University of Hawaiʻi at Mānoa
College of Tropical Agriculture and Human Resilience

Changes in termite species distribution on Oʻahu, Hawaiʻi

Expansion of *Coptotermes gestroi* (Blattodea: Heterotermitidae)

At a Glance: The eight termite species identified in Hawaiʻi include the Asian subterranean termite, *Coptotermes gestroi* (Wasmann), reported in 2001 at Barber's Point, Oʻahu. This publication compares survey data from 2012 with survey and field search data from 2022–2024 to identify recent changes in termite species distribution. The observed expansion of *Co. gestroi* is concerning because this termite species may be harder to target using current management practices, and also because *Co. gestroi* has the potential to hybridize with the long-established Formosan subterranean termite, *Coptotermes formosanus* Shiraki.

Figure 1. A *Coptotermes gestroi* soldier (left) and two workers (center, right). Photo courtesy of Jia-Wei Tay.

Introduction

The worldwide economic impact of termites is estimated to be about $40 billion USD annually, of which about 80% is attributed to subterranean termites (Rust and Su 2012). Several types of management for termites have been employed in Hawaiʻi, including liquid termiticides, Basaltic Termite Barrier, stainless steel barriers, fumigation, and the use of treated wood (Grace et al. 2002). In 1995, a revolutionary tool developed by Nan-Yao Su became commercially available as the Sentricon system for population suppression of subterranean termites (Su 1994). Honored as the 2007 Distinguished Alumnus of the University of Hawaiʻi at Mānoa's formerly named College of Tropical Agriculture and Human Resources (UHM CTAHR), Dr. Su created with his wife in 2009 the Nan-Yao and Jill Su Endowed Fund for Entomology to assist our College's graduate and undergraduate students studying entomology.

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, was first officially recorded in Hawaiʻi in 1913 (Oshima 1920), but was likely present in Hawaiʻi "as early as 1869" (Yates and Tamashiro 1999). In 1922, Snyder described four drywood termite species in Hawaiʻi, including one variety that would be synonymized. Today, these species are identified as the lowland tree termite, *Incisitermes immigrans* (which he called *Kalotermes immigrans* Snyder); the forest tree termite, *Neotermes connexus* Snyder (including his variety *N. connexus* var. *major* Snyder, now a synonym); and what he called *Cryptotermes piceatus* Synder (now known as the West Indian drywood termite, *Cryptotermes brevis* Walker).

Since Snyder, four additional termite species have been identified in Hawaiʻi. In 1996, a distribution survey of termites discovered established colonies of the Indo-Malaysian drywood termite, *Cryptotermes cynocephalus* Light, on the eastern portion of Oʻahu (Scheffrahn et al. 2000). Woodrow et al. (2001) reported that the Pacific dampwood termite, *Zootermopsis angusticollis* (Hagen) had established on Maui, and the western drywood termite, *Incisitermes minor* (Hagen), had established on Oʻahu. Woodrow et al. (2001) also reported the distribution of the Asian subterranean termite, *Coptotermes gestroi* (Wasmann), on Oʻahu (Figure 1). A roadside survey of

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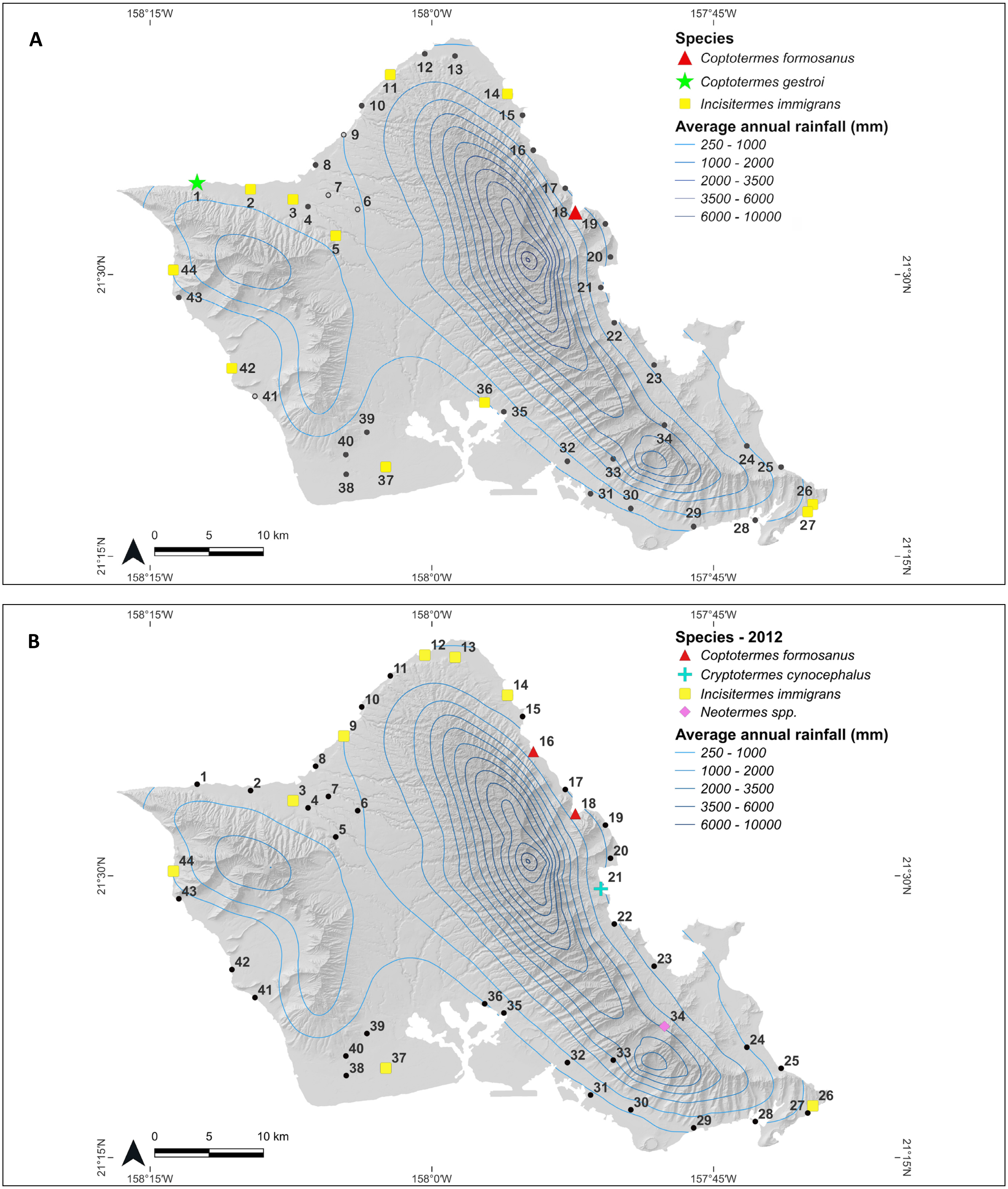

Figure 2. Comparative termite distributions on the island of Oʻahu as determined by revisiting the sites surveyed by Tong et al. (2017). Points 6, 7, 9, 21, and 41 were not searched in 2023–2024 due to changes in accessibility. (A) Results of a 2023–2024 systematic resurvey of the Tong et al. (2017) sites. (B) Original 2012 systematic survey results from Tong et al. (2017).

termites on Oʻahu in 2012 mapped four of these eight species of termites (Tong et al. 2017).

Building on this historical context, this study re-evaluated termite species distributions on Oʻahu by revisiting the roadside sites surveyed in 2012 by Tong et al. (2017). To broaden our coverage, we also incorporated data from supplemental searches carried out during other experiments and mapped all occurrence reports submitted to the University of Hawaiʻi Urban Entomology Laboratory. This combined approach allowed us to determine how species' ranges have shifted over the past decade.

Survey Design

Systematic survey: A systematic survey of termites was conducted on Oʻahu, HI, from September 2023 to January 2024. The 44 sites from Tong et al. (2017) were revisited; these sites were along Farrington Highway, Kalanianaʻole Highway, Kamehameha Highway, Kaukonahua Road, King Street, Pali Highway, or Roosevelt Avenue from a random starting point at intervals of roughly 4 km. Sites that were previously used but were no longer publicly available or safe were discarded.

Supplemental field searches: Additional sites for other searches conducted by our laboratory, and sites reported by members of the public for termite occurrences, were also confirmed and included to better describe the current scenario of termite distribution on the island. An effort was made to search sites where subterranean termites were reported previously by Woodrow et al. (2001) and Scheffrahn et al. (2000) to look for any changes in species occurrence over time. We refer to these sites as "supplemental field searches." The supplemental field searches occurred between 2022 and 2024.

Sampling and identification: Each site was searched (10 min, one person) for evidence of termite presence (e.g., damaged wood, frass, carton, mud tubes, wings). All potential termite habitats—including built structures, standing trees and shrubs, discarded wood, leaf litter and organic debris, roadside trash piles, and wood debris—were searched for visible damage. Wood with evidence of termite activity was opened, and live termites were collected using an aspirator. When soldiers were not evident immediately, one or more pieces of wood were taken back to the lab for further processing. Wood was split with a hatchet to collect soldiers. Samples were stored in 95% ethanol for later identification.

Termites were identified to the species level (Bacchus 1987, Scheffrahn and Su 2021, Snyder 1922, Tong et al. 2025, Weesner 1965). The locations of live termites were mapped using QGIS (Version 3.44, QGIS Association).

Results

Three species of termites (*Co. formosanus*, *Co. gestroi*, and *I. immigrans*) were found at 38 sites from the systematic survey (Figure 2A), compared to four species of termites (*Co. formosanus*, *Cr. cynocephalus*, *I. immigrans*, and *N. connexus* found during the 2012 systematic survey (Figure 2B). A few locations were not searched due to changes in accessibility. Supplemental field searches, including public reports and confirmations, added another three species, for a total of six termite species identified on Oʻahu during 2022–2024: *Co. formosanus*, *Co. gestro*i, *Cr. brevis*, *Cr. cynocephalus*, *I. immigrans*, and *N. connexus* (Figure 3).

Of the seven sites where Scheffrahn et al. (2000) reported *Co. formosanus*, one site was no longer accessible, and no live Co. formosanus termites were found at the other sites. Of the 32 sites where Woodrow et al. (2001) reported *Coptotermes* termites, 12 sites were no longer accessible. Live *Co. formosanus* termites were found only at Poamoho Research Station and Kahana Bay Beach Park, and live *Co. gestroi* termites were found at Puʻuloa Beach Park and at the Barber's Point Riding Stables in Kalaeloa (Figure 3).

Discussion

Management implications of shifts in termite distribution: The expansion of *Co. gestroi* on Oʻahu is concerning, as the management of *Co. gestroi* presents unique challenges due to its tunneling geometry and foraging patterns compared to *Co. formosanus*, which may affect bait interception of traditional in-ground bait stations (Su et al. 2023). Because the use of above-ground bait stations is recommended when treating *Co. gestroi* (Su et al. 2023), the identification of *Co. gestroi* and *Co. formosanus* should be considered when applying bait [Refer to Tong et al. (2025) for complete identification keys].

Increased awareness among the public and the available termite management tools may explain the reduced number of *Co. formosanus*-positive sites on Oʻahu. In-ground termite bait systems were used at some sites where *Co. formosanus* was previously found, and no live *Co. formosanus* were found at those treated sites in recent surveys. To improve future detection rate, we recommend

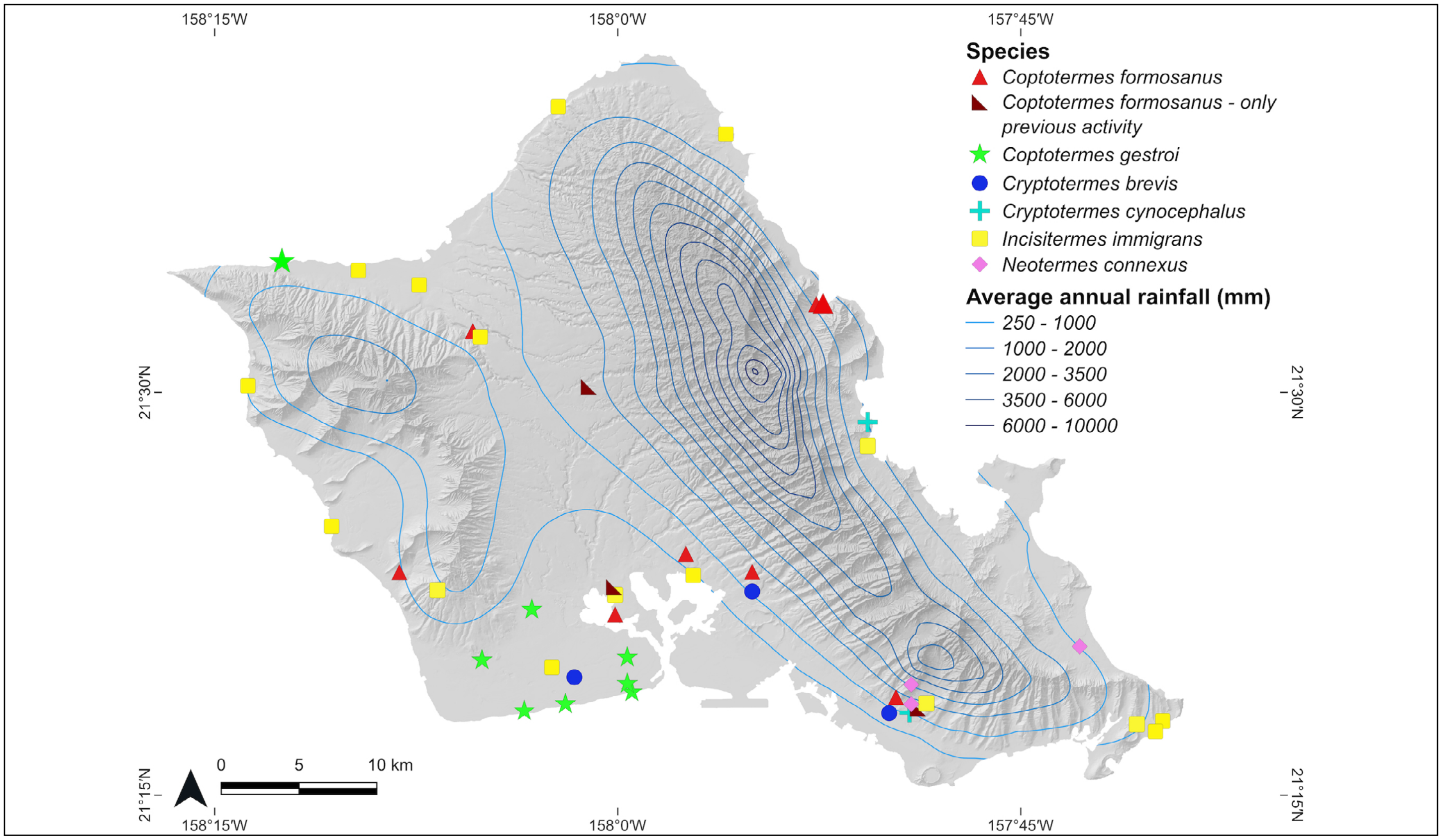

Figure 3. Distribution of six termite species on the island of Oʻahu. This distribution combines the results of a systematic survey conducted September 2023 to January 2024 with data from supplemental field searches conducted between 2022 and 2024. Supplementary searches revealed increased *Co. gestroi* occurrences. Sites previously positive for *Co. formosanus* that showed no activity by 2024 (but did show activity in 2022–2023) are indicated as *Coptotermes formosanus – only previous activity*.

additional survey methods such as light traps and termite bait placement. Light traps work better for collecting termites such as alates (the winged reproductives form) that occur in man-made structures that are not permitted or accessible to examine physically, while baits are useful to detect subterranean termites that nest underground.

Previously, *Co. gestroi* was limited to the south west region of Oʻahu. In the current study, *Co. gestroi* was found on the north west region of Oʻahu near Kawaihāpai Airfield, a U.S. Army-owned general aviation airfield for commercial (skydiving and glider operations) and military traffic. These termites were predominantly found near beachside ironwood tree stumps. Although an effort was made to sample in an area between the south west portion and the north west region of Oʻahu (permission to search granted by Camp Pālehua), only drywood termites were found. However, this area was relatively smaller, and many other routes may be possible between the areas than the currently survey route. We speculate that *Co. gestroi* subsequently reached the north west region of Oʻahu through airport-related movement. Kalaeloa Airfield serves both military aircraft—whose crews may transit from infested regions—and private commercial flights (flight logs show regular service to/from areas where *Co. gestroi* is well established). Similarly, finding Indo-Malaysian drywood termite, *Cr. cynocephalus* in Mānoa, about 19 km from where it has been previously recorded, could be a result of recent human-assisted transport.

Although our current hand-search surveys readily detect drywood termites in natural wood, future work should involve collaborations with pest control companies (e.g., Henderson and Delaplane 1994, Neoh and Lee 2009, Tong et al. 2017) with increased public participation to broaden sampling. Alate trapping can more accurately show the distributions of subterranean species and species more commonly found on private property, such as *Cr. brevis*. However, alate trapping requires more time, resources, and permissions (e.g., to sample on private property).

A promising and less labor-intensive methodology using autonomous surveillance systems and artificial intelligence may be used to monitor termite alates in the future. Paryavi et al. (2025) developed a custom surveillance system for trap monitoring for the coconut rhinoceros beetle, *Oryctes* *rhinoceros* Linnaeus. With some adjustments, such as customizing the trap body, focal point of the camera, light, and funnel, this system may provide data on the termite species present in an area and their flight phenology. Further, real-time data from trap monitors may be used to help readjust extension efforts for termite education.

Hybridization Risk: Beyond range expansion, a second emerging concern is hybridization between *Co. gestroi* and *Co. formosanus*. This phenomenon has been confirmed in field populations in both Florida and Taiwan (Chen et al. 2024; Chouvenc et al. 2025), raising concern about the increased potential for hybrid establishment where the two species co-occur and their swarming overlaps (Chouvenc et al. 2025). Although hybrid individuals have not yet been detected in Hawaiʻi, the issue is significant: Florida, Hawaiʻi, Taiwan, and Hainan are the only four regions where both species currently co-occur (Chouvenc et al. 2025). Both *Co. gestroi* and *Co. formosanus* are among the most damaging and destructive termite species in the world. This warrants close monitoring for potential hybrid emergence.

Given these shifts in termite distributions and the emerging hybrid risk, we must adapt our monitoring and management strategies accordingly. Taken together, these findings underscore the need for ongoing, integrated surveillance programs that combine systematic field surveys, genetic screening, and stakeholder engagement.

Conclusion

The updated termite distribution survey highlights important shifts in the presence of subterranean and drywood termites on Oʻahu. The spread of *Co. gestroi* and the decline in *Co. formosanus* in some sites suggest that termite population dynamics on the island are changing, potentially due to management efforts or anthropogenic factors. These findings reinforce the need for adaptive and region-specific termite management strategies. As both *Co. formosanus* and *Co. gestroi* co-occur in Hawaiʻi, the potential emergence of hybrid populations, as observed in Florida and Taiwan, represents a future concern that should be closely monitored through genetic and ecological studies. The importance of long-term monitoring of invasive termites on islands like Oʻahu need to be considered in future studies. Our findings provide updated distribution records and offer insights to guide management strategies on Oʻahu. Future research will aim to extend surveys to other Hawaiian Islands.

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