

First Record of *Cryptotermes cynocephalus* Light (Isoptera: Kalotermitidae) and Natural Woodland Infestations of *C. brevis* (Walker) on Oahu, Hawaiian Islands

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Abstract: A termite survey of 18 coastal woodland localities on Oahu yielded five termite species including *Neotermes connexus* Snyder, *Incisitermes immigrans* (Snyder), *Cryptotermes brevis* (Walker), *Cryptotermes cynocephalus* Light, and *Coptotermes formosanus* Shiraki. The Indomalaysian and Australian species *Cr. cynocephalus* is reported in Hawaii for the first time and may have pest status there. The discovery of *Cr. brevis* colonies in a natural habitat is unprecedented and suggests that this population may either be related to prehistoric ancestors from the Neotropics or a new woodland biotype which evolved from colonies introduced by humans.

Keywords: termite, survey, *Coptotermes*, *Incisitermes*, *Neotermes*

Introduction

The termite fauna of the Hawaiian Islands was most recently reviewed by Bess (1970) who listed three species of drywood termites (Kalotermitidae) from Oahu including *Neotermes connexus* Snyder, *Incisitermes immigrans* (Snyder), and *Cryptotermes brevis* (Walker). Among the subterranean termites (Rhinotermitidae) of Hawaii, the Formosan subterranean termite, *Coptotermes formosanus* Shiraki remains a major subterranean termite pest throughout Oahu, and parts of other Hawaiian islands (Tamashiro et al. 1987), while *Co. vastator* has apparently not been found in Honolulu since a mature colony was discovered there in 1963 (Bess 1966). Recently, however, *Co. vastator* has been identified as the cause of serious structural damage in Guam previously blamed on *Co. formosanus* (Su and Scheffrahn 1997). This study presents the results of a limited survey of termites conducted on Oahu in December 1996.

Materials and Methods

Termites were collected with aspirator from hatchet-split dead standing and fallen wood in the southeast (sites 1-3), west coast (sites 4-7), east coast (sites 8-15) and north coast (sites 16-18) of Oahu on 5-7 December 1996 (Fig. 1 and Table 1). Soldiers were collected in all samples and identification was based on that caste. *Neotermes connexus* and *Incisitermes immigrans* were identified based on original descriptions by Snyder (1922). *Cryptotermes* spp. were identified by various revisions (Chhotani 1970, Gay and Watson 1982, and Bacchus 1987). Samples of *Coptotermes formosanus* were compared with various voucher speci-

Figure 1. Termite collection localities on Oahu Island, Hawai'i. See Table 1 for locality descriptions.

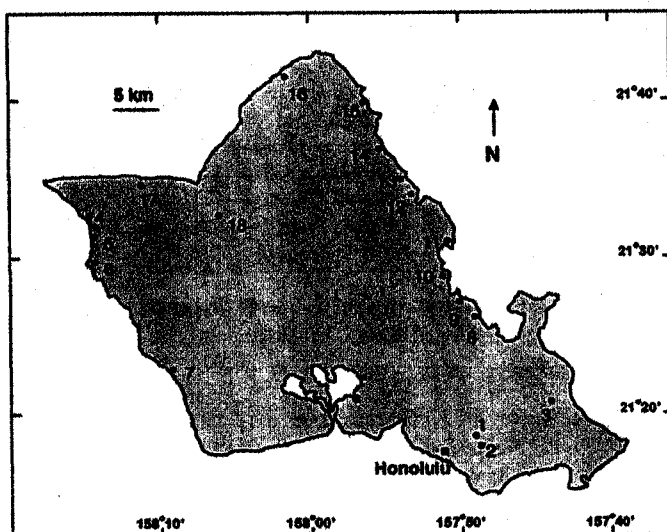


Table 1. Termite collections on Oahu from standing and fallen tree limbs and trunks.

Map no.	Location	Species ^a (no. colonies)
1	Manoa Falls Trail (N. Waikiki)	Nc (1)
2	Waahila Ridge Trail (N. Waikiki)	Nc (6), Cf (2)
3	Highway 72 2 km N.W. Waimanalo	Ii (4), Cf(3)
4	Kaena Point State Park	Ii (10)
5	Kaneana Cave area	Ii (11)
6	Keaau Beach Park	Ii (6), Cf (3)
7	Highway 93 at Hakimo Road (Nanakuli)	Cb (6), Ii (1)
8	Heeia State Park	Ii (9), Cf (1)
9	Kahaluu Beach	Ii (4), Cf (1)
10	Waiahole Valley Road at Highway 83	Cc (5), Cf (1)
11	Kualoa Regional Park	Cc (2), Ii (2)
12	Kahana Valley State Park	Nc (1)
13	Punaluu	Ii (2), Cf (2)
14	Hauula Trail	Nc (2)
15	Malaekahana State Recreational Area	Ii (10)
16	Waialeale	Ii (4)
17	Mokuleia Beach Park	Ii (4)
18	5 km S.W. Waiialua	Ii (3)

^aKalotermitidae: Cb = *Cryptotermes brevis*, Cc = *Cryptotermes cynocephalus*, Ii = *Incisitermes immigrans*, Nc = *Neotermes connexus*; Rhinotermitidae: Cf = *Coptotermes formosanus*.

mens of *Co. formosanus* from Hawaii and Florida. Scanning electron micrographs were taken of *Cr. cynocephalus* soldiers dehydrated by a modified method of Nation (1983) to allow for hexamethyldisilazane immersion for one day.

Results and Discussion

A total of 106 colony samples were collected primarily from the coastal perimeter of Oahu (Table 1 and Fig. 1). Of these, *I. immigrans* was collected in greatest abundance (70 samples) followed by *Co. formosanus* (13), *N. connexus* (10), *Cr. cynocephalus* (7) and *Cr. brevis* (6).

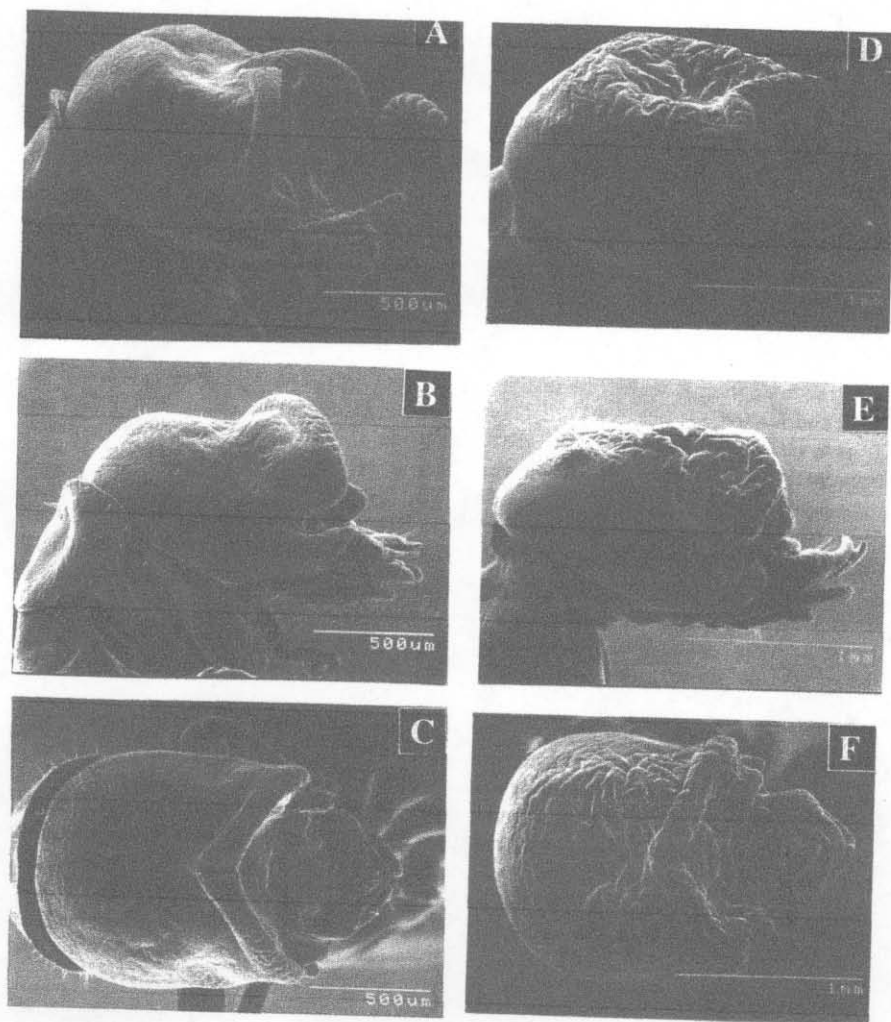
Colonies of *Cr. cynocephalus* were collected from standing dead tree limbs at two sites (10–11, Fig. 1) about 4 km apart along Kaneohe Bay on the east coast of Oahu. Three of the seven colonies contained alates and one very large colony sample contained 28 soldiers (Fig. 2A–C).

Cryptotermes cynocephalus is a new record for the Hawaiian Islands. In its type locality of Manila, Philippines, it is a common "house" termite (Light 1921). This species has also been recorded from Java (Indonesia), New Britain Is., Sri Lanka, Malaysia, Sarawak, Thailand, and Australia (Chhotani 1970, Gay and Watson 1982, and Bacchus 1987). Gay and Watson (1982) indicate that this species is endemic to northeastern Australia where it is common in rain forest and sclerophyll woodlands as well as structural lumber. It is reported to be both a wild and domestic species where it occurs (Bacchus 1987). If so, it may be that some structural drywood termite infestations on Oahu which were blamed on *Cr. brevis* may actually be those of *Cr. cynocephalus*. Interestingly, Ehrhorn (1934) reported that *Cr. cynocephalus* was intercepted at Honolulu in 1930 in a shipment of wood from the Philippines. *Cryptotermes cynocephalus* is one of the smallest species in the genus (Bacchus 1987, Gay and Watson 1982). The alate of *Cr. cynocephalus* is smaller, darker brown, and has shorter (ca. 6 mm) and darker wings compared with *Cr. brevis* (wing length 8–9 mm). The soldier head capsule of *Cr. cynocephalus* is less rugose, has a more elevated frontal flange, more projecting frontal horns, and is $2/3$ the width of the *Cr. brevis* head capsule. Pseudergates and nymphs of *Cr. cynocephalus* are less than half the weight of *Cr. brevis*.

The natural woodland infestations of *Cr. brevis* (Fig. 2D–F) in Nanakuli (site 7, Fig. 1) are the first clearly documented for this domesticated tropicopolitan species. Six colonies, two with primary reproductives, were collected from various standing dead limbs in a littoral forest of *Acacia* sp. about 100 m from the ocean and >100m from the nearest structural lumber. Minnick (1973) mentions finding an outdoor colony of *Cr. brevis* containing all castes infesting a dying oleander in Key West, Florida, however, it was unclear if the bush was adjacent to and protected from rainfall by a building in which he was studying *Cr. brevis*. In an ongoing survey of the termites of Florida and the West Indies where *Cr. brevis* is a common structural pest, this species has never been collected from natural growth even though hundreds of samples of other *Cryptotermes* species have been collected from these regions (Scheffrahn et al. unpublished).

The global origin of *Cr. brevis* remains obscure. It was, until now, absent from nature, and yet, simultaneously a structural pest in all eight major zoogeographic regions of the world (Bacchus 1987). It was suggested that *Cr. darwini* (Light), a closely related species from the Galapagos Is. (Light 1935), and *Cr. brevis* are synonyms (Bacchus 1987), however, direct comparisons were inconclusive (Bacchus 1987). *Cryptotermes darwini* was taken in nature from dead standing and fallen tree limbs on three islands of the Galapagos archipelago (Light 1935). If synonymous, then the possibility exists that *Cr. brevis* (= *Cr. darwini*) was first introduced naturally to Hawaii via infested limbs on a floating log rafting from either the Galapagos Islands or the adjacent Neotropical mainland. Later human habi-

Figure 2. Scanning electron micrographs of *Cryptotermes cynocephalus* soldier head capsule collected at site 10 (Table 1) in oblique (A, with antennae), lateral (B), and dorsal (C) views; and *C. brevis* from site 7 in oblique (D), lateral (E), and dorsal (F) views.



tation of Hawaii provided the preferred habitat associated with this species. On the other hand, *Cr. brevis* may have initially been introduced by man prior to its first report on Hawaii in 1884 (Ehrhorn 1934). Undoubtedly, human transport in modern times has facilitated many reintroductions of *Cr. brevis* to Hawaii.

We offer two hypotheses for the occurrence of the Nanakuli colonies of *Cr. brevis*. The first assumes that *Cr. brevis* was a natural arrival to Hawaii. If so, the Nanakuli population may share a common ancestry with neotropical immigrants. The second assumes that all *Cr. brevis* populations in Hawaii originated from human transport, and therefore, the Nanakuli

population represents the first "naturalized" woodland biotype of *Cr. brevis* found anywhere. Future taxonomic and genetic studies might provide conclusive evidence to explain the first arrival of *Cr. brevis* to Hawaii.

As mentioned by Ehrhorn (1934) and Bess (1970), *I. immigrans* is common in the relatively more xeric habitats of the coastal lowlands of Oahu, while *N. connexus* was collected in the wetter valleys and highlands. These species are generally not associated with structural lumber and were likely introduced naturally to Hawaii by rafting on timbers along the equatorial currents of the Pacific Ocean. *Incisitermes immigrans* may have arrived from its Ecuadorian or Galapagos homelands (Light 1935), thus paralleling the natural introduction hypothesis of *Cr. brevis* (= *Cr. darwini*) forwarded above. *Neotermes connexus* may have arrived in Hawaii from Papuan origins (Bess 1970). Like *Cr. brevis*, the earliest report of both species on Hawaii dates to 1883 or earlier (Ehrhorn 1934).

Our survey supports recent observations that *Co. formosanus* populations have spread throughout Oahu owing to its >90 year occupation of the island (Tamashiro et al. 1987). Unlike Florida, where this species has been introduced more recently and is associated with structures, on Oahu we collected *Co. formosanus* in areas far removed from human habitation.

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