

SHIP-BORNE TERMITE (ISOPTERA) BORDER INTERCEPTIONS IN AUSTRALIA AND ONBOARD INFESTATIONS IN FLORIDA, 1986-2009

RUDOLF H. SCHEFFRAHN¹ AND WILLIAM CROWE²¹Fort Lauderdale Research and Education Center, University of Florida, Institute of Food and Agricultural Sciences, 3205 College Avenue, Davie, Florida, 33314, U.S.A. rhsc@ufl.edu²Australian Quarantine and Inspection Service, P.O. Box 222, Hamilton Central, Queensland, 4007, Australia bill.crowe@aqis.gov.au

ABSTRACT

Alate termite flights from mature colonies infesting marine vessels is a primary mechanism for anthropogenic transoceanic establishment of invasive termite species. A taxonomic review is given of 133 recorded termite infestations onboard vessels in Australia and Florida between 1986 and 2009. The differing governmental approaches to regulating entry by foreign boats appears to reflect the relative frequency of exotic termite establishments in Australia and Florida.

Key Words: invasive species, biosecurity, overwater dispersal, Kalotermitidae, Rhinotermitidae, Termitidae

RESUMEN

El vuelo de termitas aladas de colonias maduras que infestan barcos es el mecanismo principal para el movimiento transoceánico y establecimiento de especies de termitas invasoras. Se provee una revisión taxonómica de 133 infestaciones de termitas encontradas en barcos en Australia y la Florida entre 1986 y 2009. Los diferentes enfoques gubernamentales en regular la entrada de barcos extranjeros tienden a reflejar la frecuencia relativa de establecimiento de termitas exóticas en Australia y la Florida.

Natural overwater dispersal of infested flotsam and anthropogenic dispersal by maritime vessels are the 2 primary means by which termites are transported across distant sea barriers (Scheffrahn et al. 2009). The cessation of rapid late Pleistocene/Holocene sea level rise at about 7K years before present (ybp, Fleming et al. 1998) predates the first known long-distance human maritime voyages by some 3.5K ybp (Anderson et al. 2006). Therefore, contemporary nonanthropogenic termite distributions were established between these 2 periods. Distant termite dispersal by flotsam can be presumed to be a very rare event with a success rate inversely proportional to distance. Establishment of the depauperate native terrestrial faunas on distant oceanic volcanic islands such as Hawaii was the result of transoceanic dispersal (Cowie & Holland 2006). Near-shore islands like the Krakatau can be colonized much more frequently by both flotsam transport and cross-water termite dispersal flights (Gathorne-Hardy & Jones 2000).

Shipboard transport of termite colonies, where success is not affected by travel distance, has been suspected in recent (Gay 1967; Scheffrahn & Su 2005) and early (Scheffrahn et al. 2009) transoceanic termite establishments. Vessels can be colonized during construction (usually only Kalo-

termitidae) or by alates (all taxa) flying onboard during dockage, either on water or in dry dock. Hochmair & Scheffrahn (2010) showed a strong correlation between land-borne infestations of *Coptotermes* spp. in Florida and their distance to maritime boat dockage suggesting that marine vessels are predominant vehicles for dissemination of this pest genus.

Within the last century, 6 exotic termite species have become established in Florida (Scheffrahn et al. 1988; Scheffrahn et al. 1992; Scheffrahn et al. 2002; Scheffrahn & Su 1995; Su et al. 1997), more than any other state or territory in America, followed by Hawaii with 5 species (or 4 species if *Zootermopsis angusticollis* Hagen is not established, Woodrow et al. 1999; Yeap et al. 2007). Australia has a slightly greater human population than Florida, a much larger tidal coastline, and both share similar economies, climates, pleasure boating industries, and proximities to tropical nations to the north and south, respectively. Yet, in the last century, a single exotic termite, *Cr. brevis* (Walker), has become established in Australia (Peters 1990). As for other suspected exotic *Cryptotermes*, Gay & Watson (1982) determined that *Cr. cynocephalus* Light and *Cr. domesticus* (Haviland) are endemic to northeast Australia. Gay (1967) reported that *Cr. dudleyi*

Banks, an exotic drywood termite from Southeast Asia, was already established in Darwin by 1913.

In a further attempt to understand the dynamics and taxa involved in exotic termite establishments, we provide a summary of onboard termite infestations in Florida and border interceptions in Australia and we contrast the regulatory procedures used for boats arriving from foreign ports.

MATERIALS AND METHODS

Termite specimens from Australia were found during interceptive inspections by WC and other Australian Quarantine and Inspection Service (AQIS) personnel. Florida samples were collected by or submitted to RHS by pest control professionals and boat owners or operators. In both cases, onboard specimens were collected and stored in ethanol. Identifications were made by the authors using voucher specimens from their respective collections. Other information sought included date of collection, given in Table 1 only in years, location collected (city), vessel origin (if known), and vessel and/or infestation type. For species identification, samples were required to contain morphologically robust winged imagoes and/or soldiers. Workers were identified morphologically only to genus.

RESULTS AND DISCUSSION

During 1986-2009, 74 and 59 termite incidents onboard boats were recorded in Australia and Florida, respectively (Table 1). The Australian records are comprehensive and represent all known AQIS interceptions. The Florida incidents represent an informal and very incomplete sampling of the actual number of boat infestations occurring around the State. Three vessels were infested simultaneously by 2 species and each is recorded as a separate incident in Table 1. Unlike Australia where only *Cr. brevis* is established, most boats in Florida are infested in their home waters where exotic species abound. This phenomenon enhances the spread of termites in Florida from boat-to-land or land-to-boat by dockside dispersal flights and also elevates the likelihood that boats voyaging from Florida could spread termites to foreign ports. Although long, open ocean voyages are not the norm for Florida boaters, some will "island-hop" throughout the West Indies. One yacht, suspected of acquiring *Co. gestroi* Wasmann (= *havilandi*, Kirton & Brown 2003) during a winter dockage in the Turks and Caicos Islands (Scheffrahn & Su 2005) was simultaneously infested with *Incisitermes minor* (Hagen). It was presumed that the latter species infested this boat while under construction in San Diego, California.

The subterranean genus *Coptotermes* (Family Rhinotermitidae) was observed in 53% of all boat

infestations (Fig. 1) with *Co. formosanus* Shiraki being the most common onboard pest in both Florida (27 records) and Australia (13 records) followed by *Co. gestroi* with 15 and 4 records, respectively. Three other infestations by subterranean termites were recorded including 2 by *Reticulitermes virginicus* (Banks) in Florida and 1 by *Heterotermes* sp. in a boat that sailed from Florida to Grand Cayman Island. The second most prevalent genus, at 30% of boat infestations, was *Cryptotermes* (Family Kalotermitidae). Australian interceptions yielding 8 infestations each of *Cr. brevis* (Walker) and *Cr. domesticus* (Haviland), 3 infestations of *Cr. dudleyi* Banks, 2 of *Cr. cynocephalus* Light, and 15 *Cr.* species undetermined. Only 3 infestations of *Cr. brevis* were recorded from Florida; however, fumigations for this species are so routine in Florida that samples are seldom collected for identification. One pest control company in Fort Lauderdale estimates that it is contracted to fumigate about 15 boats a year for drywood termites (read *Cr. brevis*, Edwards, J. K., personal communication). On the other hand, 6 infestations of *I. minor* were recorded in both Australia and Florida. Alates of *I. minor* are much more robust and dark (reddish pronotum and head) than *Cr. brevis* and have a different flight season and diel periodicity. Therefore, *I. minor* flights prompt elevated identification requests by the Florida pest control industry. Australia recorded a single shipboard infestation each of *I. immigrans* (Snyder) and *I. sp.*, while in Florida, a single infestation of *I. snyderi* (Light) was observed on a houseboat in Key West. The most unexpected find of this study was a mature infestation in 2009 of *Rugitermes panamae* (Snyder) from an itinerant yacht intercepted while visiting Bundaberg Australia. The yacht was apparently infested by this "dampwood" species during a voyage in 2003 to Central America. Colonies of the predominantly arboreal genus *Nasutitermes* (Termitidae) were found on boats 3 times during the last 25 years. *Nasutitermes acajutlae* (Holmgren) was found twice and *N. nigriceps* (Haldeman) once in Florida. Although not recorded in Table 1, *N. corniger* (Motschulsky) was found infesting 2 boats in dry dock in Dania Beach, Florida, as part of a land-borne infestation of this pest (Scheffrahn et al. 2002).

We suggest herein that the difference in the number of exotic termite species established in Florida versus Australia is attributable, at least in part, to differing laws and regulations intended to exclude exotic pests. The U.S. Customs and Border Patrol (CBP) requires that pleasure vessels arriving in the U.S. from a foreign port must report their arrival by telephone and be directed, with passengers and crew, to the nearest port of entry or nearest designated reporting location for a CBP face-to-face interview and/or vessel inspection (Anonymous 2009). Inspections focus on im-

TABLE 1. TERMITE INFESTATIONS BY GENUS AND SPECIES ONBOARD VESSELS DURING 1986-2009 (VOUCHER SPECIMENS IN THE UNIVERSITY OF FLORIDA TERMITE COLLECTION OR AQIS RECORDS).

Vessel location where termites found	Vessel origin ¹	Genus	Species	Year	Vessel comments
Islamorada Key, FL		<i>Coptotermes</i>	<i>formosanus</i>	1986	boat
North Palm Beach, FL	Tennessee	<i>Coptotermes</i>	<i>formosanus</i>	1995	boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	1995	11 m boat
Jacksonville, FL		<i>Coptotermes</i>	<i>formosanus</i>	1997	cable ship
Lighthouse Point, FL		<i>Coptotermes</i>	<i>formosanus</i>	1998	boat
Hypoluxo, FL		<i>Coptotermes</i>	<i>formosanus</i>	1998	26 m boat
Palm Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	1999	9 m boat
Brunswick, Georgia		<i>Coptotermes</i>	<i>formosanus</i>	1999	10 m boat
Palm Beach Gardens, FL		<i>Coptotermes</i>	<i>formosanus</i>	2000	9 m boat
Hillsborough Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	2000	large boat
Hallandale, FL	Hong Kong	<i>Coptotermes</i>	<i>formosanus</i>	2000	23 m boat
Tampa, FL		<i>Coptotermes</i>	<i>formosanus</i>	2001	10 m boat
Pompano Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	2001	16 m boat
Tampa, FL		<i>Coptotermes</i>	<i>formosanus</i>	2002	10 m boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2002	26 m speed boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2002	15 m cabin cruiser
Holmes Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	2002	boat
Dania Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	2003	11 m boat
Hollywood, FL		<i>Coptotermes</i>	<i>formosanus</i>	2004	boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2004	boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2004	18 m fishing yacht
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2005	15 m sailboat
Jacksonville Beach, FL		<i>Coptotermes</i>	<i>formosanus</i>	2006	13 m boat
Marathon Key, FL		<i>Coptotermes</i>	<i>formosanus</i>	2006	small boat
Fort Lauderdale, FL		<i>Coptotermes</i>	<i>formosanus</i>	2008	15 m boat
Volusia County, FL	Hong Kong	<i>Coptotermes</i>	<i>formosanus</i>	2008	18 m cabin cruiser
Panama City, FL		<i>Coptotermes</i>	<i>formosanus</i>	2008	9 m boat
Lake Park, FL		<i>Coptotermes</i>	<i>formosanus</i>	2008	8 m boat
Fort Pierce, FL	Jamaica	<i>Coptotermes</i>	<i>gestroi</i>	1991	Boat
Hollywood, FL	Virgin Gordo, B.V.I.	<i>Coptotermes</i>	<i>gestroi</i>	1995	boat in dry dock
Fort Lauderdale, FL	Turks, Caicos	<i>Coptotermes</i>	<i>gestroi</i>	2001	27 m yacht
Key West, FL		<i>Coptotermes</i>	<i>gestroi</i>	2003	15 m sailboat
Key West, FL		<i>Coptotermes</i>	<i>gestroi</i>	2005	houseboat, nest with queen
Key West, FL		<i>Coptotermes</i>	<i>gestroi</i>	2005	8 m motor boat
Tequesta, FL		<i>Coptotermes</i>	<i>gestroi</i>	2005	9 m fishing boat
Key Largo, FL	Cuba	<i>Coptotermes</i>	<i>gestroi</i>	2006	Sailboat
Key West, FL		<i>Coptotermes</i>	<i>gestroi</i>	2007	Sailboat
Key West, FL		<i>Coptotermes</i>	<i>gestroi</i>	2007	Boat
Miami Beach, FL		<i>Coptotermes</i>	<i>gestroi</i>	2007	12 m fishing boat transom
Stock Island Key, FL	Key West	<i>Coptotermes</i>	<i>gestroi</i>	2007	15 m cabin cruiser
St. Petersburg, FL		<i>Coptotermes</i>	<i>gestroi</i>	2007	11 m Yacht
Boca Chica Key, FL	Key West	<i>Coptotermes</i>	<i>gestroi</i>	2007	sailboat
Stock Island (Key West), FL		<i>Coptotermes</i>	<i>gestroi</i>	2007	Boat
Franklin, Louisiana	Florida	<i>Cryptotermes</i>	<i>brevis</i>	2000	17 m boat
Marathon Key, FL		<i>Cryptotermes</i>	<i>brevis</i>	2005	Sailboat
Cudjoe Key, FL		<i>Cryptotermes</i>	<i>brevis</i>	2006	Boat
Grand Cayman, Cayman Is.	Florida	<i>Heterotermes</i>	sp.	1995	Boat

¹Unknown if blank²dead imagos only, no live infestation.

TABLE 1. (CONTINUED) TERMITES INFESTATIONS BY GENUS AND SPECIES ONBOARD VESSELS DURING 1986-2009 (VOUCHER SPECIMENS IN THE UNIVERSITY OF FLORIDA TERMITES COLLECTION OR AQIS RECORDS).

Vessel location where termites found	Vessel origin ¹	Genus	Species	Year	Vessel comments
Fort Lauderdale, FL		<i>Incisitermes</i>	<i>minor</i>	2000	Boat
Miami, FL	Los Angeles, CA	<i>Incisitermes</i>	<i>minor</i>	2000	26 m boat
Fort Lauderdale, FL	San Diego, CA	<i>Incisitermes</i>	<i>minor</i>	2001	27 m yacht
Marathon Key, FL	Taiwan	<i>Incisitermes</i>	<i>minor</i>	2006	Boat
Dania Beach, FL	western Mexico	<i>Incisitermes</i>	<i>minor</i>	2007	20 m boat
St. Augustine, FL	FL Keys	<i>Incisitermes</i>	<i>minor</i>	2008	Boat
Key West, FL		<i>Incisitermes</i>	<i>snyderi</i>	2000	Houseboat
Fort Lauderdale, FL	St. Thomas U.S.V.I.	<i>Nasutitermes</i>	<i>acajutlae</i>	2002	15 m boat
Jacksonville, FL	Puerto Rico	<i>Nasutitermes</i>	<i>acajutlae</i>	2002	container on ship
Fort Lauderdale, FL		<i>Nasutitermes</i>	<i>nigriceps</i>	1996	Sailboat
Key West, FL		<i>Reticulitermes</i>	<i>virginicus</i>	2000	Houseboat
Jacksonville Beach, FL		<i>Reticulitermes</i>	<i>virginicus</i>	2003	Boat
Darwin, NT, AUS	China	<i>Coptotermes</i>	<i>formosanus</i>	1994	boat (refugee)
Perth, WA, AUS	Hong Kong	<i>Coptotermes</i>	<i>formosanus</i>	2000	Boat
Brisbane, Qld, AUS	China	<i>Coptotermes</i>	<i>formosanus</i>	2002	boat, fibreglass
Sydney, NSW, AUS		<i>Coptotermes</i>	<i>formosanus</i>	2003	Yacht
Brisbane, Qld, AUS	Hong Kong	<i>Coptotermes</i>	<i>formosanus</i>	2003	boat
Brisbane, Qld, AUS	China	<i>Coptotermes</i>	<i>formosanus</i>	2003	Yacht
Brisbane, Qld, AUS	USA / Japan	<i>Coptotermes</i>	<i>formosanus</i>	2005	9 m boat
Brisbane, Qld, AUS	USA	<i>Coptotermes</i>	<i>formosanus</i>	2005	boat (with <i>I. minor</i>)
Townsville, Qld, AUS	Hong Kong/Asia	<i>Coptotermes</i>	<i>formosanus</i>	2005	Boat
Bundaberg, Qld, AUS	Hawaii	<i>Coptotermes</i>	<i>formosanus</i>	2006	itinerant yacht
Brisbane, Qld, AUS	Japan	<i>Coptotermes</i>	<i>formosanus</i>	2007	Boat
Newcastle, NSW, AUS	China	<i>Coptotermes</i>	<i>formosanus</i>	2008	Boat
Brisbane, Qld, AUS	USA	<i>Coptotermes</i>	<i>formosanus</i>	2009	itinerant yacht
Darwin, NT, AUS	Thailand	<i>Coptotermes</i>	<i>gestroi</i>	1986	Yacht
Darwin, NT, AUS	Thailand	<i>Coptotermes</i>	<i>gestroi</i>	1994	Boat
Bundaberg, Qld, AUS	Marshall Islands	<i>Coptotermes</i>	<i>gestroi</i>	1996	Yacht
Brisbane, Qld, AUS	China	<i>Coptotermes</i>	<i>gestroi</i>	2003	Boat
Brisbane, Qld, AUS	USA	<i>Coptotermes</i>	sp.	2002	Yacht
Cairns, Qld, AUS	AUS	<i>Coptotermes</i>	sp.	2005	dinghy from TI to Cairns
Sydney, NSW, AUS	Unknown	<i>Coptotermes</i>	sp.	2006	navy boat
Brisbane, Qld, AUS	New Caledonia	<i>Coptotermes</i>	sp.	2008	boat (returning AUS yacht)
Brisbane, Qld, AUS	Taiwan	<i>Coptotermes</i>	sp.	2008	Boat
Brisbane, Qld, AUS	Hong Kong	<i>Coptotermes</i>	sp.	2005	yacht (flybridge in lockers)
Mackay, Qld, AUS	Taiwan	<i>Coptotermes</i>	sp.	2005	Boat
Brisbane, Qld, AUS	France	<i>Coptotermes</i>	sp.	2008	Yacht
Brisbane, Qld, AUS	USA	<i>Coptotermes</i>	sp.	2008	Boat
Perth, WA, AUS	Singapore	<i>Coptotermes</i>	<i>travians?</i>	2002	boat, fibreglass & wood
Townsville, Qld, AUS		<i>Cryptotermes</i>	<i>brevis</i>	1989	Yacht
Brisbane, Qld, AUS	USA	<i>Cryptotermes</i>	<i>brevis</i>	2003	wooden yacht (with <i>I. Minor</i>)
Brisbane, Qld, AUS	USA	<i>Cryptotermes</i>	<i>brevis</i>	2005	Superyacht
Cardwell, Qld, AUS		<i>Cryptotermes</i>	<i>brevis</i>	2006	Trimaran
Brisbane, Qld, AUS	South Africa	<i>Cryptotermes</i>	<i>brevis</i>	2007	Boat
Brisbane, Qld, AUS	USA	<i>Cryptotermes</i>	<i>brevis</i>	2008	Boat
Airlie Beach, Qld, AUS	USA	<i>Cryptotermes</i>	<i>brevis</i>	2009	Catalina 400 MK II

¹Unknown if blank.²dead imagos only, no live infestation.

TABLE 1. (CONTINUED) TERMITE INFESTATIONS BY GENUS AND SPECIES ONBOARD VESSELS DURING 1986-2009 (VOUCHER SPECIMENS IN THE UNIVERSITY OF FLORIDA TERMITE COLLECTION OR AQIS RECORDS).

Vessel location where termites found	Vessel origin ¹	Genus	Species	Year	Vessel comments
Mackay, Qld, AUS	USA	<i>Cryptotermes</i>	<i>brevis?</i>	2009	28 m super yacht
Bundaberg, Qld, AUS	USA	<i>Cryptotermes</i>	<i>cavifrons</i> ¹	2008	Yacht
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>cynocephalus</i>	2005	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>cynocephalus</i>	2009	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	1986	Yacht
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	1987	yacht
Brisbane, Qld, AUS	Vanuatu	<i>Cryptotermes</i>	<i>domesticus</i>	1999	boat
Sydney, NSW, AUS		<i>Cryptotermes</i>	<i>domesticus</i>	2003	yacht
Broome, WA, AUS	Papela, Roti, Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	2005	foreign fishing vessel
Gove, NT, AUS	Karja Sama, Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	2006	foreign fishing vessel
Gove, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	2006	foreign fishing vessel
Broome, WA, AUS	Indonesia	<i>Cryptotermes</i>	<i>domesticus</i>	2007	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>dudleyi</i>	1994	boat
Darwin, NT, AUS	Philippines	<i>Cryptotermes</i>	<i>dudleyi</i>	2006	boat
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	<i>dudleyi</i>	2008	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	1993	boat
Gove, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	1993	foreign fishing vessel
Darwin, NT, AUS	Vietnam	<i>Cryptotermes</i>	sp.	2001	boat
Gove, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2004	foreign fishing vessel
Thursday Island, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2004	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2004	boat
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2005	foreign fishing vessel
Broome, WA, AUS	Papela Roti, Indonesia	<i>Cryptotermes</i>	sp.	2006	foreign fishing vessel
Broome, WA, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2007	foreign fishing vessel
Bundaberg, Qld, AUS	USA	<i>Cryptotermes</i>	sp.	2007	boat
Broome, WA, AUS	Sulawesi, Indonesia	<i>Cryptotermes</i>	sp.	2005	foreign fishing vessel
Broome, WA, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2005	foreign fishing vessel
Broome, WA, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2005	foreign fishing vessel
Darwin, NT, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2005	foreign fishing vessel
Broome, WA, AUS	Indonesia	<i>Cryptotermes</i>	sp.	2009	foreign fishing vessel
Brisbane, Qld, AUS	Thailand	<i>Drepanotermes</i> ²	sp.	2008	boat
Bundaberg, Qld, AUS	Hawaii	<i>Incisitermes</i>	<i>immigrans</i>	2007	boat
Brisbane, Qld, AUS		<i>Incisitermes</i>	<i>minor</i>	2001	yacht
Brisbane, Qld, AUS	USA	<i>Incisitermes</i>	<i>minor</i>	2003	wooden yacht (with <i>Cr. brevis</i>)
Brisbane, Qld, AUS	USA	<i>Incisitermes</i>	<i>minor</i>	2005	boat (with <i>Co. formosanus</i>)

¹Unknown if blank²dead imagos only, no live infestation.

TABLE 1. (CONTINUED) TERMITE INFESTATIONS BY GENUS AND SPECIES ONBOARD VESSELS DURING 1986-2009 (VOUCHER SPECIMENS IN THE UNIVERSITY OF FLORIDA TERMITE COLLECTION OR AQIS RECORDS).

Vessel location where termites found	Vessel origin ¹	Genus	Species	Year	Vessel comments
Brisbane, Qld, AUS	Fiji (made in USA)	<i>Incisitermes</i>	<i>minor</i>	2006	super yacht
Bundaberg, Qld, AUS	USA	<i>Incisitermes</i>	<i>minor</i>	2006	trimaran
Cairns, Qld, AUS	USA	<i>Incisitermes</i>	<i>minor</i>	2009	trimaran
Broome, WA, AUS	Papela Roti, Indonesia	<i>Incisitermes</i>	sp.	2006	foreign fishing vessel
Bundaberg, Qld, AUS	Central Amer.	<i>Rugitermes</i>	<i>panamae</i>	2009	Yacht

¹Unknown if blank.

²dead imagos only, no live infestation.

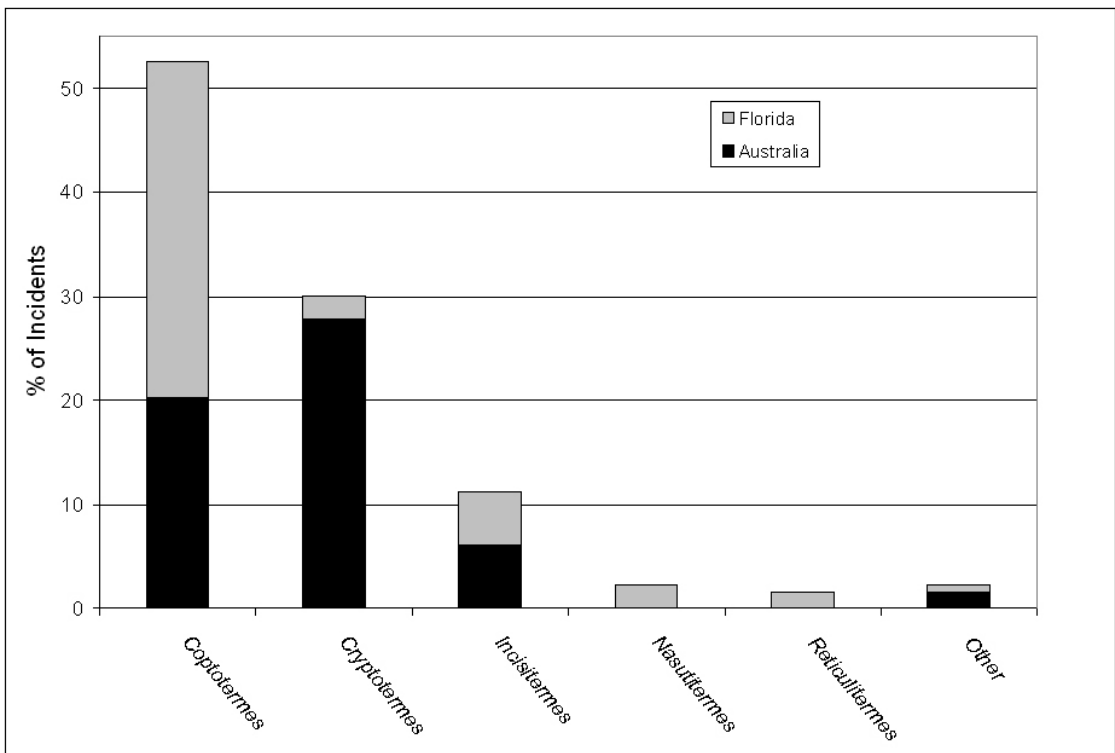


Fig. 1. Frequency of termite genera collected on vessels in Australia and Florida. "Other" includes *Drepanotermes* and *Rugitermes* from Australia and *Heterotermes* from Florida.

migration compliance by the passengers and crew, possible illegal contraband, and agricultural pests in cargo. Structural and household pests, which are usually disassociated with cargo and dwell within the vessel's own structure, are not mandated for inspection. In contrast to Florida practices, passengers and crew aboard vessels arriving to Australia from a foreign port must obtain clearance by the Australian Customs and Border Protection Service and the Australian Quarantine and Inspection Service (AQIS). Vessels with timber in their cargo or construction

must also be inspected by AQIS. The level of AQIS inspection required will depend on the amount of timber present and the construction/re-fit and sailing history of the vessel. The inspection can be conducted by an AQIS quarantine officer or AQIS entomologist with or without a licensed pest control professional and approved termite detection method. If termites are found upon inspection, the vessel must be fumigated with methyl bromide (AQIS method T9047) or sulfuryl fluoride (AQIS method T9090) at the owner's expense (Anonymous 2010).

ACKNOWLEDGMENTS

We thank boat owners and pest control companies in Florida for submitting termite samples to RHS.

REFERENCES CITED

- ANDERSON, A., CHAPPELL, J., GAGAN, M., AND GROVE, R. 2006. Prehistoric maritime migration in the Pacific islands: An hypothesis of ENSO forcing. *The Holocene* 16: 1-6.
- ANONYMOUS. 2009. Code of Federal Regulations (United States) 19CFR4.2.
- ANONYMOUS. 2010. ICON Condition C9645. Australian Quarantine and Inspection Service.
- COWIE, R. H., AND HOLLAND, B. S. 2006. Dispersal is fundamental to biogeography and the evolution of biodiversity on oceanic islands. *J. Biogeography* 33: 193-198.
- FLEMING, K., JOHNSTON, P., ZWARTZ, D., YOKOYAMA, Y., LAMBECK, K., AND CHAPPEL, J. 1998. Refining the eustatic sea-level curve since the last glacial maximum using far- and intermediate-field sites. *Earth and Planetary Science Letters* 163: 327-342.
- GATHORNE-HARDY, F. J., AND JONES, D. T. 2000. The recolonization of the Krakatau islands by termites (Isoptera), and their biogeographical origins. *Biol. J. Linnean Soc.* 71: 251-267.
- GAY, F. J. 1967. A world review of introduced species of termites. *CSIRO Bulletin Melbourne, Australia* 286: 1-88.
- GAY, F. J., AND WATSON, J. A. L. 1982. The genus *Cryptotermes* in Australia (Isoptera: Kalotermitidae). *Australian J. Zool. Supplementary Series* 30, 88: 1-64.
- HOCHMAIR, H. H., AND SCHEFFRAHN, R. H. 2010. Spatial association of marine dockage with land-borne infestations of invasive termites in urban South Florida. *J. Econ. Entomol.* 103: 1338-1346.
- KIRTON, L. G., AND BROWN, V. K. 2003. The taxonomic status of pest species of *Coptotermes* in Southeast Asia: Resolving the paradox in the pest status of the termites, *Coptotermes gestroi*, *C. havilandi* and *C. travians* (Isoptera: Rhinotermitidae). *Sociobiol.* 42: 43-63.
- PETERS, B. C. 1990. Infestations of *Cryptotermes brevis* (Walker) (Isoptera: Kalotermitidae) in Queensland, Australia. 1. History, detection and identification. *Australian Forester* 53: 79-88.
- SCHEFFRAHN, R. H., AND SU, N.-Y. 1995. A new subterranean termite introduced to Florida: *Heterotermes Froggatt* (Rhinotermitidae: Heterotermitinae) established in Miami. *Florida Entomol.* 78: 623-627.
- SCHEFFRAHN, R. H., AND SU, N.-Y. 2005. Distribution of the termite genus *Coptotermes* (Isoptera: Rhinotermitidae) in Florida. *Florida Entomol.* 88: 201-203.
- SCHEFFRAHN, R. H., CABRERA, B. J., KERN JR., W. H., AND SU, N.-Y. 2002. *Nasutitermes costalis* (Isoptera: Termitidae) in Florida: First record of a non-endemic establishment by a higher termite. *Florida Entomol.* 85: 273-275.
- SCHEFFRAHN, R. H., KŘEČK, J., RIPA, R., AND LUPPICHINI, P. 2009. Endemic origin and vast anthropogenic dispersal of the West Indian drywood termite. *Biol. Invasions* 11: 787-799.
- SCHEFFRAHN, R. H., MANGOLD, J. R., AND SU, N.-Y. 1988. A survey of structure-infesting termites of peninsular Florida. *Florida Entomol.* 71: 615-630.
- SU, N.-Y., SCHEFFRAHN, R. H., AND WEISSLING, T. 1997. A new introduction of a subterranean termite, *Coptotermes havilandi* Holmgren (Isoptera: Rhinotermitidae) in Miami, Florida. *Florida Entomol.* 80: 408-411.
- WOODROW, R. J., GRACE, J. K., AND YATES III, J. R. 1999. *Hawaii's Termites: An Identification Guide*. Honolulu (HI): University of Hawaii. 6 p. (Household and Structural Pests; HSP-1).
- YEAP, B.-K., OTHMAN, A. S., LEE, V. S., AND LEE, C.-Y. 2007. Genetic relationship between *Coptotermes gestroi* and *Coptotermes vastator* (Isoptera: Rhinotermitidae). *J. Econ. Entomol.* 100: 467-474.