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**Title: Keys for Distinguishing Eight Termites Species in Hawai‘i**

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## Background

(Drywood termite photographed in Hawai‘i)

Hawai‘i’s subtropical climate, interisland transport network, and continual influx of global commerce have created ideal conditions for the establishment or spread of termites. These factors, combined with urban expansion and the widespread use of wood-based construction, have made termite management a growing challenge in the islands. Collectively, subterranean and drywood termites are estimated to cause over $100 million in annual damage to structures and trees in Hawai‘i (Grace, 2010).

Since the last termite identification guide for Hawai‘i was published in 1999 (Woodrow et al., 1999), the number of termite species known from the state has increased from seven to eight (Grace, 2010). Notably, the Asian subterranean termite, *Coptotermes gestroi*, has emerged as a new pest. Initially confined to lands southwest of Pearl Harbor (Woodrow et al., 2001), *C. gestroi* is now well established across much of the western half of O‘ahu, ranging from the south shore to the northernmost beaches (Tong and Tay, 2025). Compared to the long-time Hawai‘i resident (*C. formosanus)*, *C. gestroi* occurs at warmer and drier areas on Oahu and exhibits greater tolerance to drought and heat (Grace, 2014), traits that may facilitate its continued expansion amid global climate change. Alongside the changes in termite species composition in Hawai‘i, the broader scientific classification of termites has also evolved in 2018 where termites were reclassified from the order Isoptera to Blattodea (Harrison et al., 2018).

Understanding the biology and behavior of termite species is crucial for their effective management. For example, most indoor treatments, such as fumigation or heat, are most effective against drywood termites that nest within wood. In contrast, subterranean termites like *C. formosanus* and *C. gestroi* mostly live in underground colonies and forage into structures. Treatments targeting the structure alone often fail to eliminate reproductives of subterranean termites. Furthermore, *C. formosanus* and *C. gestroi* exhibit different tunneling behaviors, which has implications for the effectiveness of traditional in-ground termite bait stations, highlighting the importance of accurate identification when developing pest control strategies.

Given these biological and behavioral distinctions, accurate identification becomes critical not only for effective management but also for rapid detection and response of newly introduced invasive species or potential hybrid termite species (Chouvenc et al., 2025; Tong and Tay, 2015). Careful inspection of materials, especially wood products, is a crucial step to prevent termites from hitchhiking and spreading to new areas. Finally, public awareness is a key part of long-term control efforts. Residents should not assume all termites are the same; recognizing differences among species can lead to more effective reporting, response (destructive vs. non-destructive species), and management.

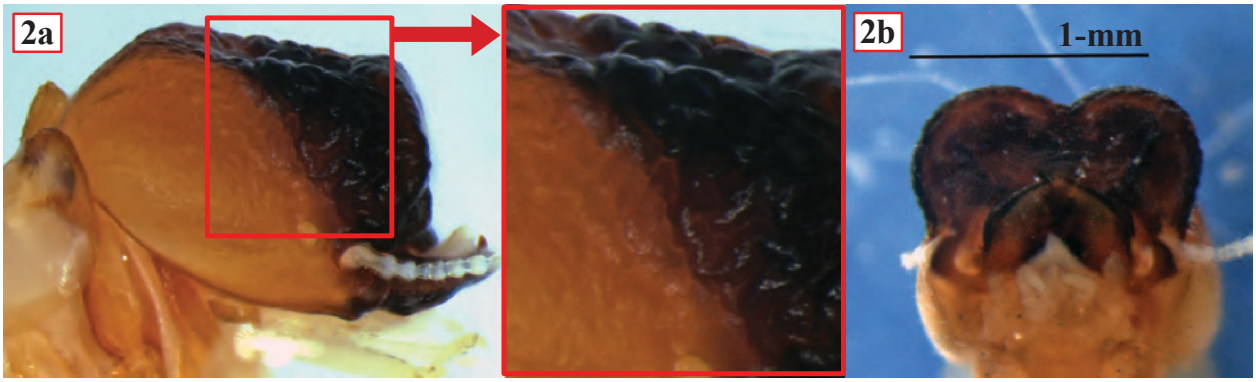
This updated identification key with photographs and diagrams consolidates diagnostic anatomical characters for soldiers and alates (winged reproductive form) of all termite species currently confirmed in Hawai‘i, significantly enhance accuracy during identification.

# KEY TO THE TERMITE SOLDIERS OF HAWAI'I:

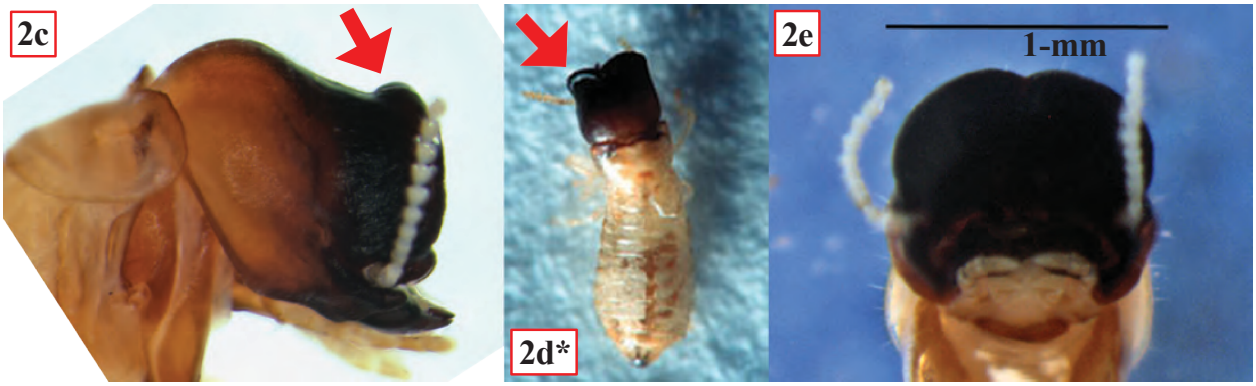
**1.** Head plug-like, appears pushed-in (Figure 1a); mandibles (jaws) small or not visible when viewed from above [Kalotermitidae: *Cryptotermes*]. ..... **2**


- Head does not appear pushed-in; mandibles easily visible from above (Figure 1b, 1c)..... **3**

**2.** Head wrinkled (Figure 2a); no distinct ridge at front edge of head (Figure 2a); head usually over 1-mm wide (Figure 2b = face view) ..... ***Cryptotermes brevis***

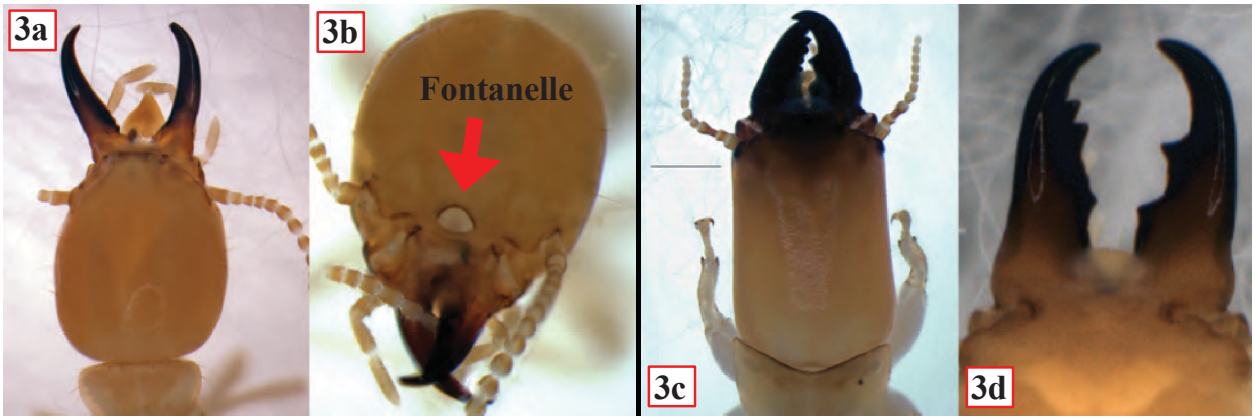



- Head smoother (Figure 2c, 2d); distinct ridge at front edge of head (Figure 2c, 2d*); head usually less than 1-mm wide (Figure 2e = face view)..... ***Cryptotermes cynocephalus***



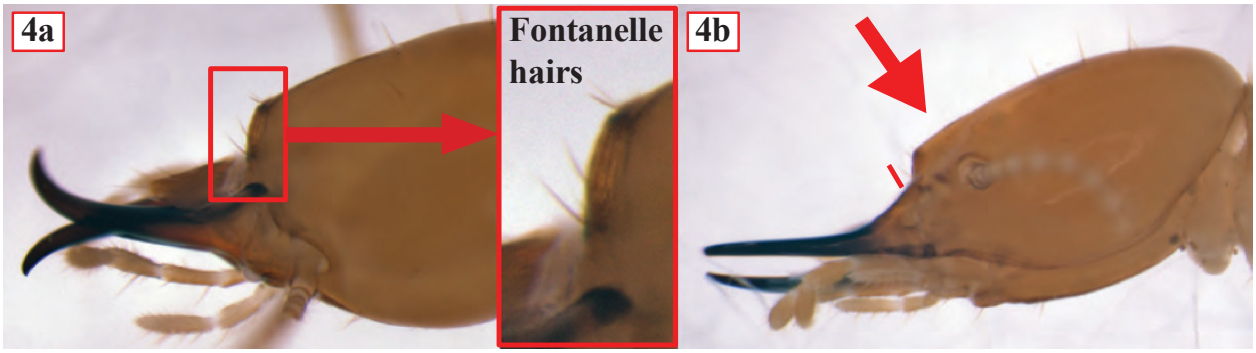

** a photo from Woodrow et al., 1999*

**3.** Head orange, oval-shaped when viewed from above (Figure 3a); mandibles smooth and sickle-shaped, black (Figure 3a); fontanelle (frontal pore) present (Figure 3b) [Rhinotermitidae: *Coptotermes*]..... **4**

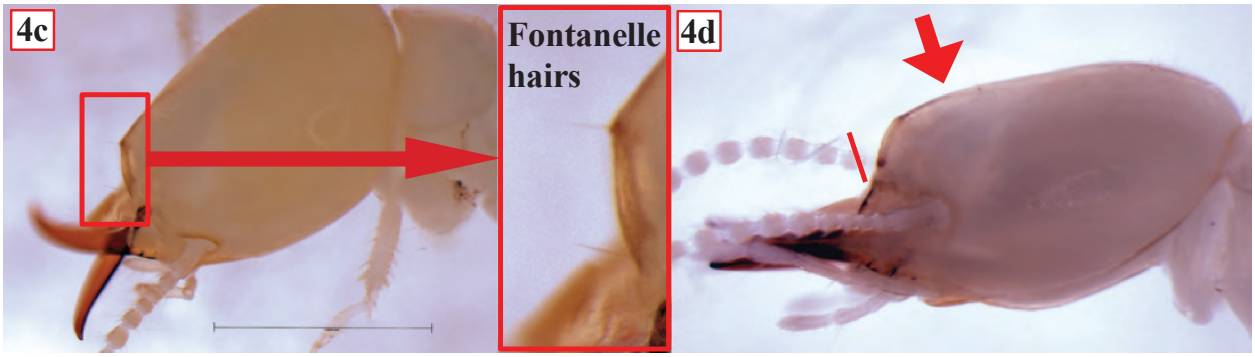



- Head orange, often dark brown to black near mandibles, rectangular when viewed from above (Figure 3c); mandibles serrated and dark (Figure 3d); no fontanelle. ..... **5**

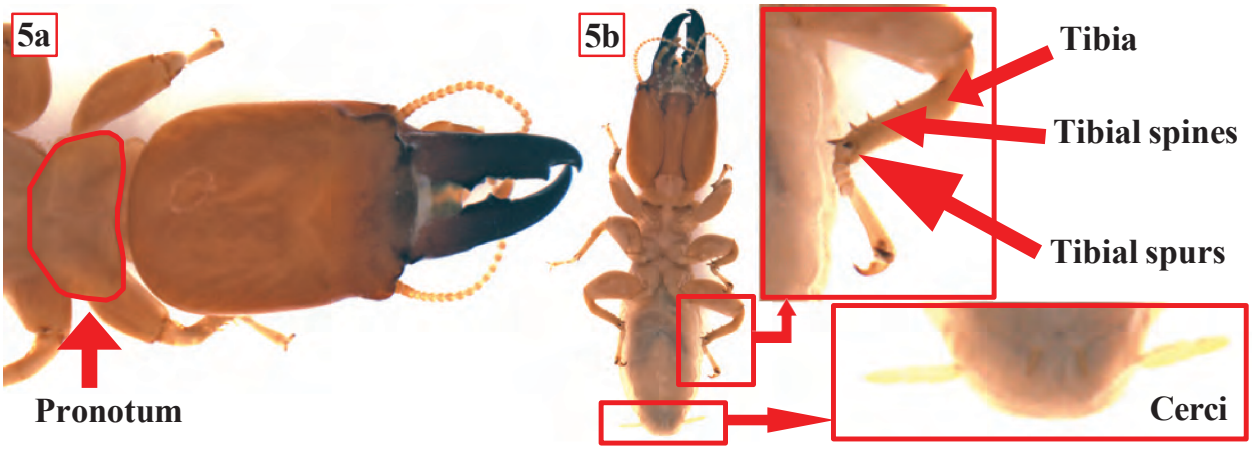
**4.** Two pairs of hairs at opening of fontanelle (Figure 4a); no slight bump at front of head in profile view (Figure 4b)..... ***Coptotermes formosanus***



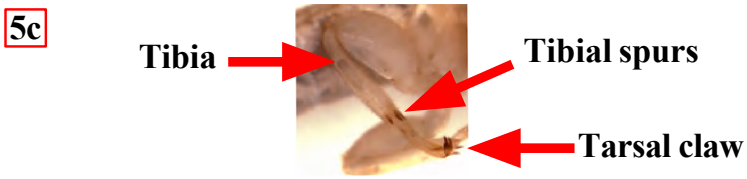

- One pair of hairs at opening of fontanelle (Figure 4c); slight bump at front of head in profile view (Figure 4d) [note: specimen is faded]..... ***Coptotermes gestroi***



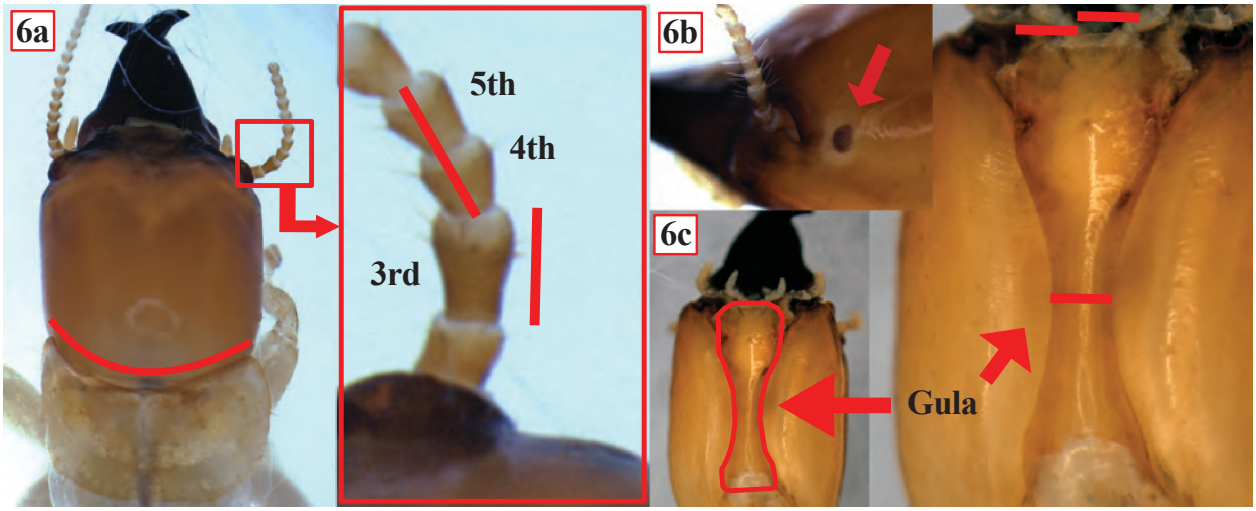
**5.** Pronotum (first thoracic segment) narrower than head (Figure 5a); sclerotized spines on shaft of tibia (Figure 5b); cerci (paired appendages at the end of the abdomen) long (over 3 segments each) (Figure 5b). .....***Zootermopsis angusticollis***




- Pronotum wider or nearly as wide as head; no sclerotized spines on shaft of tibia (hairs may be present), but tibial spurs (downward facing spines on tip of tibia) present (Figure 5c); cerci short (less than 3 segments each). .....**6**

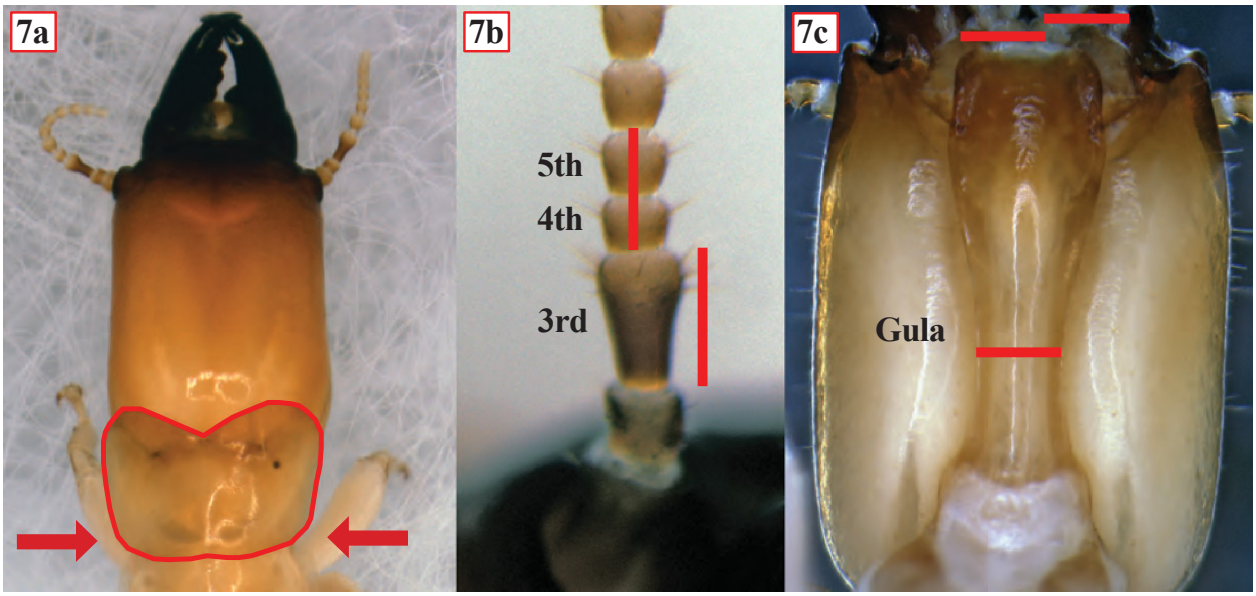



**6.** Third antennal segment not longer than 4th and 5th combined (Figure 6a); eye dark and conspicuous (Figure 6b); pronotum more "C"-shaped at top margin (Figure 6a); gula (throat, on ventral side of head) greatly narrowed in center, less than half as wide as top portion near mandibles (Figure 6c, lines = width at narrowest). .....***Neotermes connexus***

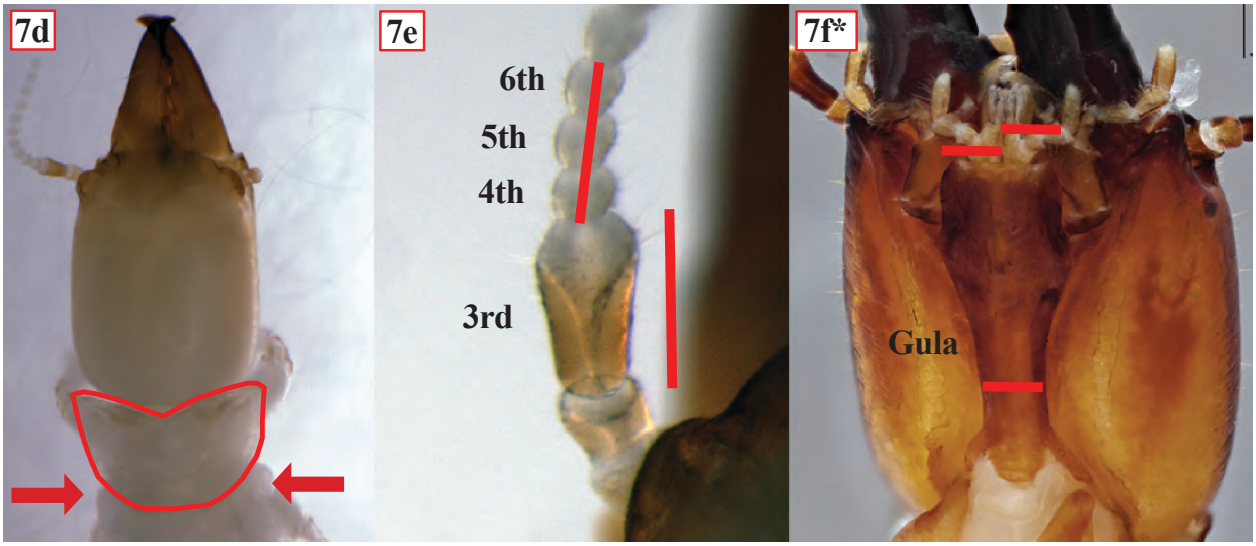



- Third antennal segment equal to or longer than 4th and 5th combined; eye light or inconspicuous; pronotum more "V"-shaped at top margin [Kalotermitidae: *Incisitermes*]..... **7**

**7.** Third antennal segment equal to or longer than the 4th and 5th combined, but not longer than the 4th, 5th, and 6th combined (Figure 7b); pronotum width at top margin about equal to width at bottom margin (Figure 7a); gula not as narrowed in center, less than half as wide as top portion near mandibles (Figure 7c, lines = width at narrowest). ..... ***Incisitermes immigrans***




- Third antennal segment about equal to the 4th, 5th, and 6th combined (Figure 7e); pronotum width at top margin much wider than width at bottom margin (Figure 7d); gula narrowed in center, about half as wide as top portion near mandibles (Figure 7f*, lines = width at narrowest) [*note: specimens in Figure 7d and 7e are faded*]. ..... ***Incisitermes minor***

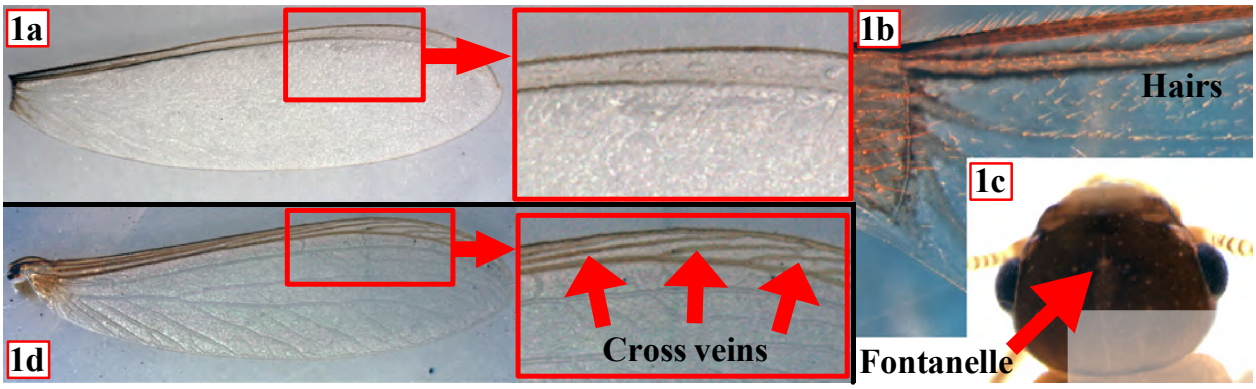



** a photo by Ed Freytag*

**The following key emphasizes the alate (winged form) characteristics that are distinct across species:**

## KEY TO THE TERMITE ALATES OF HAWAI'I:

**1.** Wings with only two heavily sclerotized (thickened) veins (Figure 1a) with no cross veins (Figure 1a); wings covered with minute hairs (Figure 1b); fontanelle (pore) present on head (Figure 1c) [Rhinotermitidae: *Coptotermes*] ..... **2**



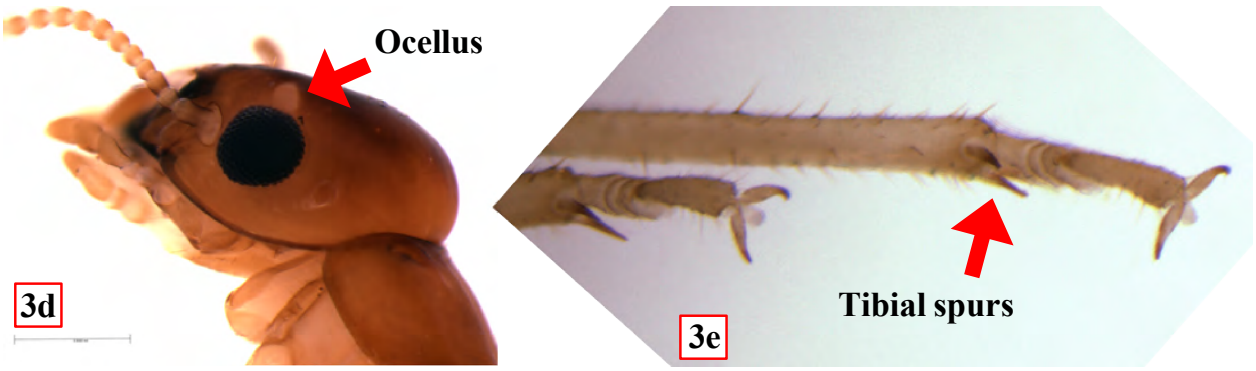

--- Wings with three or more heavily sclerotized veins (Figure 1d) with cross veins (Figure 1d); wings not covered with minute hairs; fontanelle absent [Termopsidae, Kalotermitidae]. ..... **3**

**2.** Total length with wings ~14-mm; head light yellow-brown (Figure 2a); antennal spots not prominent or crescent-shaped (Figure 2a) [near ocelli (simple eyes)]; maximum head width 1.5-mm; wing length over 10-mm (Figure 2b); costal band (faint yellow band) present near radial sector towards tip of wing (Figure 2b)..... ***Coptotermes formosanus***

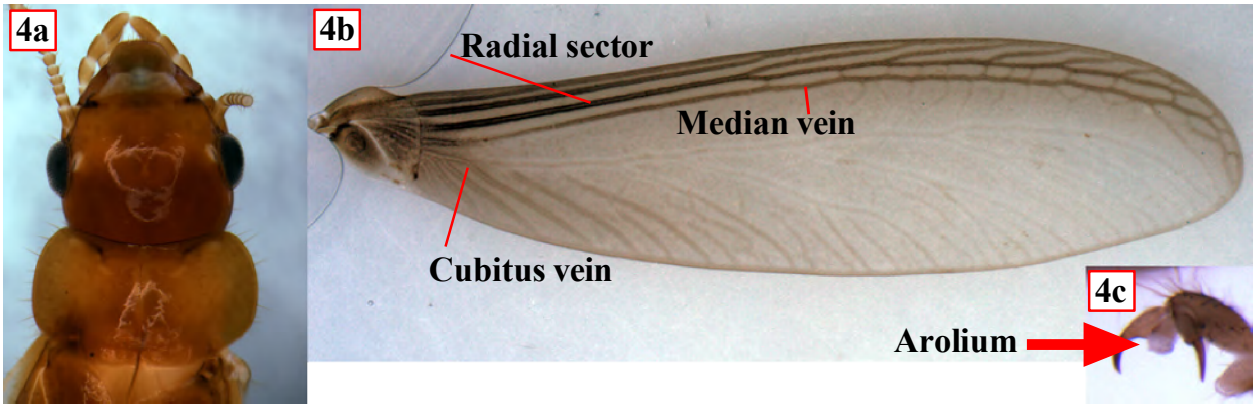

--- Total length with wings less than 12-mm; head dark brown (Figure 2c); crescent-shaped antennal spots prominent (Figure 2c) [near ocelli]; maximum head width less than 1.4-mm; wing length less than 10-mm; no costal band (Figure 2d) ..... ***Coptotermes gestroi***

**3.** Ocelli (simple eyes) absent (Figure 3a); cerci prominent, more than 3-segmented (Figure 3b); wings leathery; wing length ~18-mm; tibia with one or more spines on shaft (tibial spurs also present) (Figure 3c) [Termopsidae]. ..... ***Zootermopsis angusticollis***


--- Ocelli (simple eyes) present (Figure 3d); wings not leathery; wing length less than 18-mm; no sclerotized spines on shaft of tibia (hairs may be present), but tibial spurs present (Figure 3e) [Kalotermitidae]. ..... **4**

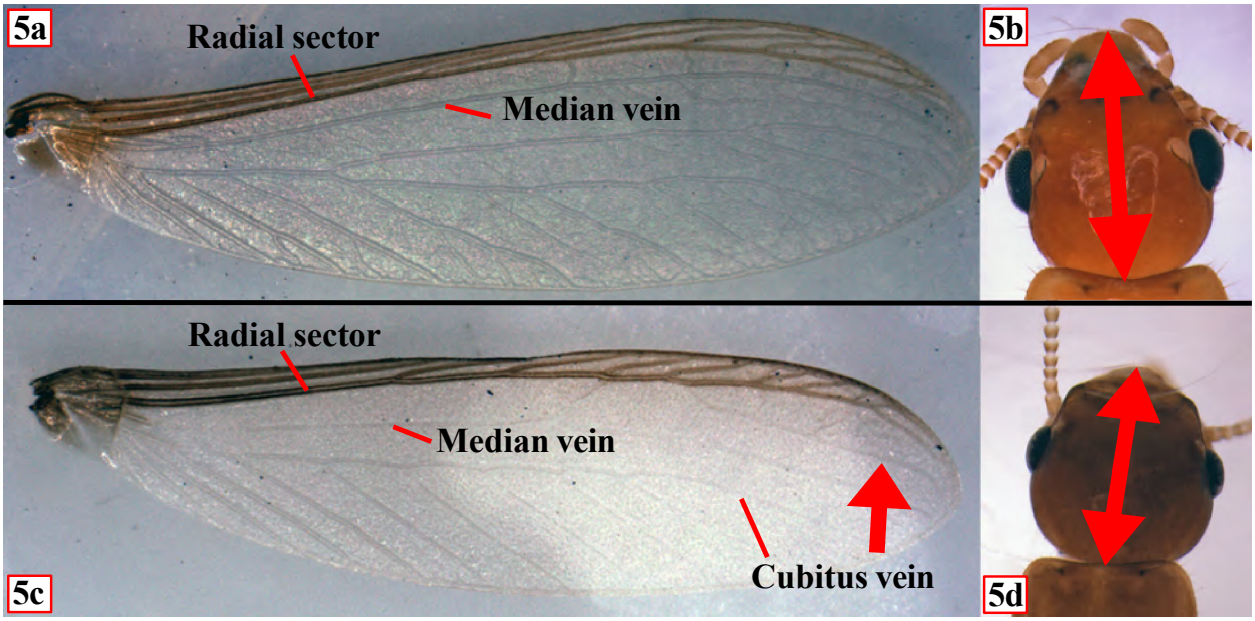



**4.** Total body length with wings 16-18-mm; pronotum width ~2-mm (Fig 4a); wing length over 12-mm; median vein as heavily sclerotized as the radial sector and closely paralleling it (Figure 4b); arolium (pad between tarsal claws) present (Figure 4c)..... ***Neotermes connexus***



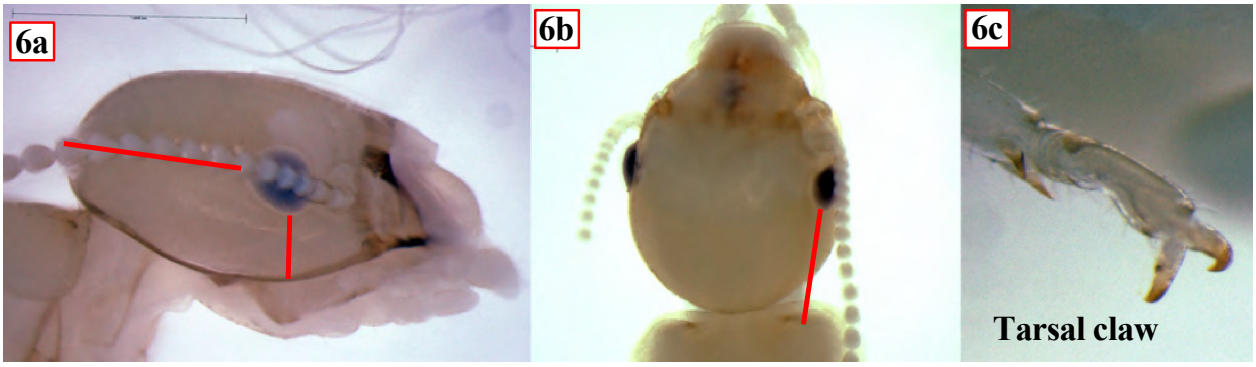

--- Total body length with wings less than 16-mm; wing length less than 12-mm; weak (not sclerotized) median vein not paralleling radial sector ..... **5**

**5.** Median vein reaching apex (tip) of wing (Figure 5a); head length from back of head to tip of labrum over 1.3-mm (Figure 5b) [*Incisitermes*] ..... **6**



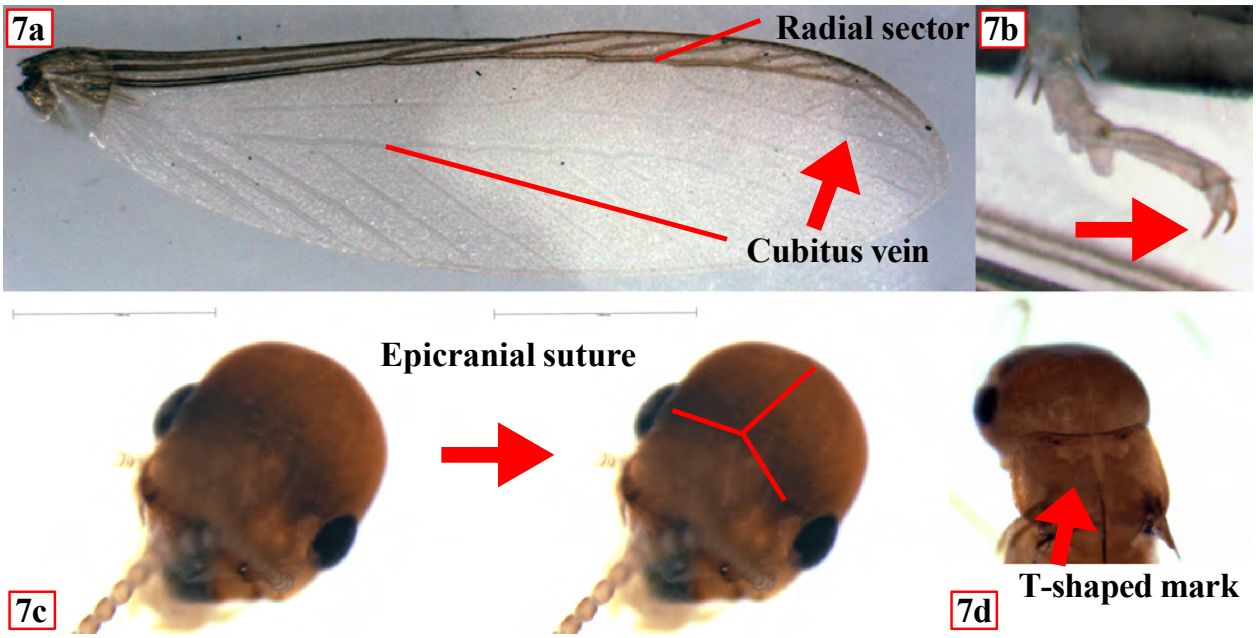

--- Median vein generally not reaching apex of wing (Figure 5c); head length to tip of labrum less than 1.3-mm (Figure 5d) [*Cryptotermes*]. ..... **7**

**6.** Head reddish-brown, body bluish-black; eyes positioned ~3x its diameter from back margin of head (Figure 6a, 6b); and roughly equal to their diameter from the bottom margin of head (Figure 6a); wing length 8-9-mm; wings smoky-gray with black veins; arolium absent (Figure 6c) (*note: specimen is faded*) ..... ***Incisitermes minor***

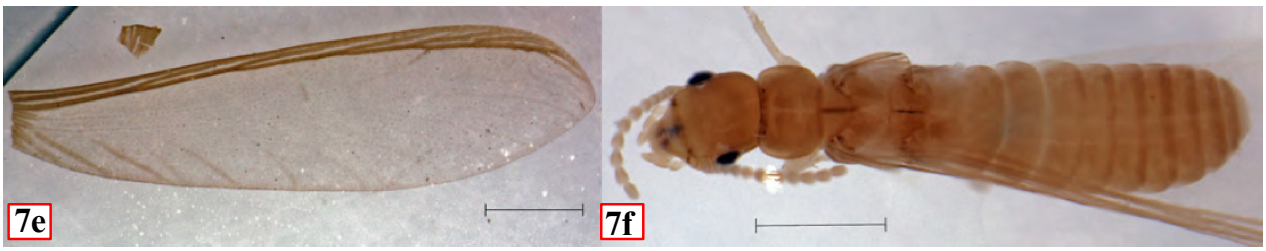



--- Head yellow-brown to chestnut (Figure 6d), body pale yellow; wing length 10-mm (Figure 6e); wings yellow to light brown (Figure 6e); eyes separated from bottom margin of head by less than its diameter (Figure 6d); arolium present (Figure 6f) ..... ***Incisitermes immigrans***

**7.** Total length with wings 10-12-mm; wing length 8-9 mm, prismatic when dry; median vein usually bending forward to join radial sector (Figure 7a); cubitus vein joining radial sector in distal third of wing (Figure 7a); arolium absent (Figure 7b); maximum head width just above 1-mm, head length 1-1.2-mm (Figure 7c); epicranial suture (Y-shaped lines) usually visible (Figure 7c); pale T-shaped mark on pronotum often present (Figure 7d) ..... ***Cryptotermes brevis***




--- Total length with wings ~6-mm; wings ~5.5-mm long, dark (Figure 7e, *note: specimen slightly faded*); median vein bending forward to join radial sector (Figure 7e); body length without wings less than 5-mm (Figure 7b); arolium present; maximum head width less than 1-mm, maximum head length less than 1-mm (0.76-0.85-mm) (Figure 7f). ..... ***Cryptotermes cynocephalus***



## Concluding remarks

The composition of Hawai‘i’s termite fauna will continue to evolve as global trade, climate change, and inter-island movement create new introduction pathways and alter habitat suitability. Surveillance, coupled with the use of identification tools such as this key, is essential for limiting future economic and ecological damage. A recent study by Chouvenc et al. (2025) confirmed the first field-documented hybridization between *C. formosanus* and *C. gestroi* populations in Florida, raising concerns that similar interspecies breeding could occur in Hawai‘i where both species also coexist. Individuals encountering specimens that do not clearly match the provided key descriptions or that appear in unexpected locations are encouraged to contact the University of Hawai‘i entomologists or the Hawai‘i Department of Agriculture for further assistance. Continued collaboration among researchers, pest-management professionals, and the public is the best defense against the next unwanted invasive species arrival.

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