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Bees of the Bukit Timah Nature Reserve and vicinity

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ABSTRACT. As a unique coastal hill dipterocarp forest remnant in Singapore, Bukit Timah Nature Reserve is a key refuge for flowering plants, but little information has been available about its bee pollinators and their floral associations. Historical and recent surveys of bees (Hymenoptera: Apoidea: Anthophila) at Bukit Timah and vicinity were compiled, yielding a total known fauna of four families, 23 genera, and 75 species (including unnamed morphospecies). Of these, 55 bee species, several known only from historical collections, have been recorded from the Bukit Timah Nature Reserve (BTNR) itself, which is dominated by mature, shady forest with few apparent flowers along the trails. More bee species (61) have been recorded from nearby Dairy Farm Nature Park (DF), which has more open, sunnier secondary forest with more conspicuous floral resources. Sampling methods included net collecting and honey baiting along transects, malaise trapping within the forest, and observations at flowers. Accounts are provided for species of particular taxonomic or conservation interest, and two new provisional synonymies are indicated. Floral associations are summarised for 32 floral hosts from BTNR (only 10 plant species) and from DF (28 plant species, including 5 shared with BTNR). For all species known from BTNR and vicinity, earliest and most recent dates of capture for both this area and for Singapore as a whole are provided. Four eusocial stingless bee species formerly collected in Singapore but not recently recorded are considered to be nationally extinct. An additional few poorly known solitary bee species may also be nationally extinct. By contrast, solitary bee species new to Singapore continue to be discovered at BTNR, notably *Megachile* resin and leafcutter bees attracted to reintroduced Tiger Orchids in 2014 during a mass bloom. Despite high species richness of native angiosperms persisting at BTNR, especially in its core, few bee species and individuals were found in recent bee surveys, likely reflecting limited availability of floral resources in the shady forest understorey. However, additional bee species are likely to be found in BTNR if further sampling is done during infrequent mass bloom events and traps are deployed at canopy level.

Keywords. Pollinator declines, stingless bees, faunal survey, insect-plant interactions, extinction.

Introduction

Bees are dominant pollinators in Southeast Asian lowland dipterocarp forests, the main habitat type of Bukit Timah Nature Reserve (Chin et al., 1995). Despite their ecological importance, knowledge of the taxonomy, distribution, life history, and floral associations of Southeast Asian bees, including those of Singapore, remains incomplete due in part to a severe taxonomic impediment (Van der Vecht, 1950).

The comprehensive biodiversity survey of the 163 ha Bukit Timah Nature Reserve (BTNR) has been introduced by Chan & Davison (2019). Here we review the bee species and floral associations of BTNR and vicinity based on compilation of all available historical and modern bee samples. Important published studies relevant to the bees of Bukit Timah and vicinity include those on collections by D.H. Murphy in the 1960s-mid 1970s (see Murphy, 1973; note that most bees from this study were not identified to species at that time), honey-baiting surveys focusing on stingless bees (Liow et al., 2001), surveys of flower-visiting bees and other insects in Singapore's parks including Dairy Farm Nature Park (Soh & Ngiam, 2013), observations of *Megachile* and other bees visiting reintroduced Tiger Orchids during a mass bloom in 2014 (specimen records detailed in Ascher et al., 2016), and a survey of Singaporean Anthidiini (Soh et al., 2016). The present study summarises records obtained from all of these studies along with those from subsequent surveys conducted by the authors (see below). It provides one of the only thorough and taxonomically rigorous status assessments for a site in tropical Asia. Based on all available data we document here, both loss and persistence of tropical bee pollinators in the highest quality forest fragment remaining within the urbanised city-state of Singapore.

Materials and Methods

Database

We compiled a dataset of 1094 bee occurrence records, mostly specimen-based, from the Bukit Timah Nature Reserve (BTNR), Dairy Farm Nature Park (DF) and surrounding areas. The database includes extensive capture of historical 20th century records from specimens in Singapore's Lee Kong Chian Natural History Museum (LKCNHM), and also summarises available information about type and other specimens in the Natural History Museum, London (NHMUK), the United States National Museum (Smithsonian), and other overseas museums, along with collection events documented in the descriptive and revisionary literature for bees (e.g., Smith, 1857, based on collections made in 1854 by A.R. Wallace, presumably in the vicinity of DF; Schwarz, 1939, based largely on specimens collected by C.F. Baker; Lieftinck, 1962; Murphy, 1973; Sakagami, 1978; Reyes, 1991). The database, totalling 7459 Singaporean records, also comprehensively summarises recent (post-2000) collections by the authors and colleagues associated with the Insect Diversity Laboratory at the National University of Singapore. Major studies consulted included:

Historical collections from 1854–1976

Bees collected by Alfred Russel Wallace in Singapore were described by F. Smith (1857), and included new species of forest-associated stingless bees but few solitary bee species. Although collection localities for this material cannot be determined precisely, the bees were most likely obtained during April–July 1854 in the Bukit Timah vicinity when Wallace was based there at the site of the present St. Joseph's Church. The first reports of bees definitely attributable to Bukit Timah were collected there by Charles Fuller Baker in 1911 and reported by Schwarz (1939) in his revision of Indo-Malayan stingless bees. Baker re-collected some of the stingless bees recorded by Wallace, but not *Homotrigona fimbriata* (Smith), which has not been collected in Singapore since the type was obtained. Subsequently, as acting Assistant Director of the Singapore Botanic Gardens during 1917–1918, Baker and his assistant collected bees from "Singapore" including forest-associated stingless and solitary bees some of which may have come from Bukit Timah or the vicinity.

The most extensive and precisely labelled historical collections of bees available from Bukit Timah were by D. H. Murphy and associates during the 1960s and 1970s (Murphy, 1973). Some are attributed to precise locations within the BTNR such as Taban Valley, but without precise indication of habitat type.

Subsequent collections up to 2018

Liow et al. (2001) studied bee diversity across eight lowland tropical forest sites in Malaysia and Singapore of varying degrees of anthropogenic disturbance, including BTNR. They conducted honey baiting along transects and opportunistically collected bees at flowers, recording only three identified species at BTNR, *Apis cerana* F., and the meliponines *Tetragonula laeviceps* (Smith) and *Tetragonula geissleri* (Cockerell).

The National Biodiversity Centre, National Parks Board (NParks) conducted a survey of flower-visiting insects by photographs and capture (under NParks permit number NP/RP12-014) from February to June 2012 at seven parks, one of which was Dairy Farm Nature Park (Soh & Ngiam, 2013). Notable species recorded in the survey exclusively at that site included *Megachile* (*Aethomegachile*) *ramera* Cockerell (see Ascher et al., 2016) and *Lipotriches* (*Austronomia*) *takauensis* (Friese).

Clumps of Tiger Orchids (*Grammatophyllum speciosum* Blume) outside the BTNR visitor centre bloomed in 2014. These orchids attracted several bees. Surveys were conducted (under NParks permit number NP/RP14-075a) yielding observations of ten of the 18 *Megachile* spp. reported from Singapore in a review of the *Megachile* spp. of Singapore (Ascher et al., 2016) where details of collection are provided.

For an undergraduate honours project, J.J.L. Lai investigated the impact of urbanisation on bee and wasp diversity in relation to species-specific functional traits. Dairy Farm Nature Park was one of the six parks she surveyed from September to December 2015. At DF she recorded *Amegilla* (*Glossamegilla*) *insularis* (Smith), a large, conspicuous bee species of conservation interest due to its scarcity in Singapore and a strong association of its subgenus with forest habitats, noted long ago by Lieftinck (1956).

We also included specimen records derived from samples taken weekly from malaise traps operated in BTNR from February to October 2017 by the Evolutionary Biology Laboratory, Dept. of Biological Sciences, National University of Singapore (principal investigator R. Meier; specimens provided by M. Foo). Bees from these malaise trap samples were identified and databased by the authors.

Additional specimen records come from recently completed standardised transect surveys (2017–2018) conducted by undergraduate researchers R.L.L. Lee and A.Q.E. Leong along routes indicated in Fig. 1. Nine surveys were conducted from October 2017 to January 2018 (under NParks permit number NP/RP16-179) along three transects: (1) Dairy Farm Loop to Seraya Loop, in shady forest (2) Taban Loop to Catchment Path, in shady forest, and (3) the Public Utilities Board (PUB) pipeline turf area, a sunny, grassy opening at the eastern edge of the core BTNR forest, paralleling the BKE highway separating BTNR from the Central Catchment Nature Reserve. Honey baiting and opportunistic netting were carried out following the methods set out by Liow et al. (2001).

Additional samples from DF were obtained from other studies, including one conducted from November 2017 to January 2018 by Julien Clerbois for his MSc Thesis research (2018, Université Libre de Bruxelles, Institute for Environmental Management and Land-use Planning (IGEAT) (under NParks permit number NP/RP15-011-3).

In addition, opportunistic photographs and observations records made by visitors and the authors to BTNR from 2010 to 2018 were considered to supplement the checklist. Nests of the Giant Honey Bee, *Apis dorsata* F., most often found in the dry season, were widely noted by the public (Fig. 2) as was the largest bee present in Singapore, the carpenter bee *Xylocopa latipes* (Drury).

To further enhance the understanding of the forest-associated bee fauna of BTNR, we summarised bee records from immediately adjacent areas such as Dairy Farm Nature Reserve (DF), Upper Bukit Timah Road (UBTR), and the section of disused railway line adjacent to BTNR (RW). The resulting inclusive datasets provide a more comprehensive view of the bees and their floral associations in the Bukit Timah vicinity to inform understanding of pollination within the reserve. Confirmed records for BTNR and DF are noted in the inventory along with the first and last dates of occurrence and total number of records available for both Bukit Timah and vicinity and for Singapore as a whole.

Results

Bee diversity in BTNR

Of the 130 bee species and morphospecies currently known from Singapore (Soh et al., 2016; images of most can be found at the Biodiversity of Singapore website: which is continuously updated), 75 species from all four locally-occurring bee families (Colletidae, Halictidae, Megachilidae, and Apidae) can be found in BTNR and the vicinity (Appendix 1). Of these 75 species, only 55 species have been verified to

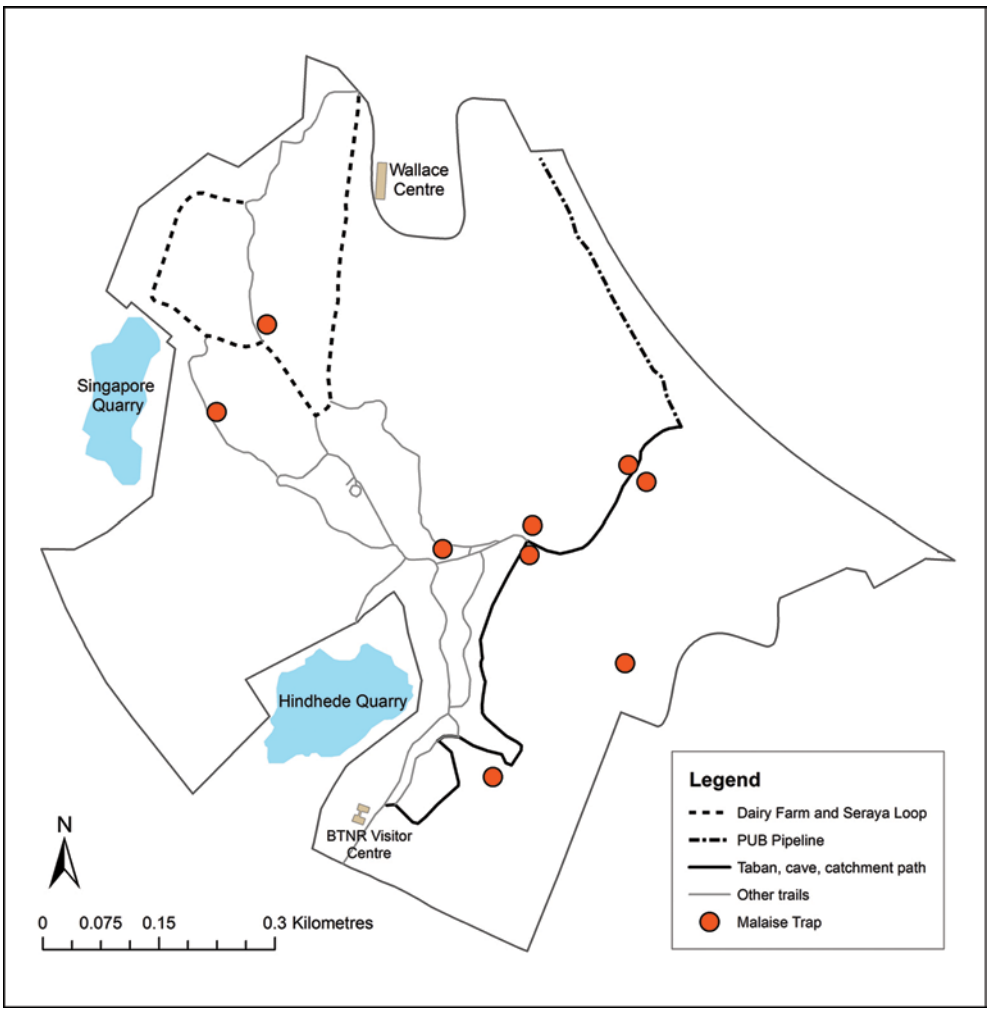

Fig. 1. Malaise trap locations in BTNR. Red dots indicate sites where malaise traps were deployed. The three transects are indicated with dashed, solid, and dot-and-dashed lines respectively. **A.** Dairy Farm Loop to Seraya Loop, in shady forest. **B.** Taban Loop to Catchment Path, in shady forest. **C.** The Public Utilities Board (PUB) pipeline turf area.

occur in BTNR itself. Totals by family for the Bukit Timah vicinity, followed in parentheses by totals for BTNR proper, are as follows: Colletidae: 3 (0), Halictidae 17 (14), Megachilidae: 21 (16), Apidae: 34 (28). Thus, the fauna is dominated by long-tongued bees (families Megachilidae and Apidae). Eleven of the 75 species (14.66%) are known only from historical records (pre-2000). Appendix I gives the full list of bee species in BTNR and the surrounding areas.

Floral Records

A total of 457 bee specimens with floral interactions were recorded for BTNR and vicinity (Appendix II). Although some 1249 species of plant have been recorded from BTNR (Ho et al., 2019), of which 1135 are flowering plants, we have recorded only c. 30 plant species as floral hosts of bees in BTNR and vicinity. With the exception of the Tiger Orchids (*Grammatophyllum speciosum*) that were reintroduced into BTNR and DF, most of these are free-flowering herbs or shrubs easily accessible along sunlit gaps along trails, at the forest edge, notably the PUB pipeline, and at other openings. Plant species in the BTNR and vicinity that have been recorded as attracting a diverse range of bee species include (with native status and number of bee species recorded as visitors): *Asystasia gangetica* ssp. *micrantha* (non-native, 11), *Muntingia calabura* (non-native, 13), *Bidens pilosa* (non-native, 11), *Cratoxylum cochinchinense* (native, 14), *Melastoma malabathricum* (native, 16), *Grammatophyllum speciosum* (native, 21). Appendix III gives a list of plant species with documented bee interactions, with names and exotic versus native status extracted from Chong et al. (2009).

Species accounts

As the taxonomy, distribution, and conservation status of bees in Southeast Asia in general, and of Singapore in particular, are poorly documented, we provide details here for those species of particular taxonomic or conservation interest:

1. *Lasioglossum (Ctenonomia) semirussatum* (Cockerell, 1920)

This species is known globally from only two collections of male specimens. The type in the United States National Museum was collected in "Singapore" by C.F. Baker, likely during 1917–1918 (see above). The only subsequent collection known to us, and the only record with precise locality, was a single male from Bukit Timah forest on 28 January 1976, presumably collected by D.H. Murphy et al., and deposited in the LKCNHM. Photographs of the latter specimen are provided here (Fig. 3) so as to make accessible notable identification features of the species such as its red metasoma and yellow clypeal apex.

2. *Patellapis (Pachyhalictus) intricata* (Vachal, 1895["1894"])

Recorded in 1975 at Bukit Timah forest on 19 December 1976 from Rifle Range Road secondary forest (LKCNHM). There are no subsequent records from Singapore of this distinctive sweat bee (see morphological drawings by Pesenko & Wu (1997); as *Pachyhalictus intricatus*), but it persists in forests of southern Johor.

3. *Lipotriches (Rhopalomelissa) minutula* (Friese, 1909)

This small species, a member of a Palaeotropical subgenus known to collect pollen from grass, is widely distributed in the Indomalayan region (Pauly, 2014), but Bukit Timah is the only known site for it within Singapore. Unfortunately, the single female from Bukit Timah Nature Reserve (LCKNHM) lacks a collection date. It was curated with D.H. Murphy material and was presumably collected during the 1960s.

Fig. 2. Visitors to BTNR view a nest of *Apis dorsata* in BTNR. (Photo: X. Fang).

4. *Geniotrigona thoracica* (Smith, 1857)
The worker type specimen of this species (repository NHMUK), the largest stingless bee in Southeast Asia, was collected in Singapore by Alfred Russel Wallace, likely during 18 April–13 July 1854 and possibly from Bukit Timah or its vicinity. It was subsequently reported from Bukit Timah on 30 June 1911 (Schwarz, 1939; it was also recorded in 1911 from the Singapore Botanic Gardens), likely by C.F. Baker, and most recently at Bukit Timah Forest on 17 March 1973 and on 7 March 1976 at Taban Valley (LKCNHM), likely by D.H. Murphy. The lack of any records in Singapore of this large, attractive, and thus very conspicuous species (despite attempts to recollect it at Taban Valley and elsewhere) since 1976 suggests that it is nationally extinct. It has been found recently in Johor, Malaysia, e.g. by Liow et al. (2001), but only locally and in small numbers. *Trigona pallidicincta* Cockerell, 1918, described from a male holotype (NHMUK) from Singapore, was cited as incertae sedis in the catalogue of the Indo-Malayan stingless bees (Rasmussen, 2008). The long body length (9 mm) and wing colour indicated in the description suggest that it is a male *Geniotrigona thoracica*, leading us to propose a probable new synonymy.

5. *Homotrigona (Homotrigona) fimbriata* (Smith, 1857).
Although the type specimen (NHMUK) is from "Singapore" there are no subsequent records (Schwarz, 1939) and it is thus presumed to be nationally extinct. This species is listed here because the type material collected by A.R. Wallace could have been obtained from the Bukit Timah vicinity in 1854. We have not observed this species recently in the forests of southern Johor, although it persists on Tioman Island off the east coast of Peninsular Malaysia. An unusual colour form reported from there proves to be characteristic of this population, and is not attributable to a callow condition (cf. Schwarz, 1939).

6. *Homotrigona (Lophotrigona) canifrons* (Smith, 1857).
Recorded from Bukit Timah on 26 July 1911 by C.F. Baker (Schwarz, 1939), but not subsequently from Singapore where it is presumed to be nationally extinct. We have not found this species when observing stingless bees in southern Johor, leading us to believe that it may be of broader conservation concern. *Lophotrigona* and also *Tetrigona* were reduced to subgeneric rank within an expanded genus *Homotrigona* by Rasmussen et al. (2017).

7. *Nomada malayana* Cameron, 1909
This strikingly coloured cleptoparasitic species is newly recorded from Singapore based on comparison of local material with images of the female type specimen (NHMUK) from Kuching, Sarawak, Borneo, Malaysia. In Singapore this cleptoparasite, presumably of *Lasioglossum*, is known from one female collected 6 June 1976 in Bukit Timah forest by D.H. Murphy (LKCNHM). Although there are no recent specimens from Bukit Timah and vicinity, this species is known to persist in Singapore as a female was found 2 November 2014 on Sentosa. Based on the description and photos of the male type of *Nomada testaceobalteata* Cameron, 1910,

Fig. 3. Male specimen of *Lasioglossum* (*Ctenonomia*) *semirussatum* (Cockerell) deposited in the LKCNHM (scale bar 1 mm). (Photos: Insect Diversity Lab, NUS Department of Biological Sciences)

from Kuching we regard this as a likely junior synonym of *N. malayana*, pending revisionary study of Southeast Asian *Nomada*, which belong to the poorly documented *furva* species group.

8. *Tetragonula (Tetragonilla) atripes* (Smith, 1857)
This distinctively orange-coloured meliponine species was not recorded historically from Singapore (note lack of records in Schwarz, 1939) but was collected at Bukit Timah on 16 December 1965. There are no subsequent records, leading us to regard it as nationally extinct, but it is known to persist in southern Johor, e.g., at Gunung Panti where an active nest has been photographed recently.

Discussion

Loss and Discovery of Bees in BTNR

Detecting bees in rainforests is a challenge and obtaining a comprehensive species inventory requires use of varied methods. However, extensive recent sampling using multiple methods shows a depauperate bee fauna lacking a number of forest-associated bee species known historically. Honey baiting is considered an effective method for stingless bees, and was deployed in various surveys (Liow et al., 2001), yet has not yielded multiple large-bodied or otherwise conspicuous stingless bee species found by A.R. Wallace in 1854 or by C.F. Baker in 1911-1918 or by D.H. Murphy from the 1960s until 1976. Malaise traps have been shown to be highly effective for collecting forest-associated bees, and those deployed in Singapore's mangroves and Nee Soon Swamp Forest have yielded new country records or important re-discoveries (unpublished data). However, malaise traps set in BTNR have caught relatively few bee individuals or species, and even fewer of particular taxonomic or conservation interest.

The lack of recent records of four stingless bee species, *Geniotrigona thoracica*, *Homotrigona fimbriata*, *Homotrigona* (*Lophotrigona*) *canifrons*, and *Tetragonula* (*Tetragonilla*) *atripes*, suggests that these have become extinct in BTNR, as has been well documented at the site for vertebrates (e.g., Lim, 2019; Teo & Thomas, 2019). The "vertebrate-like" effective population size of Meliponini (Romiguier et al., 2014) may have contributed to their loss from this small, isolated forest fragment. Among persisting species, low abundance and low number of known nests for the largest-bodied extant stingless bee *Homotrigona* (*Tetrigona*) *apicalis* (Smith) raises uncertainly about whether a viable breeding population exists to ensure long-term maintenance of genetic diversity.

The absence of species known from historical specimens from our modern records suggests that bee diversity has declined considerably at BTNR. One problem for bees in particular that may be overlooked by site managers is that forest regrowth may reduce sunlight and thus bee floral resources.

On the other hand, surveys on restoration plantings of tiger orchids planted at the entrance of BTNR and in Dairy Farm Nature Park by Z.W.W. Soh and colleagues during the mass bloom of 2014 resulted in the discovery of new canopy-associated *Megachile* spp. for Singapore and the rediscovery of species found by early workers but not by Murphy (see Ascher et al., 2016). Additional surveys at Dairy Farm were also relatively productive in terms of diversity of floral interactions discovered.

Prospects for improved sampling in BTNR

Our knowledge of bee species diversity in Bukit Timah and vicinity, and of Singapore as a whole, may be further improved. The inherent challenge of sampling bees in tall tropical forests is compounded by fragmentary knowledge of the life history of many taxa, notably parasites, and also by the pollination ecology of lowland forests of Southeast Asia characterised by highly infrequent, mass blooming events, largely restricted to the inaccessible forest canopy (Chin et al., 1995). Conventional bee

sampling method of hand-netting has proven largely ineffective in the shady rainforest understorey where flowering herbaceous shrubs are largely absent, aside from one notable exception where restored Tiger Orchids at ground level were blooming and accessible to study. Some species that are regularly observed in Singapore's forests were scarce or absent in our BTNR samples, and some of these are likely under-recorded. For example, *Apis dorsata* nests are regularly spotted during periods of bloom, yet the species is not obtained regularly by hand-netting. A full accounting of bees present at BTNR, which may include several as yet undetected species of *Coelioxys* cleptoparasites of *Megachile* among others, will require further sampling by multiple methods during infrequent mass-flowering events. Deployment of malaise traps in the canopy may reveal novel species, but Roubik (1993) provided evidence against stratum "preferences" among tropical forest bees and showed that most if not all species recorded from the canopy could also be obtained at ground level. The vast majority of flowering plant species noted by Corlett (1990) or Ho et al. (2019) have not yet been sampled for bees, especially the trees, and potentially play host to additional bee species. However, bee species' diversity in Southeast Asia is known to be low relative to the flora, and pollen specialisation (oligolecty and mesolecty) is not prevalent among Asian forest bees, suggesting that unsampled melittophilous plants may be visited by generalists such as Meliponini. Malaise traps deployed in Singapore's mangroves and swamp forests have yielded novel bee species never obtained by net, but those deployed in BTNR yielded mostly common stingless bee species, with no very noteworthy bees found. This suggests that our rather unrewarding net samples were representative of a truly poor bee fauna along the shady forest trails.

Conservation implications

Relatively low apparent abundance of free-flowering shrubs at BTNR in the understorey may be a factor for lower bee abundance and species richness in recent samples as compared to DF, which has greater availability of herbaceous flowering plants and more open, sunnier edges which promote a richer bee fauna. Much of the BTNR core is too heavily forested and thus shaded to provide good bee habitats except during irregular mass bloom periods such as occurred in 1987 when canopy trees provided extensive floral resources, many as yet unsampled for their bees (see Corlett, 1990). Some sites within BTNR may have declined as sites for bee collecting, at least by net, due to regrowth of secondary forest cover. Routine removal of weeds from forest openings such as the summit of Bukit Timah may contribute to a lack of bees and certainly impedes detection of bee populations that may be present. Occasional mass flowering of the canopy is likely insufficient to maintain populations of stingless bees within BTNR, where reliable blooming understorey flowers are few, so conservation of more disturbed sites in the vicinity such as DF and the PUB pipeline at the edge of BTNR may be important to maintain bee populations needed to pollinate the diverse flora remaining in the Bukit Timah forest. In general, non-forest vegetation is often considered to have limited conservation value in Singapore, except as a source of nectar (Corlett, 1997). Here, our findings agree that continuous flowering

of both native forest-edge shrubs such as *Melastoma malabathricum* and non-native weeds such as *Asystasia gangetica* ssp. *micrantha* may be crucial for maintaining bee populations between infrequent mass flowering of the forest canopy.

Conclusions

As recently as 1976, BTNR and vicinity was known to have multiple forest-associated native bees not known from elsewhere in Singapore. Unfortunately, these have not been re-collected in subsequent studies. The bee fauna known to persist in BTNR consists at present of species also found in the CCNR and more open sites in the vicinity such as DF. As was noted long ago by A.R. Wallace, openings in the forest may be crucial for detecting insects, although their persistence may depend on maintenance of large expanses of primary forests in the vicinity.

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Appendix I. Bee species recorded from Bukit Timah and vicinity in Singapore. For each bee species first and last year of record is noted for the site and for the country of Singapore. Localities of occurrence within Bukit Timah and vicinity (BT v.) are provided in code for the forested Bukit Timah Nature Reserve core (BTNR), the more open PUB pipeline at its eastern edge (PUB) along with Dairy Farm Nature Park (DF), and Upper Bukit Timah Road (UBTR).

	Species	Year of Record at:				Known BT vicinity locations
		BT vicinity		Singapore		
		First	Last	First	Last	
	Colletidae					
1	*Hylaeus* (*Nesoprosopis*) *penangensis* (Cockerell, 1920)	2014	2014	1975	2018	DF
2	*Hylaeus* (*Nesoprosopis*) sp.1 aff. *transversalis*	2014	2017	2013	2017	DF
3	*Hylaeus* (*Nesoprosopis*) sp.3 aff. *transversalis*	2017	2017	2015	2017	DF
	Halictidae					
4	*Lasioglossum* (*Ctenonomia*) *albescens* (Smith, 1853)	2014	2017	2012	2017	DF
5	*Lasioglossum* (*Ctenonomia*) *deliense* (Strand, 1910)	2014	2017	1976	2018	DF, PUB
6	*Lasioglossum* (*Ctenonomia*) *semirussatum* (Cockerell, 1920)	1976	1976	1917-18	1976	BTNR
7	*Lasioglossum* (*Ctenonomia*) *vagans* (Smith, 1857)	2014	2018	1972	2018	BTNR, DF, PUB
8	*Lasioglossum* (*Ctenonomia*) sp.1 [nr. *vagans*]	2009	2018	1976	2018	BTNR, DF, PUB
9	*Lasioglossum* (*Homalictus*) *singapurellum* (Blüthgen, 1926)	2014	2014	1917-18	2018	DF
10	*Lipotriches* (*Austronomia*) *takauensis* (Friese, 1910)	2009	2018	1918	2018	BTNR, DF, PUB
11	*Lipotriches* (*Rhopalomelissa*) *ceratina* (Smith, 1857)	1965	2018	1854*	2018	BTNR, DF, PUB
12	*Lipotriches* (*Rhopalomelissa*) *minutula* (Friese, 1909)	1960s?	1960s?	1960s?	1960s?	BTNR
13	*Nomia* (*Acunomia*) *iridescens* Smith, 1857	2014	2017	1918	2018	BTNR, DF, PUB
14	*Nomia* (*Acunomia*) *strigata* (Fabricius, 1793)	1975	2018	1910	2018	BTNR, DF, PUB

Appendix I. Continuation.

	Species	Year of Record at:				Known BT vicinity locations
		BT vicinity		Singapore		
		First	Last	First	Last	
15	*Nomia* (*Hoplonomia*) *incerta* Gribodo, 1894	1980	2015	1980	2018	BTNR, DF
16	*Nomia* (*Maculonomia*) *apicalis* Smith, 1857	1976	1976	1854*	1976	DF
17	*Nomia* (*Maculonomia*) *fuscipennis* Smith, 1875	1974	2018	1947	2018	BTNR, DF, PUB
18	*Nomia* (*Maculonomia*) sp. [undescribed]	2017	2017	2008	2018	BTNR, DF
19	*Patellapis* (*Pachyhalictus*) *intricata* (Vachal, 1895["1894"])	1975	1975	1975	1976	BTNR
20	*Patellapis* (*Pachyhalictus*) *murbanus* (Blüthgen, 1931)	1970	2017	1918	2018	BTNR, DF, PUB
	Megachilidae					
21	*Anthidiellum* (*Pycanthidiellum*) *smithii smithii* (Ritsema, 1874)	2014	2014	2014	2014	BTNR, DF
22	*Coelioxys* (*Callosarissa*) *confusus* Smith, 1875	2014	2014	1970	2018	BTNR, DF
23	*Euaspis polynesia* Vachal, 1903	2014	2014	1968	2018	BTNR
24	*Heriades* (*Michenerella*) *othonis* Friese, 1914	1976	2014	1970	2018	BTNR, DF
25	*Megachile* (*Aethomegachile*) *borneana* Cameron, 1903	2012	2012	2012	2015	DF
26	*Megachile* (*Aethomegachile*) *conjuncta* Smith, 1853	2015	2015	1854*	2017	DF
27	*Megachile* (*Aethomegachile*) *laticeps* Smith, 1853	2013	2015	1917	2018	BTNR, DF
28	*Megachile* (*Aethomegachile*) nr. *borneana*	2012	2012	2012	2015	DF
29	*Megachile* (*Aethomegachile*) *ramera* Cockerell, 1918	2012	2012	1917	2012	DF
30	*Megachile* (*Aethomegachile*) sp. [*fusciventris* group]	2012	2015	1918	2018	BTNR, DF
31	*Megachile* (*Anodonteutricharea*) *tricincta* Bingham, 1897	2014	2014	1976	2017	BTNR, DF
32	*Megachile* (*Callomegachile sensu lato*) *tuberculata* Smith, 1857	2014	2014	1961	2016	BTNR, DF

Appendix I. Continuation.

	Species	Year of Record at: BT vicinity First	BT vicinity Last	Singapore First	Singapore Last	Known BT vicinity locations
33	*Megachile* (*Callomegachile*) *disjuncta* (Fabricius, 1781)	2014	2015	2010	2018	BTNR, DF
34	*Megachile* (*Callomegachile*) *fulvipennis* Smith, 1879	2014	2015	1976	2018	BTNR, DF
35	*Megachile* (*Callomegachile*) *indonesica* (Engel and Schwarz, 2011)	2014	2015	2014	2015	BTNR, DF
36	*Megachile* (*Callomegachile*) *ornata* Smith, 1853	2014	2014	2014	2014	BTNR
37	*Megachile* (*Callomegachile*) *umbripennis* Smith, 1853	2013	2015	1974	2018	BTNR, DF
38	*Megachile* (*Callomegachile*) sp. (species-group of *biroi*)	2014	2014	2014	2014	BTNR, DF
39	*Megachile* (*Carinula) stulta* Bingham, 1897	2014	2015	2012	2018	BTNR, DF
40	*Megachile* (*Creightonella*) *atrata* Smith, 1853	2014	2014	1976	2017	DF
41	*Megachile* (*Eutricharaea*) *subrixator* Cockerell, 1915	2014	2015	1915	2018	BTNR, DF
	Apidae					
42	*Amegilla* (*Glossamegilla*) *insularis* (Smith, 1857)	1976	2015	1897	2018	BTNR, DF
43	*Amegilla* (*Zonamegilla*) *andrewsi* (Cockerell, 1910)	1976	2018	1918	2018	BTNR, DF, PUB
44	*Apis* (*Apis*) *cerana* Fabricius, 1793	1989	2018	1919	2018	BTNR, DF, PUB, RW
45	*Apis* (*Megapis*) *dorsata dorsata* Fabricius, 1793	1989	2015	1962	2018	BTNR, DF, RW, UBTR
46	*Apis* (*Micrapis*) *andreniformis* Smith, 1857	2015	2017	1919	2018	DF, UBTR
47	*Braunsapis clarihirta* Reyes, 1991	2014	2016	1929	2016	BTNR, DF
48	*Braunsapis cupulifera* (Vachal, 1895["1894"])	1986	2017	1905	2018	BTNR, DF, PUB
49	*Braunsapis hewitti* (Cameron, 1908)	2012	2017	1962	2018	BTNR, DF
50	*Braunsapis puangensis* (Cockerell, 1929)	2015	2015	2013	2018	DF

Appendix I. Continuation.

	Species	Year of Record at: BT vicinity First	BT vicinity Last	Singapore First	Singapore Last	Known BT vicinity locations
51	*Ceratina* (*Catoceratina*) *perforatrix pyramidalis* Cockerell, 1919	1973	2016	1917	2018	BTNR, DF
52	*Ceratina* (*Ceratinidia*) *collusor* Cockerell, 1919	2010	2018	1917-18	2018	BTNR, DF, PUB
53	*Ceratina* (*Ceratinidia*) *lieftincki* van der Vecht, 1952	1974	2018	1962	2018	BTNR, DF, PUB
54	*Ceratina* (*Ceratinidia*) *nigrolateralis incerta* Cockerell, 1919	2009	2018	1917	2018	BTNR, DF, PUB
55	*Ceratina* (*Lioceratina*) *ridleyi* Cockerell, 1910	1968	2017	1910	2018	BTNR
56	*Ceratina* (*Neoceratina*) *dentipes* Friese, 1914	2014	2018	1972	2018	DF, PUB
57	*Ceratina* (*Pithitis*) *unimaculata palmerii* Cameron, 1908	1973	2018	1962	2018	BTNR, DF, PUB, UBTR
58	*Ceratina* (*Xanthoceratina*) *fuliginosa* Cockerell, 1916	2014	2014	2011	2014	DF
59	*Geniotrigona thoracica* (Smith, 1857)	1911	1976	1854*	1976	BTNR
60	*Heterotrigona* (*Heterotrigona*) *itama* (Cockerell, 1918)	1973	2015	1911	2018	BTNR, DF
61	*Homotrigona* (*Homotrigona*) *fimbriata* (Smith, 1857)	1854?*	1854?*	1854	1854	BT?*
62	*Homotrigona* (*Lophotrigona*) *canifrons* (Smith, 1857)	1911	1911	1911	1911	BT
63	*Homotrigona* (*Tetrigona*) *apicalis* (Smith, 1857)	1911	2018	1907	2018	BTNR, DF, UBTR
64	*Nomada malayana* Cameron, 1909	1976	1976	1976	2014	BTNR
65	*Tetragonula* (*Tetragonula*) *geissleri* (Cockerell, 1918)	1974	2018	1918	2018	BTNR, DF, PUB
66	*Tetragonula* (*Tetragonula*) *laeviceps* (Smith, 1857)	2009	2018	1854*	2018	BTNR, DF, UBTR
67	*Tetragonula* (*Tetragonula*) *pagdeniformis* (Sakagami, 1978)	1967	2018	1967	2018	BTNR, DF
68	*Tetragonula* (*Tetragonilla*) *atripes* (Smith, 1857)	1965	1965	1965	1965	BT

Appendix I. Continuation.

	Species	Year of Record at: BT vicinity First	Last	Singapore First	Last	Known BT vicinity locations
69	*Thyreus ceylonicus lilacinus* (Cockerell, 1919)	2010	2016	1902	2018	BTNR, DF, UBTR
70	*Thyreus himalayensis* (Radoszkowski, 1893)	1976	2017	1908	2018	BTNR, DF
71	*Xylocopa* (*Koptortosoma*) *aestuans* (Linnaeus, 1758)	1965	1989	1854*	2018	BTNR
72	*Xylocopa* (*Koptortosoma*) *caerulea* (Fabricius, 1804)	1980	2015	1854*	2018	BTNR, DF
73	*Xylocopa* (*Koptortosoma*) *flavonigrescens* Smith, 1854	2017	2017	1972	2018	PUB
74	*Xylocopa* (*Nyctomelitta*) *myops* Ritsema, 1876	1968	1968	1901	2017	BTNR
75	*Xylocopa* (*Platynopoda*) *latipes* (Drury, 1773)	2015	2018	1854*	2018	BTNR, DF, PUB, RW, UBTR

*Likely collected by A. R. Wallace in the Bukit Timah vicinity in 1854 but not labelled precisely.

Appendix II. Floral associations of the bee species recorded from Bukit Timah and vicinity in Singapore

For each bee species, floral associations are indicated for the main areas of observation, i.e. Dairy Farm, BTNR, and PUB Pipeline, with flowers indicated by a two-letter abbreviation (see Appendix III). Number of records from Bukit Timah vicinity and from Singapore as a whole are cited.

	Species	Floral Associations at			Number of Records	
		BTNR	Dairy Farm	PUB Pipeline	BT vicinity	Singapore
	Colletidae					
1	*Hylaeus* (*Nesoprosopis*) *penangensis* (Cockerell, 1920)		*Sz*		1	206
2	*Hylaeus* (*Nesoprosopis*) sp.1 aff. *transversalis*		*Ds*		5	13
3	*Hylaeus* (*Nesoprosopis*) sp.3 aff. *transversalis*		*Ds, Hr*		2	3
	Halictidae					
4	*Lasioglossum* (*Ctenonomia*) *albescens* (Smith, 1853)		*Ag, Bp, Ds*		9	24
5	*Lasioglossum* (*Ctenonomia*) *deliense* (Strand, 1910)		*Hr, Ds*	*Mma*	6	62
6	*Lasioglossum* (*Ctenonomia*) *semirussatum* (Cockerell, 1920)				1	2
7	*Lasioglossum* (*Ctenonomia*) *vagans* (Smith, 1857)			*Mo, St*	11	84
8	*Lasioglossum* (*Ctenonomia*) sp.1 [nr. *vagans*]		*Bp, Pf, St*	*Mma, Mo*	19	51
9	*Lasioglossum* (*Homalictus*) *singapurellum* (Blüthgen, 1926)				1	28
10	*Lipotriches* (*Austronomia*) *takauensis* (Friese, 1910)		*Ag, Dt, De, Hr, Mma, Sa*	*Mo*	21	27
11	*Lipotriches* (*Rhopalomelissa*) *ceratina* (Smith, 1857)	*Mc*	*Li, Mi, Pc*		25	74
12	*Lipotriches* (*Rhopalomelissa*) *minutula* (Friese, 1909)				1	1
13	*Nomia* (*Acunomia*) *iridescens* Smith, 1857	*Gs*	*Cc, Gs*		12	38

Appendix II. Continuation.

	Species	Floral Associations at			Number of Records	
		BTNR	Dairy Farm	PUB Pipeline	BT vicinity	Singapore
14	*Nomia* (*Acunomia*) *strigata* (Fabricius, 1793)	*Gs, Mc*	*Ag, Ds, Hrs, Li, Mi, Mma, Rs, Sz*	*Mma, Mo, St*	47	430
15	*Nomia* (*Hoplonomia*) *incerta* Gribodo, 1894		*Al, Cc, Gs, Pf, Sz*		30	118
16	*Nomia* (*Maculonomia*) *apicalis* Smith, 1857				2	3
17	*Nomia* (*Maculonomia*) *fuscipennis* Smith, 1875		*Ds, Hr, Li, Lr, Mma, Pf*	*Mma*	35	63
18	*Nomia* (*Maculonomia*) sp. [undescribed]				2	7
19	*Patellapis* (*Pachyhalictus*) *intricata* (Vachal, 1895["1894"])				1	3
20	*Patellapis* (*Pachyhalictus*) *murbanus* (Blüthgen, 1931)		*Ag, Ds, Hr, Mma*	*Mma*	26	82
	Megachilidae					
21	*Anthidiellum* (*Pycanthidiellum*) *smithii smithii* (Ritsema, 1874)	*Mc*	*Ba*		8	8
22	*Coelioxys* (*Callosarissa*) *confusus* Smith, 1875	*Mc*	*Bp*		17	119
23	*Euaspis polynesia* Vachal, 1903	*Mc*			1	10
24	*Heriades* (*Michenerella*) *othonis* Friese, 1914		*Bp*		2	68
25	*Megachile* (*Aethomegachile*) *borneana* Cameron, 1903				1	2
26	*Megachile* (*Aethomegachile*) *conjuncta* Smith, 1853		*Cc*		1	23
27	*Megachile* (*Aethomegachile*) *laticeps* Smith, 1853	*Gs*	*Ag, Bp, Cc*		16	168
28	*Megachile* (*Aethomegachile*) nr. *borneana*		*Ag*		2	5
29	*Megachile* (*Aethomegachile*) *ramera* Cockerell, 1918		*Ag*		2	3

Appendix II. Continuation.

	Species	Floral Associations at			Number of Records	
		BTNR	Dairy Farm	PUB Pipeline	BT vicinity	Singapore
30	*Megachile* (*Aethomegachile*) sp. [*fusciventris* group]	*Gs*	*Ag, Cc*		13	22
31	*Megachile* (*Anodonteutricharea*) *tricincta* Bingham, 1897	*Mc*	*Ba, Bp, Gs, Mc*		37	44
32	*Megachile* (*Callomegachile sensu lato*) *tuberculata* Smith, 1857	*Gs*	*Gs*		4	9
33	*Megachile* (*Callomegachile*) *disjuncta* (Fabricius, 1781)	*Gs, Mc*	*Cc, Gs*		22	278
34	*Megachile* (*Callomegachile*) *fulvipennis* Smith, 1879	*Gs*	*Cc, Gs*		24	86
35	*Megachile* (*Callomegachile*) *indonesica* (Engel and Schwarz, 2011)	*Gs*	*Cc, Gs*		27	42
36	*Megachile* (*Callomegachile*) *ornata* Smith, 1853	*Gs*			1	2
37	*Megachile* (*Callomegachile*) *umbripennis* Smith, 1853	*Ag, Gs, Mc*	*Cc*		6	335
38	*Megachile* (*Callomegachile*) sp. (species-group of *biroi*)	*Gs*	*Gs*		16	18
39	*Megachile* (*Carinula) stulta* Bingham, 1897	*Gs, Mc*	*Ba, Bp, Cc, Gs, Mc, Sz*		33	58
40	*Megachile* (*Creightonella*) *atrata* Smith, 1853		*Sz*		1	58
41	*Megachile* (*Eutricharaea*) *subrixator* Cockerell, 1915	*Ag*	*Ba, Bp, Cc*		32	140
	Apidae					
42	*Amegilla* (*Glossamegilla*) *insularis* (Smith, 1857)		*Pb*		2	13
43	*Amegilla* (*Zonamegilla*) *andrewsi* (Cockerell, 1910)		*Ag, Lr, Mma, Mph, Mpu*	*Ds, Mma*	33	334
44	*Apis* (*Apis*) *cerana* Fabricius, 1793		*Ag, Cm, Mma, Mpu, St*	*Ag, Mma*	27	287

Appendix II. Continuation.

	Species	Floral Associations at			Number of Records	
		BTNR	Dairy Farm	PUB Pipeline	BT vicinity	Singapore
45	*Apis* (*Megapis*) *dorsata dorsata* Fabricius, 1793	(*Ag* @ UBTR)	*Ag, Ct, Mpu*		9	180
46	*Apis* (*Micrapis*) *andreniformis* Smith, 1857		*Cc, Tg*		4	226
47	*Braunsapis clarihirta* Reyes, 1991		*Gs*		10	57
48	*Braunsapis cupulifera* (Vachal, 1895["1894"])	*Mc*	*Gs, Li, Mma*	*Lr*	22	185
49	*Braunsapis hewitti* (Cameron, 1908)	*Mc*	*Mma*		8	186
50	*Braunsapis puangensis* (Cockerell, 1929)				1	91
51	*Ceratina* (*Catoceratina*) *perforatrix pyramidalis* Cockerell, 1919		*Ag, Gs, Hr, Ip, Pb, Rs*		14	43
52	*Ceratina* (*Ceratinidia*) *collusor* Cockerell, 1919	*Mc, Mma*	*Ba, Ds, Li, Mma*	*Mma, Mo, St*	96	200
53	*Ceratina* (*Ceratinidia*) *lieftincki* van der Vecht, 1952	*Eu*	*Cr*		11	152
54	*Ceratina* (*Ceratinidia*) *nigrolateralis incerta* Cockerell, 1919		*Ag, Ba, Bp, Ds, Gs, Hr, Mma, St*	*Mma*	54	174
55	*Ceratina* (*Lioceratina*) *ridleyi* Cockerell, 1910		*Os*		6	12
56	*Ceratina* (*Neoceratina*) *dentipes* Friese, 1914		*Lp*	*Mo, St*	4	27
57	*Ceratina* (*Pithitis*) *unimaculata palmerii* Cameron, 1908		*Ag, Bp, Gs, Mma*	*Ag, Mma*	26	66
58	*Ceratina* (*Xanthoceratina*) *fuliginosa* Cockerell, 1916		*Gs*		2	6
59	*Geniotrigona thoracica* (Smith, 1857)	Oc			11	18
60	*Heterotrigona* (*Heterotrigona*) *itama* (Cockerell, 1918)	*Mc,* Oc	*Cc, Li, Pf*		13	88
61	*Homotrigona* (*Homotrigona*) *fimbriata* (Smith, 1857)				1*	1*
62	*Homotrigona* (*Lophotrigona*) *canifrons* (Smith, 1857)				1	2

Appendix II. Continuation.

	Species	Floral Associations at			Number of Records	
		BTNR	Dairy Farm	PUB Pipeline	BT vicinity	Singapore
63	*Homotrigona* (*Tetrigona*) *apicalis* (Smith, 1857)		*Ds*		16	56
64	*Nomada malayana* Cameron, 1909				2	4
65	*Tetragonula* (*Tetragonula*) *geissleri* (Cockerell, 1918)	*Gs*	*Cm, Lr, Mma, Pl*		30	161
66	*Tetragonula* (*Tetragonula*) *laeviceps* (Smith, 1857)		*Cc, Cm, Ds, Hrs, Mma, St, Ts*		114	863
67	*Tetragonula* (*Tetragonula*) *pagdeniformis* (Sakagami, 1978)	*Gs*	*Cm*		27	160
68	*Tetragonula* (*Tetragonilla*) *atripes* (Smith, 1857)				2	2
69	*Thyreus ceylonicus lilacinus* (Cockerell, 1919)	*Sp*	*Ag*		6	58
70	*Thyreus himalayensis* (Radoszkowski, 1893)		*Ag, Bp*		8	206
71	*Xylocopa* (*Koptortosoma*) *aestuans* (Linnaeus, 1758)				8	396
72	*Xylocopa* (*Koptortosoma*) *caerulea* (Fabricius, 1804)		*Pf, Sz*		4	35
73	*Xylocopa* (*Koptortosoma*) *flavonigrescens* Smith, 1854				1	112
74	*Xylocopa* (*Nyctomelitta*) *myops* Ritsema, 1876				1	10
75	*Xylocopa* (*Platynopoda*) *latipes* (Drury, 1773)	*Mma*	*Mma*	*Mma*	13	232

*Likely collected by A. R. Wallace in the Bukit Timah vicinity in 1854 but not labelled precisely.

Appendix III. Floral Associations of bees in Bukit Timah and vicinity in Singapore. For each plant species the family, species name and two letter abbreviation, growth form, origin (native vs. exotic, catch location (see Appendix I) and number of associated bee species by site and combined, and number of associated bee specimens from Bukit Timah and vicinity are noted.

Family	Plant	Abbr.	Growth form**	Origin**	Catch Locations	# of Associated Species at				No. of associated specimens at BT vicinity
						BTNR	DF	PUB	Combined	
Acanthaceae	*Asystasia gangetica* ssp. *micrantha* (Nees) Ensermu	*Ag*	Herb	Exotic	BTNR, DF, PUB, UBTR	2	16	1	18*	61
	Pachystachys lutea Nees	*Pl*	Shrub	Exotic	DF		1		1	3
	Ruellia simplex C.Wright	*Rs*	Herb	Exotic	DF		2		2	2
	Thunbergia grandiflora Roxb.	*Tg*	Climber	Exotic	DF		1		1	1
Amaryllidaceae	*Hymenocallis speciosa* (L.f. ex Salisb.) Salisb.	*Hs*	Herb	Exotic	DF		1		1	3
Arecaceae	*Caryota mitis* Lour.	*Cm*	Tree	Native	DF		4		4	9
Asteraceae	*Bidens alba* (L.) DC.	*Ba*	Herb	Exotic	DF		6		6	27
	Bidens pilosa L.	*Bp*	Herb	Exotic	DF		11		11	17
	Sphagneticola trilobata (L.) Pruski	*St*	Herb	Exotic	DF, PUB		4	4	8	9
Cactaceae	*Pereskia bleo* (Kunth) DC.	*Pb*	Shrub	Exotic	DF		2		2	2
Cleomaceae	*Cleome rutidosperma* DC.	*Cr*	Herb	Exotic	DF		1		1	5
Convolvulaceae	*Ipomoea* sp.	*Ip*	Climber		DF		1		1	1

Appendix III. Continuation.

Family	Plant	Abbr.	Growth form**	Origin**	Catch Locations	# of Associated Species at				No. of associated specimens at BT vicinity
						BTNR	DF	PUB	Combined	
Dilleniaceae	*Dillenia suffruticosa* (Griff. ex Hook.f. & Thomson) Martelli	*Ds*	Shrub	Native	DF, PUB		12†	1	13†	26
Fabaceae	*Calliandra tergemina* var. *emarginata* (Humb. & Bonpl. ex Willd.) Barneby	*Ct*	Tree	Exotic	DF		1		1	1
	Desmodium triflorum (L.) DC.	*Dt*	Herb	Uncertain	DF		1		1	1
	Desmodium sp.	*De*		Uncertain	DF		1		1	1
	Mimosa pudica L.	*Mpu*	Shrub	Exotic	DF		3		3	6
	Mimosa sp.	*Mi*			DF		2		2	2
Hypericaceae	*Cratoxylum cochinchinense* (Lour.) Blume	*Cc*	Tree	Native	DF		14		14	56
Iridaceae	*Trimezia steyermarkii* R.C.Foster	*Ts*	Herb	Exotic	DF		1		1	1
Lamiaceae	*Premna foetida* Reinw. ex Blume	*Pf*	Shrub	Native	DF		5		5	12
Linderniaceae	*Legazpia polygonoides* (Benth.) T. Yamaz.	*Lp*	Shrub		DF		1		1	2
Malvaceae	*Hibiscus rosa-sinensis* L.	*Hrs*	Shrub	Native	DF		1		1	1
Melastomataceae	*Heterotis rotundifolia* (Sm.) Jacq.-Fél.	*Hr*	Climber	Exotic	DF		7		7	12

Appendix III. Continuation.

Family	Plant	Abbr.	Growth form**	Origin**	Catch Locations	# of Associated Species at				No. of associated specimens at BT vicinity
						BTNR	DF	PUB	Combined	
	Melastoma malabathricum L.	*Mma*	Shrub	Native	BTNR, DF, PUB	2	14	11	16	114
Muntingiaceae	*Muntingia calabura* L.	*Mc*	Tree	Exotic	BTNR, DF	13	2		13	29
Myrtaceae	*Eugenia* sp.§	*Eu*			BTNR	1			1	1
	Syzygium zeylanicum (L.) DC.	*Sz*	Shrub	Native	DF		6		6	6
Ochnaceae	Sp. indet.	*Oc*			BTNR	2			2	5
Orchidaceae	*Grammatophyllum speciosum* Blume	*Gs*	Epiphyte	Native	BTNR, DF	14	15		22	88
	Spathoglottis plicata Blume	*Sp*	Herb	Native	BTNR	1			1	1
Phyllanthaceae	*Baccaurea* sp.	*Bac*	Tree		BTNR	1‡			1‡	1
Poaceae	*Paspalum conjugatum* P.J.Bergius	*Pc*	Herb	Exotic	DF		1		1	2
Polygonaceae	*Antigonon leptopus* Hook. & Arn.	*Al*	Climber	Exotic	DF		1		1	6
Pontederiaceae	*Monochoria* sp.	*Mo*	Herb	Uncertain	PUB			6	6	6
Rubiaceae	*Mussaenda philippica* A.Rich.	*Mph*	Shrub	Exotic	DF		1		1	1
	Ophiorrhiza sp.	*Os*	Herb	Native	BTNR	1				1
	Spermacoce alata Aubl.	*Sa*	Herb	Exotic	DF		1		1	1

Appendix III. Continuation.

Family	Plant	Abbr.	Growth form**	Origin**	Catch Locations	# of Associated Species at				No. of associated specimens at BT vicinity
						BTNR	DF	PUB	Combined	
Verbenaceae	*Lantana camara* L.	*Lc*	Shrub	Exotic	DF		1		1	2
Vitaceae	*Leea indica* (Burm.f.) Merr.	*Li*	Tree	Native	DF		6		6	28
	Leea rubra Blume ex. Spreng.	*Lr*	Shrub	Native	BTNR, DF	1	3		4	4

*Includes *Apis* (*Megapis*) *dorsata dorsata* record from UBTR
†Counts *Hylaeus* (*Nesoprosopis*) sp. as a species
‡Only observed in association with *Tetragonula* sp.
§An old name that probably refers to *Syzygium* sp. This floral association was recorded by D. H. Murphy in 1974.
** Information from *A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated species* (Chong, Tan, & Corlett, 2009)