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Variation in shape and size of fecal pellets as a diagnostic tool for drywood (Kalotermitidae: Blattodea) termite species identification

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Abstract

A study on the variation in size and shape of dry wood termites fecal pellets were conducted to determine if it can be used as a diagnostic tool for species identification. Specimens of both fecal pellets and termites (soldier caste) were collected. Species identification were based on available keys. Fecal Pellet's were mounted on a microscope to view and measure the variations in shape and size between species. Out of 38 specimens, 21 were identified as *Cryptotermes dudleyi* Banks and the remaining is *C. cynocephalus* Light. Termite's difference in length was noticeable, *C. cynocephalus* is shorter, i.e., less than 5mm while *C. dudleyi* exceeds 5mm. The shape of fecal pellets were almost identical between the two species however *C. dudleyi* was much wider by 0.7mm and longer by 0.22mm than *C. cynocephalus*. Thus the difference in size can already provide hint to pest controller, students or researcher as to the identification of dry wood termites.

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Introduction

In the Philippines, Drywood termites also called as one-piece-type termite (Bagnères and Hanus, 2015) is a common pest infesting wood structures in houses (Acda, 2004) and furniture in academic buildings (Rojo, 2017). There are only two species of this group observed to be destructive in the country, viz., the native *Cryptotermes cyanocephalus* Light (Light, 1921) and *Cryptotermes dudleyi* Banks (Acda 2004; Garcia *et al.* 2012). These termites are difficult to detect and observe due to their cryptic habitat (Grace, 2009) they live entirely within the wood members they infest (Scheffrahn and Su, 2014) and only during swarming do young adults leave their galleries to begin new colonies (Scheffrahn and Su, 1997).

Morphological identification of termite species can be difficult as diagnostic morphological features can be rare and are often restricted to soldiers or alates (Cassala *et al.*, 2016). While Pseudergates (false worker) which is the most abundant caste in drywood termites as well as the workers in subterranean termite (Gold *et al.*, 2005) are indistinguishable from each other to the level of species (Brammer and Scheffrahn, 2002). These difficulties can be addressed by employing molecular techniques (e.g., DNA barcoding). Wang *et al.* (2009), subjected workers to molecular identification while soldiers and alates were identified based on taxonomic keys. However this method is costly, time consuming (Dunn, 2003) and requires technically capable personnel.

These difficulties in identifying drywood termites as discussed above is aggravated by its cryptic habit. Collection of specimen for identification can be arduous because this would mean breaking infested wood into pieces just to extract termite. Furthermore, the number of soldier caste which is usually used specimen for identification, is limited per colony. In *Cryototermes secundus*, the number of soldier ranges only from 1 to 10 per colony with median of 2 (Korb, 2007). Fecal pellets are diagnostic for drywood termites (Moore, 1993) these are ejected from the galleries inside the wood and are mostly the only sign of infestation (Haverty *et al.*, 2005). The report of Grace (2009), showed that fecal pellets may be a valuable source of information on the biology of these cryptic insects, including the identity of the termite species. Haverty *et al.*, (2005) demonstrated that hydrocarbon extracts of termite fecal pellets from damaged wood can be characterized and used to identify termites. However, this method is also difficult. Using the variation in shape and size of fecal pellets for drywood termite identification would be easier. But Brammer and Scheffreahn (2002), argued that fecal pellets of drywood termites are similar in shape and size. But considering there are only two species of destructive drywood termites in the Philippines a significant variation in shape and size of fecal pellets between these two species could be used as a diagnostic character for species identification with these consideration the study was conducted respectively.

Material and methods

Specimen Collection

Heavily infested wooden structures were inspected for presence of drywood termites. Both fecal pellets and termites were collected. Termites were placed in Eppendorf tube with 95% ethanol for identification. The termite was identified using available keys. Only those fecal pellets excreted from identified soldier caste were used for this study. Atleast 38 specimens were collected.

Shape and Size of fecal pellets

All fecal pellets were mounted on a Leica microscope with camera connected to a desktop computer with a software CaptaVision installed. Pictures of the mounted specimens were taken and shapes between the two species were compared. Size measurements were done using ImageJ software.

Result and discussion

Species identification

Out of 38 specimens, 21 were identified as *Cryptotermes dudleyi* Banks and the remaining is *C. cynocephalus* Light. Pseudergates of both termites were almost identical and it is quite difficult to differentiate the two based on morphological characters of this morph (Fig. 1). Morphological identification of termite species can be difficult as diagnostic morphological features can be rare and are often restricted to soldiers or alates (Cassala *et al.*, 2016). Workers are indistinguishable from each other to the level of species (Brammer and Scheffrahn, 2002) However, it is important to note the body length of *Cryptotermes* spp. pseudergates varied. *C. cynocephalus* is shorter, i.e., less than 5mm while *C. dudleyi* exceeds 5mm (Fig. 1). The same size difference can also be observed between alates and soldier castes of both *C. cynocephalus* and *C. dudleyi* (Light, 1921).

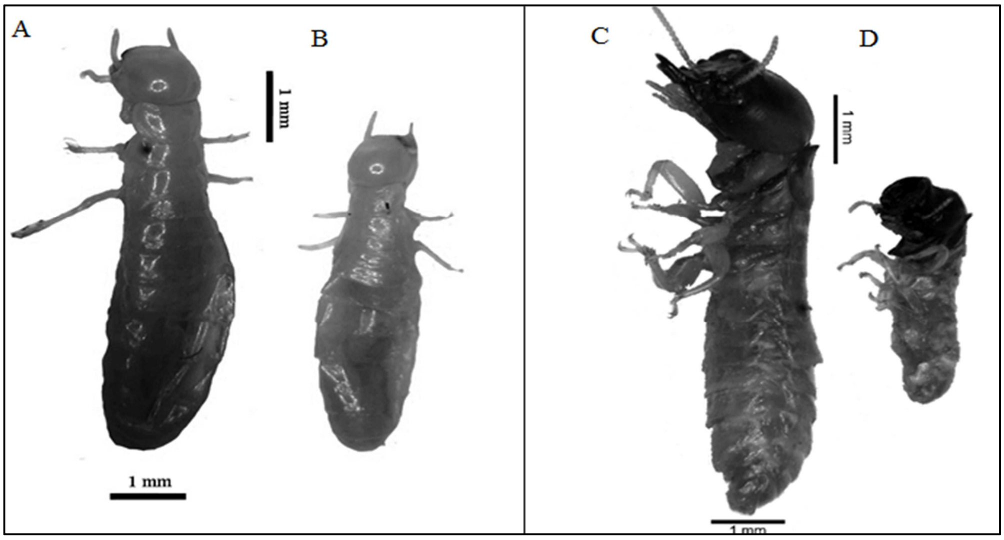

Fig. 1. Size difference between *C. dudleyi.* and *C cynocephalus* (A) Pseudergate of *C. dudleyi* (B) Pseudergate of *C. cynocephalus* (C) Soldier *Cryptotermes dudleyi* (D) *C. cynocephalus.*

In soldiers, the morphological difference between the two species is very obvious. The most notable character is the length of mandibles and head. Fig. 1 shows the soldiers of both species. *C. dudleyi* has longer mandibles, which are very obvious, compared to *C. cynocephalus*. The head of *C. dudleyi* is slender and longer than 1 mm while that of *C. cynocephalus* is bulldog-like and shorter than 1mm. The frontal area of *C. cynocephalus* is deeply notched or concave, giving the head a bilobed appearance as described by Light (1921) while the head of *C. dudleyi* is elongate, with sides almost straight and tapering slightly anteriorly as described by Scheffrahn and Krecek (1999).

Fecal Pellets

Fig. 2 shows the fecal pellets of both *C. dudleyi* and *C. cynocephalus*. The shape of fecal pellets of both species were almost identical. It is very hard to distinguish which fecal pellets belongs to, considering only the shape.

Therefore, the morphology of fecal pellets cannot be used as an effective feature for species identification or diagnostic tool for these two common destructive drywood termites in the Philippines.

This observation confirmed the report of Brammer and Scheffrahn (2002) that fecal pellets of *Cryptotermes* are similar in shape with other comparably sized species of Kalotermitidae. The description of Scheffrahn and Su (2014) that drywood termite fecal pellets has six longitudinal surfaces capped with one rounded and one more tapered end was consistent with what is shown in Fig. 2.

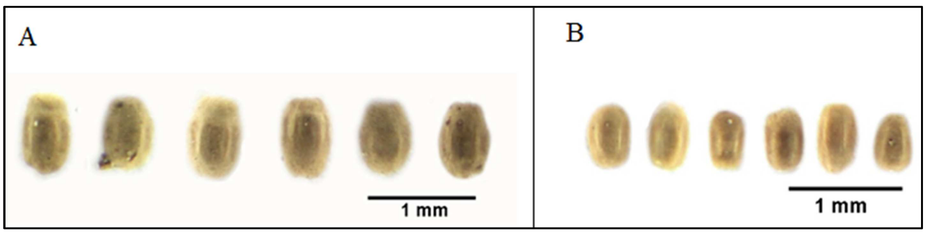

Fig. 2. Fecal pellets of *Cryptotermes* spp. (A) *C. dudleyi* (B) *C. cynocephalus.*

Although the shape was almost the same, the dimensions varied. As shown in Table 1, on the average, *C. dudleyi* was much wider by 0.7mm and longer by 0.22mm. This difference is expected since *C. dudleyi* is much bigger than the *C. cynocephalus,* and thus, its fecal pellets should also be bigger. Nuorteva and Kinnunen (2008) argued that the size of the excrement (fecal pellets) depends on the size of the larvae. The hydrocarbon extracts of fecal pellets can also be used to identify termite species as their hydrocarbons are species-specific (Haverty *et al.*, 2005). This was confirmed by Grace (2009), in that hydrocarbons extracted from drywood termite fecal pellets were qualitatively and quantitatively similar to cuticular extracts and thus can be used to determine the termite species responsible without the termites present.

Table 1. Mean dimensions of *Cryptotermes.* fecal pellets.

Drywood Termite	Width (mm)	Length (mm)
C. dudleyi	0.26 ± 0.01	0.66 ± 0.02
C. cynocephalus	0.19 ± 0.01	0.44 ± 0.01

The long-chain hydrocarbons of insects serve as sex pheromones, kairomones, species and gender recognition cues, nestmate recognition, dominance and fertility cues, chemical mimicry, primer pheromones and task-specific cues (Blomquist and Bagnères, 2010). The reason why cuticular hydrocarbons are similar to those in fecal pellets was explained by Haverty *et al.* (2005) to wit: termites contact with fecal pellets inside gallery system, cannibalism, secretion of hydrocarbons into the fecal pellets from mouthparts during expelling out of pellets through “kick out” holes and deposition of hydrocarbons during passage through the rectum. The hindgut at the end of which the feces pass through is also lined with cuticle in all insects (Gullan and Cranston, 2014).

Conclusion

Although the shape of fecal pellets were almost identical but the size varied. *C dudleyi* has bigger fecal pellets compared to *C. cynocephalus*. Although the size difference would not be visible to the naked eye with the use of microscope it can already provide hint to pest controller, students or researcher regarding species identity.

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