[研究文章 Research Article]

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Coptotermes gestroi: an Invasive Pest Discovered in Eastern Taiwan for the First Time (Blattodea: Rhinotermitidae)

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Abstract: This paper reports the first observation of the invasive Asian subterranean termite, *Coptotermes gestroi* (Wassmann, 1896), in eastern Taiwan. The known distribution of *C. gestroi* in Eastern Taiwan is mapped, and potential routes by which *C. gestroi* may further disperse throughout this region are also discussed.

Keywords: Termite, invasive species, distribution, urban pest

Introduction

Two species of termites from the rhinotermitid genus *Coptotermes* Wasmann are known to occur in Taiwan: the native *Coptotermes formosanus* Shiraki, 1909, and the invasive *Coptotermes gestroi* (Wassmann, 1896). *C. formosanus* and *C. gestro*i were found to be the most destructive termite pests in Taiwanese urban areas, with more than 87% of termite infestations caused by these species (Li et al., 2011). The invasive Asian subterranean termite, *C. gestroi*, was first reported in Taiwan in 2003, having been identified based on the morphology of soldiers and workers (Tsai & Chen, 2003). During the flight season in Taiwan, winged *C. gestori* imagos were observed from March to May (Yang & Li, 2012). Li et al. (2013,) indicated that *C. gestroi* is a tropical species, which has been found most commonly in warm, low altitude areas with high rainfall, and generally in close proximity to human habitation; correspondingly, a more recent survey by Chiu et al. (2019) suggests that *C. gestroi* populations would be unlikely to spread into the more mountainous mid-to-high altitude areas of Taiwan.

The putative native range of *C. gestroi* is thought to include Indonesia, Malaysia, and the Philippines (Chouvene et al., 2015). Based on mitochondrial sequences analysis, invasive *C. gestroi* populations in Taiwan are speculated to have been introduced from the Philippines (Li et al., 2009; Yeap et al., 2013). Up to the present, established *C. gestroi* populations were known to be restricted to south-western Taiwan, mostly within an area of urbanized and agricultural zones between Taichung and Pingtung (Tsai & Chen, 2003; Li et al., 2009; Su et al., 2017; Chiu et al., 2019). Despite sporadic records of *C. gestroi* workers and soldiers from outside this area, namely, in parts of the northern and central regions of Taiwan, *C. gestroi* alates have yet to be observed in these regions, and thus, these records are thought to represent non-reproductive fragments of colonies from the south-west, which have be moved to these other localities by humans, likely via the transport of timber products (Tsai & Chen, 2003). Su et al. (2017) suggested that the northern expansion of the *C. gestroi* in Taiwan could be a recent event, based on an examination of recent collection records.

In the present study, the authors report the first observation of *C. gestori* in eastern Taiwan, based on the collection of numerous *C. gestroi* alates during a recent fieldtrip to Beinan Township, Taitung County. Potential routes by which *C. gestroi* may further disperse throughout eastern Taiwan are also discussed.

Materials and methods

Winged imagoes of *Coptotermes gestroi* were collected from Zhiben station, Beinan Township, Taitung County (22.710262, 121.060768); these samples were preserved in 95% ethanol. Diagnosis was based on the key of Yang & Li (2012). All voucher specimens were deposited in the Urban Entomology Laboratory, Department of Entomology, National Chung Hsing University (Taichung County, Taiwan).

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All specimen images were generated using the Z-stacking technique. Z-stacks images were acquired with a Leica MC170 HD digital camera attached to a Leica M205 C stereomicroscope, using LAS software (version 4.4.0, Leica Application Suite, Wetzlar, Germany); stepping was achieved by hand. Z-stacks were aligned and merged using CombineZP software (Hadley, 2010), using the settings 'Align and Balance Used Frames' for alignment, and 'Do Stack' for merging. Merged images were subsequently processed in Adobe Photoshop and Adobe Illustrator CS5. The *C. gestroi* Taiwanese distribution map (Fig. 3) was modified from that of (Su et al., 2017), using Adobe Illustrator CC (64 Bit). This distribution map's legend is as follows: within the Taiwanese land area (coastline indicated by black border), grey areas indicate elevations above sea level of 100m or greater, while white areas indicate elevations from approximately sea level to 100m above sea level; red areas indicate the assumed distribution of the *C. gestroi* in Taiwan, based on (Su et al., 2017); the red circle indicates the location of isolated observations of *C. gestroi* in northern Taiwan; the red star indicates the location of the first *C. gestroi* record in eastern Taiwan, as reported in this paper.

Results

***Coptotermes gestroi* (Wasmann, 1896)**

(Figs. 1-2)

Materials examined. 50 alates, TAIWAN: Taitung Co., Zhiben Station (22.710262, 121.060768), Beinan Township, 06.IV.2019, F, -S, Hu leg., TW7936.

Diagnosis (Modified from Yang & Li, 2012). Alates of *C. gestroi* may be distinguished from those of *C. formosanus* by following characters: head, thorax, and abdomen are pale brown, inside of ocellus with a pair of crescent-like stripes.

Remarks. The winged *C. gestroi* imagoes were attracted by the artificial light source in the Zhiben railway station on April 6th 2019. These imagos were observed starting to fly at about 18:30, when the temperature was about 25 ℃. No rainfall was recorded for that day at this location.

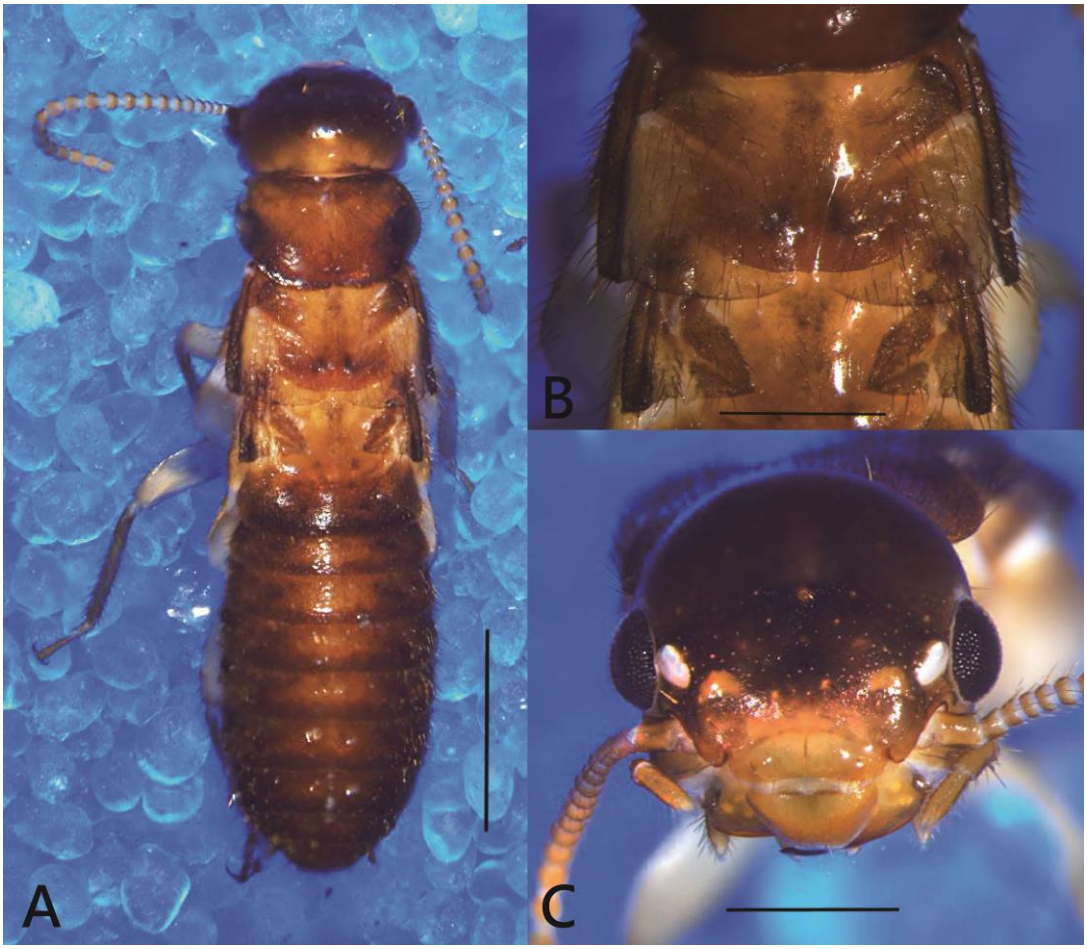

Figure 1. Habitus, wing base, and head of alates of *Coptotermes gestroi* from eastern Taiwan. A - Body habitus, scale bar: 1 mm; B - wing base, scale bar: 0.5 mm; C - head in frontal view, scale bar: 0.5 mm.

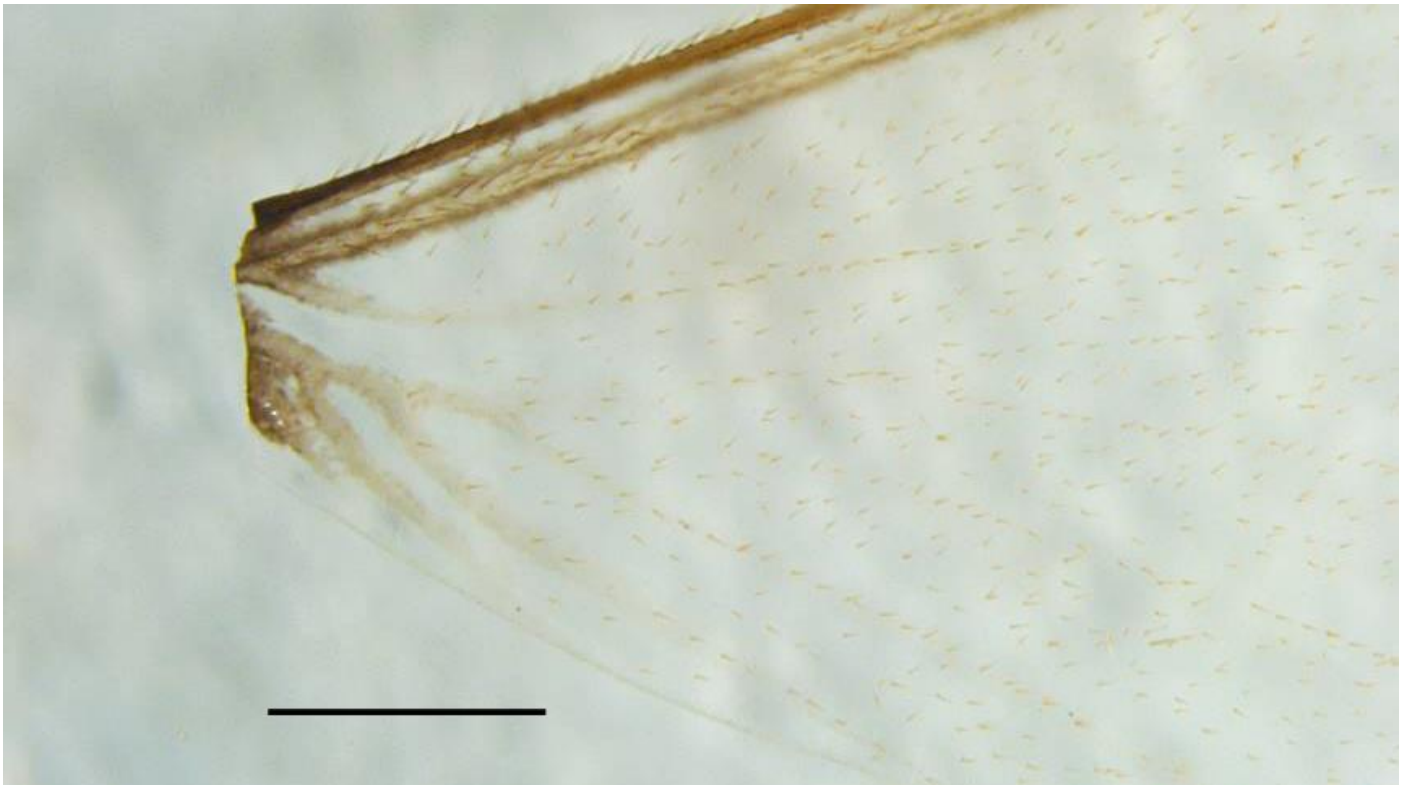

Figure 2. Wing surface of *Coptotermes gestroi* from eastern Taiwan, scale bar: 0.5 mm.

Discussions

Until 2016, almost all Taiwanese collection specimens of *Coptotermes gestroi* had been collected from south-western Taiwan (Su et al., 2017). The voucher specimens mentioned in this paper are the first recorded specimens of *C. gestroi* to be observed in eastern Taiwan. Most winged imagoes of *Coptotermes* spp. have previously been observed in the field being less than 250 m from their original colony (Mullins et al., 2015), and therefore, the observation of winged imagoes in a given locality is likely to indicate the presence of an established colony in this locality (Chouvenc & Su, 2014). However, based on the apparent preferences *C. gestroi* has shown for warm, lowland areas with high rainfall that are in close proximity to human habitation, it would therefore be expected that certain parts of eastern Taiwan (at about the same latitude as *C. gestroi*'s known range in Western Taiwan), particularly the lowland of Taitung, and even the southern part of Hualien, would provide a suitable habitat for this species. Nevertheless, *C. gestroi* had not previously been observed here, which begs the question: why hasn't this species been collected in eastern Taiwan until now?

Li et al., (2013) indicated that *C. gestroi* is most commonly be found in lowland area close to human populations, as most Taiwanese records of *C. gestroi* come from localities with these characteristics. Thus, much of the south-western region of Taiwan provides a suitable habitat for *C. gestroi*. On the other hand, most parts of the southern Taitung region are mountainous and less developed. As a result, the most likely routes by which *C. gestroi* may further disperse throughout eastern Taiwan are along the southern and eastern coastlines, and through the lower altitude areas of Pingtung County in southern Taiwan.

Su et al. (2017) proposed that the northern expansion of *C. gestroi* is likely to be a relatively recent event. Our observation suggests that the spread of *C. gestroi* throughout south-western Taiwan probably occurred earlier than the establishment of this species in south-eastern Taiwan, and that *C. gestroi* populations in south-eastern Taiwan were probably introduced from south-western Taiwan. Therefore, closer monitoring of *C. gestroi* populations in eastern Taiwan is needed. The current known distribution of *C. gestroi* is shown in Figure 3. below.

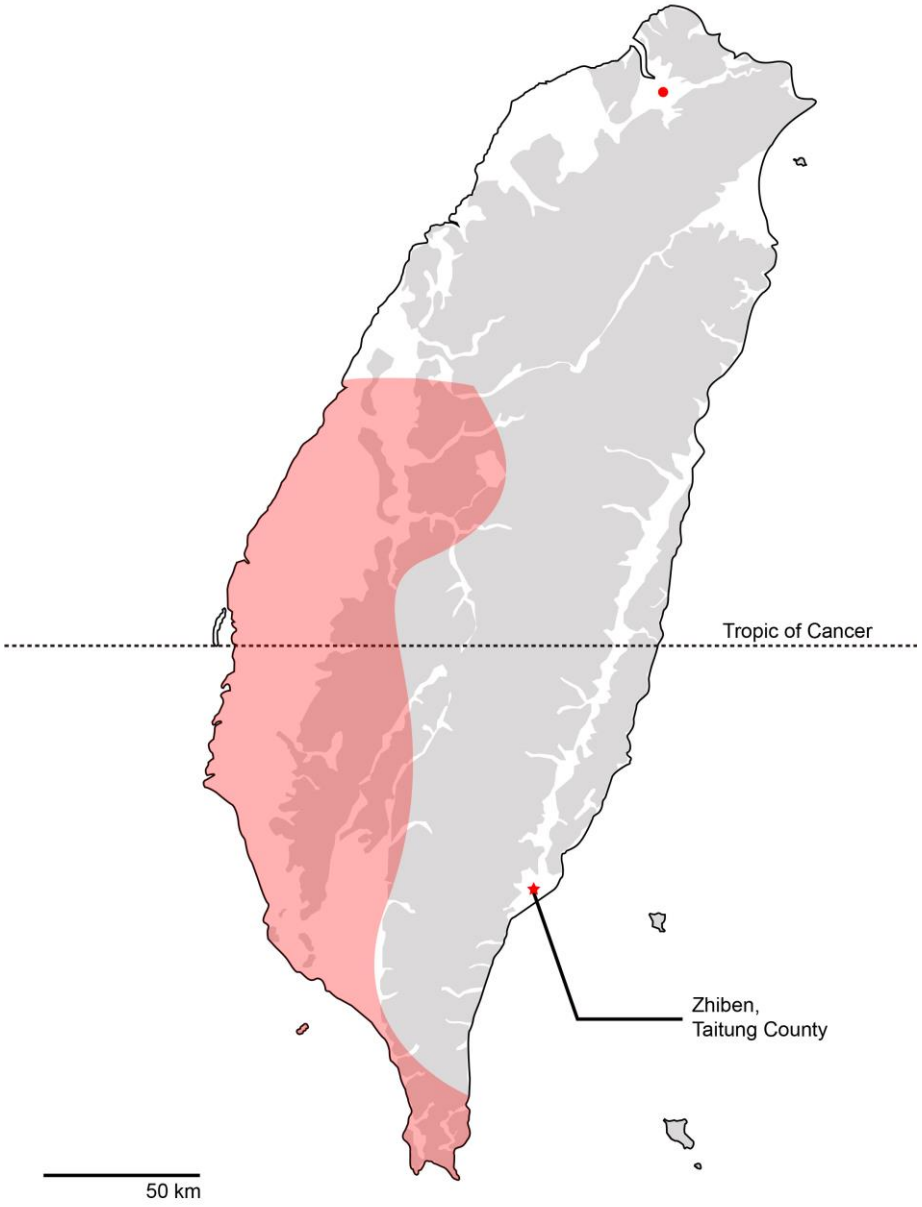

Figure 3. Distribution of *C. gestroi* in Taiwan (modified from Su et al., 2017).

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References

Chiu, Y.-N., Chiu, C.-I., Liang, W.-R., Tsai, M.-J., Yeh, H.-T. & Li, H.-F. 2019. Surveying the invasive termite, *Coptotermes gestroi* (Blattodea: Rhinotermitidae), in different altitudes of the experimental forest of National Taiwan University. *Journal of the Experimental Forest of National Taiwan University* 33 (1): 11-20. (in Chinese)

Chouvenc, T., Li, H.-F., Austin, J., Bordereau, C., Bourguignon, T., Cameron, S.L., Cancello, E.M., Constantino, R., Costa-Leonardo, A.M., Eggleton, P., Evans, T.A., Forschler, B., Grace, J.K., Hussender, C., Křeček, J., Lee, C.-Y., Lee, T., Lo, N., Messenger, M., Mullins, A., Robert, A., Roisin, Y., Scheffrahn, R.H., Sillam-Dussès, D., Šobotník, J., Szalanski, A., Takematsu, Y., Vargo, E.L., Yamada, A., Yoshimura, T. & Su, N.-Y. 2015. Revisiting *Coptotermes* (Isoptera:

Rhinotermitidae): a global taxonomic road map for species validity and distribution of an economically important subterranean termite genus. *Systematic Entomology* 41 (2): 299-306.
Chouvenc, T. & Su, N.-Y. 2014. Colony age-dependent pathway in caste development of *Coptotermes formosanus* Shiraki. *Insectes Sociaux* 61: 171-182.
Hadley, A. 2010. CombineZP (https://combinezp.software.informer.com/download/).
Li, H.-F., Ye, W., Su, N.-Y. & Kanzaki, N. 2009. Phylogeography of *Coptotermes gestroi* and *Coptotermes formosanus* (Isoptera: Rhinotermitidae) in Taiwan. *Annals of the Entomological Society of America* 102 (4): 684-693.
Li, H.-F., Su, N.-Y., Wu, W.-J. & Hsu, E.-L. 2011. Termite pests and their control in Taiwan. *Sociobiology* 57 (3): 575-586.
Li, H.-F., Fujisaki, I. & Su, N.-Y. 2013. Predicting habitat suitability of *Coptotermes gestroi* (Isoptera: Rhinotermitidae) with species distribution models. *Journal of Economic Entomology* 106 (1): 311-321.
Mullins, A. J., Messenger, M. T., Hochmair, H. H., Tonini, F., Su, N.-Y. & Riegel, C. 2015. Dispersal flights of the Formosan subterranean termite (Isoptera: Rhinotermitidae). *Journal of Economic Entomology* 108 (2): 707-719.
Su, N.-Y., Chouvenc, T. & Li, H.-F. 2017. Potential hybridization between two invasive termite species, *Coptotermes formosanus* and *C. gestroi* (Isoptera: Rhinotermitidae), and its biological and economic implications. *Insects* 8: 1-14.
Tsai, C.-C. & Chen, C.-S. 2003. First record of *Coptotermes gestroi* (Isoptera: Rhinotermitidae) from Taiwan. *Formosan Entomologist* 23: 157-161.
Yang, R.-L. & Li, H.-F. 2012. Taxonomy and identification of the five common termite species in Taiwan. *Formosan Entomologist* 32: 169-198. (in Chinese)
Yeap, B.-K., Othman, A.S. & Lee, C.-Y. 2011. Genetic analysis of population structure of *Coptotermes gestroi* (Isoptera: Rhinotermitidae) in native and itroduced populations. *Environmental Entomology* 40 (2): 470-476.

入侵性害蟲：格斯特家白蟻首次發現於東臺灣（蜚蠊目：鼻白蟻科）

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摘要: 首次報導格斯特家白蟻發現於東臺灣，並提供格斯特家白蟻在臺灣之最新分佈圖。本文亦探討其在東臺灣可能之擴散路徑。

關鍵字: 白蟻、入侵物種、分佈、都市害蟲