



Termite management in Southeast Asia – Challenges, pitfalls and modern solutions

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Acknowledgment

- Bentz Jaz and Sumitomo Chemical for the invitation to speak in this event.

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Feel free to take the photo of any slide


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Introduction

- Highly destructive insect pest in the urban environment.
- Accounted for ~ US\$40 billion of damages each year worldwide (Rust & Su 2012).
- Social insects — close allies of cockroaches.
- 3105 species have been described, but only 1 - 2% are pests.



Source: Phillip Tan (Alliance Pest)



Source: John Ho (Aardwolf Pestkare)

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Drywood termites

- Found inside drywood, often in structural timbers of buildings.
- Less dependent on moisture.
- Do not need to access the moist soil for survival.
- Fecal pellets are normally visible outside the exit holes of the infested timber.
- Tell-tale sign: Fecal pellets

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Dampwood termites

- Live entirely in wood with lots of moisture.
- Feed on decayed woods such as old tree stumps, rotting logs, wooden fence posts, and buried timber.
- Never leave its wood to forage.
- Less important economically.

Zootermopsis angusticollis
(Pacific Coast Dampwood termite)

Video: David Mora <https://www.slugabug.com/2014/01/21/the-dangers-of-dampwood-termites/>

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Subterranean termites

- Build their nests in the soil.
- Highly dependent on soil for moisture.
- When above ground, they construct shelter tubes to avoid dehydration in their search for wood.
- Most destructive.
- Economically most important termite group in Southeast Asia

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Behavior 101

- Worker of subterranean termites forage for food and body fluids with other nestmates (mouth-to-mouth, anus-to-mouth)
- Subterranean termites are phobias towards dead nestmates (necrophobic)
- Subterranean termites groom each other (allogrooming)



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Alates of *Coptotermes*



Photo credit: Xiao et al. (2012)

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Swarming termites



In tropical Southeast Asia, termite swarming occurs throughout the entire year. In other parts of Asia, termite swarms mainly between April and August.

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Coptotermes tandem running female in front, while male following from behind



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A queen of *Coptotermes*



Video credit: Rui-Hui Wang, Xin Cheng Environmental and Termite Control Co., Taiwan



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The eggs and larvae of *Coptotermes*



Photo credit: Xiao et al. (2012)

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Soldiers and workers



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Common subterranean termite pests in Singapore

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Coptotermes spp.

- Most destructive species: **Coptotermes gestroi**.
- Others: **C. curvignathus**.
- Nest underground in the soil (cryptic insects).
- In some situations, may build above-ground nests that may not require contact with the ground when moisture source is available.
- A colony consists of 1 - 3 million individuals.
- Alates swarm throughout the year, but mainly between January and June (in tropics), and April to August (in sub-temperate region).



Photo by Philip Tan (Alliance Pest)



Photo by WL Xiao (Guangdong Entomological Institute, China)

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C. gestroi is the most destructive termite species in the urban buildings and structures in SE Asia



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Coptotermes gestroi

The Asian Subterranean Termite



- Originates from southeast Asia and has spread to different tropical regions around the world. It arrived to Hawaii (1963, 1999), Florida (1996) and Brazil (before 1923).

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Photo credit: Wang-Qi Lin (Siang Wang Pest Control Co, Taiwan)

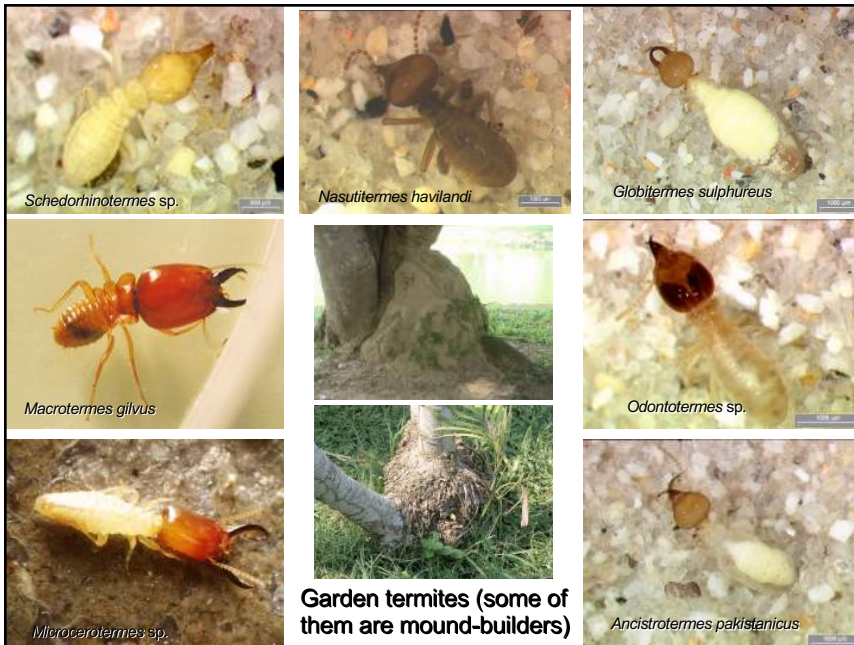


Photo credit: Wang-Qi Lin (Siang Wang Pest Control Co, Taiwan)

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Garden termites (some of them are mound-builders)

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Subterranean termites associated with garden and urban trees in Singapore

- *Coptotermes gestroi*
- *Coptotermes curvignathus*
- *Nasutitermes havilandi*
- *Macrotermes gilvus*
- *Macrotermes carbonarius*
- *Microcerotermes crassus*



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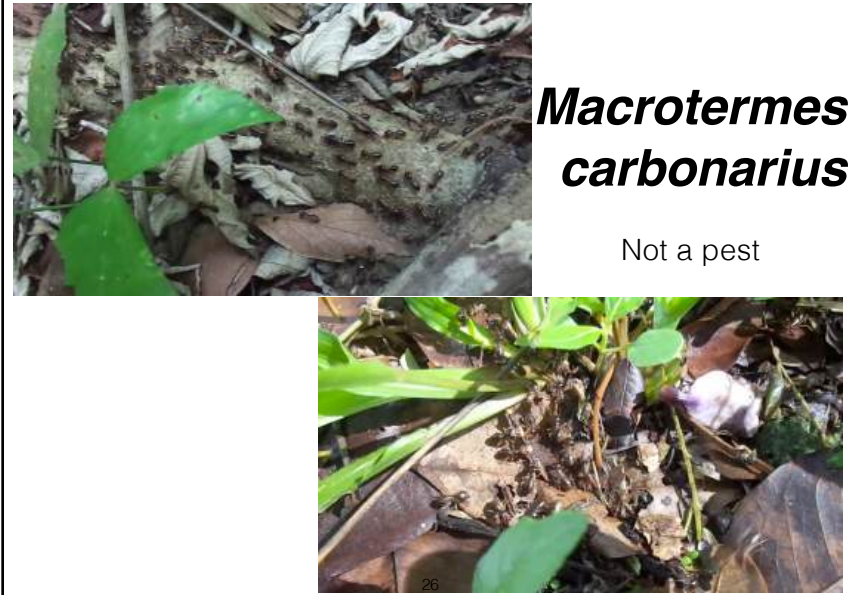
Macrotermes gilvus



25

Macrotermes carbonarius

Not a pest



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Macrotermes carbonarius



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Globitermes sulphureus



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Microcerotermes crassus



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Nasutitermes havilandi



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Common subterranean termite pest and perimeter species in SE Asia (Lee & Lee 2025)

Species	Type		
	Structural pest	Perimeter	Mound builder
<i>Coptotermes gestroi</i>	Yes	Yes	No
<i>Coptotermes curvignathus</i>	Yes	Yes	No
<i>Coptotermes kalshoveni</i>	Yes	Yes	No
<i>Macrotermes gilvus</i>	Sometimes	Yes	Yes (ground)
<i>Macrotermes carbonarius</i>	No	Yes	Yes (ground)
<i>Microcerotermes crassus</i>	Sometimes	Yes	Yes (arboreal)
<i>Microcerotermes dubius</i>	Sometimes	Yes	Yes (arboreal)
<i>Globitermes sulphureus</i>	Sometimes	Yes	Yes (ground)
<i>Ancistrotermes pakistanicus</i>	No	Yes	No
<i>Schedorhinotermes</i> spp.	Yes	Yes	No
<i>Odontotermes</i> spp.	Rarely	Yes	Yes/No

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Termite detection



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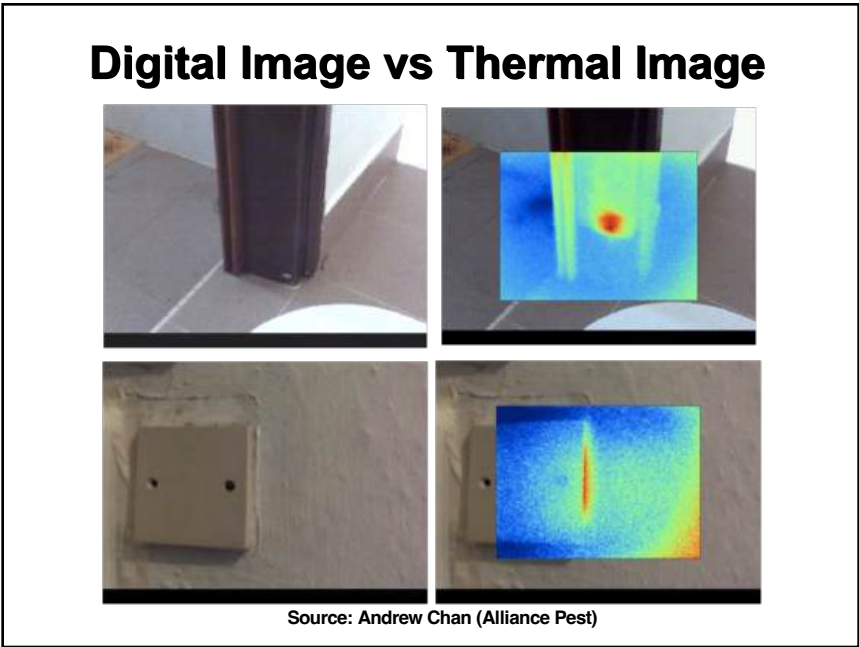
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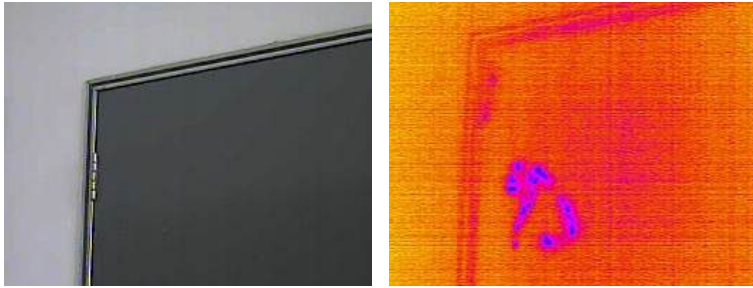


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Digital Image vs Thermal Image



Source: John Ho (Aardwolf Pestkare)

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4-in-1 detection technology

Thermal imaging, moisture, temperature, microwave



iTraker Pro

iTraker Base

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Smart Termite Detection

Intelligent Termite Alert System (ITAS)

- "Termite Alarm" system.
- Incorporation of IoT for real-time termite monitoring.
- Data from the devices are automatically sent and stored in the cloud.
- Use can access the data at anytime.



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Managing subterranean termite pests

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Liquid termiticide

- Economic damages by termites >\$40 billion each year.
- Since the 1960s, many classes of insecticides have been used against subterranean termites.
- Liquid termiticides and baiting have been widely accepted for managing subterranean termites.
- **Liquid termiticides** are used at **pre- and postconstruction**.
- **Pre-construction** treatment allows termiticides to be evenly applied to the soil and fill, creating an uninterrupted barrier between soil and the structure.



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Liquid termiticide (cont.)

- **Post-construction** treatments are applied to structures that are already built when a termite infestation is found.
- Post-construction treatment is more **labor-intensive and harder to achieve a comprehensive barrier** than pre-construction treatment.
- Types of post-construction treatments:
 - (1) trenching and rodding,
 - (2) drilling and injecting under concrete slabs.
 - (3) treatment into infested walls.



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Foaming

- When treating liquid termiticide, achieving consistency in coverage and deposition of liquid treatment under the slab is challenging.
- To overcome this, termiticide can be applied as a foam, dispensing it laterally in space under the slabs.
- Once injected into the concrete slab, foams will spread, filling up untreated gaps, enveloping any termite entryways, and transporting termiticides longer distances.



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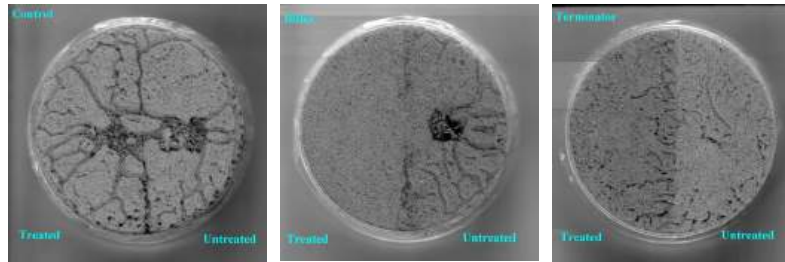
Types of termiticides

- Repellent and non-repellent termiticides.
- **Repellent** — conventional, designed to repel termites from the structures. e.g. pyrethroids (eg. fenvalerate, bifenthrin).
- **Non-repellent** — allow termites to forage through the treated soil and affect the insects and their nestmates (eg. imidacloprid, fipronil, clothianidin, chlorfenapyr, chlorantraniliprole, etc)

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Non-repellent vs repellent termiticides

Yeoh & Lee (2007), Sociobiology 50: 457 - 468.



CONTROL

REPELLENT

NON-REPELLENT

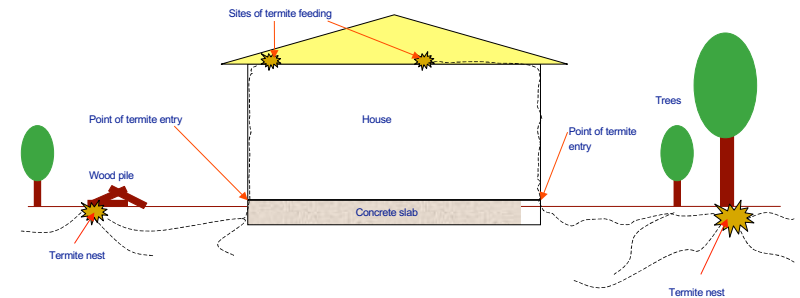
Termites tunnelled in both zones, and survivorship was >85%.

Termites tunnelled only in untreated zone. Treated zone was not penetrated.

Termites tunnelled in both treated and untreated zone, and were subsequently killed.

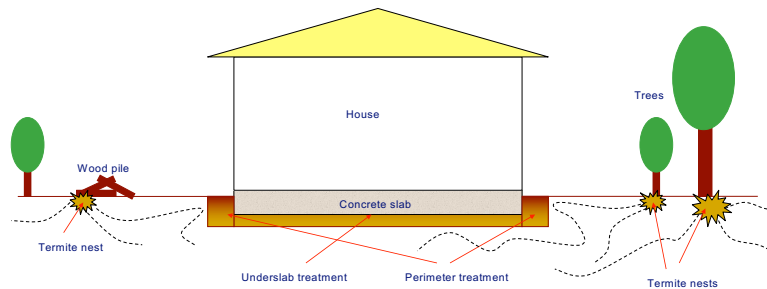
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A termite infestation in structure



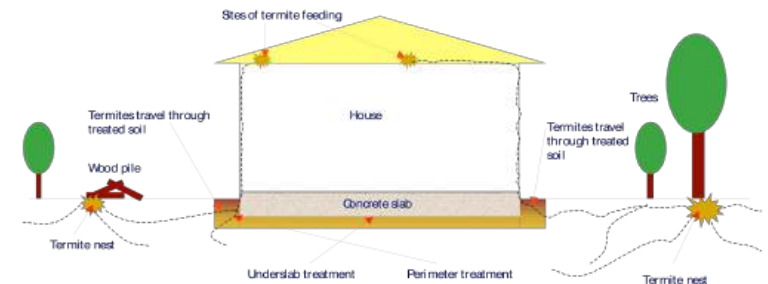
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Traditional repellent insecticide treatment



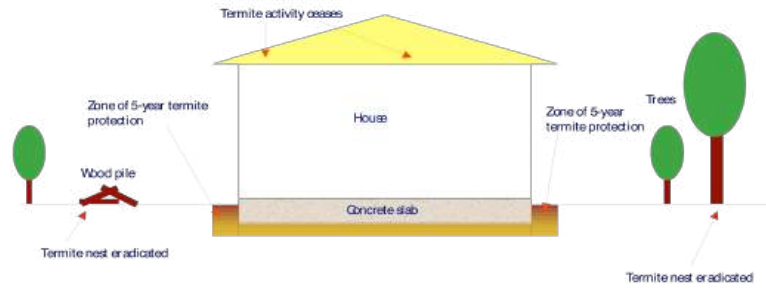
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Non-repellent insecticide treatment (eg. fipronil, imidacloprid, clothianidin, chlorfenapyr)



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Termite activity affected.....



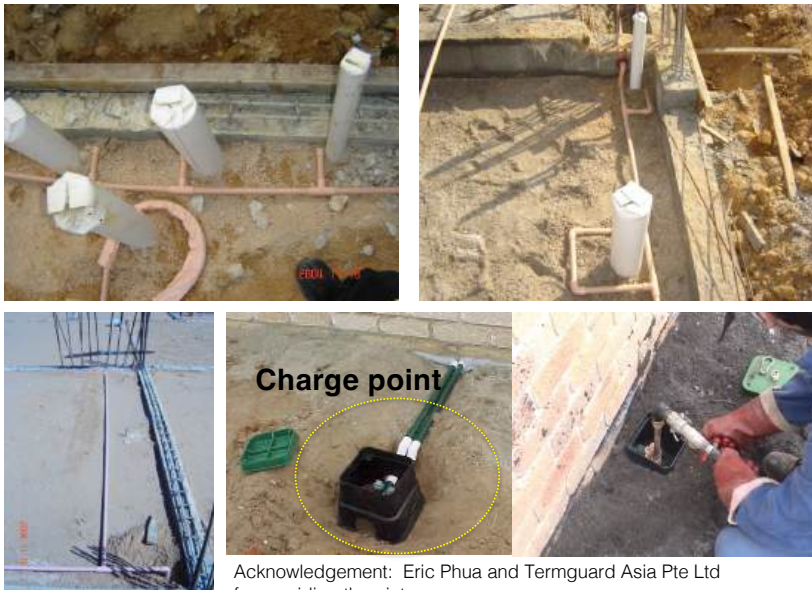
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Reticulated re-treatment system Termguard system



The system allows RE-TREATMENT of termiticide barrier underneath the building

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Acknowledgement: Eric Phua and Termguard Asia Pte Ltd for providing the pictures.

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Physical Barrier Stainless steel mesh (Termimesh™)



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Post-construction

Dusting

- Least expensive treatment method.
- Puffing an insecticide dust into the mud tubes of the termites.
- The principle is to treat foraging termites with small amount of dust, allowing them to return to their nest and pass on the toxicant to other colony members through allogrooming.
- If too much is applied, it will kill the termites too quickly, resulting in healthy termites avoiding the treated zone.

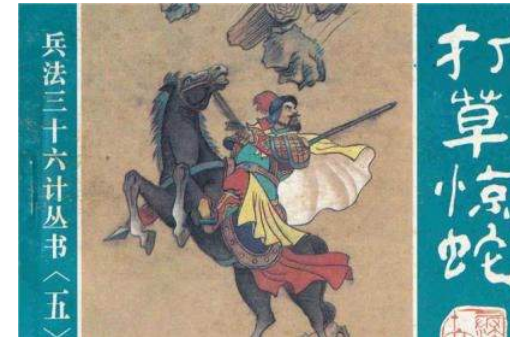


Photo credit: Alliance Pest

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Chinese Military Stratagem

Avoid beating the grass or you will startle the snake



Avoid using any method that will startle or alert the enemy to be aware of an incoming plan.

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Chinese Military Stratagem

Cast a brick to attract jade

第十七计

抛砖引玉

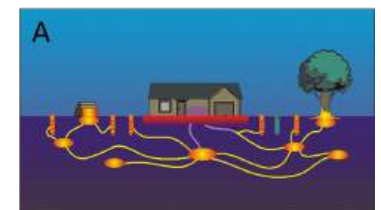


Lure your opponent with something minor in order to get a major reward.

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Baiting

- Passive management approach - requires termites to feed on baits containing an insect growth regulator.
- After termites feed on the bait, they will share the food with other colony members via trophallaxis.
- Ultimately, the colony will be suppressed or eliminated.

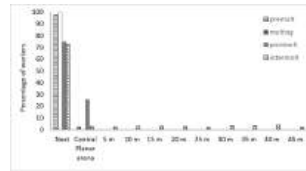
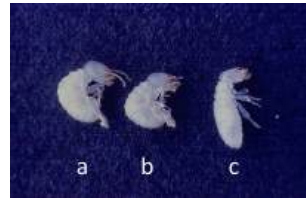


Source: Su & Lee (2023)

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Bait toxicant

- Chitin synthesis inhibitor – one type of insect growth regulator (IGR).
- Disrupt the molting process by preventing the formation of chitin.
- Chitin is a major component of insect exoskeleton.
- The molting workers will be affected.
- Because worker termites in the family Heterotermitidae continuously molt until they age and die, termites in the genera *Coptotermes*, *Reticulitermes*, and *Heterotermes* can be most effectively managed using termite baits.



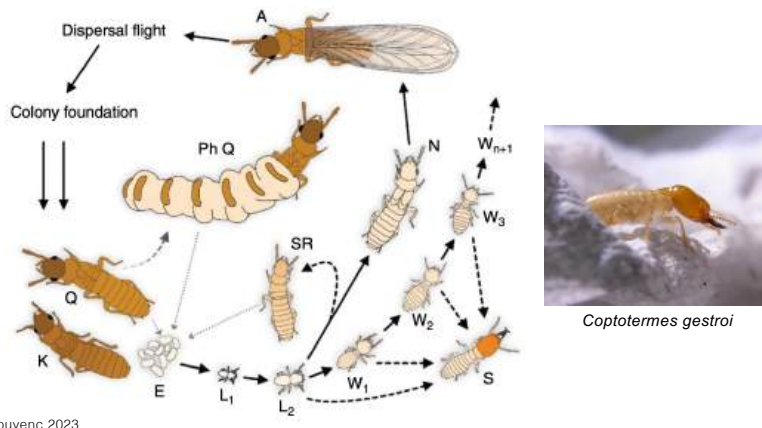
Source: Su & Lee (2023)

Comparison of worker molting of important termite species

Species	Family	Worker molting frequency
<i>Coptotermes gestroi</i>	Heterotermitidae	Continuous molting until die
<i>Coptotermes curvignathus</i>	Heterotermitidae	Continuous molting until die
<i>Macrotermes gilvus</i>	Termitidae	All worker termites are adults
<i>Macrotermes carbonarius</i>	Termitidae	All worker termites are adults
<i>Microcerotermes crassus</i>	Termitidae	All worker termites are adults
<i>Globitermes sulphureus</i>	Termitidae	All worker termites are adults
<i>Ancistrotermes pakistanicus</i>	Termitidae	All worker termites are adults
<i>Schedorhinotermes</i> sp	Rhinotermitidae	Stop molting at adulthood

Family Heterotermitidae

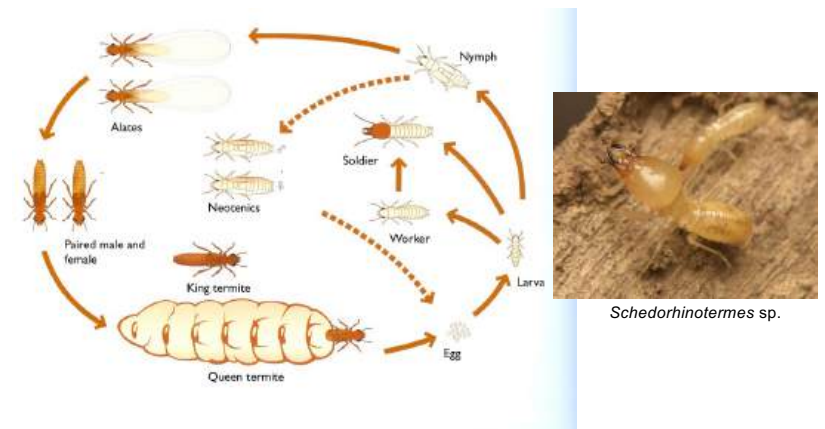
- Example: genus *Coptotermes*, *Reticulitermes*, *Heterotermes*
- The workers continuously molt until they die



Coptotermes gestroi

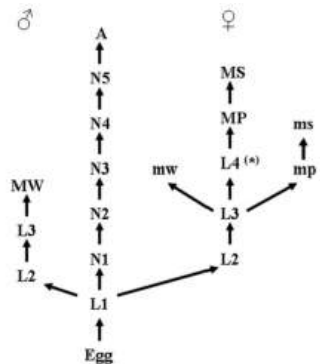
Family Rhinotermitidae

- Example: genus *Schedorhinotermes*
- The workers molt until they become adults



Schedorhinotermes sp.

Developmental pathway of Termitids (*Macrotermes* spp)



Worker caste is the terminal form and unable to undergo further moulting, and only a single stage of worker caste inside the colony.



Fig. 6. Caste developmental pathways of *M. gilvus* and *M. carbonarius*. L1-L4, first larval instar to fourth larval instar; N1-N5, first larval instar to fifth larval instar; MW, major worker; MP, major presoldier; MS, major soldier; mw, minor worker; mp, minor presoldier; ms, minor soldier; A, alate; *, only found in *M. carbonarius*.

Neoh & Lee (2009)

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Post-Construction In-ground Baiting

- Before baiting, monitoring stations containing cellulose are planted on the ground along the building perimeter.
- Once termites are found, the bait containing a toxicant is introduced.
- Bait stations are inspected at selected intervals and replenished when half of the baits are consumed.
- Upon elimination/suppression, the stations are inspected again at regular intervals.



Photo credit: Alliance Pest

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Post-Construction Above-ground baiting

- For above-ground baiting, the containerised bait is placed firmly onto an active mud tube, or a piece of infested wood.
- It is sealed tightly with masking tape so that there is no air movement that could disturb the termite feeding on the bait.
- Due to the building construction in Asia, above-ground baiting is more popular than in-ground baiting in Asia.



Photo credit: Alliance Pest

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Performance of various termite baits against *Coptotermes* spp.

Species	No. days to elimin.	Active Ingr. (%)	Amount active used (g)
<i>C. curvignathus</i> ¹	25 - 44	0.5% hexaflumuron	0.14 - 0.40
<i>C. gestro</i> ²	34 - 44	0.5% hexaflumuron	0.92 - 1.46
<i>C. gestro</i> ³	35 - 62	0.5% hexaflumuron	0.15 - 1.09
<i>C. gestro</i> ⁴	46 - 78	0.1% noviflumuron	0.021 - 0.14
<i>C. gestro</i> ⁴	41 - 80	0.5% noviflumuron	0.043 - 0.70
<i>C. gestro</i> ⁵	35 - 56	0.5% noviflumuron	0.10 - 0.80
<i>C. gestro</i> ⁶	6 - 8 wk	0.5% bistrifluron	1.06 - 3.23
<i>C. gestro</i> ⁶	4 - 5 wk	1.0% bistrifluron	1.73 - 8.33

¹Sajap et al. (2000) - in ground baiting - J. Econ. Entomol. 93: 429 - 433.

²Lee (2002) - In ground baiting - Sociobiology 39: 411 - 416.

³Sajap et al. (2002) - Above ground baiting - Sociobiology 39: 345 - 352.

⁴Lee (unpublished) - Above ground baiting.

⁵Sajap et al. (2005) - Above ground baiting - Proc. ICUP 5: 239 - 241.

⁶Lee (2007) - Above ground baiting - Proc. PRTRG 4: 8 - 11.



5 gm sugar sachet

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Baiting termites affecting urban trees in Singapore

Archives & Urban Forests

ISA
Institute of Science and Technology

Archives & Urban Forests 2025
http://doi.org/10.48048/ajaf.2025.12.07

DEPARTMENT OF ARCHITECTURE
SCHOOL OF ARCHITECTURE

Detection and Control of Subterranean Termites Using In-Ground Termite Monitoring Stations and Chitin Synthesis Inhibitor Baiting for Singapore Urban Trees

By Jaren Wong Kah Leong and Derrick Nguyen Hoang Danh

Abstract. Background: This study investigated the potential of in-ground (IG) termite monitoring stations coupled with chitin synthesis inhibitor (CSI) baiting as a complementary solution to visual inspection for tree to locate termites infestation in Singapore. Multiple Citric acid and glucose attractant from artificial termitaria systems as baits for termites, we evaluated the effectiveness of detection for termites and reported their unique baiting pattern. Chitin synthesis inhibitor (CSI) baiting and chitinase baits were used for termite control. Results: A total of 10 termite species were detected. Carpenter termite (Coptotermes) was the most common (80.0%), followed by subterranean termites (Hodgkings), Moisture wood termites (Hodgkings), Moisture wood termites (Hodgkings) and Moisture wood termites (Hodgkings). However, the detection was not related to the conditions such as infestation, feeding events, high soil moisture and reduced foraging behavior after baiting in that or over a termite. The behavior of reduced foraging, in part, could be affected when baits

Table 3. Total amount of CSI bait consumed by termites until colony elimination and time to colony elimination. CSI (chitin synthesis inhibitor); GB (Gardens by the Bay); HP (Hort Park); SBG (Singapore Botanic Garden).

Location	Site	Associated tree species	Associated termite species	Consumption rate of CSI bait (g)	Time for colony elimination for both stations (week)
GB	A	<i>P. sylvestris</i>	<i>C. gestroi</i>	206.5	3
	B	<i>E. cyclocarpum</i>	<i>C. gestroi</i>	408.5	7
	C	<i>S. aromaticum</i>	<i>C. gestroi</i>	266.4	6
	D	<i>A. columnaris</i>	<i>C. gestroi</i>	241.1	6
HP	E	<i>C. pentandra</i>	<i>C. gestroi</i>	380.5	5
SBG	F	<i>A. cunninghamii</i>	<i>C. curvignathus</i>	240.6	6
		<i>A. borneensis</i>	<i>S. medioobscurus</i>	324.9	16

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Challenges to termite management in Asia

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Majority of the people in SE Asia in major cities live in high-rise buildings



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New construction concept in Asia

Merging landscape with living space

- The deliberate introduction of beautifully planned landscape garden and planting features around and in buildings such as green walls and high-rise garden have provided suitable habitats for termite colonies to thrive.
- These sustainable gardens provides complete ecosystem of flora and fauna to flourish successfully under ideal conditions of light, water, air and nutrients.



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Bringing 'Soil and Moisture' to a Greater Height - Sky Park/ Green Roof

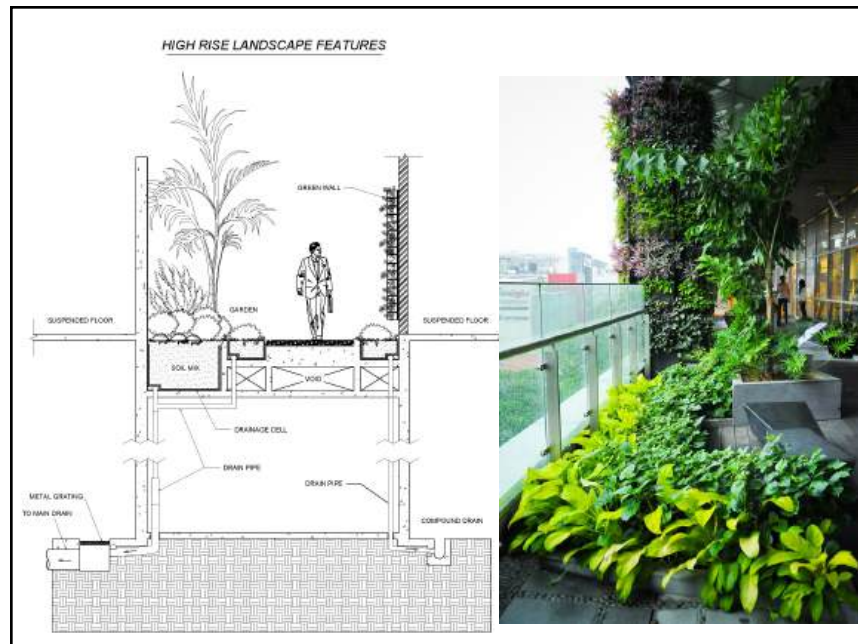


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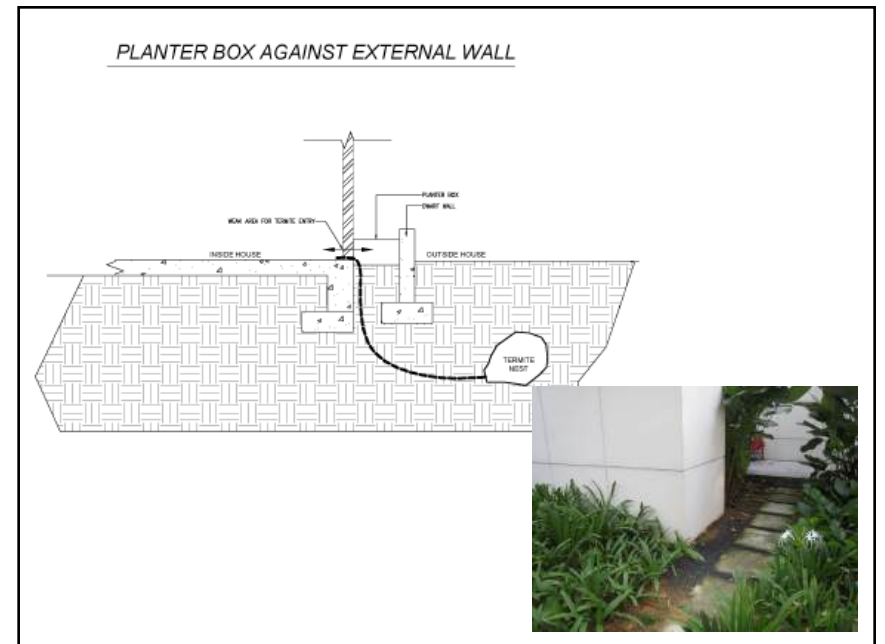


Sathorn Rd, Bangkok

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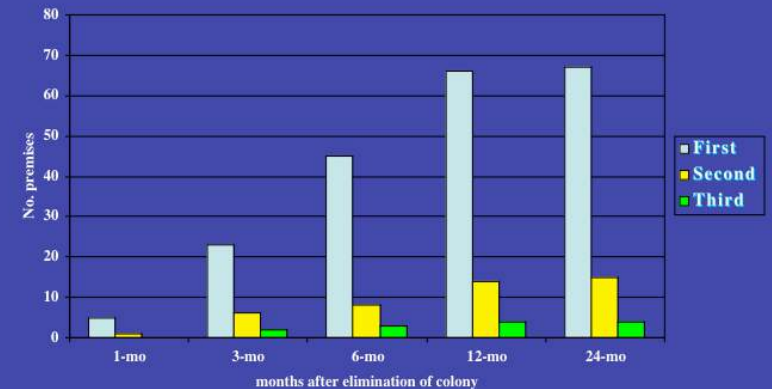
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Baiting against termites

- Termite baits are most effective against *Coptotermes* spp. Colony elimination/suppression is normally achieved within 2 - 3 months post-treatment.
- Baits also demonstrated adequate control against *Schedorhinotermes*. It can take up to 6 months to suppress/eliminate a colony of *Schedorhinotermes*.
- Re-infestation, however can happen as early as 1 month upon elimination/ suppression of the previous colony, and the case of reinfestation is positively correlated with time.

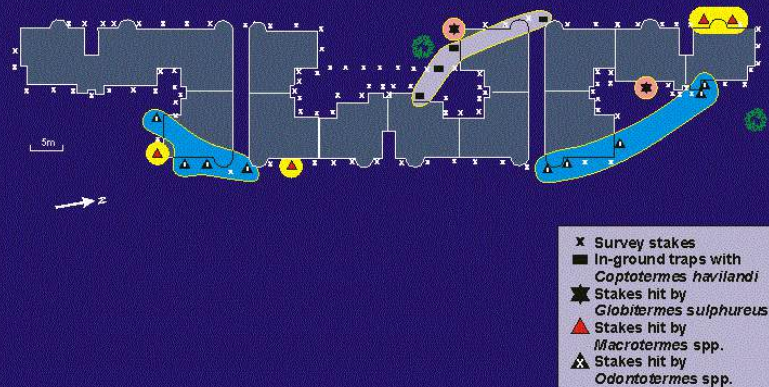
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Re-infestation(s) after colony suppression/elimination of *Coptotermes* by baits (n = 715 premises)



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Springfield Condominium (Block D)



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Succession of secondary pest species

- Elimination of primary termite species (eg. *C. gestroi*) using bait, may result in the invasion of secondary pest species (eg. *Macrotermes gilvus*).
- Many secondary pest species are not responsive to baits, resulting PMPs to resort to spray against these species.

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Performance of termite baits against common termite species in SE Asia

Species	Lower/ Higher termites	Effectiveness	Duration required for colony elimination
<i>Coptotermes gestroi</i>	Lower	Very effective	2–12 weeks
<i>Coptotermes curvignathus</i>	Lower	Very effective	4–16 weeks
<i>Macrotermes gilvus</i>	Higher	Not effective	—
<i>Macrotermes carbonarius</i>	Higher	Not effective	—
<i>Globitermes sulphureus</i>	Higher	Moderately effective*	20 weeks
<i>Microcerotermes crassus</i>	Higher	Moderately effective*	24 weeks
<i>Schedorhinotermes</i> spp.	Lower	Effective	8–20 weeks

*Only applicable to bistrifluron-based bait. Baits containing other active ingredients are not effective against these species.

Lee 2014

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Comparison of different methods of termite management at post-construction (Lee 2014)

Soil treatment (repellent insecticides)	Soil treatment (non-repellent insecticide)	Dusting	Baiting
\$\$	\$\$\$	\$	\$\$\$\$
Repellent	Non-repellent	Non-repellent	Non-repellent
Requires floor drilling	Requires floor drilling	No drilling is required	No drilling is required
Only repels termites	Targets termite colony	Often symptomatic treatment only	Targets termite colony
Effective against all termite species	Effective against all termite species	Effective against all termite species	Only effective against lower termite species
Uses relatively large amount of insecticide	Uses moderate amount of insecticide	Uses small amount of insecticide	Uses small amount of insecticide
Active treatment	Active treatment	Passive treatment	Passive treatment
Proper treatment can last several years	Proper treatment can last several years	Temporary measure	Needs multiple baiting if re-infestation occurs, otherwise can last a long time

\$ = relatively inexpensive, \$\$ = relatively moderate, \$\$\$ = relatively expensive, \$\$\$\$ = relatively more expensive

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Termite feeding rate increases with temperature

- Based on data from 133 sites across six continents.
- Termite foraging and wood consumption were highly sensitive to temperature (with feeding increasing >6.8 times per 10°C increase in temperature)—even higher more so than microbes.

DISCUSSION
Termite sensitivity to temperature affects global wood decay rates

Abstract: Termite feeding rates are highly sensitive to temperature, with feeding increasing >6.8 times per 10°C increase in temperature. This sensitivity is even higher than that of microbes. The study analyzed 133 sites across six continents, showing that termite feeding rates are more sensitive to temperature than microbial decay rates. The researchers found that termite feeding rates increase exponentially with temperature, while microbial decay rates increase more linearly. This suggests that termite activity is a more significant factor in wood decay at higher temperatures.

Science 377: 1440–1444 (2022)

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Termiticide performance and climate change

- Subterranean termite infestations are usually managed or prevented using **soil termiticides**.
- Termiticide **efficacy and persistence** are primarily affected by its **degradation rate**.
- Higher rainfall and flooding** increase degradation of soil termiticide (Kamblé 1995).
- Warmer soil temperature** and higher **moisture** enhance termiticide degradation by **microorganism** (Kamblé & Saran 2005).
- Warmer and moist soil conditions also contribute towards **greater desorption and greater volatilization** losses.
- Increased rainfalls also cause **leaching** of some termiticides.
- Could affect the soil termiticide performance that could potentially increase the prevalence of subterranean termite infestations.



In order to compensate this problem, pest management professional may increase the use of insecticides in the urban environment, leading to other environmental issues.

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The future

- Termite management is the most important segment in the pest management industry in Southeast Asia.
- Unlike in regions where heterotermitids are the dominating pests, a substantial amount of infestations in SE Asia are caused by non-heterotermitids.
- There is no one single method that could be effective against all termite problems.
- Stakeholders must work with pest management professionals to decide the best treatment options.
- Climate change will significantly impact termite management in SE Asia, especially with irregular rainfall patterns and frequent floods.

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Lee (2014)

Lee & Neoh (2023)

Lee & Lee (2025)

<https://tinyurl.com/termite9>

<https://tinyurl.com/termite10>

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Detection and Control of Subterranean Termites Using In-Ground Termite Monitoring Stations and Chitin Synthesis Inhibitor Baiting for Singapore Urban Trees

By Jaren Wong Kak Leong and Derrick Nguyen Hoang Danh

Abstract. Background: This study demonstrated the potential of in-ground (IG) termite monitoring stations coupled with chitin synthesis inhibitor (CSI) baiting as a complementary solution to visual inspection for termite detection and control in Singapore. Methods: Using two wood pieces collected from residential IG stations across a State for Singapore, we evaluated the destructiveness of termites to the species and reported their unique feeding pattern. Chitin synthesis inhibitor (CSI) baiting with 1-phenyl-3-(3-dimethylammonioethyl) carbodiimide cross-linked carbodiimide (1-EDC) was used for termites control. Results: A total of 10 termite species were identified. *Coptotermes formosus* (Hagen), *Coptotermes japonicus* (Hagen), *Reticulitermes flavipes* (Kollar), *Microtermes carolinensis* (Shannon), and *Microtermes pennsylvanicus* (Shannon) were the most abundant species. *Coptotermes formosus* and *Coptotermes japonicus* showed a preference for feeding on wood with high moisture and reduced foraging behavior after baiting in that or near a termite. This behavior of reduced foraging, in turn, could be affected when baits in baited areas are removed. Baiting termites to ingest and avoid for open food sources, leading to reduction of nearby IG stations. In terms of termite control, CSI baiting with chitin synthesis inhibitor (CSI) baiting was the only effective termite control for 1 species, *C. formosus*. In terms of termite control, CSI baiting with chitin synthesis inhibitor (CSI) baiting was the only effective termite control for 1 species, *C. formosus*. In terms of termite control, CSI baiting with chitin synthesis inhibitor (CSI) baiting was the only effective termite control for 1 species, *C. formosus*.

Keywords: Chitin-Synthesis Inhibitor; Coptotermes; In-Ground Termite Monitoring; Subterranean Termites; Termites Baiting

INTRODUCTION

The invasive *Microtermes* in Singapore continues increasing the number of trees from the current 7 million to more than 8 million by 2020 (Chen et al., 2003). Considering the large volume of trees, efficient and effective large-scale tree monitoring is essential to detect timely detection of these highly polyphagous, especially those that cause structural damage and lead to tree failure. Similar to many well-documented problems in tropical urban forestry, subterranean termite infestation is one of the most

at 1980; Schiffman and Su 2000; Zornemann and Campos 2011). This species damages the hardwood (Gomes 1962; King and Speck 1969; Lee et al. 1993; Chawron and Huber 2014) and various tree species from below the ground (Cowie et al. 1989; Lee 2014). Typically, infested trees do not show apparent symptoms during early infestation stage. Prolonged above-ground symptoms often only emerge when a subterranean termite population within a tree is well established (Chawron et al. 1999). Other subterranean termite species, such as *Coptotermes formosus*

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The worship of termite mound (Penang Island)

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A close-up photograph of a termite on a piece of wood. The termite is light-colored with a darker head and antennae. The wood is brown and textured.

**Termite management in
Southeast Asia –
Challenges, pitfalls and
modern solutions**

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