

## A Survey of Stick-Insects in Bukit Timah Nature Reserve, Singapore

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**ABSTRACT.** A survey of stick insects in Bukit Timah Nature Reserve was conducted as part of a broader biodiversity survey which covered the period from 1 April 2014 to 30 April 2018. Bushes and trees by the sides of the trails in Bukit Timah Nature Reserve were searched with hand-torches after dusk. Of the 16 species known from historical records to occur in Bukit Timah Nature Reserve, 11 species were found during the current survey. Five species that were not encountered are known to be rare. However, this does not exclude the possibility of their continued occurrence in the nature reserve. Rare phasmids are rare due mainly to scarcity of food plants and their habitat must be maintained if a wide array of biodiversity is to be conserved.

**Keywords.** Invertebrate conservation, Phasmida, species diversity

### Introduction

Stick insects and leaf insects (collectively known as phasmids) belong to the order Phasmida. The order Phasmida is currently divided into three suborders. The suborders Agathemerodea and Timematodea are limited to the Neotropics. Only members of the Verophasmatodea are found in Singapore. These insects may be divided into two infraorders, namely the Anareolatae and the Areolatae.

A survey conducted by the first author in 1997 covered stick insect species from both the Bukit Timah Nature Reserve (BTNR) and Central Catchment Nature Reserve (CCNR) (Seow-Choen, 1997a). The reason for reporting broadly at that time was the relative paucity of stick insect species within BTNR. Forty-one species of phasmids found in Singapore, extant as well as extinct, were listed in that first report and aspects of their conservation were discussed.

A recent publication (Seow-Choen, 2017) has now listed 44 species from Singapore, pointing out nine erroneous synonyms, four new synonyms, three new name combinations, one species new to Singapore and three new species. Interested readers are referred to this recent book for the most thorough treatment currently available of stick insects of Singapore.

In this survey report, only the stick and leaf insect species of BTNR (hereafter termed collectively as 'stick insects') are reported on. Bukit Timah is the highest forested point in Singapore but surrounded on all sides by dense housing beyond the buffer created by various nature parks.

## Methodology

A group of four persons was formed to survey the stick insects of BTNR as part of the Comprehensive Biodiversity Survey of Bukit Timah Nature Reserve 2014–2018 (Chan & Davison, 2019). All the team members are authors of the paper.

The objectives of the survey were (a) to collect and document the number of species of stick insects as well as the abundance of individuals of these species in the Nature Reserve and to collect data regarding suitable habitats and foodplants; (b) to establish an accurate database of the same through the use of long term surveys by monitoring these species; and (c) thereafter to apply the accurate data collected to formulate a data and science-based management plan to ensure the continued sustainability of Bukit Timah Nature Reserve as a wildlife habitat for these species.

Actual searching along the various tracks at Bukit Timah Nature Reserve was conducted during night-time by use of hand torches, with cameras for documentation. Voucher specimens were collected as needed. Foodplant identification was performed by Dr Wong Khoon Meng and Ms Seah Wei Wei from the Singapore Botanic Gardens.

## Results

A total of 16 species of stick insects has been recorded historically from Bukit Timah Nature Reserve, from ten genera, five subfamilies, five families and two infraorders (Seow-Choen, 1997a, 1997b, 2000, 2005, 2011, 2012; Brock, 1999). The total list is as follows (\* denotes species not encountered during fieldwork in 2015–2016).

### Suborder Anareolatae

#### Family Diapheromeridae

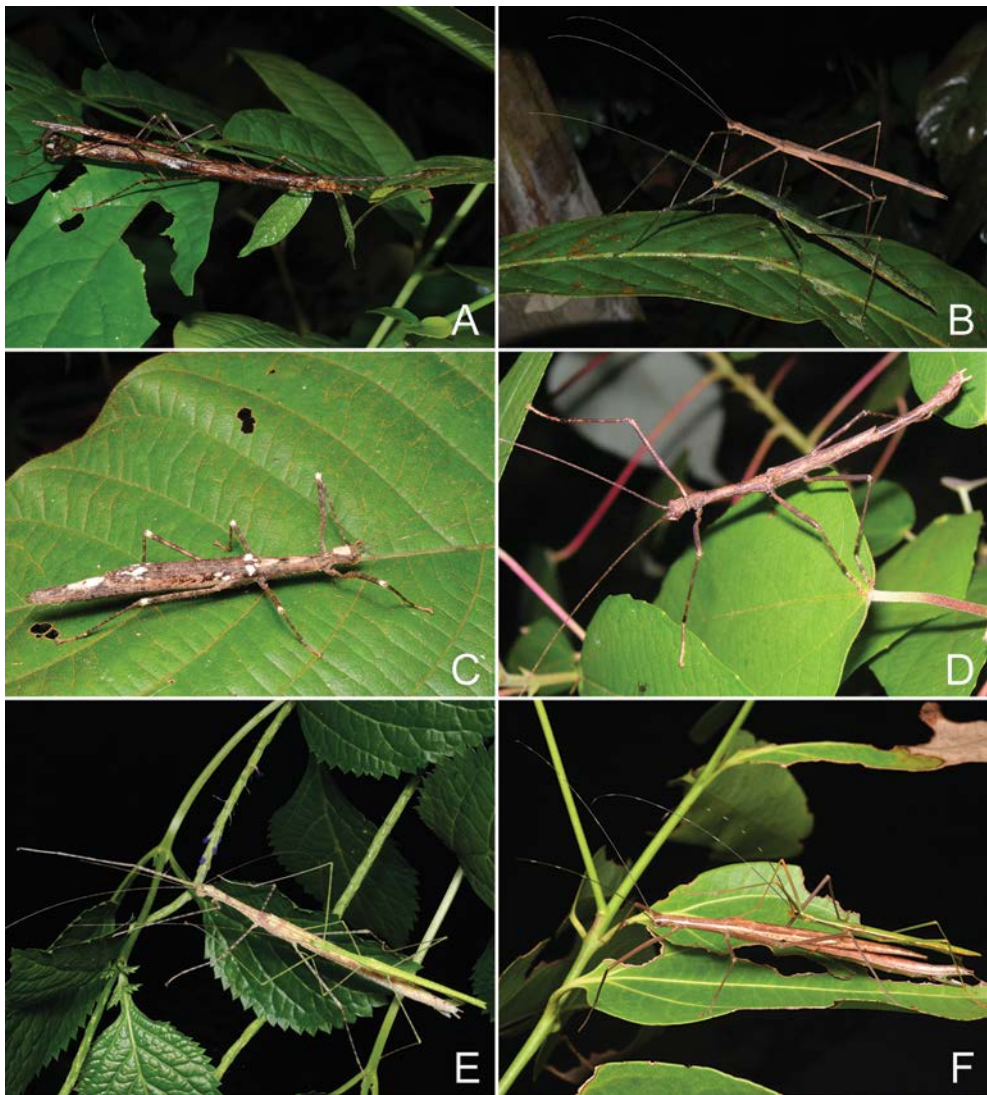
##### Subfamily Necrosiinae

1. *Asceles larunda* (Westwood 1859) (Fig. 1A)
2. *Asceles malaccae* (Saussure 1868) (Fig. 1B)
3. *Asceles tanarata singapura* Seow-Choen & Brock 1999 (Fig. 1C & D)
4. *Lobonecrosia subflava* Brock & Seow-Choen 2000\*
5. *Lopaphus brachypterus* (Haan 1842)\*
6. *Necrosia confusa* (Redtenbacher 1908) (Fig. 1E)
7. *Necrosia connexa* (Redtenbacher 1908) (Fig. 1F)
8. *Necrosia punctata* (Gray 1835) (Fig. 2A & B)
9. *Necrosia siremps* (Redtenbacher 1908) (Fig. 2C)
10. *Necrosia westwoodi* Kirby 1904\*
11. *Planososibia esacus* (Westwood 1859)\*

#### Family Phasmatidae

##### Subfamily Lonchodinae

12. *Lonchodes brevipes* Gray 1835 (Fig. 2D)
13. *Stheneboea malaya* Stål 1875 (Fig. 2E & F)



**Fig. 1.** A. Mating pair of *Asceles larunda*. B. Mating pair of *Asceles malaccaae*. C. *Asceles tanarata singapore*, adult female. D. Lateral view of male *Asceles tanarata singapore*. E. Mating pair of *Necroschia confusa*. F. Mating pair of *Necroschia connexa*. (Photos: F. Seow-Choen)

**Suborder Areolatae**  
**Family Aschiphasmataidae**

Subfamily Aschiphasmatinae  
 14. *Presbistus peleus* (Gray 1835) (Fig. 3A–D)

## Family Heteropterygidae

### Subfamily Dataminae

15. *Pyllaemenes mitratus* (Redtenbacher 1906) (Fig 3E & F)

## Family Phylliidae

### Subfamily Phylliinae

16. *Phyllium (Pulchriphyllium) bioculatum* Gray 1832\*

Of these, 11 species were encountered during the period of this survey. All 11 species were found on their foodplants along the edges of trails that were surveyed. The foodplants of these 11 species were numerous or at least present along the trails (Seow-Cheon et al., 1994; Tay & Seow-Choen, 1996).

Three of the species, *Asceles malacca*, *Asceles tanarata singapura*, and *Asceles larunda*, are feeders on the leaves of *Macaranga* species (Euphorbiaceae). These plants are very common in Singapore forests, including in Bukit Timah Nature Reserve. *Necroscia siremps* feeds on *Uncaria* (Rubiaceae) species. Singapore was an important locality for plantations of *Uncaria gambir* many decades ago as gambir was used for the tanning of leather and was a major cash crop in the early development of Singapore (Anonymous, 1889). It is not surprising that *Uncaria gambir* is still common within the reserve. The other three *Necroscia* species, namely *Necroscia connexa*, *Necroscia confusa* and *Necroscia punctata*, feed on *Cinnamomum iners* (Lauraceae). This is another very common tree in Bukit Timah Nature Reserve. *Lonchodes brevipes* feeds on a wide variety of plants and was also encountered during our survey. *Stheneboea malaya* feeds on ferns and other low growing plants; its numbers are small in our experience, but one small nymph was encountered during the survey.

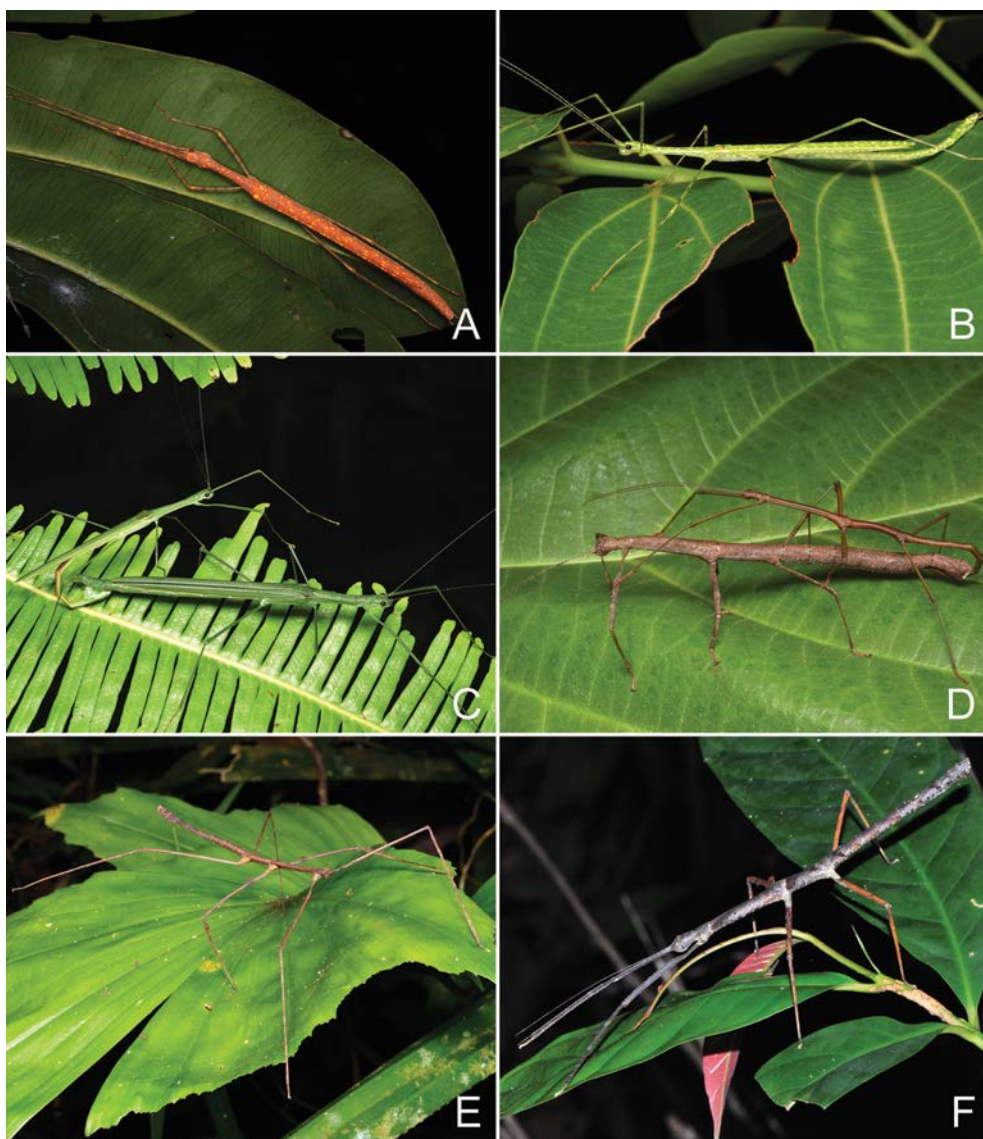
Of the five species that were not observed during the period of this survey, one is a leaf insect and four are stick insects. Leaf-insects are known to be difficult to find by searching the edges of trails as females frequent tree tops and their known foodplants within the reserves are very tall trees. The four stick insects not encountered during this survey, i.e., *Lopaphus brachypterus*, *Necroscia westwoodi*, *Lobonecroscia subflava* and *Planosibia esacus* are very specialised feeders whose natural host plants are unknown or not encountered along the edges of the trails.

## Discussion

### *National context*

In all, 44 species of stick and leaf insects have been recorded from Singapore, of which two or three might have been introduced or obtained as specimens in trade (Seow-Choen, 2017). Several of them have been recorded only once. The 16 species historically recorded from Bukit Timah Nature Reserve therefore represent approximately 40% of the known national fauna, and the 11 species found in 2015–2016 represent approximately one quarter of the known national fauna.

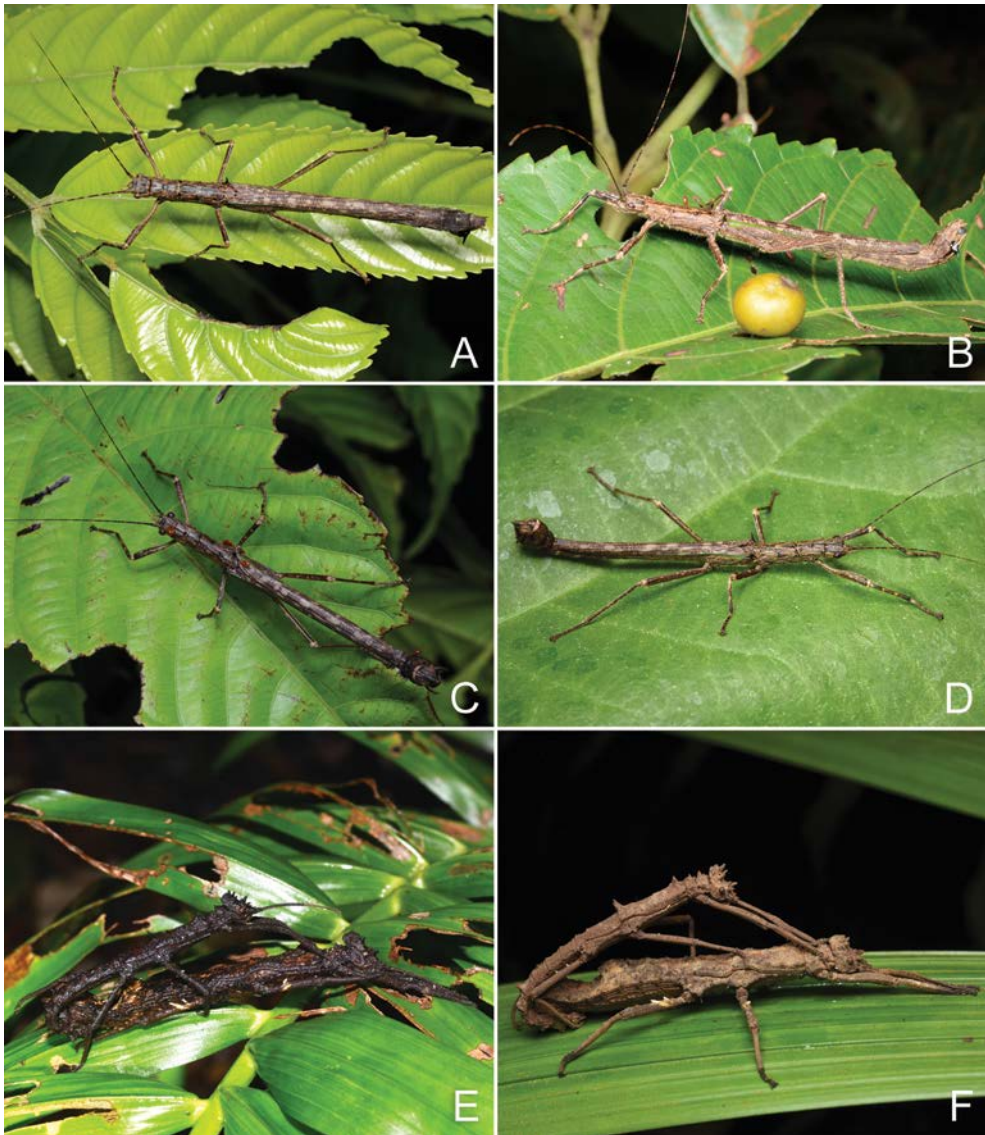
There is uneven taxonomic representation of stick insects across the different families. Seven of the currently recorded 11 species, and 11 of the historically recorded 16 species from Bukit Timah Nature Reserve, belong to the speciose family



**Fig. 2.** A. *Necroschia punctata*, adult female. B. *Necroschia punctata*, adult male. C. Mating pair of *Necroschia siremps*. D. Mating pair of *Lonchodes brevipes*. E. *Stheneboea malaya*, adult male. F. *Stheneboea malaya*, subadult female. (Photos: F. Seow-Choen)

Diapheromeridae (26 species known from Singapore). Only four of the currently recorded 11 species, and five of the historically recorded 16 species from the reserve, belong to the other four families (18 species known from Singapore).

For various reasons noted below, it is difficult to determine whether the reduced number of recent records indicates a real decline in diversity. The historical total has been built up from the records of entomologists over many decades and is therefore more likely to include extreme rarities. The current total is based on fieldwork concentrated within about 12 months during 2015–2016.



**Fig. 3.** **A.** *Presbistus peleus*, top view of adult female. **B.** *Presbistus peleus*, side view of adult female. **C.** *Presbistus peleus*, top view of adult male. **D.** *Presbistus peleus*, side view of adult male. **E & F.** Mating pairs of *Pylaemenes mitratus*. (Photos: F. Seow-Choen)

#### *Conservation implications and food plants*

The team conducted all surveys after nightfall. All searches were performed along the main road leading to the summit as well as along the main trails in Bukit Timah Nature Reserve using hand torches. No intrusion into unmarked forests was undertaken. No light traps were used. The lack of the latter two methodologies may have meant that fewer species were obtained than was, perhaps, possible if additional methods had been used. Nonetheless, stick insects are not easy to attract to light traps as most species are not exceptional fliers and most species have poor flight or are apterous.

Hence the effect of light traps, whilst they may yield some results, may not have had too much impact on our findings even if used. Nonetheless, frequent searches along jungle tracks may yield unusual results due to the insects being blown off their host plants, wandering around looking for food plants or for mates, or to escape predation.

All stick insects are specialised feeders and their food plants are usually restricted to the species of one or two genera, or even to a single known species of host plant (Seow-Choen et al., 1994; Tay & Seow-Choen, 1996). All nine phasmid species common in Bukit Timah Nature Reserve make use of food plants that are common along the road and trails sampled. The rarer species and the species that were not encountered during this survey are species for which the food plants are unknown or are not available along the edges of surveyed tracks.

This is a very important consideration in the systemisation of conservation priorities. All phasmids are very fastidious about their food plants, requiring their own peculiar species of plants in order to survive (Seow-Choen et al., 1994; Tay & Seow-Choen, 1996). Species with very specific food plant requirements may be at serious risk of extinction or occur only in isolated pockets where these plants occur. Unnecessary clearance of our natural forest trees may be an important cause of decrease in some of our indigenous stick-insect species. The first author has personally witnessed this on many occasions when bushes or trees were cleared by the sides of paths. Where before, there were many insects of species that feed on those plants, following clearance of these food plants, no more of those insects may be seen. The continual encroachment of housing around and into the fringes of forested areas has also had very negative effects on our insect populations. The building of houses around the Nature Reserves poses a great problem. Whilst phasmids are poor fliers, those that do fly are attracted to light nonetheless, and over a prolonged period, many are therefore eliminated in this manner. This threat is far more damaging than random collecting of a few specimens by museums or insect collectors.

#### *Taxonomic status*

Discerning readers may notice a change in family groups and generic names in the species presented in this report and those of the paper by Seow-Choen (1997a). The family Heteropterygidae has recently been rearranged and critically discussed (Hennemann et al., 2016). The phylogeny and systematics of Phasmida is in a state of flux and current infraorders are considered to be polyphyletic (Bradler, 2009).

The genus *Datames* Stål 1875 had been synonymised with *Pylaemenes* Stål 1875; and hence the species *Datames oileus* is now known as *Pylaemenes oileus* (Westwood 1859). However, Seow-Choen (2000) noted that *Pylaemenes oileus* is a Javan species and different from the taxon in Singapore and Peninsular Malaysia. The Singapore species is *Pylaemenes mitratus* Redtenbacher 1906.

The species noted as *Necroschia roseipennis* Audinet-Serville 1838 in Seow-Choen (1997a, 1997b) is now known to be *Necroschia connexa* Redtenbacher 1908 (Seow-Choen, 2016).

The holotype male of the species now called *Necroschia confusa* (Redtenbacher 1908) was collected from Bukit Timah Hill itself. This species was previously confused with *Necroschia affinis* (Gray 1835) from Peninsular Malaysia. Pending further studies in Peninsular Malaysia, this is likely to be an endemic species to Singapore.

*Necroschia inflata* (Redtenbacher 1908), from Singapore and Peninsular Malaysia, has also been synonymised with *Necroschia siremps* (Redtenbacher 1908) from Sumatra by Seow-Choen (2016).

Seow-Choen (2016) split *Sosibia* species into two separate genera based on the presence of spines on a globose head or the absence of spines on a flat head. The taxon called *Sosibia esacus* in the 1997 report is now therefore *Planososibia esacus* (Westwood 1859).

The undescribed Necrosciinae of the 1997 report was described as a new genus and species by Brock and Seow-Choen in 2000 as *Lobonecroscia subflava* (Seow-Choen, 2000).

The genus *Prisomera* Gray 1835 was redefined and separated from *Stheneboea* Stål. 1875 and hence *Prisomera malaya* is now known as *Sthenenoa malaya* (Hennemann, 2002).

### Conclusions

Singapore lies within a biologically very rich area with a vast array of animal and plant life. Within the small island of Singapore, and even within the small area of Bukit Timah Nature Reserve, lies a surprising variety of animal life including stick insects. Nonetheless habitat protection is essential if this heritage is to be conserved for eternity. Clearing of forest areas and felling of trees will lead to a demise of these insects as different species depend on particular and different host-plants for their survival. A delicate balance between the needs of our people and the needs of our forests' animals, and in particular stick insects, must be struck for our sake and for those of our children and their children after them.

### References

- Anonymous (1889). Gambier (*Uncaria Gambier*, Roxb.). *Bull. Misc. Inform. Kew* 1889(34): 247–253.
- Bradler, S. (2009). *Species, Phylogeny and Evolution*, SPE vol 2.1. Göttingen: Universitatverlag Göttingen.
- Brock, P.D. (1999). *Stick and Leaf Insects of Peninsular Malaysia and Singapore*. Kuala Lumpur: Malayan Nature Society.
- Chan, L. & Davison, G.W.H. (2019). Introduction to the Comprehensive Biodiversity Survey of Bukit Timah Nature Reserve, 2014–2018. *Gard. Bull. Singapore* 71 (Suppl. 1): 3–17.
- Hennemann, F.H. (2002). Notes on the Phasmatodea of Sri Lanka (Orthoptera). *Mitteilungen Muenchener Entomologischen Gesellschaft* 92: 37–38.
- Hennemann, F.H., Conle, C.V., Brock, P.D. & Seow-Choen, F. (2016). Revision of the Oriental subfamily Heteropteryginae Kirby, 1896, with a re-arrangement of the family Heteropterygidae and the descriptions of five new species of *Haaniella* Kirby, 1904. (Phasmatodea: Areolatae: Heteropterygidae). *Zootaxa* 4159(1): 1–219.
- Seow-Choen, F. (1997a). Stick and Leaf Insect (Phasmida: Insecta) Biodiversity in the Nature Reserves of Singapore. Proceedings of the Nature Reserves Survey Seminar. *Gard. Bull. Singapore* 49: 297–312.
- Seow-Choen, F. (1997b). *A Guide to the Stick & Leaf Insects of Singapore*. Singapore Science Centre.
- Seow-Choen, F. (2000). *An Illustrated Guide to the Stick and Leaf Insects of Peninsular Malaysia and Singapore*. Kota Kinabalu: Natural History Publications (Borneo).
- Seow-Choen, F. (2005). *A Pocket Guide: Phasmids of Peninsular Malaysia and Singapore*. Kota Kinabalu: Natural History Publications (Borneo).



- Seow-Choen, F. (2011). Phasmida. In: Ng, P.K.L., Corlett, R.T. & Tan, H.T.W. (eds) *Singapore Biodiversity. An Encyclopedia of the Natural Environment and Sustainable Development*, pp. 412–413. Singapore: Raffles Museum of Biodiversity Research.
- Seow-Choen, F. (2012). Stick-Insects – Masters of Mimicry. In: Wang, L.K., Yeo, D.C.J., Lim, K.K.P., Lum, S.K.Y. (eds) *Private Lives: An Exposé of Singapore's Rainforests*, pp. 174–180. Singapore: Raffles Museum of Biodiversity Research.
- Seow-Choen, F. (2016). *A Taxonomic Guide to the Stick Insects of Borneo*. Kota Kinabalu: Natural History Publications (Borneo).
- Seow-Choen, F. (2017). *A Taxonomic Guide to Stick-Insects of Singapore*. Kota Kinabalu: Natural History Publications (Borneo).
- Seow-Choen, F., Tay, E.P., Brock, P.D., Seow-En, I. (1994). Foodplants of some stick-insects (Phasmida=Phasmatodea). *Malayan Nat. J.* 47: 393–396.
- Tay, E.P. & Seow-Choen, F. (1996). Relationship of plant families and stick insects in Peninsular Malaysia and Singapore. In: Turner, I.M., Diong, C.H., Lim, S.S.L. & Ng, P.K.L. (eds) *Biodiversity and the Dynamics of Ecosystems*, DIPWA series, vol. 1., pp. 181–190. Kyoto: The International Network for Diversitas in Western Pacific and Asia.