	143	0	98	5.1			

[a] Mean DOT surface retention ± SD = 3.16 ± 0.57 mg (AI)/cm^2.
[b] Mean DOT surface retention ± SD = 1.69 ± 0.40 mg (AI)/cm^2.

for remedial treatment of drywood termites (R.H.S., unpublished data).

Results of these remedial tests and those of Scheffrahn et al. (1997) demonstrate a more consistent effectiveness of invasive, intragallery applications using a nonrepellent formulation such as spinosad SC versus the more variable and slower efficacy of surface-applied DOT solution. Gallery injection eliminates factors such as wood thickness and penetrability, broad surface accessibility, gallery depth, and surface coatings (e.g., paint) from preventing delivery of active ingredient directly into the termite colony. Conversely, gallery injection is not possible when a drywood termite infestation is completely inaccessible or can be challenging when galleries are poorly developed. Under difficult conditions, alternative treatments such as those evaluated by Lewis and Haverty (1996) might be considered as options.

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Termites (Isoptera: Kalotermitidae, Rhinotermitidae, Termitidae) of the West Indies

by

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ABSTRACT

Species and island lists are provided for termites recorded from the Greater and Lesser Antilles, Bahamas, and associated islands including Curacao, Bermuda, and Caymans. Ninety-eight species from 3 Families are included from 60 islands of the West Indies.

INTRODUCTION

Snyder (1956) compiled a 193-entry inventory list of 62 named termite species from 30 listed islands of the West Indies (Greater and Lesser Antilles, Bahamas, Bermuda, and Curacao). Since then, surveys of the termites of the West Indies and taxonomic revisions involving some species have substantially expanded the known species diversity and geographic distribution of the West Indian termite fauna. This paper is an update of Snyder's 1956 work and discusses the current status and outlook for taxonomic research on termites of the West Indies.

MATERIALS AND METHODS

Snyder (1956) based his list, in part, on specimens at the U.S. National Museum and on literature records for which he gave no citations. Our list is derived primarily from Adamson (1937, 1940, 1948) and Snyder (1956); new species descriptions, revisions, and records from published studies (see species by island list for references) and recent extensive collections especially those of Scheffrahn, Krecek, Su, and others (Dominican Republic, Puerto Rico, Dominica, Martinique, and Turks & Caicos Is.), Darlington (Guadeloupe, Montserrat, and Trinidad and Tobago), Collins (British Virgin Is., Cayman Is., and Dominica), and Krecek (Cuba incl. Isla de la Juventud). Specimens of

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most new entries used in this inventory (*i.e.* since Snyder 1956) are in the collections of the individual authorities listed.

We herein present 2 lists, the first by island locality and the second by species, following the format of Snyder (1956). Individual island records are attributed a published reference(s) or the name(s) of the authority(ies) responsible for each entry determination. Authorities of new entries are usually, but not always, the collectors of the determined specimens. For ease of use, termite taxa are listed in alphabetical order.

TERMITE SPECIES BY ISLAND	Reference or Authority
ANTIGUA	
Kalotermitidae	
Cryptotermes havilandi (Sjöstedt)	J. Darlington
Procryptotermes corniceps (Snyder)	J. Darlington
Incisitermes incisus (Silvestri)	Scheffrahn & Krecek
Rhinotermitidae	
Coptotermes havilandi Holmgren	J. Darlington
Heterotermes sp.	J. Darlington
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948
Nasutitermes acajutlae (Holmgren)	Thorne et al. 1994
BAHAMAS	
ANDROS	
Kalotermitidae	
Neotermes jouteli (Snyder)	Snyder 1956
Rhinotermitidae	
Heterotermes cardini (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Termitidae	
Nasutitermes rippertii (Rambur)	Snyder 1956
BIMINI	
Kalotermitidae	
Incisitermes snyderi (Light)	Snyder 1956
Termitidae	
Nasutitermes rippertii (Rambur)	Snyder 1956
Parvitermes brooksi (Snyder)	Snyder 1956
GRAND BAHAMA	
Rhinotermitidae	
Heterotermes sp.	Scheffrahn & Su
DRY KEY, ELEUTHERA, MANGROVE KEY	
Termitidae	
Nasutitermes rippertii (Rambur)	Snyder 1956
NEW PROVIDENCE (Nassau)	
Kalotermitidae	
Cryptotermes brevis (Walker)	Scheffrahn & Su
Cryptotermes cavifrons Banks	Snyder 1956
Incisitermes schwarzi (Banks)	Snyder 1956
Rhinotermitidae	
Heterotermes cardini (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Termitidae	
Nasutitermes rippertii (Rambur)	Snyder 1956
SAN SALVADOR (WATLING)	
Termitidae	
Nasutitermes nigriceps (Haldeman)	Snyder 1956
BARBADOS	
Kalotermitidae	
Cryptotermes brevis (Walker)	Adamson 1948
Cryptotermes havilandi (Sjöstedt)	Snyder 1956
Cryptotermes pyrodomus Bacchus	Bacchus 1987
Incisitermes incisus (Silvestri)	Snyder 1956
Neotermes castaneus (Burmeister)	Snyder 1956
Neotermes sp.	Adamson 1948
Rhinotermitidae	
Coptotermes havilandi Holmgren	Adamson 1948
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Adamson 1948
Rhinotermes marginalis (Linnaeus)	Adamson 1948
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948
BERMUDA	
Kalotermitidae	
Cryptotermes brevis (Walker)	Bacchus 1987
Cryptotermes cavifrons Banks	Snyder 1956
Incisitermes bequaerti (Snyder)	Snyder 1956
Incisitermes snyderi (Light)	Snyder 1956
Kalotermes approximatus Snyder	Snyder 1956

CAYMAN ISLANDS

CAYMAN BRAC

Kalotermitidae

Cryptotermes brevis (Walker)	M. Collins
Cryptotermes cavifrons Banks	M. Collins
Incisitermes sp.	M. Collins
Incisitermes tabogae (Snyder)	M. Collins
Procryptotermes corniceps (Snyder)	M. Collins

Termitidae

Microcerotermes arboreus Emerson	M. Collins

GRAND CAYMAN

Kalotermitidae

Cryptotermes brevis (Walker)	M. Collins
Cryptotermes cavifrons Banks	M. Collins
Cryptotermes n.sp.	A. Emerson
Incisitermes tabogae (Snyder)	A. Emerson
Neotermes castaneus (Burmeister)	M. Collins

Rhinotermitidae

Heterotermes sp.	M. Collins

Termitidae

Microcerotermes arboreus Emerson	A. Emerson
Nasutitermes costalis (Holmgren)	M. Collins
Nasutitermes nigriceps (Haldeman)	A. Emerson
Termes melindae Harris	M. Collins

LITTLE CAYMAN

Kalotermitidae

Cryptotermes cavifrons (Banks)	M. Collins
Incisitermes tabogae (Snyder)	M. Collins
Procryptotermes corniceps (Snyder)	M. Collins

Rhinotermitidae

Coptotermes havilandi (Sjöstedt)	M. Collins

Termitidae

Microcerotermes arboreus Emerson	M. Collins

CUBA

Kalotermitidae

Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes cavifrons Banks	Snyder 1956
Cryptotermes sp.nr. *hemicyclius* Bacchus	J. Krecek
Glyptotermes liberatus (Snyder)	Araujo 1977
Incisitermes sp.	J. Krecek
Incisitermes bequaerti (Snyder)	Snyder 1956

Incisitermes schwarzi (Banks)	Snyder 1956
Incisitermes snyderi (Light)	Snyder 1956
Neotermes castaneus (Burmeister)	Snyder 1956
Neotermes cubanus (Snyder)	Snyder 1956
Neotermes jouteli (Snyder)	Snyder 1956
Neotermes sp.nr. *mona* (Banks)	J. Krecek
Procryptotermes corniceps (Snyder)	J. Krecek

Rhinotermitidae

Coptotermes havilandi (Sjöstedt)	J. Krecek
Heterotermes cardini (Snyderi)	Snyder 1956
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Prorhinotermes simplex (Hagen)	Snyder 1956

Termitidae

Anoplotermes schwarzi Banks	Snyder 1956
Amitermes beaumonti Banks	J. Krecek
Constrictotermes? n.sp.	J. Krecek
Nasutitermes costalis (Holmgren)	Snyder 1956
Nasutitermes hubbardi Banks	Snyder 1956
Nasutitermes lividus (Burmeister)	Snyder 1956
Nasutitermes rippertii (Rambur)	Snyder 1956
Obtusitermes aequalis (Snyder)	Snyder 1956
Parvitermes brooksi (Snyder)	Snyder 1956
Parvitermes discolor (Banks)	Snyder 1956
Parvitermes subtilis Scheffrahn & Krecek	Scheffrahn & Krecek 1994
Termes hispaniolae Banks	Snyder 1956

CULEBRA (PUERTO RICO)

Termitidae

Parvitermes discolor (Banks)	Snyder 1956

CURACAO

Kalotermitidae

Cryptotermes brevis (Walker)	Snyder 1956

Termitidae

Nasutitermes nigriceps (Haldeman)	Snyder 1956

DOMINICA

Kalotermitidae	
Calcaritermes temnocephalus (Silvestri)	Scheffrahn & Krecek
Comatermes perfectus (Hagen)	Scheffrahn & Krecek
Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes n.sp.	Scheffrahn & Krecek
Glyptotermes sp. A	Scheffrahn & Krecek
Glyptotermes sp. B	M. Collins
Incisitermes incisus (Silvestri)	M. Collins
Incisitermes tabogae (Snyder)	M. Collins
Neotermes castaneus (Burmeister)	Snyder 1956
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Snyder 1956
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948
Nasutitermes ephratae (Holmgren)	M. Collins

GRENADA

Kalotermitidae	
Cryptotermes brevis (Walker)	Adamson 1948
Neotermes sp. A	Adamson 1948
Rhinotermitidae	
Coptotermes testaceus (Linnaeus)	Adamson 1948
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948
Termes hispaniolae (Banks)	J. Darlington

GUADELOUPE

BASSE-TERRE

Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Incisitermes incisus (Silvestri)	Darlington 1992
Neotermes sp.	Darlington 1992
Procryptotermes corniceps (Snyder)	Darlington 1992
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Adamson 1948
Rhinotermes marginalis (Linnaeus)	Darlington 1992
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948
Nasutitermes ephratae (Holmgren)	Snyder 1956
Termes hispaniolae (Banks)	J. Darlington

GRANDE TERRE

Kalotermitidae	
Cryptotermes n.sp.	Darlington 1992
Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes havilandi (Sjöstedt)	Darlington 1992
Incisitermes incisus (Sylvestri)	Darlington 1992
Incisitermes tabogae (Snyder)	Darlington 1992
Procryptotermes corniceps (Snyder)	Darlington 1992
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Adamson 1948
Termitidae	
Nasutitermes n.sp.	Darlington 1992
Nasutitermes costalis (Holmgren)	Adamson 1948
Nasutitermes ephratae (Holmgren)	Snyder 1956
Termes hispaniolae (Banks)	J. Darlington

HISPANIOLA

DOMINICAN REPUBLIC

Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes chasei Scheffrahn	Scheffrahn 1993
Cryptotermes cavifrons Banks	Scheffrahn & Su
Cryptotermes sp.nr. *hemicyclius* Bacchus	Scheffrahn & Su
Cryptotermes longicollis Banks	Scheffrahn & Su
Glyptotermes liberatus (Snyder)	Scheffrahn & Su
Incisitermes bequaerti (Snyder)	Scheffrahn & Su
Incisitermes milleri (Emerson)	Scheffrahn & Su
Incisitermes sp.nr. *snyderi* (Light)	Scheffrahn & Su
Incisitermes sp.nr. *schwarzi* (Banks)	Scheffrahn & Su
Neotermes castaneus (Burmeister)	Scheffrahn & Su
Neotermes jouteli (Banks)	Scheffrahn & Su
Neotermes mona (Banks)	Scheffrahn & Su
Procryptotermes corniceps (Snyder)	Scheffrahn & Su
Rhinotermitidae	
Heterotermes sp.	Scheffrahn & Su
Heterotermes cardini (Snyder)	Snyder 1956
Rhinotermes marginalis (Linnaeus)	Snyder 1956
Termitidae	
Anoplotermes sp. A	Scheffrahn & Su
Anoplotermes sp. B	Scheffrahn & Su
Anoplotermes meridianus Emerson	Snyder 1956

Nasutitermes costalis (Holmgren)	Snyder 1956
Nasutitermes hubbardi Banks	Scheffrahn & Su
Nasutitermes lividus (Burmeister)	Snyder 1956
Parvitermes? n.sp.	Scheffrahn & Roisin
Parvitermes discolor (Banks)	Scheffrahn & Su
Parvitermes flaveolus (Banks)	Scheffrahn & Su
Parvitermes pallidiceps (Banks)	Scheffrahn & Su
Parvitermes subtilis Scheffrahn & Krecek	Scheffrahn & Krecek 1994
Velocitermes? n.sp. A	Scheffrahn & Roisin
Velocitermes? n.sp. B	Scheffrahn & Roisin
Velocitermes antillarum (Holmgren)	Snyder 1956
Terrenitermes toussainti (Banks)	Snyder 1956, Spaeth 1967
Termes hispaniolae (Banks)	Scheffrahn & Su

HAITI

Kalotermitidae

Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes cavifrons Banks	Snyder 1956
Cryptotermes longicollis Banks	Scheffrahn & Su
Glyptotermes liberatus (Snyder)	Snyder 1956
Neotermes castaneus (Burmeister)	Snyder 1956

Rhinotermitidae

Heterotermes cardini (Snyder)	Snyder 1956
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Rhinotermes marginalis (Linnaeus)	Snyder 1956

Termitidae

Anoplotermes spp.	Snyder 1956
Anoplotermes meridianus Emerson	Snyder 1956
Microcerotermes arboreus Emerson	Snyder 1956
Nasutitermes costalis (Holmgren)	Snyder 1956
Nasutitermes lividus (Burmeister)	Snyder 1956
Parvitermes flaveolus (Banks)	Snyder 1956
Parvitermes pallidiceps (Banks)	Snyder 1956
Termes hispaniolae (Banks)	Snyder 1956
Terrenitermes toussainti (Banks)	Snyder 1956, Spaeth 1967
Velocitermes antillarum (Holmgren)	Snyder 1956

ISLA DE LA JUVENTUD (= I. DE PINOS, CUBA)

Kalotermitidae

Cryptotermes cavifrons Banks	J. Krecek
Neotermes castaneus (Burmeister)	J. Krecek

Neotermes jouteli (Snyder)	J. Krecek

Rhinotermitidae

Coptotermes havilandi (Sjöstedt)	J. Krecek

Termitidae

Anoplotermes schwarzi Banks	J. Krecek
Nasutitermes costalis (Holmgren)	J. Krecek
Nasutitermes hubbardi Banks	J. Krecek
Nasutitermes rippertii (Rambur)	J. Krecek
Parvitermes brooksi (Snyder)	J. Krecek
Termes hispaniolae (Banks)	Snyder 1956

JAMAICA

Kalotermitidae

Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes cavifrons Banks	Bacchus 1987
Cryptotermes hemicyclius Bacchus	Bacchus 1987
Glyptotermes liberatus (Snyder)	Snyder 1956
Incisitermes milleri (Emerson)	Snyder 1956
Incisitermes schwarzi (Banks)	Snyder 1956
Neotermes n.sp.	Snyder 1956
Neotermes castaneus (Burmeister)	Snyder 1956
Procryptotermes corniceps	Krishna 1962b

Rhinotermitidae

Coptotermes havilandi Holmgren	Snyder 1956
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Prorhinotermes simplex (Hagen)	Snyder 1956

Termitidae

Nasutitermes costalis (Holmgren)	Snyder 1956
Nasutitermes hubbardi Banks	Snyder 1956
Nasutitermes nigriceps (Haldeman)	Snyder 1956
Nasutitermes rippertii (Rambur)	Snyder 1956
Termes sp.	J. Darlington
Termes hispaniolae (Banks)	Snyder 1956

MARTINIQUE

Kalotermitidae

Calcaritermes temnocephalus (Silvestri)	Scheffrahn & Krecek
Comatermes perfectus (Hagen)	Scheffrahn & Krecek
Glyptotermes sp. B	Scheffrahn & Krecek
Incisitermes tabogae (Snyder)	Scheffrahn & Krecek

Neotermes sp. A	Scheffrahn & Krecek
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Adamson 1948
Rhinotermes marginalis (Linnaeus)	Snyder 1956
Termitidae	
Anoplotermes meridianus Emerson	Snyder 1956
Nasutitermes costalis (Holmgren)	Adamson 1948
Termes hispaniolae (Banks)	Scheffrahn & Krecek

MONA (PUERTO RICO)

Kalotermitidae	
Incisitermes bequaerti (Snyder)	Scheffrahn & Krecek
Incisitermes incisus (Silvestri)	Snyder 1956
Incisitermes snyderi (Light)	Snyder 1956
Neotermes mona (Banks)	Snyder 1956
Procryptotermes corniceps (Snyder)	Snyder 1956

MONTSERRAT

Kalotermitidae	
Comatermes perfectus (Hagen)	Scheffrahn & Krecek
Cryptotermes brevis (Walker)	J. Darlington
Cryptotermes longicollis Banks	J. Darlington
Cryptotermes n.sp.	J. Darlington
Glyptotermes sp.	J. Darlington
Incisitermes incisus (Silvestri)	Scheffrahn & Krecek
Incisitermes sp.nr. *snyderi* (Light)	Scheffrahn & Krecek
Neotermes castaneus (Burmeister)	Snyder 1956
Procryptotermes corniceps (Snyder)	J. Darlington
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Snyder 1956
Coptotermes havilandi Holmgren	J. Darlington
Termitidae	
Nasutitermes acajutlae (Holmgren)	Thorne *et al.* 1994
Nasutitermes costalis (Holmgren)	J. Darlington
Nasutitermes ephratae (Holmgren)	Snyder 1956
Termes hispaniolae (Banks)	J. Darlington

PUERTO RICO

Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes cavifrons Banks	Snyder 1956

Cryptotermes longicollis Banks	Scheffrahn & Su
Glyptotermes liberatus (Snyder)	Scheffrahn & Su
Glyptotermes pubescens Snyder	Snyder 1956
Incisitermes bequaerti (Snyder)	Scheffrahn & Su
Incisitermes furvus Scheffrahn	Scheffrahn 1994
Incisitermes incisus (Silvestri)	Araujo 1977
Incisitermes schwarzi (Banks)	Araujo 1977
Incisitermes snyderi (Light)	Snyder 1956
Neotermes castaneus (Burmeister)	Snyder 1956
Neotermes mona (Banks)	Scheffrahn & Su
Procryptotermes corniceps (Snyder)	Snyder 1956
Rhinotermitidae	
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Snyder 1956
Prorhinotermes simplex (Hagen)	Snyder 1956
Termitidae	
Anoplotermes meridianus Emerson	Snyder 1956
Microcerotermes arboreus Emerson	Snyder 1956
Nasutitermes costalis (Holmgren)	Snyder 1956
Nasutitermes acajutlae (Holmgren)	Thorne *et al.* 1994
Parvitermes discolor (Banks)	Snyder 1956
Parvitermes wolcotti (Snyder)	Snyder 1956

ST. KITTS

Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948

ST. LUCIA

Kalotermitidae	
Calcaritermes temnocephalus (Silvestri)	Krishna 1962a
Comatermes perfectus (Hagen)	Araujo 1977
Cryptotermes brevis (Walker)	Adamson 1948
Neotermes sp.	Adamson 1948
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948

ST. VINCENT

Kalotermitidae	
Calcaritermes temnocephalus (Silvestri)	Krishna 1962a

Cryptotermes brevis (Walker)	Adamson 1948
Glyptotermes tuberifer Krishna & Emerson	Krishna & Emerson 1962
Neotermes sp.	Adamson 1948
Rhinotermitidae	
Heterotermes tenuis (Hagen)	Adamson 1948
Termitidae	
Nasutitermes costalis (Holmgren)	Adamson 1948

TOBAGO

Kalotermitidae	
Cryptotermes brevis (Walker)	Adamson 1940
Cryptotermes dudleyi Banks	J. Darlington
Glyptotermesadamsoni Krishna & Emerson	Krishna & Emerson 1962
Neotermes holmgreni Banks	Adamson 1940
Neotermes jouteli (Banks)	Araujo 1977
Rhinotermitidae	
Coptotermes testaceus (Linnaeus)	Adamson 1940
Heterotermes tenuis (Hagen)	Adamson 1940
Termitidae	
Armitermes holmgreni Snyder	J. Darlington
Microcerotermes arboreus Emerson	Adamson 1940
Nasutitermes sp.	J. Darlington
Nasutitermes costalis (Holmgren)	Adamson 1940
Nasutitermes ephratae (Holmgren)	Adamson 1940
Nasutitermes gaigei Emerson	J. Darlington
Nasutitermes guayanae (Holmgren)	J. Darlington
Subulitermes sp.	J. Darlington
Termes hispaniolae (Banks)	Adamson 1940

TRINIDAD

Kalotermitidae	
Calcaritermes nigriceps (Emerson)	Adamson 1937
Calcaritermes temnocephalus (Silvestri)	Krishna 1962a
Comatermes perfectus (Hagen)	Krishna 1961
Cryptotermes brevis (Walker)	Adamson 1940
Cryptotermes domesticus (Haviland)	Araujo 1977
Cryptotermes dudleyi Banks	Adamson 1940
Cryptotermes havilandi (Sjöstedt)	Bacchus 1987
Cryptotermes longicollis Banks	J. Darlington

Cryptotermes rhicnocephalus Bacchus	Bacchus 1987
Glyptotermes adamsoni Krishna & Emerson	Krishna & Emerson 1962
Glyptotermes parvoculatus Krishna & Emerson	Krishna & Emerson 1962
Incisitermes sp.	J. Darlington
Neotermes sp.	Adamson 1940
Neotermes castaneus (Burmeister)	Snyder 1956
Neotermes holmgreni Banks	Snyder 1956
Neotermes jouteli (Banks)	Araujo 1977
Rugitermes n.sp.	Adamson 1940
Rhinotermitidae	
Coptotermes testaceus (Linnaeus)	Adamson 1937
Dolichorhinotermes longilabius (Emerson)	Adamson 1937
Heterotermes tenuis (Hagen)	Adamson 1937
Termitidae	
Angularitermes nasutissimus (Emerson)	Adamson 1940
Anoplotermes banksi Emerson	Adamson 1940
Anoplotermes brevipilus Emerson	Adamson 1937
Anoplotermes spp.	Snyder 1956
Araujotermes parvellus (Silvestri)	Adamson 1937, Fontes 1982
Armitermes holmgreni Snyder	Adamson 1937
Atlantitermes snyderi (Emerson)	Adamson 1937, Fontes 1982
Cavitermes tuberosus (Emerson)	Adamson 1940
Convexitermes manni (Emerson)	Fontes 1983
Crepititermes verruculosus (Emerson)	Adamson 1937
Labiotermes labralis (Holmgren)	Adamson 1937
Microcerotermes arboreus Emerson	Adamson 1937
Microcerotermes exiguus (Hagen)	Snyder 1956
Nasutitermes sp. A	J. Darlington
Nasutitermes sp. B	J. Darlington
Nasutitermes costalis (Holmgren)	Adamson 1937
Nasutitermes ephratae (Holmgren)	Adamson 1937
Nasutitermes gaigei Emerson	J. Darlington
Nasutitermes guayanae (Holmgren)	Adamson 1940
Nasutitermes intermedius Banks	Adamson 1937
Nasutitermes acajutlae (Holmgren)	Thorne *et al.* 1994
Neocapritermes angusticeps (Emerson)	Adamson 1937

Ruptitermes silvestrii (Emerson)	Adamson 1940, Mathews 1977
Subulitermes spp.	Adamson 1940
Subulitermes baileyi (Emerson)	Adamson 1940
Termes fatalis Linnaeus	J. Darlington
Termes hispaniolae (Banks)	Adamson 1937
Termes panamaensis (Snyder)	Snyder 1956
TURKS & CAICOS ISLANDS	
GRAND TURK	
Kalotermitidae	
Cryptotermes brevis (Walker)	Scheffrahn *et al.* 1990
Incisitermes bequaerti (Snyder)	Scheffrahn *et al.* 1990
Incisitermes snyderi (Light)	Scheffrahn *et al.* 1990
Neotermes mona (Banks)	Scheffrahn *et al.* 1990
Procryptotermes corniceps (Snyder)	Scheffrahn *et al.* 1990
Rhinotermitidae	
Coptotermes havilandi Holmgren	Scheffrahn *et al.* 1990
Heterotermes tenuis (Hagen)	Scheffrahn *et al.* 1990
PARROT CAY	
Kalotermitidae	
Incisitermes snyderi (Light)	Scheffrahn & Su
Neotermes mona (Banks)	Scheffrahn & Su
Procryptotermes corniceps (Snyder)	Scheffrahn & Su
PROVIDENCIALES	
Kalotermitidae	
Cryptotermes brevis (Walker)	Scheffrahn *et al.* 1990
Incisitermes bequaerti (Snyder)	Scheffrahn *et al.* 1990
Incisitermes sp.nr. *milleri* (Emerson)	Scheffrahn *et al.* 1990
Neotermes mona (Banks)	Scheffrahn *et al.* 1990
Neotermes castaneus (Burmeister)	Scheffrahn *et al.* 1990
Neotermes jouteli (Banks)	Scheffrahn *et al.* 1990
Procryptotermes corniceps (Snyder)	Scheffrahn *et al.* 1990
Rhinotermitidae	
Coptotermes havilandi Holmgren	Scheffrahn *et al.* 1990
Heterotermes tenuis (Hagen)	Scheffrahn *et al.* 1990
Termitidae	
Nasutitermes costalis (Holmgren)	Scheffrahn *et al.* 1990
Nasutitermes nigriceps (Haldeman)	Scheffrahn *et al.* 1990
SOUTH CAICOS	
Kalotermitidae	
Incisitermes snyderi (Light)	Scheffrahn & Su
Termitidae	

Nasutitermes costalis (Holmgren)	Scheffrahn & Su
VIEQUES (PUERTO RICO)	
Termitidae	
Nasutitermes acajutlae (Holmgren)	Thorne *et al.* 1994
VIRGIN ISLANDS (BRITISH)	
All inhabited islands	
Kalotermitidae	
Cryptotermes brevis (Walker)	Collins *et al.* 1994
ANEGADA	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
BEEF	
Kalotermitidae	
Incisitermes incisus (Silvestri)	Collins *et al.* 1994
Incisitermes snyderi (Light)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
COOPER, GEORGE DOG, GINGER, GREAT TOBAGO, GREATER JOST VAN DYKE, LITTLE TOBAGO	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
EUSTATIA	
Kalotermitidae	
Incisitermes incisus (Silvestri)	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
Parvitermes wolcotti (Snyder)	Collins *et al.* 1994
GREAT CAMANOE	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
Parvitermes wolcotti (Snyder)	Collins *et al.* 1994
GREAT THATCH, NECKER	
Kalotermitidae	

Incisitermes snyderi (Light)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
GUANA	
Kalotermitidae	
Incisitermes incisus (Silvestri)	Collins *et al.* 1994
Incisitermes snyderi (Light)	Collins *et al.* 1994
Neotermes mona (Banks)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
Nasutitermes costalis (Holmgren)	Collins *et al.* 1994
Parvitermes wolcotti (Snyder)	Collins *et al.* 1994
LESSER JOST VAN DYKE	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
PETER	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
SCRUB	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994
Procryptotermes corniceps (Snyder)	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
TORTOLA	
Kalotermitidae	
Incisitermes snyderi (Light)	Collins *et al.* 1994

Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
Nasutitermes costalis (Holmgren)	Collins *et al.* 1994
VIRGIN GORDA	
Kalotermitidae	
Incisitermes incisus (Silvestri)	Collins *et al.* 1994
Incisitermes snyderi (Light)	Collins *et al.* 1994
Rhinotermitidae	
Heterotermes sp.	Collins *et al.* 1994
Termitidae	
Nasutitermes acajutlae (Haldeman)	Collins *et al.* 1994
Parvitermes wolcotti (Snyder)	Collins *et al.* 1994

VIRGIN ISLANDS (U.S.)

ST. CROIX	
Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Cryptotermes cavifrons Banks	Snyder 1956
Incisitermes bequaerti (Snyder)	Snyder 1956
Incisitermes snyderi (Light)	Snyder 1956
Rhinotermitidae	
Heterotermes convexinotatus (Snyder)	Snyder 1956
Termitidae	
Nasutitermes acajutlae (Holmgren)	Adamson 1948
Nasutitermes costalis (Holmgren)	Araujo 1977
Nasutitermes ephratae (Holmgren)	Snyder 1956
Termes panamaensis (Snyder)	Snyder 1956
ST. JOHN	
Termitidae	
Nasutitermes acajutlae (Holmgren)	Thorne *et al.* 1994
ST. THOMAS	
Kalotermitidae	
Cryptotermes brevis (Walker)	Snyder 1956
Glyptotermes liberatus (Snyder)	Snyder 1956
Incisitermes bequaerti (Snyder)	Snyder 1956
Rhinotermitidae	
Heterotermes convexinotatus (Snyder)	Snyder 1956
Heterotermes tenuis (Hagen)	Adamson 1948
Termitidae	
Nasutitermes acajutlae (Holmgren)	Adamson 1948

ISLAND LOCALITES BY TERMITE SPECIES

KALOTERMITIDAE

Calcaritermes nigriceps (Emerson): Trinidad.
Calcaritermes temnocephalus (Silvestri): Dominica, Martinique, St. Lucia, St. Vincent, Trinidad.
Comatermes perfectus (Hagen): Dominica, Martinique, Montserrat, St. Lucia, Trinidad.
Cryptotermes brevis (Walker): Bahamas (New Providence), Barbados, Bermuda, Cayman Is. (Grand Cayman, Cayman Brac), Cuba, Curacao, Dominica, Grenada, Guadeloupe (Basse-Terre, Grande Terre), Hispaniola (Dominican Republic, Haiti), Jamaica, Montserrat, Puerto Rico, St. Kitts, St. Lucia, St. Vincent, Tobago, Trinidad, Turks & Caicos Is. (Grand Turk, Providenciales), Virgin Is. (British: all inhabited; U.S.: St. Croix, St. Thomas).
Cryptotermes cavifrons Banks: Bahamas (New Providence), Bermuda, Cayman Is. (Grand Cayman, Cayman Brac), Cuba, Hispaniola (Dominican Republic, Haiti), Isla de la Juventud, Jamaica, Puerto Rico, Virgin Is. (U.S.: St. Croix).
Cryptotermes chasei Scheffrahn: Hispaniola (Dominican Republic).
Cryptotermes domesticus (Haviland): Trinidad.
Cryptotermes dudleyi Banks: Tobago, Trinidad.
Cryptotermes havilandi (Sjöstedt): Antigua, Barbados, Guadeloupe (Grande Terre), Trinidad.
Cryptotermes sp. nr. *hemicyclius* Bacchus: Cuba, Hispaniola (Dominican Republic).
Cryptotermes hemicyclius Bacchus: Jamaica.
Cryptotermes longicollis Banks: Hispaniola (Dominican Republic, Haiti), Montserrat, Puerto Rico, Trinidad.
Cryptotermes n.sp.: Cayman Is. (Grand Cayman), Dominica, Guadeloupe (Grande Terre), Montserrat.
Cryptotermes pyrodomus Bacchus: Barbados.
Cryptotermes rhicnocephalus Bacchus: Trinidad.
Cryptotermes sp.: Cayman Is. (Little Cayman).
Glyptotermes adamsoni Krishna & Emerson: Tobago, Trinidad.
Glyptotermes liberatus (Snyder): Cuba, Hispaniola (Dominican Republic, Haiti), Jamaica, Puerto Rico, Virgin Is. (U.S.: St. Thomas).
Glyptotermes parvoculatus Krishna & Emerson: Trinidad.
Glyptotermes pubescens Snyder: Puerto Rico.
Glyptotermes sp.: Montserrat.
Glyptotermes sp. A: Dominica.
Glyptotermes sp. B: Dominica, Martinique.

Glyptotermes tuberifer Krishna & Emerson: St. Vincent.
Incisitermes bequaerti (Snyder): Bermuda, Cuba, Hispaniola (Dominican Republic), Mona, Puerto Rico, Turks & Caicos (Grand Turk, Providenciales), Virgin Is. (U.S.: St. Croix, St. Thomas).
Incisitermes furvus Scheffrahn: Puerto Rico.
Incisitermes incisus (Silvestri): Barbados, Dominica, Guadeloupe (Basse-Terre, Grande Terre), Mona, Montserrat, Puerto Rico, Virgin Is. (British: Beef, Eustatia, Guana, Virgin Gorda).
Incisitermes sp. nr. *milleri* (Emerson): Turks & Caicos (Providenciales).
Incisitermes milleri (Emerson): Hispaniola (Dominican Republic), Jamaica.
Incisitermes sp. nr. *schwarzi* (Banks): Hispaniola (Dominican Republic).
Incisitermes schwarzi (Banks): Bahamas (New Providence), Cuba, Jamaica, Puerto Rico.
Incisitermes sp. nr. *snyderi* (Light): Hispaniola (Dominican Republic), Montserrat.
Incisitermes snyderi (Light): Bahamas (Bimini), Bermuda, Cuba, Mona, Turks & Caicos Is. (Grand Turk, Parrot Cay, South Caicos), Virgin Is. (British: all but Eustatia, U.S.: St. Croix).
Incisitermes sp.: Cayman Is. (Cayman Brac), Cuba, Trinidad.
Incisitermes tabogae (Snyder): Cayman Is. (Grand Cayman, Cayman Brac), Dominica, Guadeloupe (Grande Terre), Martinique.
Kalotermes approximatus Snyder: Bermuda.
Neotermes castaneus (Burmeister): Barbados, Cayman Is. (Grand Cayman), Cuba, Dominica, Hispaniola (Dominican Republic, Haiti), Isla de la Juventud, Jamaica, Montserrat, Puerto Rico, Trinidad, Turks & Caicos Is. (Providenciales).
Neotermes cubanus (Snyder): Cuba.
Neotermes holmgreni Banks: Tobago, Trinidad.
Neotermes jouteli (Snyder): Bahamas (Andros), Cuba, Hispaniola (Dominican Republic), Isla de la Juventud, Tobago, Trinidad, Turks & Caicos Is. (Providenciales).
Neotermes sp. nr. *mona* (Banks): Cuba.
Neotermes mona (Banks): Hispaniola (Dominican Republic), Mona, Puerto Rico, Turks & Caicos Is. (Grand Turk, Parrot Cay, Providenciales), Virgin Is. (British: Guana).
Neotermes n.sp.: Jamaica.
Neotermes sp.: Barbados, Guadeloupe (Basse-Terre), St. Lucia, St. Vincent, Trinidad.
Neotermes sp. A: Grenada, Martinique.
Procryptotermes corniceps (Snyder): Antigua, Cayman Is. (Cayman

Brac, Little Caymen), Cuba, Guadeloupe (Basse-Terre, Grande Terre), Hispaniola (Dominican Republic), Jamaica, Mona, Montserrat, Puerto Rico, Turks & Caicos Is. (Grand Turk, Parrot Cay, Providenciales), Virgin Is. (British: Anegada, Great Camanoe, Great Thatch, Guana, Necker, Peter, Scrub).

Rugitermes n.sp.: Trinidad.

RHINOTERMITIDAE

Coptotermitinae

Coptotermes havilandi Holmgren: Antigua, Barbados, Cayman Is. (Little Cayman), Cuba, Isla de la Juventud, Jamaica, Montserrat, Turks & Caicos Is. (Grand Turk, Providenciales).

Coptotermes testaceus (Linnaeus): Grenada, Tobago, Trinidad.

Heterotermitinae

Heterotermes cardini (Snyder): Bahamas (Andros, NewProvidence), Cuba, Hispaniola (Dominican Republic, Haiti).

Heterotermes convexinotatus (Snyder): Barbados, Cuba, Hispaniola (Haiti), Jamaica, Puerto Rico, Virgin Is. (U.S.: St. Croix, St. Thomas).

Heterotermes sp.: Antigua, Bahamas (Grand Bahama), Cayman Is. (Grand Cayman), Hispaniola (Dominican Republic), Virgin Is. (British: Beef, Greater Thatch, Guana, Lesser Jost Van Dyke, Necker, Peter, Tortola, Virgin Gorda).

Heterotermes tenuis (Hagen): Bahamas (Andros, New Providence), Barbados, Cuba, Dominica, Guadeloupe (Basse-Terre, Grande Terre), Hispaniola (Haiti), Jamaica, Martinique, Montserrat, Puerto Rico, St. Vincent, Tobago, Trinidad, Turks & Caicos Is. (Grand Turk, Providenciales), Virgin Is. (U.S.: St. Thomas).

Prorhinotermitinae

Prorhinotermes simplex (Hagen): Cuba, Jamaica, Puerto Rico.

Rhinotermitinae

Dolichorhinotermes longilabius (Emerson): Trinidad.

Rhinotermes marginalis (Linnaeus): Barbados, Guadeloupe (Basse-Terre), Hispaniola (Dominican Republic, Haiti), Martinique.

TERMITIDAE

Apicotermitinae

Anoplotermes banksi Emerson: Trinidad.

Anoplotermes brevipilus Emerson: Trinidad.

Anoplotermes meridianus Emerson: Hispaniola (Dominican Republic, Haiti), Martinique, Puerto Rico.

Anoplotermes schwarzi Banks: Cuba, Isla de la Juventud.

Anoplotermes spp.: Hispaniola (Haiti), Trinidad.

Anoplotermes sp. A: Hispaniola (Dominican Republic).

Anoplotermes sp. B: Hispaniola (Dominican Republic).

Ruptitermes silvestrii (Emerson): Trinidad.

Nasutitermitinae

Angularitermes nasutissimus (Emerson): Trinidad.

Araujotermes parvellus (Silvestri): Trinidad.

Armitermes holmgreni Snyder: Tobago, Trinidad.

Atlantitermes snyderi (Emerson): Trinidad.

Convexitermes manni (Emerson): Trinidad.

Constrictotermes? n.sp.: Cuba.

Labiotermes labralis (Holmgren): Trinidad.

Nasutitermes acajutlae (Holmgren): Antigua, Montserrat, Puerto Rico, Trinidad, Vieques, Virgin Is. (British: all; U.S.: St. Croix, St. John, St. Thomas).

Nasutitermes costalis (Holmgren): Antigua, Barbados, Cayman Is. (Grand Cayman), Cuba, Dominica, Greneda, Guadeloupe (Basse-Terre, Grande Terre), Hispaniola (Dominican Republic, Haiti), Isla de la Juventud, Jamaica, Martinique, Montserrat, Puerto Rico, St. Kitts, St. Lucia, St. Vincent, Tobago, Trinidad, Turks & Caicos Is. (Providenciales, South Caicos), Virgin Is. (British: Guana, Tortola; U.S.: St. Croix).

Nasutitermes ephratae (Holmgren): Dominica, Guadeloupe (Basse-Terre, Grande Terre), Montserrat, Tobago, Trinidad, Virgin Is. (U.S.: St. Croix).

Nasutitermes gaigei Emerson: Tobago, Trinidad.

Nasutitermes guayanae (Holmgren): Tobago, Trinidad.

Nasutitermes hubbardi Banks: Cuba, Hispaniola (Dominican Republic), Isla de la Juventud, Jamaica.

Nasutitermes intermedius Banks: Trinidad.

Nasutitermes lividus (Burmeister): Cuba, Hispaniola (Dominican Republic, Haiti).

Nasutitermes n.sp.: Guadeloupe (Grande Terre).

Nasutitermes nigriceps (Haldeman): Bahamas (San Salvador), Cayman Is. (Grand Cayman), Curacao, Jamaica, Turks & Caicos Is. (Providenciales).

Nasutitermes rippertii (Rambur): Bahamas (Andros, Bimini, DryKey, Eleuthera, Mangrove Key, New Providence), Cuba, Isla de la Juventud, Jamaica.

Nasutitermes sp.: Tobago.

Nasutitermes sp. A: Trinidad.

Nasutitermes sp. B: Trinidad.

Obtusitermes aequalis (Snyder): Cuba.
Parvitermes brooksi (Snyder): Bahamas (Bimini), Cuba.
Parvitermes discolor (Banks): Cuba, Culebra, Hispaniola (Dominican Republic), Puerto Rico.
Parvitermes flaveolus (Banks): Hispaniola (Dominican Republic, Haiti).
Parvitermes? n.sp.: Hispaniola (Dominican Republic).
Parvitermes pallidiceps (Banks): Hispaniola (Dominican Republic, Haiti).
Parvitermes subtilis Scheffrahn & Krecek: Cuba, Hispaniola (Dominican Republic).
Parvitermes wolcotti (Snyder): Puerto Rico, Virgin Is. (British: Great Camanoe, Guana, Eustatia, Virgin Gorda).
Subulitermes baileyi (Emerson): Trinidad.
Subulitermes sp.: Tobago.
Subulitermes spp.: Trinidad.
Terrenitermes toussainti (Banks): Hispaniola (Dominican Republic, Haiti).
Velocitermes antillarum (Holmgren): Hispaniola (Dominican Republic, Haiti).
Velocitermes? n.sp. A: Hispaniola (Dominican Republic).
Velocitermes? n.sp. B: Hispaniola (Dominican Republic).

Termitinae

Amitermes beaumonti Banks: Cuba.
Cavitermes tuberosus (Emerson): Trinidad.
Crepititermes verruculosus (Emerson): Trinidad.
Microcerotermes arboreus Emerson: Cayman Is. (Cayman Brac, Grand Cayman, Little Cayman), Hispaniola (Haiti), Puerto Rico, Tobago, Trinidad.
Microcerotermes exiguus (Hagen): Trinidad.
Neocapritermes angusticeps (Emerson): Trinidad.
Termes fatalis Linnaeus: Trinidad.
Termes hispaniolae Banks: Cuba, Greneda, Guadeloupe (Basse-Terre, Grande Terre), Hispaniola (Dominican Republic, Haiti), Isla de la Juventud, Jamaica, Martinique, Montserrat, Tobago, Trinidad.
Termes melindae Harris: Cayman Is. (Grand Cayman).
Termes panamaensis (Snyder): Trinidad, Virgin Is. (U.S.: St. Croix).
Termes sp.: Jamaica.

RESULTS AND DISCUSSION

The taxonomic problems common to New World termite classification (Collins 1988) are well exemplified by the West Indian fauna. Many descriptions of West Indian species dating from the 1920s and earlier are based on small samples and are lacking of the diagnostic details, measurements, and illustrations needed for identification. Unfortunately, some types have been misplaced, lost, or damaged by age and/or mishandling so that identification by comparison with types may not be possible. Identification may, regrettably, rely on inadequate descriptions and comparison with non-type specimens. The identification key provided in Snyder's 1956 inventory is rather brief and contains numerous species omissions and errors. A further restraint to positive identification is that many West Indian species are described only from one (usually the soldier) caste.

Heterotermes and *Incisitermes* are problematic genera with regard to species determinations. Descriptions of winged imagos of West Indian *Heterotermes* spp. are based, for the most part, on location of the median vein, number of wing hairs, and shape of notal margins (Snyder 1924). Soldiers are separated by their relative abundance of head capsule hair. Snyder (1924) suggested the existence of "a single extremely variable species" or, alternatively, "a complex series of very closely related species, there being two extremes *tenuis* Hagen and *convexinotatus* Snyder with intergrading connecting species which display characters of either extreme" (Snyder 1924). Recent collections of *Heterotermes* from Cuba, the Dominican Republic, and Puerto Rico support the hypothesis of a single variable species, however, an extensive taxonomic investigation of *Heterotermes* has yet to be conducted. Some *Incisitermes* spp. also show either substantial regional variability or subtle species differences. Collins (1988) also points out difficulties with identification of *Incisitermes* soldiers due to character variability and polymorphism.

Since Snyder's (1956) list, several studies have revised the nomenclature of some West Indian species. Krishna (1961) reassigned numerous kalotermitid species to 3 genera: *Comatermes*, *Incisitermes*, and *Neotermes*. *Glyptotermes posticus* (Hagen) is now informally considered a synonym of *G. liberatus* (Araujo, 1977; Darlington, Scheffrahn, and Krecek unpubl.), however, the type of *G. posticus* has been lost and no paratypes have been located thus far. Among termitids, *Velocitermes toussainti* was placed in its own monotypic genus, *Terrenitermes* (Spaeth 1967). Mathews (1977) moved *Speculitermes silvestrii* to his new genus *Ruptitermes*. *Subulitermes snyderi* was assigned to

Atlantitermes (Fontes 1979) and *S. parvellus* was assigned to *Araujotermes* (Fontes 1982). Additional generic reassignments are being considered for existing and new species of West Indian *Parvitermes* and *Velocitermes* (Scheffrahn & Roisin, unpubl.).

Structure-infesting termites from all 3 families are well represented in the West Indies. Among the Kalotermitidae, *Cryptotermes brevis* is the most widespread. *C. brevis* probably occurs on all human-inhabited islands and is found almost exclusively in sound, dry structural lumber. The exotic species *Cryptotermes domesticus*, *C. dudleyi* and *C. havilandi* are also structural pests on the islands on which they occur (Gay 1967). *Incistermes* is another widespread genus of drywood termites in the region. Structural infestations of *Incisitermes* spp. are likely to occur in the West Indies but are poorly documented. The Rhinotermitidae are represented by two economically important genera, *Heterotermes* and *Coptotermes*. *Heterotermes* spp. are the most common and widespread subterranean termite pests of structural lumber throughout the West Indies where they occupy a similar niche to mainland Nearctic *Reticulitermes* spp. *Heterotermes* spp. may also attack the roots of some living plants including sugar cane. *Coptotermes havilandi* is now widely established throughout the region, especially in coastal cities. Among nest-building Termitidae, *Nasutitermes acajutlae*, *N. costalis*, *N. nigriceps*, and *N. rippertii* are the most likely to attack structural lumber. Information on other genera which may be responsible for structural damage or agricultural losses is scarce (Harris 1971), lacking, or doubtful.

Various surveys and taxonomic studies of the termites of the West Indies are planned or in progress including detailed geographic surveys of the Dominican Republic (Scheffrahn and others), Puerto Rico (Jones & Scheffrahn), Cuba (Krecek), and the Lesser Antilles including Montserrat, Dominica, and Martinique (Scheffrahn, Krecek, Darlington, Collins, Su, and others). It is expected that these efforts will provide a more clear understanding of the origins and dispersal of termites of the West Indies and neighboring regions.

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CRYPTOTERMES ABRUPTUS, A NEW DRYWOOD TERMITE (ISOPTERA: KALOTERMITIDAE) FROM SOUTHEASTERN MEXICO

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ABSTRACT

Cryptotermes abruptus n. sp. is described from soldiers and alates collected on Isla de Cozumel, Mexico, and vicinity. It is the fifteenth neotropical *Cryptotermes* species to be described. The overhanging frons in the soldier caste of this species is unique among all termites worldwide.

Key Words: taxonomy, new species, Neotropics, Yucatan peninsula, Quintana Roo

RESUMEN

Cryptotermes abruptus n. sp. es descrito basado en soldados y alados recolectados en México en la Isla Cozumel y los alrededores. Hasta donde se conoce, ésta es la decimoquinta especie neotropical de *Cryptotermes* descrita. El gran desarrollo de la frente en la casta de los soldados es único entre las termitas a nivel mundial.

The tropicopolitan genus *Cryptotermes* Banks consists of nearly 50 living species (Bacchus 1987, Gay & Watson 1982, Scheffrahn 1993) of which fourteen are known from the Neotropical Region. Two neotropical species, *C. brevis* (Walker) and *C. cavifrons* Banks, have ranges that also include the southern Nearctic Region. Only three *Cryptotermes* species are known from Mexico, including *C. brevis*, an introduced pest with an obscure New World origin, and the native species, *C. fatulus* (Light) and *C. longicollis* Banks (Araujo 1977).

On a recent expedition to Isla de Cozumel, one of us (J. A. C.) took samples from three colonies of a most unusual new *Cryptotermes*. A reexamination of older material collected from Mexico by J. K. yielded a fourth sample of this species from the nearby Yucatan coast. Herein is provided a description of the imago and soldier of *C. abruptus* n. sp.

MATERIALS AND METHODS

Morphometrics of specimens preserved in 85:15 ethanol:water were made with a stereomicroscope fitted with a calibrated ocular micrometer. Measurements and nomenclature were adopted mainly from those of Krishna (1961), Gay & Watson (1982), and Bacchus (1987). Structures useful in describing the phragmotic head capsule of *Cryptotermes* soldiers include the frontal flange or ridge dividing the vertex and frons;

and two pairs of protuberances, one dorsal pair in front of the antennal fossae and one ventral pair projecting forward from the genae called the frontal and genal horns, respectively (Krishna 1961, Gay & Watson 1982). The frontal flange of *Cryptotermes abruptus* n. sp. is modified with a projection that we term the frontal peak.

Prints of scanning electron micrographs were scanned at 600 dpi, the digital image outline traced using photograph-enhancing software (Photo Magic, Micrographx Inc., Richardson, Texas), and the background converted to black. Emission of wing membrane iridescence was induced by overlapping folded wings of fresh (ca. 2 month-old) alates and viewing in 85% ethanol over a black background under reflected light.

The holotype soldier and morphotype imago are deposited in the collection of American Museum of Natural History, New York. Paratype soldiers and alates are deposited in the National Museum of Natural History (Smithsonian), Washington, D.C.; the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Division of Plant Industries, Gainesville; and in the first author's collection at the University of Florida Research and Education Center, Ft. Lauderdale.

Cryptotermes abruptus Scheffrahn and Křeček, **new species**

Imago (Table 1)

General color pale yellow to pale orange-yellow except as noted. Darkest pigmentation in forewing scales which form a median chevron pattern. Pale V-shaped area underlying frontal suture; antennae pale yellow; pronotum outlined by darker orange-yellow; abdominal tergites and sternites yellow-brown; femora pale yellow, tibia darker. Head subquadrate; cranial suture indistinct to whitish. Pronotum as wide as head capsule, widest in middle; anterior margin weakly concave; posterior margin weakly biconvex. Antennae of 16-19 segments, usually 17-18; relative length formula 2 = 3 = 4 = 5, sometimes 2 > 3, 3 < 4, or 4 < 5. Eyes ovoid, flattened on edge near antennal fossae. Ocelli white, ovoid; abutted against eyes. Sclerotized wing venation

TABLE 1. MEASUREMENTS OF *CRYPTOTERMES ABRUPTUS* IMAGO.

Measurement in mm (n = 7♀, 7♂ from 2 colonies)	Range	Mean ± S.D.	Morphotype
Head length with labrum	1.10-1.24	1.17 ± 0.036	1.16
Head length to postclypeus	0.82-0.87	0.84 ± 0.014	0.85
Head width, maximum at eyes	0.89-0.93	0.91 ± 0.014	0.92
Eye diameter, maximum	0.28-0.31	0.30 ± 0.0083	0.30
Eye to head base, minimum	0.14-0.16	0.15 ± 0.0092	0.14
Ocellus diameter, maximum	0.11-0.14	0.13 ± 0.0084	0.12
Pronotum, maximum length	0.65-0.72	0.69 ± 0.019	0.65
Pronotum, maximum width	0.85-0.93	0.88 ± 0.026	0.85
Total length with wings	8.09-8.80	8.49 ± 0.17	8.38
Total length without wings	3.83-4.90	4.27 ± 0.33	3.91
Forewing length from suture	6.25-6.96	6.66 ± 0.22	6.67
Forewing, maximum width	1.81-1.98	1.91 ± 0.43	1.86

light brown; wing membrane faintly golden-brown; iridescence golden-green or golden-purple. Subcosta, radius, and radial sector sclerotized; radius joining costal margin at midwing; radial sector with 4-5 anterior branches, media unsclerotized, joining radial sector beyond midwing. Arolium present.

Soldier (Fig. 1, Table 2)

Head nearly black in anterior, grading from chestnut brown to orange in posterior 1/5-2/5. Antennae pale, more yellow in proximal articles. Mandibles black, grading to chestnut brown near bases. Rugosity of head capsule shallow, composed of sinuous, evenly spaced striations along sides, frontal peak, and occiput. Head, in dorsal view, much longer than wide with slight to moderate median constriction; vertex extended on same plane with frontal flange to terminate as bluntly pointed peak forming 120-130° angle. Frontal peak overhanging mandibles, frons, genal horns, and labial palps beneath. Frontal flange posterior delineated in dorsal view by a very slight V-shaped elevation suggesting a median notch behind frontal peak; combination of posterior elevation of frontal flange and frontal peak rhomboidal in outline; frontal flange becoming more narrow and elevated lateral to frontal peak. In lateral view, frons sloping back about 30° beyond vertical and overhanging mouthparts. Plane of frons elevated along vertical midline from frontal peak to base of postclypeus (Fig. 1C); less rugose than head capsule. Distinct knob on lateral base of head capsule at insertion of ventral mandibular condyle. Anteclypeus very narrow. Labrum very small; usually cradled in slot formed by crossed mandibles or bent upward and supported on closed mandibles. Frontal horns shallow, evenly rounded; anterior to, and even with antennal fossae. Genal horns very small, pointed, projecting forward; directly abutting and behind frontal horns. Mandibles very short and small, blades angled 40-50° from base in ventral view; little or no basal hump; mandibles angled on their long axis to form cradle; dentition weak. Eye, when visible, faint, narrow; near lower middle of head capsule. Antennae with 12-14 articles; relative length formula 2 ≥ 3 ≥ 4 = 5. Pronotum somewhat wider than long; anterior margin finely serrate and weakly concave.

Comparisons.

The imago of *C. abruptus* is close to *C. cavifrons* in overall size, coloration, and shape. *Cryptotermes abruptus* has more pilous head, pronotum, legs, and wing scales than *C. cavifrons*. The golden iridescence of overlapping *C. abrutus* wing membranes is absent in *C. cavifrons* and all other known neotropical congeners.

The soldier of *C. abruptus* is readily distinguished from all other *Cryptotermes* species and all other termite taxa, by its broadly overhanging frontal peak which eclipses the dorsal view of all underlying structures including the frontal horns and mouthparts, including the mandibles, labrum, and palps (Fig. 1B). In this view, only the vertex and antennae are visible. The nearest soldier is that of *C. domesticus* (Haviland), a somewhat variable species, which has a vertical or only slightly overhanging frons and a notched frontal peak. Unlike *C. abruptus*, the frontal peak of *C. domesticus* does not block the dorsal view of the genal horns and mouthparts. The mandibles and genal horns of *C. domesticus* are much more prominent than those of *C. abruptus*, while the frontal horns of *C. domesticus* are smaller than those of *C. abruptus*.

Type Material

Holotype soldier and 2 paratype soldiers collected in Mexico, Quintana Roo State, on Isla de Cozumel near El Caracol; other paratype soldiers from Cozumel near La-

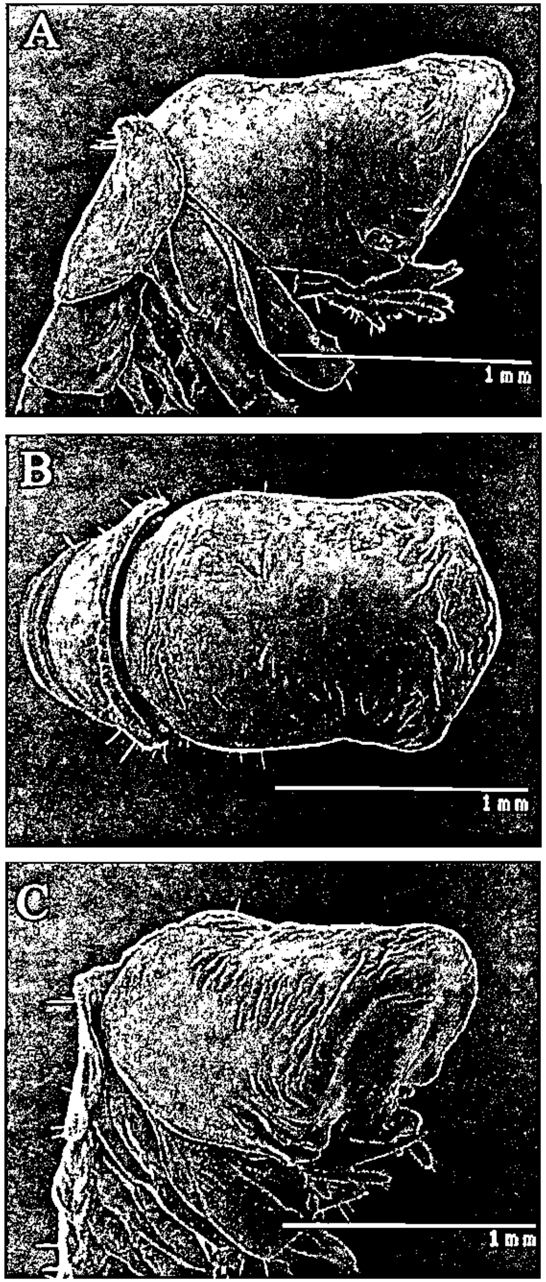

FIG. 1. Scanning electron micrographs showing lateral (A), dorsal (B), and oblique (C) views of soldier headcapsule of *Cryptotermes abruptus* n.sp. Antennae removed for clarity.

TABLE 2. MEASUREMENTS OF *CRYPTOTERMES ABRUPTUS* SOLDIER.

Measurement in mm (n=10 from 4 colonies)	Range	Mean ± S.D.	Holotype
Head length with frontal flange	1.38-1.75	1.55 ± 0.13	1.67
Head length to tip of mandibles	1.38-1.57	1.46 ± 0.056	1.47
Head length to frontal horns	1.18-1.32	1.26 ± 0.044	1.27
Frontal flange width	0.98-1.13	1.07 ± 0.044	1.13
Frontal horns, outside span	0.82-0.92	0.86 ± 0.027	0.85
Head width, maximum	1.10-1.21	1.16 ± 0.028	1.18
Head height, excluding postmentum	1.03-1.11	1.07 ± 0.027	1.06
Pronotum, maximum width	1.08-1.19	1.14 ± 0.033	1.19
Pronotum, maximum length	0.75-0.90	0.85 ± 0.045	0.88
Left mandible length, tip to ventral condyle	0.52-0.59	0.56 ± 0.023	0.59
Total length	3.96-4.60	4.24 ± 0.20	4.26

guna de Columbia and Punta Chiquero by J. A. C. on 7-V-1997, and Quintana Roo State, Puerto Morelos, by J. K. on 9-VIII-1987. Morphotype winged imago and 11 paramorphotype imagos from the Laguna de Columbia colony and 2 paramorphotype imagos from the Puerto Morelos colony.

Etymology

Abruptus (Latin = steep), in reference to the precipitous inclination of the frontal peak and frons in the soldier.

BIOLOGY

Colonies of *C. abruptus* were encountered in dead, dry limbs of various woody hosts at the type localities. This habit is unremarkable, being typical of most congeners.

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NEOTERMES PHRAGMOSUS, A NEW DAMPWOOD TERMITE (ISOPTERA: KALOTERMITIDAE) FROM SOUTHEASTERN CUBA

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ABSTRACT

Neotermes phragmosus n. sp. is described from the imago and soldier castes. The imago head capsule of *N. phragmosus* has a distinctly phragmotic and concave frons. Plesiomorphic characters of *N. phragmosus* unique among the Kalotermitidae include partial separation of the otherwise fused first and second marginal teeth of the left imago/worker mandible, long subcosta and radius, and increased number of antennal articles in both imagos and soldiers. This species is confined to the xeric coastal habitats of southeastern Cuba.

Key Words: new species, taxonomy, West Indies, Greater Antilles, Caribbean

RESUMEN

El *Neotermes phragmosus* n. sp. es descrito de la casta imago y la casta soldado. La cápsula de la cabeza del imago *N. phragmosus* tiene el frente distintivamente fragmotico y cóncavo. Las características plesiomorficas del *N. phragmosus* son únicas entre los Kalotermitidae incluyen la separación parcial de los primeros y segundos dientes marginales de la mandíbula izquierda del imago/trabajador, que en otros casos se encuentra fundidos; un subcosta y un radio largados; y un mayor número de artículos en las antenas en los imagos y los soldados. Esta especie está restríngida a la zona árida costera del sureste de Cuba.

A species of *Neotermes*, collected in extreme southeastern Cuba, was originally listed as *Neotermes* sp. nr. *mona* (Banks) (Scheffrahn et al. 1994). A subsequent redescription of *N. mona* (Krecek et al. 2000) revealed that the Cuban *Neotermes* was a new species that is described herein from the winged imago and small and large soldier castes. *Neotermes phragmosus* n. sp. is the fourth *Neotermes* species recorded from Cuba and the sixth from the Greater Antilles. *Neotermes phragmosus* and *N. cubanus* (Snyder) are endemic solely to Cuba (Snyder 1956, data herein). Of the two additional Cuban species, *N. castaneus* (Burmeister) is also recorded from the Bahamas, Cayman Islands, Florida, Hispaniola, Jamaica, and Turks and Caicos Islands (Scheffrahn et al. unpublished), while *N. jouteli* (Banks) ranges into the Bahamas, Cuba, Florida, and Mexico (Scheffrahn et al. 2000). The remaining Greater Antillean species include *N. platyfrons* Krecek and Scheffrahn (2001) from Hispaniola, and *N. mona* from the Bahamas, Hispaniola, Puerto Rico, Turks and Caicos, and Virgin Islands (Krecek et al. 2000).

MATERIALS AND METHODS

The description of *N. phragmosus* is based on 87 colony samples from the authors' collection taken from 23 localities in Guantánamo Province, Cuba, as part of a survey of termites of Cuba and the West Indies (Fig. 4). Collection localities were mapped using ArcView GIS version 3.0a software and relevant map data from Digital Map of the World version 1.0 (Environmental Systems Research Institute, Inc. Redlands, CA). Morphometric data from specimens preserved in 85% ethanol were obtained using a stereomicroscope fitted with an ocular micrometer. Scanning electron micrographs were scanned at 300 dpi, the specimen outline captured with photograph-enhancing software (Adobe Photoshop Elements, Adobe Systems Inc., San Jose, CA), the background converted to black, and the scale bar digitally redrawn. The imago head capsule photomicrograph was obtained using a digitized three-dimensional imaging system (Auto-Montage, Syncroscopy Inc. Frederick, MD) and further enhanced as mentioned above.

The holotype alate and paratype large and small soldier will be deposited at the American Museum of Natural History, New York. The additional alate and soldier paratypes will be submitted to the National Museum of Natural History (Smithsonian Institution), Washington, D.C., and to the Florida State Collection of Arthropods, Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. The remaining paratypes will be held in the authors' collection at the University of Florida Research and Education Center, Fort Lauderdale, Florida.

NEOTERMES PHRAGMOSUS, NEW SPECIES

Neotermes sp. nr. *mona* (Banks); Scheffrahn et al. 1994: 217 (Cuba).

Imago (Figs. 2 and 3, Table 1).

In dorsal view, head capsule ferruginous orange, except for slightly darker ferruginous ante-

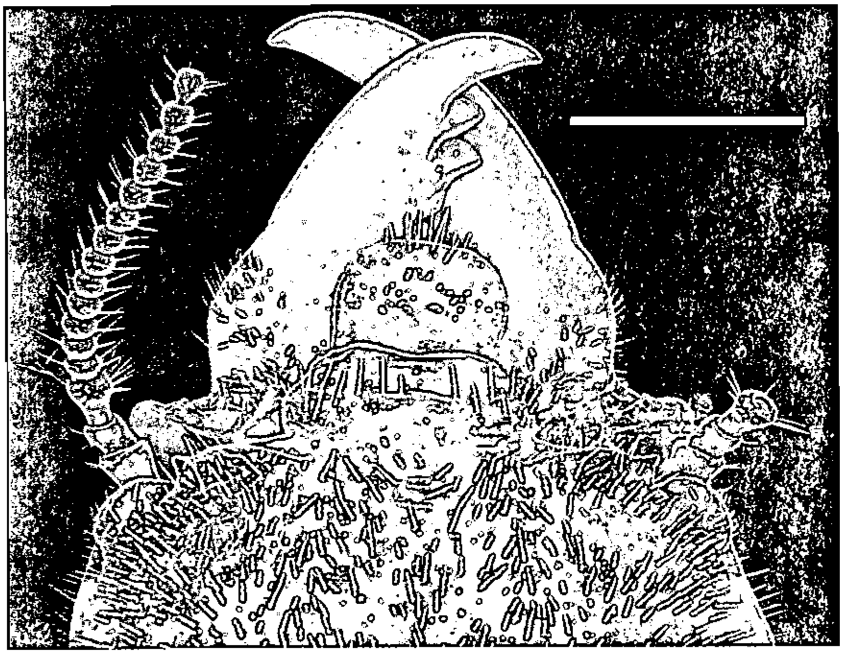

Fig. 1. Scanning electron micrograph of anterior of the large soldier head (dorsal view) of *Neotermes phragmosus* n. sp. from Tortuguilla, Guantánamo Province, Cuba. Scale bar equals 1 mm.

rior frons and postclypeus. Compound eyes almost black. Mandibles chestnut brown. Antennal articles 1-3 ferruginous; remaining articles ferruginous orange. Anteclypeus yellowish. Ferruginous orange chevron patterns formed by wing scales on pterothorax faint and wide; remaining dorsum of body pale orange-yellow. Sclerotized wing venation ferruginous orange, remainder of wings and abdominal sternites yellowish.

In dorsal view, head capsule suboval with sides along and anterior to eyes slightly concave; posterior of head capsule broadly rounded. Head converging to anterior in ventral aspect. In oblique view, frons phragmotic, broadly excavated; depression sharply delimited by moderately raised ridge; surface of frons covered by dense wrinkling of variable orientation (Fig. 2). A pair of tiny tubercles behind ocelli; lateral branches of epicranial suture near tubercles. In lateral view, plane of frons margin slopes weakly toward a slightly convex vertex. Compound eyes large and protruding, subcircular; eye margins narrowly subrectate along ocelli and along posteroventral area, and broadly subrectate or slightly concave along antennal sockets. Ocelli slightly protruding, large, elliptical; contacting or very narrowly separated from eyes; distinctly converging anteriorly. Mandibular bases and anterolateral corners of head capsule with distinct striations. Left mandible with slight hump at basal two-fifths; basal hump with several ~0.03 mm long setae; first and second marginal teeth partially separated; each with separate pointed apex (Fig. 3); third marginal tooth with sinuous anterior and posterior margins. Right mandible with molar plate longer than posterior margin of second marginal tooth and composed of ca. 20 ridges (Fig. 3).

Several dozen setae of medium length (~0.05mm) dispersed on head, pronotum, wing scales, abdominal tergites, and sternites. Antennae with 18-24 articles, 75% (n = 64) with 22-24 articles, 10% with 24; relative length formula 2>3>4 = 5 or 2 = 3>4 = 5. Pronotum robust, about twice as wide as its median length. Pronotum with anterior margin evenly concave, lateral margins faintly convex, posterolateral margins subtruncate or faintly concave, and posterior margin slightly concave medially; anterior and lateral margins with raised and rounded rim. Fore wing with very long subcosta and radius; subcosta terminating at costal margin usually beyond 1/2 of wing length from suture and near intersection of radius and costal margin at 2/3 of wing length. Radial sector with 4-6 branches that fork in apical third of wing just beyond intersection of radius into costal margin. Median vein sclerotized and with about four sclerotized and short posterior branches; branches dissolve gradually into membrane except for usually the two most distal branches, that terminate at wing margin. Wing membrane faintly and irregularly nodulate with some nodules fused. Arolia distinct.

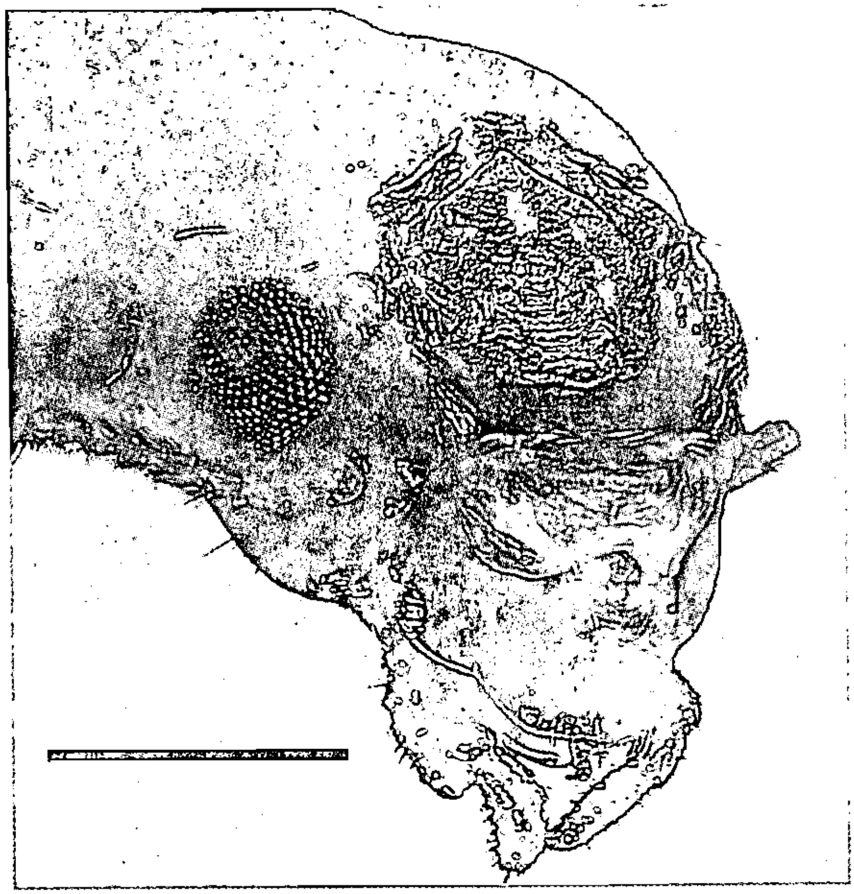

Fig. 2. Photomicrograph of the oblique view of imago head of *Neotermes phragmosus* n. sp. from the U.S. Naval Base, Guantánamo, Cuba, showing deeply excavated and phragmotic frons. Scale bar equals 1 mm.

Comparisons.

The *N. phragmosus* imago is unique among congeners in that its frons is characteristically truncated, depressed, encircled by a ridge, and rugose. Imagos of *N. phragmosus* and the allopatric *N. mona* are the largest among the West Indian Kalotermitidae. The *N. phragmosus* imago has less dense pilosity than *N. mona* on the head, pronotum, and wing scales. Few short setae on basal hump of mandibles present in *N. phragmosus* imago are absent both in *N. mona* and *N. jouteli*.

Compared to the sympatric *N. jouteli*, *N. phragmosus* alates differ primarily in size, the first species being distinctly smaller than the second one, usually without any overlapping. Those most distinctive characters are: 1.77-2.16 mm for head length with labrum of *N. jouteli*, versus 2.24-2.74 mm for *N. phragmosus*; labrum width maximum 0.60-0.70 mm versus 0.74-0.83 mm; pronotum maximum length is 1.06-1.32 mm of *N. jouteli*, but 1.44-1.81 in *N. phragmosus*; and pronotum width with 1.75-2.05 mm, while 2.10-2.59, respectively. Total body length is also useful; 13.92-16.05 mm in *N. jouteli*, versus 15.80-19.04 mm in *N. phragmosus*.

Soldier. (Fig. 1, Tables 2 and 3).

The soldier caste consists of two distinct morphs, large and small, both usually present in mature colonies. Other than size, there are few distinguishing characters that separate small and large soldiers of *N. phragmosus* compared with some congeners and species in several other kalotermitid genera.

Head capsule and labrum ferruginous orange in dorsal view. Antennae ferruginous orange; three proximal articles ferruginous. Anteclypeus pale yellowish. Mandibles glossy, almost black; basal areas dark chestnut. Epicranial sutures faint or absent. Eyes dark gray. Thorax, including femora and abdominal dorsum and sternum pale yellowish. Tibiae and genae pale orange-yellow. Postmentum pale ferruginous.

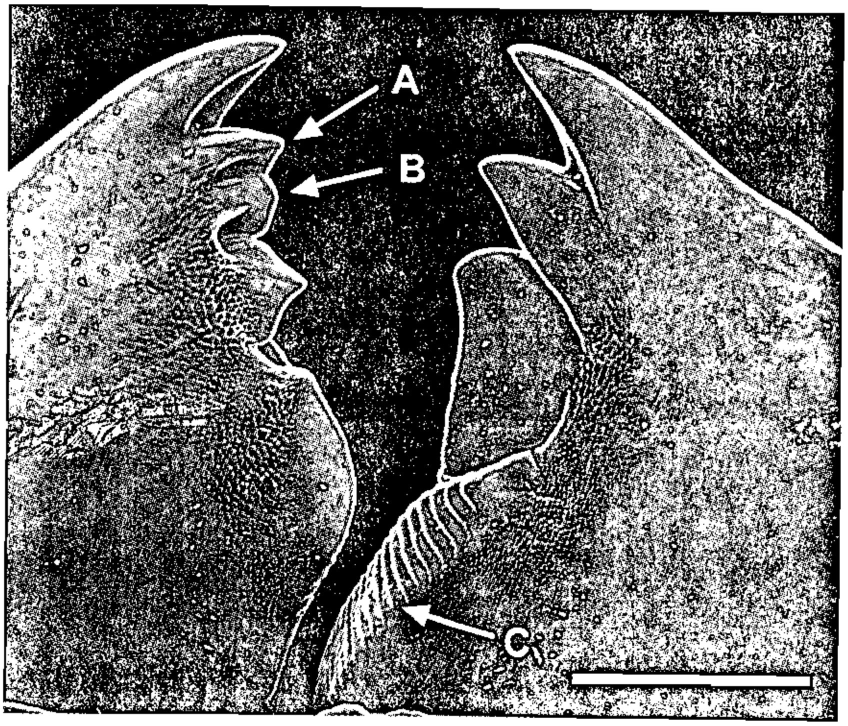

Fig. 3. Scanning electron micrograph of imago mandibles of *Neotermes phragmosus* n. sp., dorsal view, from Tortuguilla, Guantánamo Province, Cuba. Labels: first marginal tooth (A), second marginal tooth (B) of left mandible, and molar plate (C) of right mandible. Scale bar equals 0.5 mm. Labrum removed for clarity.

In dorsal view, head capsule subsquare, with sides subparallel, faintly convex in large soldiers, slightly convex in small morph; posterior corners rounded and posterior margin widely rectate in both morphs. Head capsule, thorax, and abdomen covered with dense mat of long setae (~0.1 mm); occiput glabrous. Frons depressed, faintly submerged, and broadly continuous with postclypeus; depressed area faintly striate. Frontal carinae tapered into distinctly protruding tubercle near antennal carinae. Labrum broadly linguiform; apex slightly convex. Mandibles elongate and relatively robust, with remarkably pilose basal humps; dentition distinct. Small soldier antennae with 17-21 articles, usually 18; large morph with 16-20 articles, usually 18 or 20; third antennal article subclavate, terminal articles usually slightly elongate; antennal formula $2<3>4 = 5$. Antennal carinae protruding and faintly rugose. Pronotum papilionaceous, noticeably wider than head, and more than twice as wide as long in middle. Anterior margin of pronotum deeply and evenly concave; anterolateral corners abruptly rounded, sides of pronotum subparallel, faintly convex; posterior margin weakly emarginate. Pterothorax with posterolateral sides subtruncate, more so in small soldiers than in large soldiers. All soldiers with short wing buds.

In lateral view, head capsule dorsoventrally flattened; principal plane of frons occupying about half of head capsule length in small soldiers; about one third in large morph. Frons slopes ≈15° from plane of vertex; mandibles noticeably curved upward; eyes large and vertically oriented; without peripheral satellite facets. Pilosity of frons and anterior vertex dense. Hind femora moderately broadened in small soldiers and noticeably inflated in large morphs.

Comparisons.

No single measurement in either soldier morph is diagnostic for separating *N. phragmosus* from its nearest congener, *N. mona*. Nevertheless, the small morph of *N. phragmosus* is larger in the majority of measurements than that of *N. mona*. The mandibular hump pilosity of *N. phragmosus* is considerably more conspicuous than that of both *N. mona* and *N. jouteli*. The *N. phragmosus* soldiers possess a distinctly protruding tubercle on each frontal carina, which, both in *N. mona* and *N. jouteli*, are rudimentary. Striations of frons in *N. phragmosus* are considerable, while absent or very faint in *N. mona*. The rugosity of antennal carinae is faint in *N. phragmosus*, while being well developed in *N. mona*. The eyes of *N.*

TABLE 1. MEASUREMENTS OF *NEOTERMES PHRAGMOSUS* IMAGO.

Measurement in mm (n = 9 males, 10 females from 6 colonies)	Range	Mean ± S.D.	Holotype
Head length with labrum	2.24-2.74	2.58 ± 0.12	2.64
Head length to postclypeus	1.56-2.00	1.86 ± 0.12	1.93
Head width, maximum at eyes	1.83-2.27	2.11 ± 0.093	2.12
Head height without postmentum	1.00-1.19	1.14 ± 0.050	1.18
Labrum width, maximum	0.74-0.83	0.80 ± 0.026	0.80
Eye diameter with sclerite, maximum	0.56-0.68	0.64 ± 0.034	0.67
Eye to head base, minimum from sclerite	0.27-0.38	0.33 ± 0.029	0.34
Ocellus diameter, maximum	0.18-0.26	0.23 ± 0.020	0.22
Ocellus diameter, minimum	0.16-0.20	0.19 ± 0.0098	0.19
Eye sclerite to ocellus, minimum	0-0.016	0.0090 ± 0.0066	0.0082
Pronotum, maximum length	1.44-1.81	1.67 ± 0.10	1.77
Pronotum, maximum width	2.10-2.59	2.44 ± 0.13	2.59
Total length with wings	15.80-19.04	17.88 ± 0.75	17.69
Total length without wings	8.91-13.10	11.35 ± 1.09	12.29
Fore wing length from suture	11.07-13.77	12.93 ± 0.61	13.23
Fore wing, maximum width	3.08-4.07	3.79 ± 0.28	4.07
Hind tibia length	1.60-1.90	1.78 ± 0.089	1.83

phragmosus do not display peripheral facets, which are typical of *N. mona*. Finally, the antennae of *N. phragmosus* soldiers have more articles compared to those of *N. mona*, in which the range is 13-19, 12-18 in *N. jouteli*, while in *N. phragmosus* it is 16-21.

Compared with the sympatric *N. jouteli*, *N. phragmosus* soldiers of both forms differ in having a much wider and much more deeply concave anterior margin of the pronotum. The character is particularly distinctive in large soldiers (pronotum width in *N. jouteli* ranges between 2.61-3.03 mm, while the same measurement in *N. phragmosus* is 3.32-3.96 mm). Pronotal length of *N. phragmosus* large soldiers ranges between 2.15-2.52 mm while in *N. jouteli* the length is 1.71-1.85 mm. Both soldier morphs of *N. phragmosus* are more pilose than *N. jouteli* around the anterior portion of the head including mandible bases. The maximum head width (2.93-3.46 mm) and left mandible length (2.64-2.90 mm) of *N. phragmosus* large soldiers do not overlap with those respective measurements (2.34-2.70 and 2.17-2.42 mm) in *N. jouteli*. Although some small soldier measurements overlap for both species, the *N. phragmosus* small soldier is larger overall than that of *N. jouteli*.

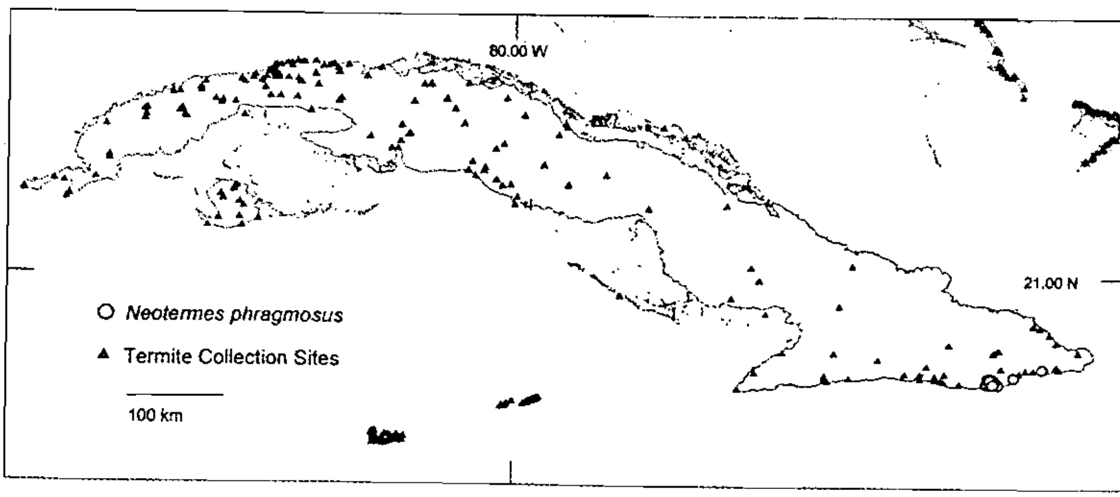

Fig. 4. *Neotermes phragmosus* n. sp. localities and termite collection sites on Cuba and neighboring islands.

TABLE 2. MEASUREMENTS OF *NEOTERMES PHRAGMOSUS* SMALL SOLDIER.

Measurement in mm (n = 12 from 7 colonies)	Range	Mean ± S.D.
Head length to tip of mandibles	3.91-5.30	4.69 ± 0.40
Head length to postclypeus	2.43-3.47	3.04 ± 0.32
Head width, maximum	2.28-3.10	2.77 ± 0.24
Antennal carinae, outside span	2.04-2.60	2.35 ± 0.16
Head height, excluding postmentum	1.34-1.83	1.53 ± 0.15
Labrum, maximum width	0.64-0.82	0.73 ± 0.053
Postclypeus width, maximum	0.87-1.10	0.98 ± 0.066
Left mandible length, tip to most distant visible point of ventral condyle	2.17-2.69	2.42 ± 0.15
Postmentum, length in middle	1.88-2.47	2.17 ± 0.20
Postmentum, maximum width	0.80-1.11	0.93 ± 0.087
Postmentum, minimum width	0.49-0.60	0.54 ± 0.045
Pronotum, maximum width	2.69-3.36	3.07 ± 0.19
Pronotum, maximum length	1.63-2.20	1.93 ± 0.16
Hind tibia length	1.38-1.95	1.71 ± 0.15
Total length	9.72-14.85	12.48 ± 1.67

Etymology.

The species name reflects the unique and striking phragmosis of the imago frons; possibly the most developed for this character among the Isoptera.

Remarks.

The holotype colony was collected in a very xeric coastal habitat from the dead wood of living *Calotropis procera* Aiton (Asclepiadaceae), an exotic shrub. The colony penetrated into xylem elements within the living cambium. Other colonies were collected from dead branches and trunks of mangroves, buttonwood, and other littoral woods. The dispersal flight season of *N. phragmosus* is unknown, but we suspect nocturnal autumn flights similar to those of others congeners as alates were collected in late August and early November.

Type material.

Holotype colony series. **Cuba.** Guantánamo Province; Tortuguilla; 19.98°N, 74.93°W; 20-VIII-1974; coll. J. Krecek; 1 female alate holotype, 13 alate paratypes, 6 paratype small soldiers and 6 paratype large soldiers (CU-968).

Paratype colonies series. All material originates from Guantánamo Prov.: Imias; 20.07°N, 74.64°W; VIII-1975; coll. L. de Armas; 1 paratype small and large soldier (CU-1038). The following samples were collected at the U.S. Naval Base Guantánamo Bay by J. Chase, J. Mangold, and R.H. Scheffrahn 2-XI-2001 to 6-XI-2001: Kittery Beach; 19.906°N, 75.089°W; 1 paratype imago (CU-1076); N. Kittery Beach; 19.905°N, 75.088°W;

Table 3. Measurements of *Neotermes phragmosus* large soldier.

Measurement in mm (n = 11 from 6 colonies)	Range	Mean ± S.D.
Head length to tip of mandibles	5.30-6.09	5.69 ± 0.22
Head length to postclypeus	3.61-4.16	3.87 ± 0.17
Head width, maximum	2.93-3.46	3.25 ± 0.17
Antennal carinae, outside span	2.54-2.97	2.78 ± 0.13
Head height, excluding postmentum	1.83-2.30	2.15 ± 0.14
Labrum, maximum width	0.70-0.83	0.78 ± 0.049
Postclypeus width, maximum	1.06-1.21	1.13 ± 0.046
Left mandible length, tip to most distant visible point of ventral condyle	2.64-2.90	2.77 ± 0.080
Postmentum, length in middle	2.57-3.03	2.79 ± 0.14
Postmentum, maximum width	0.93-1.14	1.06 ± 0.078
Postmentum, minimum width	0.47-0.65	0.58 ± 0.063
Pronotum, maximum width	3.32-3.96	3.66 ± 0.16
Pronotum, maximum length	2.15-2.52	2.33 ± 0.11
Hind tibia length	1.75-2.10	2.01 ± 0.10
Total length	12.83-16.07	13.96 ± 1.13

1 paratype small and large soldier (CU-1343); Old Chief's Club; 19.925°N, 75.131°W; 1 paratype imago (CU-1374); Boat landing, leeward mangroves; 19.941°N, 75.152°W; 1 paratype large soldier (CU-1401); 1 paratype small soldier (CU-1408); Naval Station Brig; 19.936°N, 75.124°W; 1 paratype small soldier (CU-1430); 1 paratype imago (CU-1433); Evan's Point; 19.921°N, 75.141°W; 1 paratype imago (CU-1447); 1 paratype small and large soldier (CU-1448); Leeward mangroves, *Coccothrinax* habitat; 19.958°N, 75.165°W; 1 paratype imago and small soldier (CU-1521), 1 paratype large soldier (CU-1523).

Discussion

The characters of *Neotermes phragmosus* require that morphological definitions for the Kalotermitidae be broadened for both the imago and soldier. Plesiomorphic traits of *N. phragmosis* outside of Krishna's (1961) imago diagnosis include: 1) a maximum of 24 antennal articles (increase of 3), 2) separation of the second and third marginal teeth of the left mandible, 3) the molar plate of the right mandible longer than the posterior margin of the second marginal tooth, and 4) fore wing subcosta extending to at least mid wing with radius intersecting costal margin well beyond mid wing. In the soldier, the number of antennal articles is increased from 19 to 21. It is noteworthy that for the soldier, Kambhampati & Eggleton (2000) use the threshold gap of 20-22 antennal articles to separate the Termopsidae from the Kalotermitidae.

Although a weak frontal concavity and rudimentary phragmosis occur in several Neotropical *Neotermes* imagos, i.e. *N. jouteli* (Scheffrahn et al. 2000), *N. mona* (Krecek et al. 2000), and *N. platyfrons* (Krecek & Scheffrahn 2001), the degree of its development in *N. phragmosus* is remarkable and suggests apomorphism for defense of incipient colonies against predatory ants or competition by termites vying for nuptial microhabitats. The evolutionary significance of pilosity of the mandibular humps in the soldier is unclear. Mandibular basal pilosity is not uncommon in *Neotermes*; it appears also in *Glyptotermes*, *Paraneotermes*, and *Incisitermes*, but this trait reaches its maximum expression in *N. phragmosus*.

Together with the *Antillitermes subtilis* (Scheffrahn & Krecek 1993), *Constrictotermes guantanamensis* Krecek et al. (1996), *Cryptotermes spathifrons*, and *C. cymatofrons* (Scheffrahn & Krecek 1999), *N. phragmosus* is the fifth species recently described from southeastern Cuba. All species but *C. cymatofrons* are confined to xeric habitats.

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Chemical Prevention of Colony Foundation by *Cryptotermes brevis* (Isoptera: Kalotermitidae) in Attic Modules

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ABSTRACT Disodium octaborate tetrahydrate (DOT) dust, DOT aqueous solution, imidacloprid dust, and amorphous silica gel dust with synergized 1% pyrethrins were applied on wood surfaces to simulated attic modules. Modules (30 by 30 cm) with and without fiberglass insulation were exposed to dispersal flights of *Cryptotermes brevis* (Walker) in May and June of 1998 and 1999. Six months after flights, modules were disassembled and inspected for nuptial chamber location and contents. During both years, air and water control treatments contained 22.2 ± 9.94 (mean ± SD) nuptial chambers, 7.5 ± 5.7 live imagos, and 2.0 ± 1.4 chambers with brood. This survivorship indicated that the attic modules performed well as a colonizing platform for *C. brevis*. *C. brevis* dealates preferred constructing nuptial chambers in the crevices at the bases or tops of the modules instead of internal crevices. Modules treated in 1998 and 1999 with DOT or silica dusts contained no live termites, whereas zero of five modules treated with imidacloprid dust in 1998 and two of 20 modules treated with imidacloprid dust in 1999 contained single live incipient colonies. In 1998, 15% DOT solution, applied as a postconstruction treatment, yielded significantly fewer chambers and live termites than controls, but was not as effective as dusts in preventing successful colonization. In 1999, the DOT solution, applied as a construction-phase treatment, was equally as effective in preventing colonization as the dust treatments during that year. Results indicate that dust formulations of DOT, silica gel, and imidacloprid can be used to prevent drywood termite colonization in existing building voids and attics. Where the entire wood framing is exposed to treatment, such as during building construction, aqueous DOT solution can be equally effective as dusts in preventing colonization by *C. brevis*.

KEY WORDS *Cryptotermes brevis*, drywood termite, nuptial chamber, borates, imidacloprid, silica gel

THE WEST INDIAN drywood termite, *Cryptotermes brevis* (Walker), is an important pest of structures in Florida, other Gulf Coast States, Hawaii, and many tropical and subtropical regions of the world (Gay 1967). Dispersal flights (swarms) of *C. brevis* are nocturnal and peak in late spring. *C. brevis* is unlike any other termite in that infestations are, with one exception, associated exclusively with wooden structures. Only recently has a local woodland infestation of *C. brevis* been discovered in Hawaii (Scheffrahn et al. 2000). But because *C. brevis* is probably not endemic to Hawaii, a native habitat for this widely distributed species has yet to be found.

Scheffrahn et al. (1998) demonstrated that naturally dispersing *C. brevis* imagos could be induced to colonize crevices created between pairs of small wooden blocks. Furthermore, these blocks could be treated beforehand with chemicals to assess the effects of such treatments in preventing colonization of the blocks by *C. brevis*. We subsequently wondered whether it was valid to use relatively small blocks to assess the efficacy of treatments intended for large-scale applications to dimensional lumber in wall or attic framing of buildings.

In this study, the scale of the colony foundation bioassay was enlarged to accommodate dimensional lumber, screw fasteners, and building insulation. Selected treatments were applied to this novel bioassay design and colonization success by *C. brevis* determined after the 1998 and 1999 flight seasons.

Materials and Methods

Construction grade spruce (*Picea* sp.) "2 by 4" (3.8 by 8.9 by 305 cm) boards and 9.5 mm thick plywood sheets were purchased from a local lumberyard. Only boards free of cracks, checks, and excessive sap were selected. Before each yearly test, boards were aged outdoors under full sun and rain exposure for 8 wk before assembly. Bioassay (attic) modules were assembled from 2 by 4 sections cut and joined in the design and dimensions given in Fig. 1. Sections of boards were joined with a total of eight 51 mm long screws. The plywood backing (30.5 by 30.5 cm) was affixed at the corners with four 19 mm long screws. Insulated attic modules were prepared by inserting 5 by 23-cm strips of paper-backed fiberglass insulation flush into the three voids between the four 2 by 4 cross

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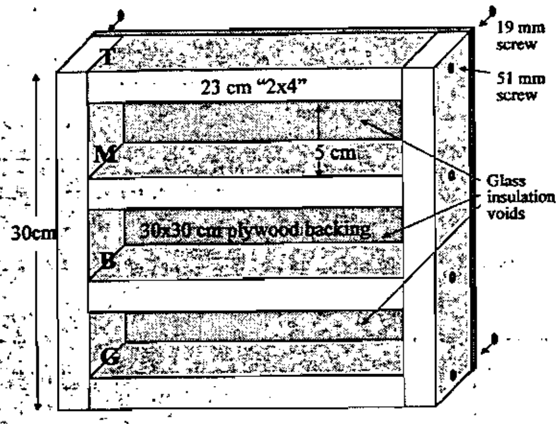

Fig. 1. Design of attic module. Nuptial chamber locations: T, top; M, middle; B, bottom; G, ground.

ribs. With the exception of the 1999 disodium octaborate tetrahydrate solution treatment in which the insulation was inserted after the solution was applied, the insulation strips were inserted before chemicals were applied as to simulate postconstruction treatments. Modules used for each flight season (1998 and 1999) were constructed during their respective year of identical materials. The treatments were divided among two flight seasons because available facilities could not accommodate all treatments simultaneously.

In 1998, 13 treatments, each replicated five times for a total of 65 modules, were exposed to *C. brevis* dispersal flights. Chemical treatments included 150,000 ppm aqueous disodium octaborate tetrahydrate (DOT, Tim-bor; U.S. Borax, Valencia, CA) applied at 35 or 70 ml per attic module; 98% DOT anhydrous dust applied at 13.5 or 2.7 g; 100 ppm imidacloprid dust (Premise 0.1% dust; Bayer, KS; City, MO) applied at 0.95 g; water control, 70 ml; and untreated (air) control. All chemical treatments were applied on both insulated and uninsulated attic modules except for imidacloprid, which was applied to uninsulated modules only. The DOT solutions and water were applied evenly with a hand sprayer to cover all exposed upper surfaces of the modules to simulate postconstruction treatments (i.e., limited application exposure of wood elements as in a true attic). To also simulate postconstruction treatments in attics, the dusts were deposited using a flour sifter to evenly dispense dust particles by gravity onto the top surfaces of the modules positioned with the plywood side down.

In 1999, 16 treatments, each replicated five times for a total of 80 modules, were tested. Chemical treatments included 150,000 ppm DOT applied at 100 ml per attic unit; 98% DOT dust applied at 1.5 or 0.75 g; 100 ppm imidacloprid dust at 1.0 or 0.5 g; 40% amorphous silica gel with 1% pyrethrins and 10% piperonyl butoxide (Drione; AgrEvo Environmental Health, Montvale, NJ) at 0.5 g; water control, 100 ml; and untreated (air) control. All test materials were applied to both insulated and uninsulated attic modules. The DOT solution and water were applied evenly to all surfaces of the modules before installing insulation to simulate construction-phase framing (i.e., unlimited application exposure) treatment. The dusts were deposited as in 1998.

Treated modules were placed upright on their small side (Fig. 1) on a large table in a windowless 5 by 8 m laboratory room that served as an alate dispersal venue. Treatments were segregated from each other in metal isolation trays from which dealates could not escape from by crawling and thereby cross-contaminate neighboring treatments. Our observations showed that once alighted on modules, alates shed their wings (dealated) and thus did not to fly to neighboring modules. The room contained mixed colonies of *C. brevis* infesting wooden doors, structural lumber, and furniture collected in Key West, Miami, and St. Petersburg, FL, respectively. The trays were arranged randomly beneath six 3.9-W fluorescent lights that were continuously illuminated. Tray positions were randomly and periodically transposed during the flight season. A water pan, which served as an alate monitoring trap, was placed nearby. Alates were counted in the water trap every 1–3 d to monitor dispersal flight activity over the span of the flight season. In December 1998 and December 1999, all attic modules tested during the respective flight seasons were disassembled by individually unscrewing each board to uncover colonizing termites in nuptial chambers. The incipient colony status, including location and number of nuptial chambers, contents of each chamber (number of live dealates and dealate gender) and number and composition of brood (one to three instars) in each chamber was recorded. A nuptial chamber is defined here as an enclosure composed of any combination of excavated wood, existing wood surfaces, and other construction materials (fecal pellets, liquid feces, and frass) used by young dealates to form a nesting enclosure. A nuptial chamber marks a colonization attempt by dealates, whereas live dealates in a nuptial chamber indicate the absence of overt toxicity by chemical treatments. A nuptial chamber containing at least one live heterosexual dealate pair (king and queen) or brood is indicative of successful colony foundation (Scheffrahn et al. 1998).

Data for the 1998 and 1999 experiments were separately analyzed by analysis of variance (ANOVA). Variables analyzed included number of nuptial chambers, live dealates per chamber, heterosexual pairs per chamber, and chambers containing brood. Effects of chemical treatment, insulation, and their interaction were tested based on the residual error mean square into which was pooled higher level effects (e.g., chemical × insulation) when the latter did not have a larger ($P = 0.25$) mean square than the residual (Sokal and Rohlf 1981). Because data consisted of whole numbers and zeros, they were first transformed by the square root of ($x = 0.5$) where x is an individual sample observation. Arithmetic means are presented (Tables 1 and 2). Significant differences among treatment means were determined using the Waller–Duncan

Table 1. Means ± SE per attic module of *C. brevis* nuptial chambers, dealates in chambers, chambers with at least one male and one female dealate, and chambers with brood in control and chemically treated attic modules infested April–June 1998 and disassembled December 1998

Treatment	g(AI)	No. nuptial chambers	Live dealates in chambers	Chambers containing ≥1♂ + 1♀	Chambers containing brood
Control (air)		20.3 ± 1.02b	7.3 ± 1.08a	2.5 ± 0.37a	2.7 ± 0.56a
Control (water)		29.8 ± 3.31a	9.8 ± 2.24a	3.5 ± 0.73a	2.3 ± 0.94ab
DOT solution	5.15	21.1 ± 2.34b	4.3 ± 1.22b	1.4 ± 0.40b	1.1 ± 0.41bc
DOT solution	10.3	22.8 ± 3.08b	3.7 ± 1.40b	1.5 ± 0.54b	1.4 ± 0.62b
DOT dust	2.6	2.5 ± 0.97c	0 ± 0c	0 ± 0c	0 ± 0c
DOT dust	13.2	2.9 ± 1.16c	0 ± 0c	0 ± 0c	0 ± 0c
Imidacloprid dust	0.001	0.4 ± 0.24	0 ± 0	0 ± 0	0 ± 0
Treatment effects statistics:					
F		61.55	19.31	17.33	6.12
df1		5	5	5	5
df2		53	48	48	53
P		0.0001	0.0001	0.0001	0.0002

Means of 10 attic modules (five insulated and five uninsulated) except for imidacloprid dust for which only uninsulated modules were tested. Means within a column followed by the same letter are not significantly different by the Waller–Duncan Bayesian *k*-ratio *t*-test ($k = 100$, $P = 0.05$).

Bayesian *k*-ratio *t*-test ($k = 100$, $P = 0.05$) (SAS Institute 1989).

Colonization site preference by dealates within modules was determined using combined 1998 and 1999 data for water- and air-treated modules. Only chambers containing at least one live dealate were included in the chi-square analysis (SAS Institute 1989). Four module colonization sites were designated as follows: the top crevices nearest the room light, the middle, the bottom, and the ground crevices nearest the segregation trays (Fig. 1). Each module contained a mirror-image pair for each location. Counts of these pairs were combined before analysis.

Results and Discussion

Cryptotermes brevis again proved to be an ideal species for conducting colony foundation and prevention studies because alates readily fly indoors and are attracted to artificial light (Scheffrahn et al. 1998). Considering the synanthropic nature of this species, all conditions in this study constituted a true field experiment. The flight and courtship behavior of *C. brevis* observed by us agrees with those reported by Minnick (1973) who collected alates in light traps during crepuscular swarms in Florida in May and June. In both 1998 and 1999, the first alates were captured in the water trap during the last week of April with flights peaking in mid-May and ending in early June (Fig. 2). A total of 7,304 and 6,454 dead dealates was recorded in December 1998 and 1999, respectively, on all trays and on all modules outside of nuptial chambers. It was estimated that at least that many more alates had flown in the laboratory room during their respective flight seasons as many dead alates were observed in other areas of the room but could not be accurately counted.

For 1998 and 1999, significant effects ($F = 29.94$; $df = 1, 59$; $P = 0.0001$; and $F = 16.02$, $df = 1, 71$, $P = 0.002$, respectively) were observed for nuptial cham-

Table 2. Means ± SE per attic module of *C. brevis* nuptial chambers, dealates in chambers, chambers with at least one male and one female dealate, and chambers with brood in control and chemically treated attic modules infested April–June 1999 and disassembled December 1999

Treatment	g(AI)	No. nuptial chambers	Live dealates in chambers	Chambers containing ≥1♂ + ≥1♀	Chambers containing brood
Control (air)		18.9 ± 3.75a	7.0 ± 1.90a	3.1 ± 0.80a	2.0 ± 0.56a
Control (water)		18.6 ± 2.71a	6.8 ± 1.95a	2.9 ± 0.82a	1.1 ± 0.35b
DOT solution[a]	15.7	9.0 ± 2.24b	0.3 ± 0.3b	0.1 ± 0.1b	0 ± 0c
DOT dust	0.74	5.3 ± 1.40c	0 ± 0b	0 ± 0b	0 ± 0c
DOT dust	1.47	2.6 ± 0.73cd	0 ± 0b	0 ± 0b	0 ± 0c
Imidacloprid dust	0.001	1.9 ± 0.91d	0.2 ± 0.20b	0.1 ± 0.10b	0 ± 0c
Imidacloprid dust	0.0005	1.8 ± 0.55d	0.2 ± 0.20b	0.1 ± 0.10b	0.1 ± 0.10c
Silica gel/pyrethrins	0.51	0 ± 0e	0 ± 0b	0 ± 0b	0 ± 0c
Treatment effects statistics:					
F		31.48	22.93	21.34	16.56
df1		7	7	7	7
df2		71	64	64	64
P		0.0001	0.0001	0.0001	0.0001

Means of 10 attic modules (five insulated and five uninsulated). Means within a column followed by the same letter are not significantly different by the Waller–Duncan Bayesian *k*-ratio *t*-test ($k = 100$, $P = 0.05$).

[a] Treatment covered all surfaces of module before installing insulation to simulate a construction-phase treatment of exposed wood framing.

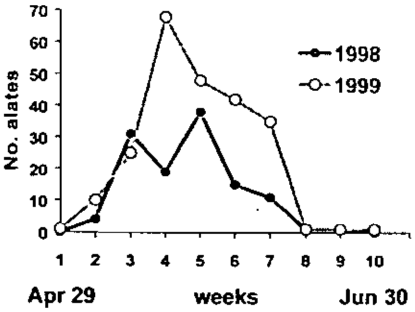

Fig. 2. Weekly water-trap catches of *C. brevis* alates.

ber formation due to insulation. For 1999, a significant effect (F = 4.82; df = 1, 64; P = 0.0318) also was observed for chambers with at least one male and one female. Because no other significant effects due to insulation were detected for variables such as number of chambers, live dealates, heterosexual pairs, and brood, the data for insulated and uninsulated modules were combined by treatments (n = 10) and treatment effects analyzed by ANOVA. In both 1998 and 1999, the effect of attic module treatments was highly significant for all colonization parameters measured, including number of chambers, live dealates, heterosexual pairs, and brood (Tables 1 and 2). Two types of nuptial chambers were usually encountered, those that were empty and those that contained live or dead dealates. The empty chambers mostly consisted of small surface excavations 0.5–1 mm in depth and a few millimeters in width. Chambers containing live dealates and especially live brood were larger and deeper; up to 21 mm in width and 8 mm in depth. These also usually contained pellets, although in some cases pellets had been expelled outside of the chambers.

Chamber locations were not equally distributed among colonization sites in attic modules (χ^2 = 59.83, df = 3, P = 0.001). Almost all nuptial chambers were found in the eight crevices forming the junctures between the 2 by 4 boards (see Fig. 1 for crevice locations). Of 145 total chambers with at least one live dealate, 37 were associated with the top crevices, 18 with the middle, 16 with the bottom, and 74 with the ground crevices. This preference for the top and bottom crevices suggests that dealates may have two selection strategies for colonization sites: one for a location furthest from the light source (ground) and one for the first crevice encountered after dealation (top).

For the 1998 study, the air and water controls contained 20.3 ± 1.02 (mean ± SE) and 29.8 ± 3.31 nuptial chambers, 7.3 ± 1.08 and 9.8 ± 2.24 live imagos, and 2.7 ± 0.56 and 2.3 ± 0.94 chambers with brood, respectively, indicating that the attic modules performed well as a colonizing platform for *C. brevis* (Table 1). In 1998, DOT dust treatments at both concentrations were 100% effective in preventing *C. brevis* colonization and they reduced chamber construction in attic modules by 89% compared with all controls. Imidacloprid dust was also 100% effective in

preventing colony foundation, but this
based on only five uninsulated attic modul
fore, imidacloprid dust was not included i
ysis. Although attic modules treated with
tions contained significantly fewer live
heterosexual pairs, and combinations of
pared with control treatments, colonizatio
completely prevented by top-sprayed DO
applications as was previously reported by
et al. (1998) with the small block bioassay.
we conclude that the bioassay design and
critical elements for testing the field effica
onization-preventing treatments.

For the 1999 study, the air and water co
tained a mean of 18.9 ± 3.75 (mean ± SE)
2.71 nuptial chambers, 7.0 ± 1.90 and 6.8
imagos, and 2.0 ± 0.56 and 1.1 ± 0.35 cham
brood, respectively (Table 2). In 1999, al
treatments had significantly fewer nuptial
and live termites than the two control t
Again both DOT dust treatments were 100
in preventing *C. brevis* colonization and the
chamber construction in attic modules by
pared with controls even though the rate o
was reduced 1.7- and 3.5-fold from the lov
1998. The silica gel/pyrethrin treatments pre
successful colonization as well as complete
ing nuptial chamber construction. The im
dust treatments reduced chamber construct
els at or below DOT treatments. However
modules treated with imidacloprid dust, o
lated module (0.001 g [AI]) had a live he
pair and one uninsulated module (0.0005 g)
heterosexual pair with a brood of one secon
third instar. The amount of active ingredie
the imidacloprid treatments was the lowest
all treatments.

In 1999, the DOT solution treatments, ap
module surfaces before insulating, yield
cantly fewer nuptial chambers than con
ments and reduced live termites in chambe
equal to the dust treatments. As a result
coverage, the amount of DOT used on simu
construction treatments (Table 2) was 1.5
higher than postconstruction applications o
lutions (Table 1). We hypothesize that al
mulations (DOT and imidacloprid) were
because dealates readily contacted lethal qu
dust while searching for colonization sites i
construct nuptial chambers. Results of this
dicate that dust deposits be used in attics
tural voids for commercial postconstruct
ments for preventing drywood termite col
Postconstruction deposits of DOT solutions
as effective in preventing colonization be
deposits were not dislodgeable; however, so
posits nevertheless reduced colonization e
dislodgeability (i.e., degree of availability
dust is important in ensuring that dealates
lethal deposit while searching for a coloni
because DOT is relatively low in toxicity t
termites compared with other chemicals (S

et al. 1997). Treatment of all module surfaces with DOT solutions inhibited colonization by *C. brevis*, suggesting that similar treatment of wood framing of structures during construction should greatly reduce or eliminate the likelihood of infestation by drywood termites.

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Redescriptions of the Dampwood Termites *Neotermes jouteli* and *N. luykxi* (Isoptera: Kalotermitidae) from Florida, Cuba, Bahamas, and Turks and Caicos Islands

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ABSTRACT Two species of dampwood termites, *Neotermes jouteli* (Banks) and *N. luykxi* Nickle & Collins, are redescribed based on the imago and the small and large soldier caste. Morphological characters are reported to separate the above castes of these two species. *N. jouteli* occurs in southeastern Florida, the central Bahamas, Cuba, and Mexico. *N. luykxi* is endemic to southeastern Florida, the Bahamas, and Turks and Caicos Islands, but is apparently absent from Cuba. A key to the *Neotermes* found sympatrically with *N. luykxi* is given.

KEY WORDS *Neotermes jouteli*, imagos, soldiers, taxonomy, West Indies, Caribbean

The genus *Neotermes* Holmgren 1911 comprises the largest taxon of the family Kalotermitidae with ≈100 described species (Krishna 1961, Ernst and Araujo 1986, Huang et al. 1989, Constantino 1998). *Neotermes* species are commonly called dampwood termites owing to their higher moisture requirements compared with some structure-infesting drywood species in the genera *Incisitermes* and *Cryptotermes*. *Neotermes* colonies usually live in substantial standing or fallen wood. Galleries occasionally extend from dead tree branches to penetrate xylem elements within live cambium. When infesting structures, *Neotermes* spp. are associated with wood exposed to free water (Scheffrahn et al. 1988, 1990). Five species of *Neotermes* have been described from Florida, the Greater Antilles, Bahamas and associated islands. These include *Neotermes castaneus* (Burmeister), *N. cubanus* (Snyder), *N. jouteli* (Banks), *N. luykxi* Nickle & Collins, and *N. mona* (Banks). *Neotermes mona* has recently been redescribed by the authors (unpublished data).

Luykx and Syren (1979) and Luykx et al. (1990) used chromosome characters to determine that specimens previously identified as *N. jouteli* actually consist of two distinct karyotypes. Compelled by these karyotypic differences, Nickle and Collins (1989) described *N. luykxi* based on specimens collected in southeastern Florida. A comparison of measurements selected for *N. jouteli* and *N. luykxi* by Nickle and Collins (1989) yielded widely overlapping ranges in the soldier caste, and the authors reported no qualitative differences with which to separate soldiers or imagos of these species. They did, however, show that the imago of *N. luykxi* is consistently smaller than that of *N. jouteli*. Nickle and Collins (1989) reported the most significant difference between the two species was chromosome number. Unfortunately, chromosome-staining techniques cannot be applied to alcohol-preserved specimens and these preparations require functional reproductives (Luykx and Syren 1979). In the light of this morphological ambiguity and the recent acquisition of extensive new collections, we provide herein redescriptions, comparative diagnoses, and new distribution records of *N. jouteli* and *N. luykxi*.

Materials and Methods

Redescriptions are based on examination of 276 colony samples (155 for *N. jouteli* and 121 for *N. luykxi*), all in the authors' collection, including 52 samples from Florida, 151 from the Bahamas (North Andros, Cat, Gorda Cay, Grand Bahama, Great Inagua, New Providence, North Cat Cay, and San Salvador), three from the Turks and Caicos (Providenciales Island) Islands, and 93 from Cuba and associated islands (Isla de la Juventud, Cayo Anclito, and Cayo Conuco).

Morphometric data from 85% alcohol-preserved specimens were obtained using a stereomicroscope fitted with an ocular micrometer. Measurements were partly adopted from Roonwal (1970). Eye height is defined as the maximum lateral width of the imago eye when viewed from the dorsal aspect. The color scheme of Sands (1965) was used with relevant modifications. The terms "small," and "large" soldiers (Krishna 1961) are equal to the terms "short-headed" and "long-headed" soldiers (Banks and Snyder 1920), respectively. These terms are used to separate the two common size morphs of soldiers occurring within some kalotermitid species. Scanning electron micrographs (SEMs) were taken with a Hitachi S530 instrument at 20kV of specimens that were dehydrated in absolute ethanol and 1,1,1,3,3,3-hexamethyldisilazane

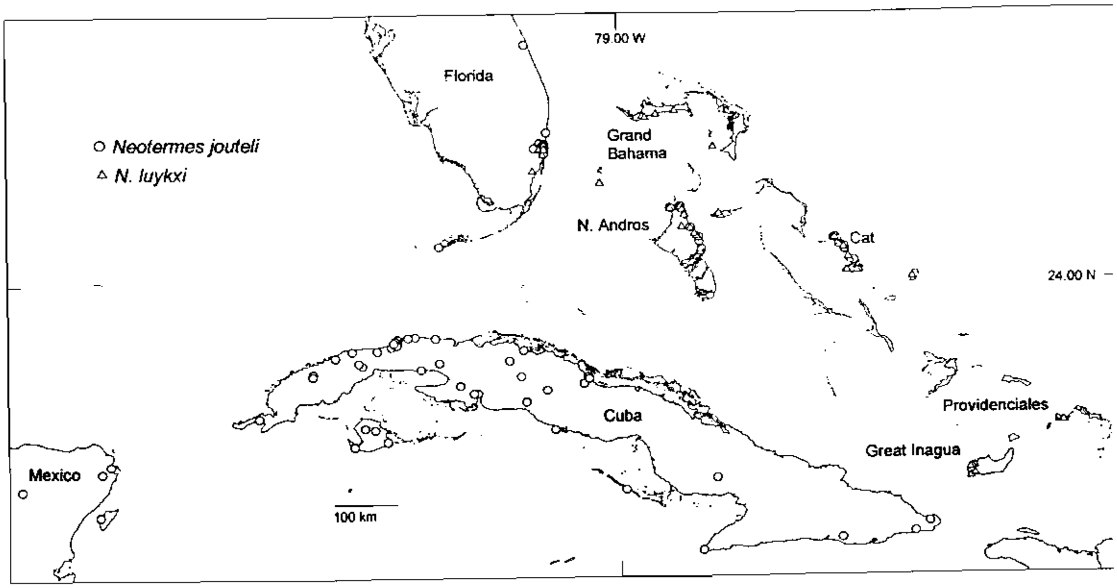

Fig. 1. Localities and distribution of *N. jouteli* and *N. luykxi* in Florida and the West Indies from authors' collection. *jouteli* is also reported from central and southern Mexico (see text).

(Nation 1983) and then sputter-coated with platinum. SEMs were digitized at 600 dpi, the resultant image outline traced using photograph-enhancing software (Photo Magic, Micrografx, Richardson, TX), the background converted to black, and the scale bar redrawn. Collection localities were mapped (Fig. 1) using ArcView GIS version 3.0a software and relevant map data from Digital Map of the World version 1.0 (Environmental Systems Research Institute, Redlands, CA).

Key to the Species of *Neotermes* from Florida, the Bahamas, Cuba, and the Turks and Caicos Islands

Soldiers.

1. Eyes darkly pigmented 2
- Eyes unpigmented or faintly pigmented . . . 4
2. Smaller species, maximum head width of large soldiers ≤2.70 mm, left mandible length ≤2.42 mm; pilosity of head capsule sparse 3
- Larger species, maximum head width of large soldiers ≥2.87 mm, left mandible length ≥2.54 mm; frons and anterior vertex with dense pilosity . . . . *N. mona*
3. Antennal carinae rugose and markedly protruded; eyes elongate, without satellite facets; setae on basal mandibular humps distinct. . . . . *N. jouteli*
- Antennal carinae smooth and only moderately protruded; eyes subcircular, with satellite facets; setae on basal mandibular humps vestigial or absent . . . . *N. luykxi*
4. Head pigmentation robust, reddish; mandibles almost black, only bases faintly less pigmented; soldiers caste dimorphic; large soldier with very swollen femora, third antennal article clavate and darker than distal articles; pronotum ≈1.5× wider than long; pronotum margins are not raised . . . . *N. cuban*
- Head pigmentation pale, orange-yellow; mandibles almost black distally, but much paler ferruginous at bases; soldier caste monomorphic; femora not obviously swollen; third antennal article, not clavate, similar to second and fourth, and concolorous with distal articles; pronotum >2× wider than long; anterolateral margins of pronotum raised . . . . . *N. castan*

Imagos.

1. Head and pronotum sparsely covered with short (≈0.05-mm-long) setae . . . .
- Head and pronotum variably covered with long (0.2–0.4-mm-long) setae . . . .
2. Larger species; head width at eyes ≥1.59 mm fore wing maximum width ≥3.13 mm. Eye larger; 0.45–0.54 mm maximum diameter height 0.21–0.28 mm. Frons rugose; mandibular bases striate; frons surrounded by slightly elevated ridge . . . . *N. jou*
- Smaller species; head width at eyes ≤1.52 mm fore wing maximum width ≤3.10 mm. Eye smaller; 0.38–0.42 mm maximum diameter height 0.13–0.18 mm. Frons and mandibular bases smooth; frons without ridge . . *N. lu*
3. Compound eyes very large, diameter ≥0.57 mm . . . . *N. m*
- Compound eyes moderately large, diamete ≈0.40–0.54 mm . . . .
4. Setae on head and pronotum ≈0.2 mm long . . . . *N. casta*
- Setae on head and pronotum ≈0.4 mm long . . . . *N. cuba*

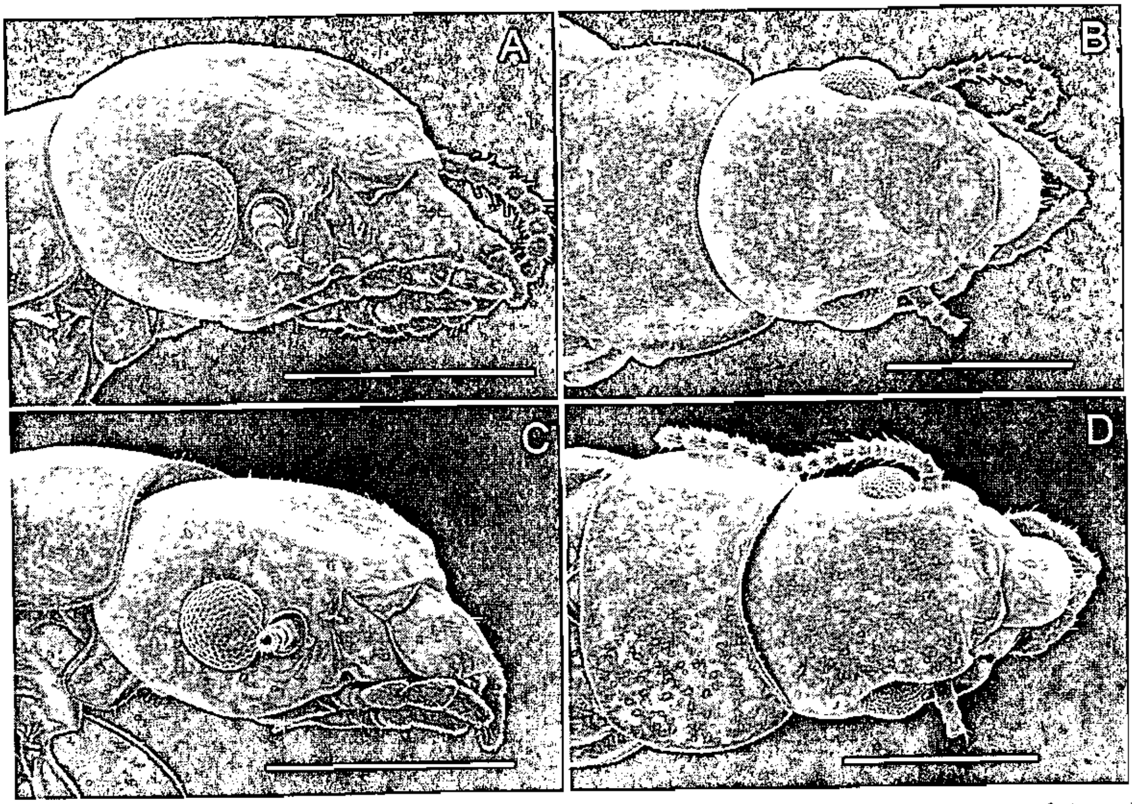

Fig. 2. Scanning electron micrographs of *Neotermes* imago heads. Oblique (A, C) and dorsal (B, D) views of *N. jouteli* (A, B) from Dania, FL, and *N. luykxi* (C, D) from Ft. Lauderdale, FL, respectively. Right antennae beyond third article removed for clarity. Scale bars = 1 mm.

Neotermes jouteli (Banks)
(Fig. 2 A and B; 3 A and C; and 4 A and C)

Kalotermes jouteli Banks: Banks and Snyder 1920 [imago, soldier].

Neotermes jouteli: Krishna 1961.

Neotermes jouteli: Nickle & Collins 1989 [imago, soldier].

Imago (Fig. 2 A–B; Table 1). General coloration almost uniformly ferruginous orange, except for ferruginous head and chestnut brown postclypeus, anterior frons, and exposed portion of mandibles. In older kings and queens, anterolateral corners of head capsule dark or very dark chestnut brown. Anteclypeus yellowish. Antennae ferruginous orange except for three ferruginous basal articles. Compound eyes almost black. Chevron pattern on pterothorax faint. Femora whitish; tibiae pale chestnut brown.

In dorsal view, head capsule slightly suboval, with sides subrectate and converging to front; posterior of head capsule widely rounded; frons moderately concave in oblique view with transverse striations on triangular depression abutting clypeus. In lateral view, frons plane angled ≈15° from plane of anterior vertex. Pilosity of head capsule and pronotum scarce and very short. Compound eyes relatively large; subcircular, with subrectate margin abutting antennal sockets. Ocular sclerites narrow. Ocelli noticeably protruding, comparatively large, oval, contacting or slightly removed from eyes; converging to anterior in dorsal view. Mandibular bases with faint striations. Vertex with very shallow and round depression centered at intersection of epicranial suture. Anterolateral corners of head slightly raised dorsally. Areas between antennal sockets and frons striated and forming bases of a slight, semicircular ridge encompassing frons and separating frons from depression of vertex. Head capsule and pronotum with microstriations, giving mat appearance to those structures. Antennae with 15–19 articles, usually 18 or 19; antennal formula variable because of inconsistent second and third articles, but usually 2 > 3 > 4 = 5. Pronotum ≈2 times wider than median length. Anterior margin of pronotum shallowly concave or weakly incised; sides subrectate, converging to the posterior or subparallel; posterior margin faintly concave. Anterior and lateral margins of pronotum raised. Anterior wings with long subcosta running approximately one-third wing length from suture; radius extending approximately two-thirds of wing length from suture. Radial sector with 3–5 branches. Media heavily sclerotized with several weak bilateral branches. Wing membrane with very faint nodulations. Arolia present; apically pigmented in older kings and queens.

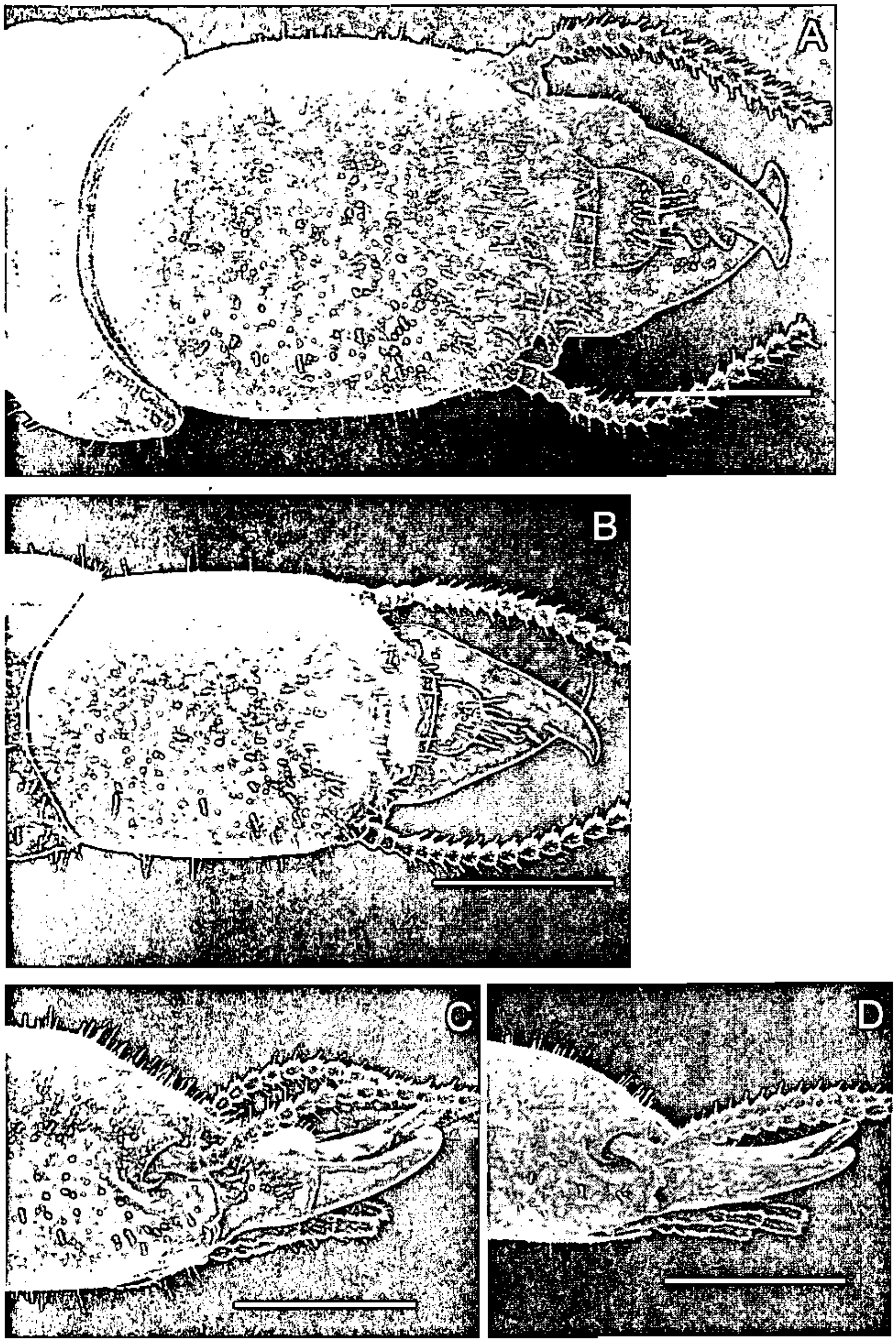

Fig. 3. Scanning electron micrographs of *Neotermes* small soldier heads. Dorsal (A, B) and lateral (C, D) views of *N.* (A, C) from Dania, FL, and *N. luykxi* (B, D) from Ft. Lauderdale, FL, respectively. Scale bars = 1 mm.

Small Soldier (Fig. 3 A and C; Table 2) Head capsule, labrum, and antennal flagella beyond third article ferruginous orange. Anterior frons, postclypeus, frontal, and antennal carinae, and three proximal antennal articles slightly darker ferruginous in about half the specimens. Remaining specimens almost concol with ferruginous orange vertex. Anteclypeus wl Mandibles almost black distally, dark to very chestnut brown at base. Epicranial suture ves only posterior fragment of posterior branch pres

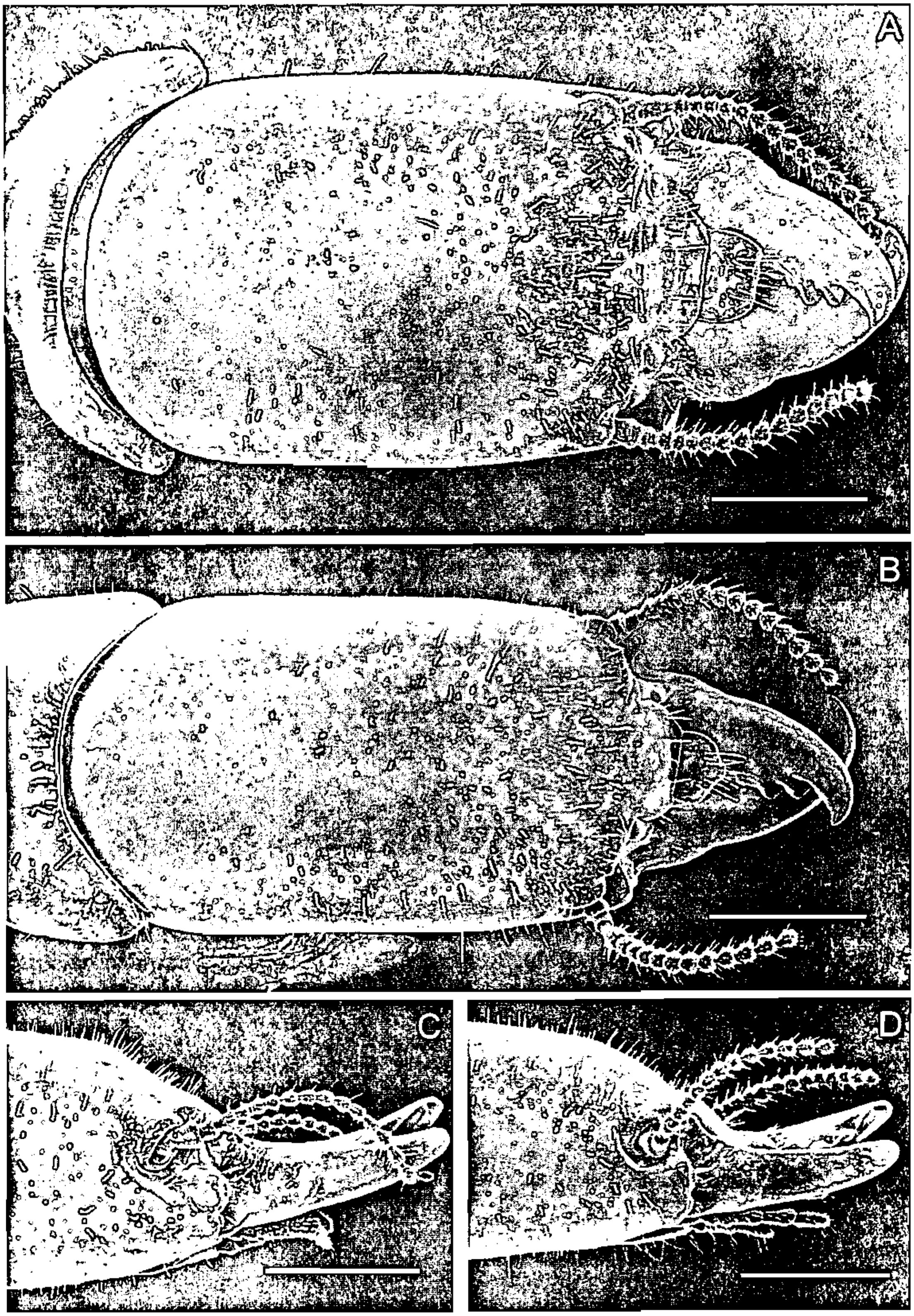

Fig. 4. Scanning electron micrographs of *Neotermes* large soldier heads. Dorsal (A, B) and lateral (C, D) views of *N. jouteli* (A, C) from Dania, FL, and *N. luykxi* (B, D) from Ft. Lauderdale, FL, respectively. Scale bars = 1 mm.

Table 1. Measurements of *Neotermes jouteli* and *N. luykxi* imagos, $n = 5$ males, 5 females from 6 colonies for each

Measurement, mm	*N. jouteli*		*N. luykxi*	
	Range	Mean ± SD	Range	
Head length with labrum	1.77–2.16	1.98 ± 0.12	1.67–1.89	
Head length to postclypeus	1.34–1.54	1.43 ± 0.063	1.24–1.41	
Head width, max at eyes	1.59–1.81	1.68 ± 0.071	1.39–1.52	
Head height w/o postmentum	0.88–1.05	0.96 ± 0.053	0.82–0.88	
Labrum width, max	0.60–0.70	0.65 ± 0.031	0.49–0.56	
Eye max diameter w/sclerite	0.45–0.54	0.49 ± 0.027	0.38–0.42	
Eye height	0.21–0.28	0.26 ± 0.022	0.13–0.18	
Eye sclerite to head base, min.	0.26–0.34	0.30 ± 0.029	0.19–0.25	
Ocellus diameter, max	0.17–0.22	0.19 ± 0.016	0.15–0.18	
Ocellus diameter, min.	0.14–0.17	0.15 ± 0.012	0.12–0.15	
Eye sclerite to ocellus, min	0.0–0.03	0.01 ± 0.012	0.02–0.04	
Pronotum, max length	1.06–1.32	1.20 ± 0.095	1.03–1.26	
Pronotum, max width	1.75–2.05	1.92 ± 0.10	1.40–1.81	
Total length with wings	13.92–16.05	14.89 ± 0.69	12.50–14.34	1
Total length without wings	7.95–9.66	8.73 ± 0.51	7.10–9.66	
Fore wing length from suture	10.37–11.79	11.22 ± 0.56	9.23–10.37	
Fore wing, max width	3.13–3.79	3.33 ± 0.23	2.60–3.10	

some specimens. Pronotum ferruginous orange, with narrow darker border. Femora yellow-white, remainder of body pale ferruginous orange, almost concolorous with pronotum. Postmentum ferruginous contrasting with ferruginous orange genae.

In dorsal view, head capsule short, subsquare, barely longer than wide, and with slightly convex sides; head evenly rounded in posterior, except for narrow rectate occipital margin in some individuals. Frons flattened, with scanty, faint, and transverse striations between dorsal mandibular condyles. Frontal carinae, between antennal fossae and dorsal mandibular condyles, bearing single, acutely pointed tubercle near their middle. Labrum widely linguiform when extended, with subparallel or distally slightly divergent sides; apex evenly rounded, not inflated or convoluted. Mandibles long

and with basal humps; humps adorned w
spaced setae. Lateral margins of mandib
straight beyond humps; apical one-fourth bey
moderately curved; dentition on both manc
spicuous. Left apical tooth (i.e., mandible tip b
marginal tooth) ≈2 times longer than its wic
Antennae with 15–17 articles, usually 16; tl
slightly elongated, subclavate; articles bey
moniliform or slightly elongated; relative l
mula $2 < 3 > 4 = 5$. Antennal carinae
protruding and rugose. Pronotum wide and
terior margin of pronotum usually deeply c
incised; sides of pronotum subparallel or fa
vex; posterior margin moderately convex
subrectate median margin. All soldiers with
wing pads; pads more pronounced on met

Table 2. Measurements of *Neotermes jouteli* and *N. luykxi* small soldiers, $n = 10$ from 7 colonies for each species

Measurement, mm	*N. jouteli*		*N. luykxi*
	Range	Mean ± SD	Range
Head length to tip of mandibles	3.66–4.60	4.03 ± 0.29	3.07–3.66
Head length to postclypeus	2.48–3.12	2.72 ± 0.20	2.18–2.52
Head width, max	2.12–2.35	2.23 ± 0.073	1.68–2.07
Antennal carinae, outside span	1.93–2.25	2.03 ± 0.11	1.48–1.83
Head height, w/o postmentum	1.38–1.67	1.54 ± 0.096	1.18–1.46
Labrum, max width	0.59–0.70	0.64 ± 0.032	0.43–0.54
Postclypeus width, max	0.82–0.90	0.85 ± 0.038	0.67–0.82
Left mandible length, tip to most distant visible point of ventral condyle	1.85–2.32	2.01 ± 0.14	1.50–1.75
Overlap of closed mandible tips	0.44–0.74	0.58 ± 0.090	0.29–0.54
Postmentum, median length	1.58–2.24	1.87 ± 0.18	1.52–1.91
Postmentum, max width	0.70–0.85	0.77 ± 0.056	0.62–0.77
Postmentum, min. width	0.44–0.52	0.48 ± 0.027	0.33–0.44
3rd antennal article length	0.16–0.23	0.20 ± 0.023	0.12–0.16
3rd antennal article width, max	0.14–0.16	0.15 ± 0.0064	0.12–0.15
3rd antennal article width, min.	0.07–0.10	0.08 ± 0.084	0.07–0.08
Scape length	0.26–0.29	0.28 ± 0.011	0.22–0.26
Eye diameter, max	0.20–0.28	0.23 ± 0.023	0.10–0.16
Pronotum, max width	2.35–2.74	2.50 ± 0.13	1.80–2.32
Pronotum, max length	1.40–1.65	1.49 ± 0.085	1.02–1.44
Hind tibia length	1.54–1.72	1.61 ± 0.064	1.14–1.46
Hind femur length	1.37–1.64	1.48 ± 0.089	1.13–1.39
Hind femur width, max	0.56–0.74	0.62 ± 0.062	0.38–0.61
Abdomen width, max	2.10–2.49	2.30 ± 0.16	1.48–2.39
Total length	8.66–11.64	9.70 ± 1.04	7.67–10.51

Table 3. Measurements of *Neotermes jouteli* and *N. luykxi* large soldiers, $n = 10$ for each species representing 9 colonies of *N. jouteli*, and 8 colonies of *N. luykxi*

Measurement, mm	*N. jouteli*		*N. luykxi*	
	Range	Mean ± SD	Range	Mean ± SD
Head length to tip of mandibles	4.90–5.56	5.16 ± 0.22	4.16–5.40	4.82 ± 0.44
Head length to postclypeus	3.47–4.01	3.71 ± 0.19	2.97–4.06	3.55 ± 0.42
Head width, max	2.34–2.70	2.52 ± 0.090	1.85–2.47	2.15 ± 0.22
Antennal carinae, outside span	2.24–2.47	2.39 ± 0.078	1.73–2.17	1.96 ± 0.16
Head height, w/o postmentum	1.81–1.93	1.87 ± 0.044	1.40–1.87	1.61 ± 0.17
Labrum, max width	0.64–0.74	0.67 ± 0.029	0.46–0.56	0.52 ± 0.036
Postclypeus width, max	0.96–1.05	1.01 ± 0.038	0.82–0.93	0.87 ± 0.039
Left mandible length, tip to most distant visible point of ventral condyle	2.17–2.42	2.28 ± 0.080	1.77–2.09	1.92 ± 0.11
Overlap of closed mandible tips	0.52–0.83	0.70 ± 0.12	0.42–0.74	0.57 ± 0.12
Postmentum, median length	2.41–2.84	2.64 ± 0.16	2.27–3.23	2.75 ± 0.32
Postmentum, max width	0.85–0.95	0.90 ± 0.034	0.70–0.93	0.81 ± 0.078
Postmentum, min width	0.47–0.62	0.53 ± 0.043	0.31–0.49	0.38 ± 0.051
3rd antennal article length	0.15–0.23	0.21 ± 0.026	0.14–0.19	0.16 ± 0.015
3rd antennal article width, max	0.15–0.16	0.16 ± 0.0054	0.13–0.17	0.15 ± 0.0013
3rd antennal article width, min.	0.09–0.11	0.09 ± 0.0057	0.07–0.09	0.08 ± 0.0055
Scape length	0.29–0.37	0.32 ± 0.030	0.23–0.28	0.25 ± 0.018
Eye diameter, max	0.22–0.31	0.25 ± 0.033	0.08–0.17	0.13 ± 0.026
Pronotum, max width	2.61–3.03	2.83 ± 0.11	2.03–2.72	2.33 ± 0.23
Pronotum, max length	1.71–1.85	1.79 ± 0.046	1.32–1.81	1.52 ± 0.17
Hind tibia length	1.68–1.93	1.81 ± 0.070	1.31–1.67	1.50 ± 0.12
Hind femur length	1.61–1.77	1.69 ± 0.049	1.31–1.64	1.46 ± 0.12
Hind femur width, max	0.77–0.96	0.87 ± 0.064	0.62–0.95	0.76 ± 0.12
Abdomen width, max	2.31–2.90	2.54 ± 0.18	1.85–2.74	2.20 ± 0.33
Total length	10.22–13.35	11.56 ± 0.97	9.09–11.36	10.44 ± 0.80

In lateral view, head capsule slightly dorso-ventrally flattened; frons plane slopes ≈20° from plane of vertex; mandibles moderately curved upward; eyes almost black, large, dorsoventrally elongated; without peripheral satellite facets. Postmentum slightly to moderately constricted near middle. Pilosity of frons and anterior vertex more dense than on occiput. Hind femora swollen.

Large Soldier (Fig. 4 A and C; Table 3) Head capsule, labrum, and antennal flagellum beyond third article ferruginous orange. Anterior frons, postclypeus, frontal, antennal carinae, and three proximal antennal articles slightly darker, ferruginous. Anteclypeus yellowish. Mandibles glossy, pitch black, with very dark chestnut brown bases. Epicranial suture faint, with bifurcation usually absent. Vestigial evidence of pale reticulation very near and along posterior branch of epicranial suture. Darker ferruginous postmentum contrasting with ferruginous orange genae. Pronotum and remainder of tergum slightly paler and with less reddish tinge than vertex, pale ferruginous orange, and with fine, but distinctly darker margin. Femora yellow-white. Sternum pale ferruginous orange.

In dorsal view, head capsule moderately elongate, subrectangular, with sides subparallel; head evenly rounded in posterior corners and subrectate or shallowly emarginate along medium edge of occiput edge. Frons flattened or slightly concave, with few, moderate, and transverse striations between and posterior to dorsal mandibular condyles. Frontal carinae, between antennal fossae and dorsal mandibular condyles, bearing single, blunt, or acutely pointed tubercle near their middle. Labrum subcircular when retracted, linguiform when extended, and with subparallel sides; apex not inflated. Mandibles short in comparison to head capsule length, massive, each with a moderate basal hump; humps covered dorso-laterally with evenly spaced, ≤0.11 mm long setae on faintly wrinkled surface. Lateral margins of mandibles each gradually curving beyond humps, then curving abruptly at apex; dentition on both mandibles massive, left apical tooth ≈2 times longer than its width at base. Angle between anterior margin of first right marginal tooth and inner margin of apical tooth >90°. Antennae with 12–18 articles, usually 16 or 17; third antennal article subclavate, with slightly variable length, and with antennal articles beyond usually moniliform or elongated; relative length formula usually $2 < 3 > 4 = 5$. Antennal carinae markedly protruding and rugose. Pronotum much wider than long. Anterior margin of pronotum deeply concave or incised; sides of pronotum subparallel or faintly convex; posterior margin moderately convex; median posterior margin subrectate or very faintly emarginate. All soldiers with very short wing pads; pads more pronounced on metanotum.

In lateral view, head capsule slightly dorso-ventrally flattened; frons plane sloping ≈20° from plane of vertex; mandibles moderately curved upward; eyes almost black, usually dorsoventrally elongated or subcircular, without peripheral satellite facets. Pilosity of frons and anterior vertex more dense than on occiput. Hind femora swollen. In ventral view, postmentum with slight to moderate median constriction.

Material Measured. FLORIDA: Broward Co.: Dania, John Lloyd State Park; 26.07° N, 80.12° W; 10-II-1993; R. Scheffrahn and A. van Liempt; 2 alates, 1 designated as neotype and 1 for SEM, 1 large soldier, 1 for SEM (FL187). Same locality: 15-II-1999, B. Maharajh, J. Krecek; 2 small soldiers, 1 for SEM, 1 large soldier (FL557). Broward Co.: Fort Lauderdale: H. T. Birch State Park: 26.13° N, 80.18° W; 10-XI-1987; Scheffrahn; 2 alates (FL209), and 1 small soldier (FL216). Broward Co.: Davie: Tree Tops Park: 26.07° N, 80.28° W; 10-IX-1995; Krecek; 1 alate (FL561). Monroe Co.: Key West, mangroves near airport: 24.56° N, 81.76° W; 20-X-1994; Scheffrahn, Krecek; 1 small soldier, 1 large soldier (FL558, FL559). Same locality, 1 large soldier (FL560). BAHAMAS: All samples collected by J. Chase, Krecek, J. Mangold, J. de la Rosa, and Scheffrahn. Cat Island: lake shore near Thurston Hill: 24.55° N, 75.63° W; 26-V-1995; 1 small, and 2 large soldiers (BA34). 1 km SE of Douds: 24.27° N, 75.40° W; 27-V-1995; 1 queen (BA53); Port Howe Area: 24.16° N, 75.33° W; 27-V-1995; 2 small soldiers and 1 large soldier (BA82). 1 km S of Bain Town: 24.65° N, 75.72° W; 28-V-1995; 1 small and 1 large soldier (BA142). 2 km E of Bluff; 24.52° N, 75.57° W; 28-V-1995; 1 queen, and 2 small soldiers (BA170). North Andros Island: Behring Point: 24.48° N, 77.72° W; 30-V-1995; 1 small, 1 large soldier (BA227), 2 alates and 1 king (BA234).

Type Material. HOLOTYPE: soldier, catalog no. 21857 National Museum of Natural History, Washington, DC. All known types misplaced, mislabeled, or lost. NEOTYPE: female alate, inventory no. FL187 University of Florida, Fort Lauderdale Research and Education Center (see collection data above).

Distribution. FLORIDA: Monroe, Dade, Broward, St. Lucie, and Indian River Counties. BAHAMAS: Andros and Cat (new record) Islands. CUBA: including Isla de la Juventud (Scheffrahn et al. 1994), Cayo Anclitas, and Cayo Conuco (new records). MEXICO: Vera Cruz, Tampico and Vera Cruz (Banks and Snyder 1920); Sinaloa, Mazatlan and Socorro Island (Light 1933); Jalisco, Bara de Navidad and Chamela (Nickle and Collins 1988). New records all from Quintana Roo: Laguna Chankanah: 20.43° N, 87.00° W; 7-V-1997, J. Chase (MX001); Highway 295 at km 15: 20.824° N, 88.193° W; 7-XII-1997, J.A. Chase and J. R. Mangold (MX121); 16.5 km N. Punta Sam: 21.216° N, 86.832° W; 9-XII-1997, J. Chase and J. Mangold (MX163–164); Hwy 180, 292 km marker: 21.097° N, 86.969° W; 10-XII-1997, J. Chase and J. Mangold (MX193).

Remarks on Distribution. The range of *N. jouteli* is remarkably broad (eastern Cuba to Socorro Island, Mexico, ≈3,800 km). Reports of *N. jouteli* from the Dominican Republic (Harris 1955, Araujo 1977, Scheffrahn et al. 1994) are now attributed to a new species of *Neotermes* (unpublished data). Records from Trinidad and Tobago assigned to *N. jouteli* (Araujo 1977) are probably erroneous in light of extensive collections from these islands in recent years (R.H.S., unpublished data).

Neotermes luykxi Nickle & Collins
(Fig. 2 C and D, 3 B and D, and 4 B and D)

Neotermes luykxi Nickle & Collins 1989 [imago, soldier].

Imago (Fig. 2 C–D, Table 1). General coloration uniformly ferruginous orange; lacking darker highlights on head, postclypeus, frons, and exposed [
of mandibles. In older kings and queens, antero[
lobed corners of head capsule dark chestnut [
Anteclypeus yellowish. Antennae ferruginous [
except for three ferruginous basal articles. Con[
eyes almost black. Chevron pattern on pter[
faint. Femora whitish, tibiae pale chestnut br[

In dorsal view, head capsule slightly subova[
sides rectate and converging to front; posterior [
capsule widely rounded; frons smooth and very [
concave in oblique view. In lateral view, plane [
nearly continuous with plane of vertex. Con[
eyes relatively small; ocular sclerite wide. Ocel[
paratively small, always separated from eye[
faintly protruding. Mandibular bases withou[
tions. Vertex with shallow circular depressio[
tered at intersection of epicranial suture. Ant[
eral corners of head capsule very faintly lobb[
ridge encircling frons. Head capsule and pro[
surface with smooth, polished appearance. Ma[
with 17–19 articles, usually 18 or 19; antennal fo[
variable, usually 2 = 3 > 4 = 5 or 2 > 3 > 4 = [
of pronotum evenly convex; anterior margi[
faintly elevated. Anterior wings with long su[
running approximately one-third of wing lengt[
suture and radius ≈two-thirds of wing lengt[
suture. Radial sector with 3–5 branches. Media[
with faint and sporadic interconnecting veinlets[
membrane with very faint nodulations. Arolia p[

Comparisons. With the exception of the d[
from eye to ocellus, the means of all measure[
although overlapping, are greater for the alat[
jouteli compared with those of *N. luykxi*. Ther[
size overlap between species for head width [
maximum width of labrum, maximum eye dia[
width of fore wing, and eye height (Table 1[
postclypeus and frons of the *N. jouteli* imago is [
than surrounding structures while in *N. luyk*[
are concolorous. The frontal concavity is deep[
more rugose and the ocellus protrudes more and[
to be larger in *N. jouteli* than in *N. luykxi* wh[
ocullar sclerite is wider in *N. luykxi*. In *N. jout*[
mandibular bases are striated and the frons [
from the anterior vertex plane, while in *N. luyk*[
manidular bases are smooth and the frons is o[
plane with the anterior vertex.

Small Soldier. (Fig. 3 B and D; Table 2)[
capsule, labrum, and antennal flagellae beyon[
article ferruginous orange. Anterior frons, [
clypeus, frontal, and antennal carinae, and thre[
imal antennal articles slightly darker, ferrugin[
about half of specimens; in remaining specime[
most concolorous with ferruginous orange vert[
teclypeus whitish. Mandibles almost black d[
dark to very dark chestnut brown at bases. Epi[
suture vestigial, only fragment of posterior [
visible in some specimens. Pronotum ferrugin[
ange, without darker border or with very [
darker border in some specimens. Femora y[
white, remainder of body pale ferruginous [
almost concolorous with pronotum. Ferruginou[
mentum contrasting with ferruginous orange [

In dorsal view, head capsule short, subsquare, barely longer than wide, with sides slightly convex; head evenly rounded in posterior except for narrow rectate margin along median occiput in some specimens. Frons flat and without striations. Faint tubercle on frontal carinae usually blunt or absent. Labrum linguiform; apex of labrum inflated. Each mandibles long and slender, with lateral outline almost straight until slight curve of apical tooth. Each mandibles with very weak basal humps; pilosity on hump bases vestigial or absent. Dentition moderate; left apical tooth 1.5 times longer than its width at base. Antennae with 13–16 articles, usually 15 or 16; antennal formula variable, usually 2 = 3 > 4 = 5 or 2 > 3 > 4 = 5. One soldier from incipient colony with 10 articles. Antennal carinae smooth, moderately protruding. Eyes dark gray, large, subcircular; surrounded with peripheral satellite facets. Some individuals with very faint wing pads.

Comparisons. Small soldiers of *N. jouteli* and *N. luykxi* are more difficult to distinguish than their large soldiers counterparts; however, means of all measurements are greater in the former species (Table 2). Measurements of small soldiers of *N. jouteli* do not overlap with those of *N. luykxi* for the following characters: head width, span of antennal carinae, labrum width, left mandible length, eye diameter, pronotum width, and hind tibia length. In *N. jouteli* soldiers, the anterolateral border of the pronotum is darkened while in *N. luykxi* it is concolorous with the pronotal plate. Striation of the frons and postclypeus, present in *N. jouteli*, is absent in *N. luykxi*. In *N. jouteli*, the labrum is not inflated and the mandibles have distinct basal pilosity, while in *N. luykxi* the labrum is inflated and mandibles lack basal pilosity. Antennal carinae of *N. jouteli* are rugose, and markedly protruding; in *N. luykxi* they are smooth, and moderately protruding. The eyes of *N. jouteli* are elongated, and without satellite facets; in *N. luykxi* the eyes are subcircular and with numerous single satellite facets.

Large Soldier. (Fig. 4 B and D; Table 3). Head capsule, labrum, and antennae beyond third article ferruginous orange. Anterior frons, postclypeus, frontal, antennal carinae, and three proximal antennal articles darker, chestnut brown. Anteclypeus yellowish. Mandibles glossy, pitch black. Posterior branch of epicranial suture distinct with bifurcation absent or very faint. Remarkable pale reticulation on wide swath along posterior branch of epicranial suture. Pronotum with faintly darkened anterior margin. Postmentum ferruginous, contrasting with ferruginous orange genae. Femora yellow-white. Sternum pale ferruginous orange.

In dorsal view, head capsule subrectangular, considerably elongate, sides subparallel or very faintly constricted in middle; head capsule evenly rounded in posterior corners subrectate along occipital median. Frons flat or slightly concave; without or with faint striations. Faint or very faint single tubercles on frontal carinae. Labrum, when extended, onion-shaped in profile; apex faintly inflated in some individuals. Mandibles with broad terminal curvature; dentition moderate; mandibular apex (apical tooth) ≈1.5 times longer than its basal width. Base of mandibles humped, with vestigial, scarce, and unevenly dispersed setae ≤0.06 mm long; base of humps with almost no trace of wrinkling. Angle formed by inner margin of apical tooth and anterior margin of first right marginal tooth <90°. Antennae with 13–17 articles, usually 16; antennal formulae variable, but usually 2 < 3 > 4 = 5. Antennal carinae smooth, protruding moderately. Anterior margin of pronotum biconvex laterally and concave in middle; never incised. All large soldiers with minute wing pads on pterothorax of equal size.

In lateral view, head capsule moderately to markedly flattened dorso-ventrally. Eyes dark gray, small or faint, subcircular, unusually slightly elongated, and surrounded with remote satellite facets; facets faint. Eyes and satellite facets appear deeply imbedded in cuticle.

Comparisons. With the exception of the postmentum length, the means of all measurements, although overlapping in range, are greater for the large soldier of *N. jouteli* compared with that of *N. luykxi* (Table 3). Measurements of large soldiers of *N. jouteli* do not overlap with those of *N. luykxi* for the following characters: outside span of antennae carinae, labrum width, postclypeus width, left mandible length, scape length, eye diameter, and hind tibia length. Large soldiers of *N. luykxi* possess distinct reticulation along the posterior branch of the epicranial suture that is very faint in *N. jouteli*. The head capsule of *N. luykxi* is more elongated and more dorsoventrally flattened than that of *N. jouteli*. Mandible dentition and basal hump pilosity of *N. jouteli* is more pronounced than in large soldiers of *N. luykxi*. Antennal carinae are rugose in *N. jouteli*, while smooth in *N. luykxi*. Satellite facets of eyes are present in *N. luykxi*, and absent in *N. jouteli*.

Material Measured. FLORIDA: Broward Co.: Fort Lauderdale: H.T. Birch State Park: 26.13° N, 80.18° W; 30-VII-1985; 1 alate for SEM (FL182), and 2 alates, 1 small soldier for SEM, and 1 large soldier (FL185). Same locality: 12-IX-1986; 2 alates, 1 designated as neotype and 1 large soldier for SEM (FL221). Broward Co.: Dania: John Lloyd State Park: 26.07° N, 80.12° W; 15-II-1999; V. Maharajh and Krecek: 2 small and 1 large soldier (FL562). Same data; 2 small and 2 large soldiers (FL563). BAHAMAS: Chase, Krecek, Mangold, de la Rosa, and Scheffrahn collected all samples from Cat and North Andros Islands. Cat Island: Knowles Village: 24.37° N, 75.50° W; 26-V-1995; 1 alate and 1 small soldier (BA18). 1 km S Bain Town: 24.65° N, 75.72° W; 26-V-1995; 1 large soldier (BA38). North Andros Island: 1 km SW of Coakley Town: 24.72° N, 75.79° W; 30-V-1995; 2 alates and 2 small soldiers (BA294). Owens Town: 24.87° N, 78.02° W; 1-VI-1995; 2 alates and 1 small soldier (BA418). The following samples collected by Chase and Mangold. New Providence Island: Turkey Farm Rd. W Gladstone Rd.: 25.026° N, 77.413° W; 11-XII- 1998; 1 large soldier (BA548). Grand Bahama Island: near Garden of the Groves: 26.553° N, 78.569° W; 13-XII-1998; 1 small soldier (BA614). W. of Pelican Point: 26.647° N, 78.115° W; 13-XII-1998; 2 large soldiers (BA627).

Type Material. HOLOTYPE: short-headed soldier, Dania, FL, 30-VI-1984, P. Luykx (NMNH). MORPHOTYPE: imago, Hollywood, FL, 21-VIII-1986, P. Luykx (NMNH). All known types misplaced, mislabeled, or lost. NEOTYPE: male alate, inventory no. FL221 University of Florida, Fort Lauderdale Research and Education Center (see collection data above).

Distribution. FLORIDA: Broward, Dade, and Monroe Counties. BAHAMAS (all new records): Andros, Cat, Great Bahama, Great Inagua, New Providence, and San Salvador (assigned to *N.* nr. *jouteli* by Krecek in Dolan and Margulis 1997), North Cat Cay, and Gorda Cay. TURKS AND CAICOS: Providenciales (assigned to *N. jouteli* in Scheffrahn et al. 1990).

Geographic Variability. Compared with large soldiers from Florida, the head capsule of large *N. luykxi* soldiers from the Bahamas are more elongated, more dorso-ventrally flattened, and display a more shallow concavity of the dorsal vertex when viewed laterally.

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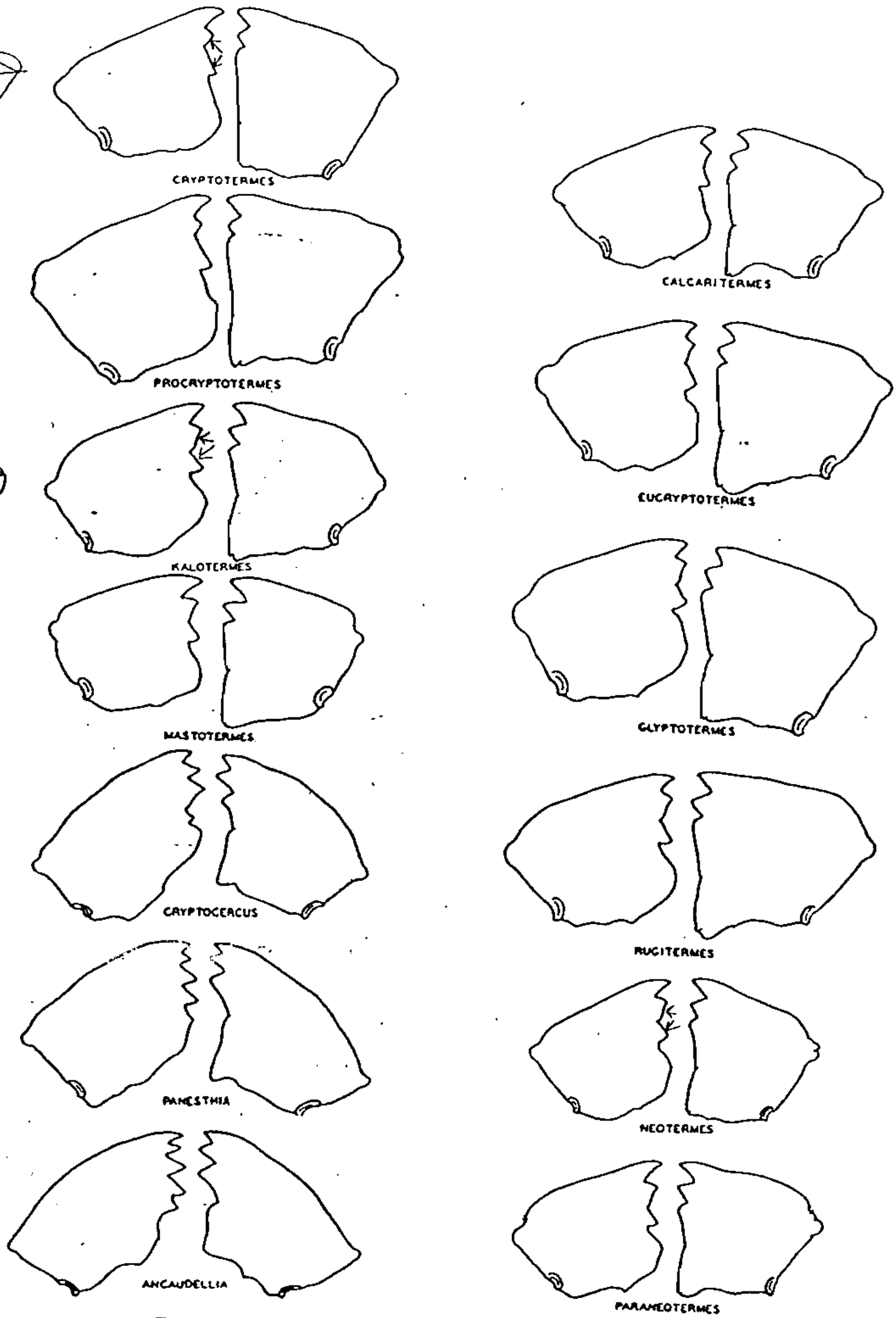

FIG. 5. Imago-worker mandibles of the families Blattidae, Mastotermitidae, and Kalotermitidae.

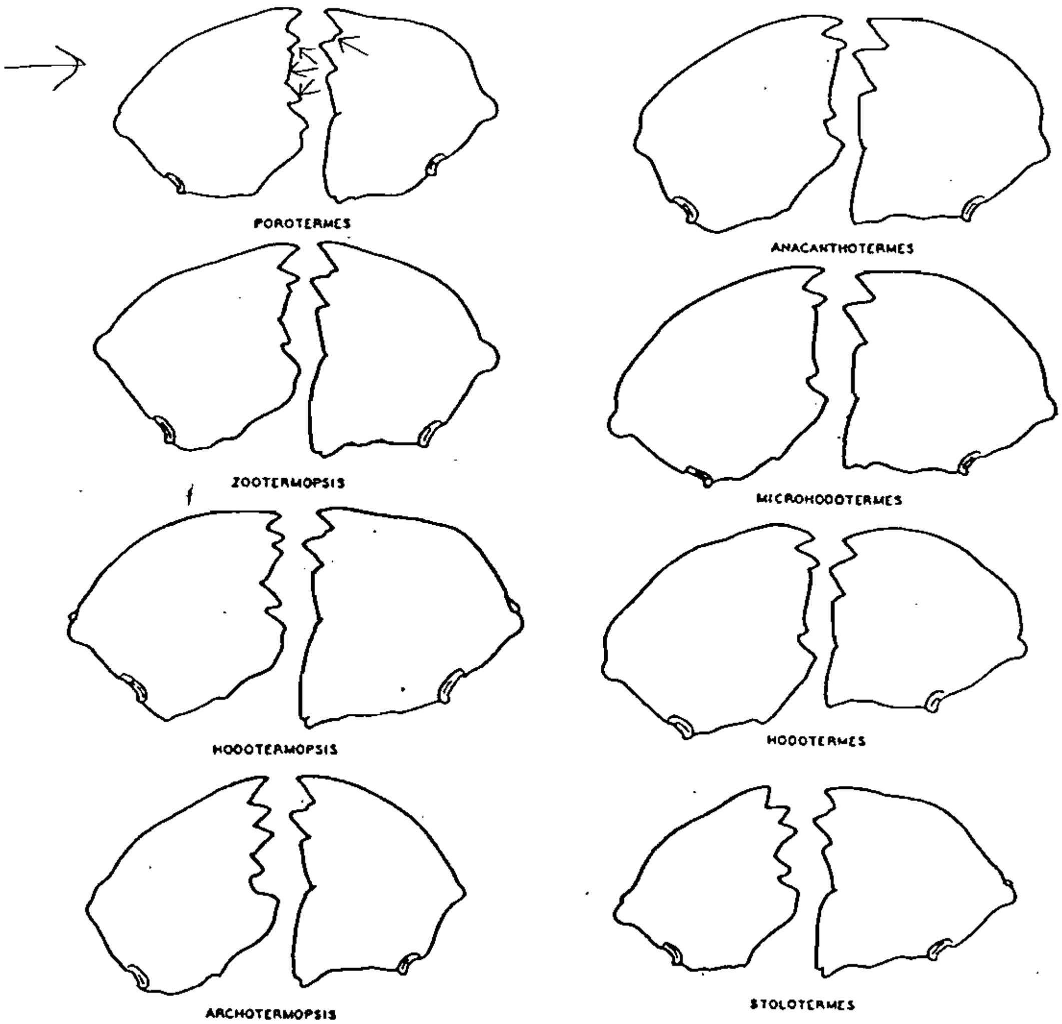

FIG. 6. Imago-worker mandibles of the family Hodotermitidae.

HODOTERMITIDAE

The Hodotermitidae seem to be an offshoot from primitive Isoptera possessing the characters common to the Mastotermitidae and the Hodotermitidae. While still maintaining a very close similarity to the blattids in the imago-worker mandibles (fig. 6) this group has evolved a higher social organization. Some of the hodotermitids, so far as is known, have an adult worker caste which is absent in the Kalotermitidae. One new character of phylogenetic importance which appears here for the first time in the imago-worker mandibles is the small subsidiary tooth at the base of the anterior edge of the first marginal of the right mandible. This small tooth is found throughout the Rhinotermitidae and in some of the primitive fungus-growing genera belonging to the subfamily Macrotermitinae of the Termitidae. So far the studies of *Cryptocercus* and related genera such as *Ancaudellia* and *Panesthia* (fig. 5) reveal the absence of the subsidiary tooth in the Blattidae.

Among the subfamilies of the Hodoter-

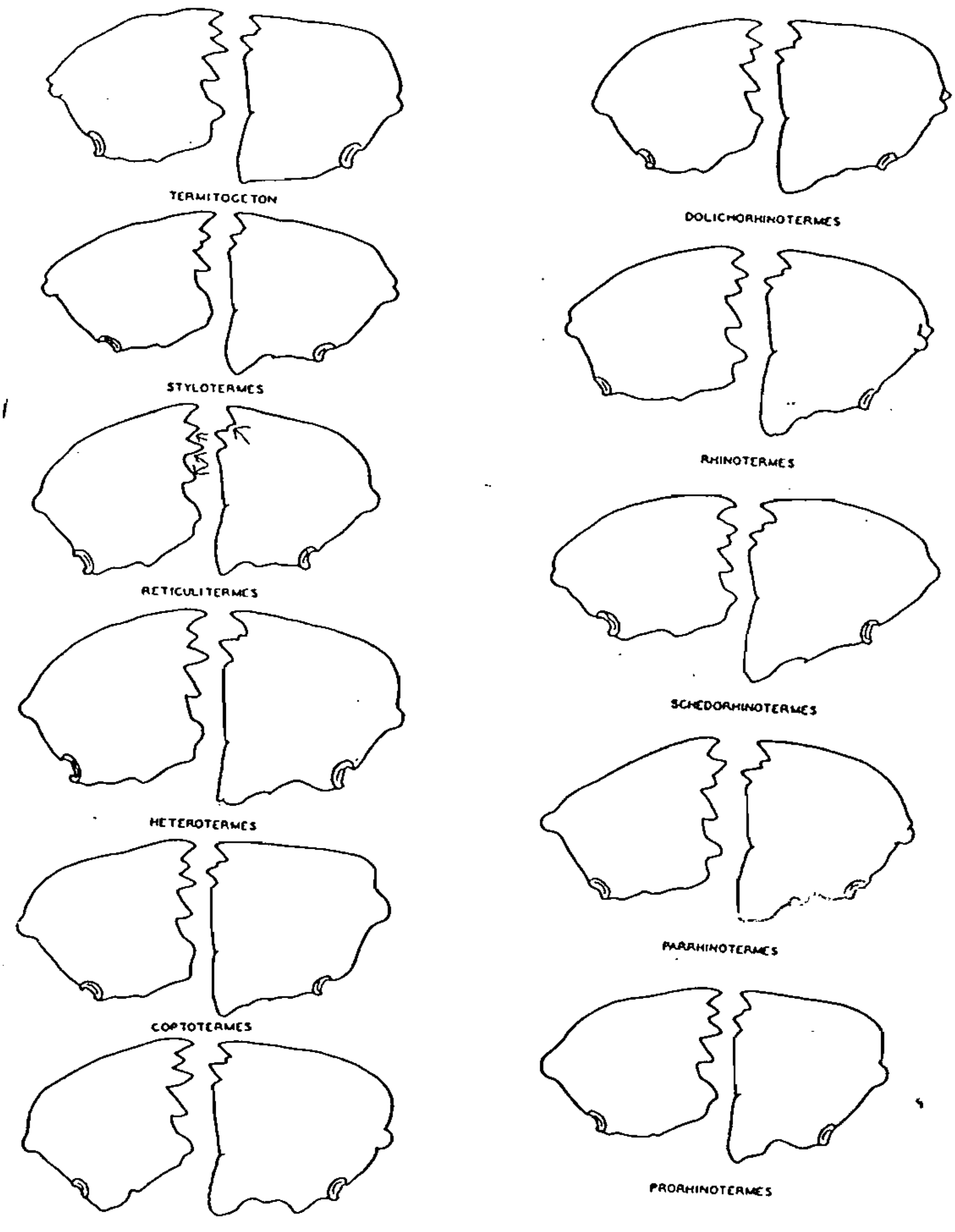

FIG. 7. Imago-worker mandibles of the family Rhinotermitidae.