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OBSERVATIONS OF ANTS AND APHIDS IN THE RATTAN SPECIES *KORTHALSIA ECHINOMETRA* BECC. AND *KORTHALSIA ROSTRATA* BLUME

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ABSTRACT. — While ants have been commonly associated with rattans, there is no known documentation of this ant–plant interaction on a local context despite the presence of several rattan species in Singapore. With Singapore experiencing rapid urbanisation and inevitable deforestation, and that most of the rattan species are now endangered and the reality of co-extinctions a high possibility, documentation of rattans and related insects is urgently required. In this paper we observed the interactions between ants and the two rattan species, *Korthalsia echinometra* and *Korthalsia rostrata* (subfamily Calamoideae, Tribe Calameae, Korthalsiinae) by documenting the ants and other insects that resided within the rattan ocreae. These observations were conducted at Bukit Timah Nature Reserve, MacRitchie Reservoir, and Nee Soon Swamp Forest in Singapore. We identified the ant species that was associated with *K. echinometra* to be *Iridomyrmex* sp. (n = 5), while those associated with *K. rostrata* were *Dolichoderus* sp. (n = 4) and *Philidris* sp. (n = 1). This suggests the possibility of a genus-specific relationship between *K. echinometra* and the ant species *Iridomyrmex* sp., and a non-specific relationship with ants for *K. rostrata* within Singapore. Our observations also suggest the possibility of an ant-hemipteran association between *Iridomyrmex* sp. and the aphid *Cerataphis orchidearum aptera* that was found in the ocrea of *K. echinometra* along with a larval brood of *Iridomyrmex* sp. We suggest that more research is warranted before any postulations can be accurately drawn.

KEY WORDS. — rattan, Calamoideae, *Korthalsia*, myrmecophytic, ants, aphids

INTRODUCTION

Many rattan species of the genus *Korthalsia* are known to be myrmecophytic, i.e., living in a mutalistic association with a colony of ants (Dransfield, 1981); other genera of myrmecophytic rattans recorded include *Calamus* and *Daemonorops* (Moog et al., 2003). *Korthalsia* is a genus of climbing palms found mostly in Southeast Asia, but is also known to have a distribution that ranges from Indochina to New Guinea (Dransfield, 2001). Six *Korthalsia* species are currently known in Singapore and all are either critically endangered or locally extinct according to Chong et al. (2009): *K. echinometra* Becc. (Critically Endangered), *K. flagellaris* Miq. (Critically Endangered), *K. laciniosa* (Griff.) Mart. (Presumed Nationally Extinct), *K. rigida* Blume (Critically Endangered), *K. rostrata* Blume (Endangered), and *K. scortechinii* Becc. (Presumed Nationally Extinct). However, nothing is known about the mutualistic ants and other insects that associate with rattans in Singapore. With Singapore undergoing rapid urbanisation and co-extinctions predicted from host species listed as endangered (Koh et al., 2004), this paper primarily looks at the ant species associated with the rattans *Korthalsia echinometra* and *K. rostrata* in Singapore.

SINGAPORE RATTANS

Commonly known as rotan semut, *K. echinometra* is a clustering high-climbing rattan with a stem length of up to 40 m. A feature of particular interest on this rattan is the presence of the ocrea, an extension of the leaf sheath beyond the petiole insertion. The ocrea in *K. echinometra* is an inflated tubular sheath up to 10 cm long with spines up to 6 cm long (Dransfield, 1997), forming a chamber which ants have been found to inhabit. Studies of *K. echinometra* conducted in Peninsular and East Malaysia (Sarawak, Sabah, Perak, and Selangor) were discovered to house the ants *Camponotus contractus* (Bequaert & Wheeler, 1922). In addition, aphids are observed to be husbanded by these ants for the honeydew that they produce (Dransfield, 1981); however little is known about the relationship between these two species. Though *K. echinometra* has been recorded from several secondary forests in Singapore, such as Bukit Timah Nature Reserve and Choa

Table 1. Rattan species, ant genera and presence of aphids found in various forests around Singapore, as reported in this paper. Location: MR = MacRitchie Reservoir; NSSF = Nee Soon Swamp Forest; BTNR = Bukit Timah Nature Reserve. Not observed = presence of aphids was not ascertained.

Individual	Rattan species	Location	GPS coordinates	Ant genus	Average ant size/mm	Presence of aphids
1	*K. echinometra*	MR	01°21.305'N, 103°48.459'E	*Iridomyrmex* sp.	5	Not observed
2	*K. echinometra*	MR	01°21.305'N, 103°48.459'E	*Iridomyrmex* sp.	5	Not observed
3	*K. echinometra*	MR	01°21.308'N, 103°48.476'E	*Iridomyrmex* sp.	5	Yes
4	*K. echinometra*	MR	01°21.317'N, 103°48.471'E	*Iridomyrmex* sp.	5	Not observed
5	*K. echinometra*	MR	01°21.336'N, 103°48.484'E	*Iridomyrmex* sp.	5	Not observed
6	*K. echinometra*	NSSF	01°23.921'N, 103°48.438'E	*Iridomyrmex* sp.	5	Yes
7	*K. echinometra*	BTNR	01°21.467'N, 103°46.392'E	*Iridomyrmex* sp.	5	Yes
1	*K. rostrata*	BTNR	Not recorded	*Dolichoderus* sp.	3	Not observed
2	*K. rostrata*	BTNR	Not recorded	*Philidris* sp.	3	Not observed
3	*K. rostrata*	BTNR	01°20.980'N, 103°46.697'E	*Dolichoderus* sp.	3	Not observed
4	*K. rostrata*	BTNR	01°20.980'N, 103°46.697'E	*Dolichoderus* sp.	3	Not observed

Chu Kang (Keng, 1998), records of *K. echinometra* and its associations with ants in Singapore are absent.

Another rattan species, *K. rostrata*, is known to reach a height of 20 m with ocreae up to a length of 3 cm, shorter than those of *K. echinometra*. The spines are scattered and relatively shorter than those of *K. echinometra*, each spine growing to a length of 3 mm (Dransfield, 1997). The ant *C. contractus* has also been found in *K.* rostrata. (Moog et al., 2003).

MATERIAL AND METHODS

The contents of each ocrea were carefully collected from individuals of *K. echinometra*. As ants were observed crawling along the lengths of the rattan stems when the ocreae were disturbed, we first collected the ants that were observed to scurry along the stem using a brush and forceps. Each individual rattan ocreae was then collected separately from the stem of *K. echinometra* along with the ants found in it. All individual ants were identified using the key provided in Fisher (2010). We also rapidly isolated four adjacent ocreae (i.e., with the stem intact) of one individual *K. echinometra* (individual 3) and isolated these in ziploc bags and froze the material in –80°C before further observations ex situ; the ants and the contents of each ocrea were carefully counted with minimal ants escaping. These were numbered from 1 (bottom) to 4 (top), with the topmost ocrea directly beneath the shoot apex (approximately 3 m above the ground).

RESULTS

Korthalsia echinometra was found at three locations in Singapore: MacRitchie Reservoir, Nee Soon Swamp Forest, and Bukit Timah Nature Reserve (Fig. 1). Especially noteworthy in MacRitchie Reservoir is the abundance of *K. echinometra* along a stream (01°21.305'N, 103°48.459'E). All the ants collected from *K. echinometra* in MacRitchie Reservoir (n = 5), Nee Soon Swamp Forest (n = 1), and Bukit Timah Nature Reserve (n = 1) were identified to be *Iridomyrmex* sp. We identified all individual ants, collected from different *K. echinometra* individuals, to the genus level and ascertained these to be of the same species.

We found larval broods and ant pupae within the ocrea samples collected (Table 2; Figs. 2, 3), with mature and juvenile aphids observed along the stems (Fig. 4). These aphids were identified to be *Cerataphis orchidearum aptera* (Fig. 4) using the descriptors and pictures provided by Sorensen (2009).

All *K. rostrata* sampled (n = 4) were from Bukit Timah Nature Reserve. A group of *K. rostrata* (n = 2) was found along the Jungle Falls Path but very few ants were observed. Two younger *K. rostrata* were found along the Cave Path.

The ants identified in *K. rostrata* differed from those found in *K. echinometra.* Of the four *K. rostrata* rattans sampled, three housed ants of the genus *Dolichoderus*, while one contained ants of the genus *Philidris* (Fig. 5). All individuals from

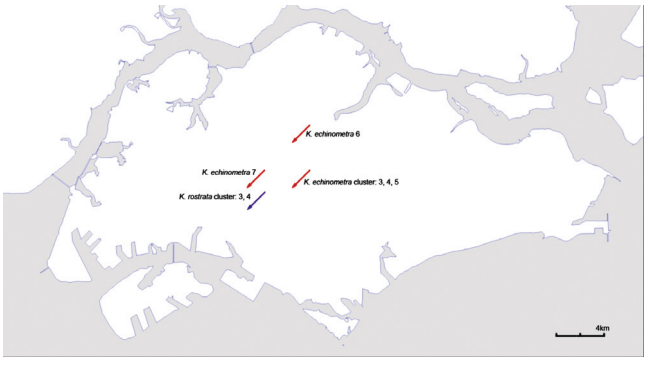

Fig. 1. Relative locations of study sites. *K. echinometra* was studied at the Bukit Timah Nature Reserve for cluster 7; MacRitchie Reservoir for clusters 3, 4, and 5; the Nee Soon Swamp Forest for cluster 6. *K. rostrata* was studied at the Bukit Timah Nature Reserve.

Table 2. Ant stages and numbers of *Iridomyrmex* sp. found in each of the four ocreae studied in one rattan stem of *K. echinometra* individual 3 in MacRitchie Reservoir (also see Fig. 2).

Ocrea number	Quantity				
	Workers	Winged drones	Winged virgin queens	Pupae	Larvae
1	20	8	0	32	3
2	15	1	4	1	16
3	60	1	0	9	>200
4	18	0	0	2	4

both genera were identified to the genus level. These ants were found to be much smaller in size than the *Iridomyrmex* found in *K. rostrata*. The ocreae of *K. rostrata* are also much smaller than those of *K. echinometra* (see Fig. 6).

DISCUSSION

This is the first preliminary investigation of a relationship between ants (i.e., *Iridomyrmex* sp., *Philidris* sp., and

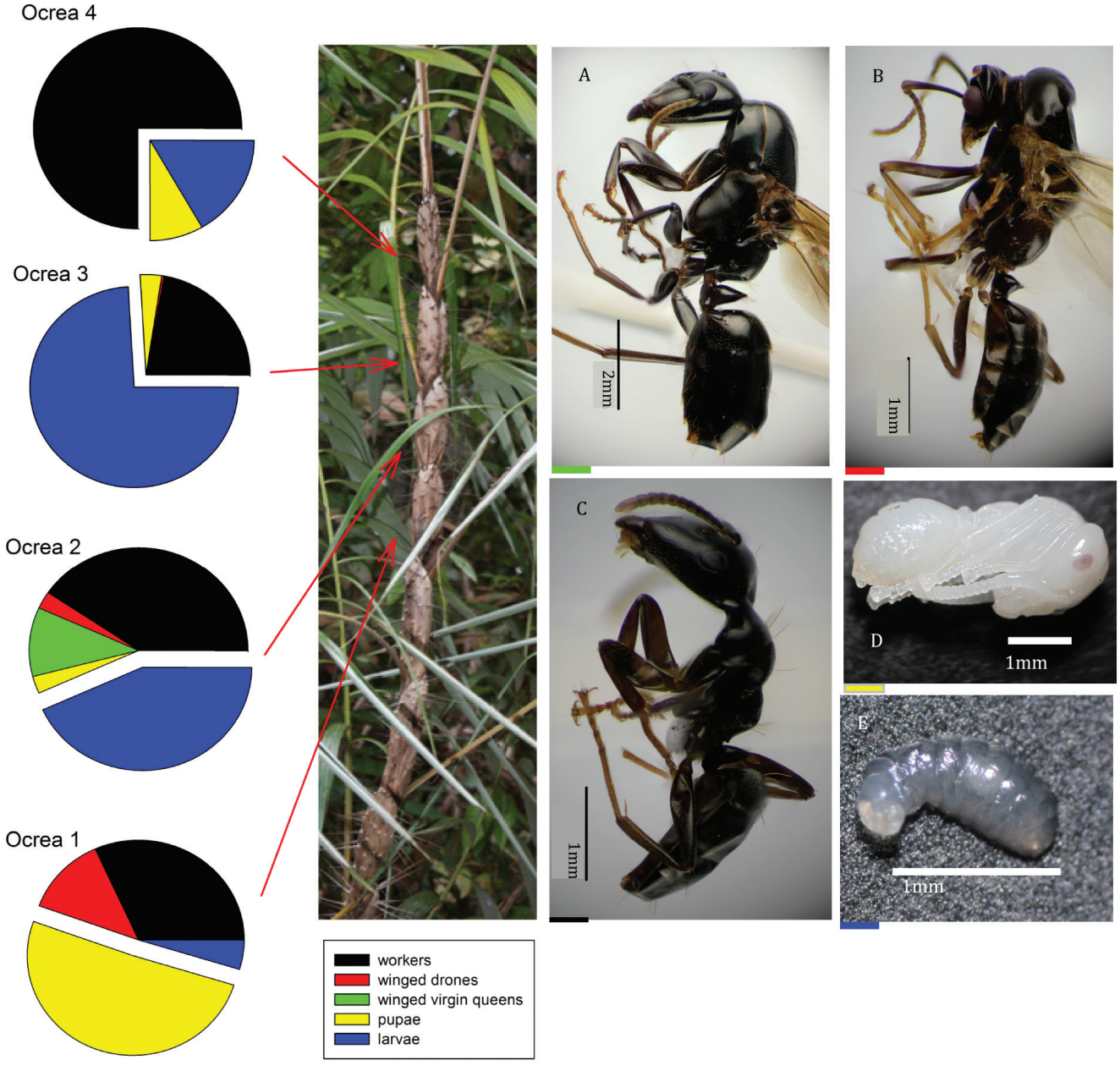

Fig. 2. Pie charts of *Iridomyrmex* sp. found in each of the four ocreae studied in one rattan stem of *K. echinometra* individual 3 in MacRitchie Reservoir (see also Table 1): (A) winged virgin queen; (B) winged drone; (C) worker. The workers have also been observed in *K. echinometra* from the Nee Soon Swamp Forest. (Photographs by: J. H. Tang). (D) Pupa; and (E) larva. (Photographs by: A. H. B. Loo).

Fig. 3. *Iridomyrmex* sp. ants attending to larvae broods in an ocrea of *K. echinometra* at the Nee Soon Swamp Forest.

Dolichoderus sp.) and their rattan host plants (i.e., *Korthalsia echinometra* and *K. rostrata*) in Singapore. Though our sampling size is low (n = 7), the ever-presence of these ants, and these ants only, is unlikely to be incidental. All seven individuals of *K. echinometra* visited in this study were found to be inhabited only by *Iridomyrmex* sp., indicating the possible existence of an ant-plant symbiotic relationship. The observation of larval broods within the inflated ocreae of at least one *K. echinometra* specimen (see Fig. 3) suggests that *Iridomyrmex* sp. uses some of these ocreae (ocrea 1 and 2; Table 2; Figs. 2, 3) as a brooding site.

It is interesting to note that, of the four ocreae from *K. echinometra* individual 3 (see Tables 1, 2), only ocrea 2 contained winged virgin queens while most of the drones appeared to be clustered in ocrea 1 (see Fig. 2). Though we

Fig. 4. (A) *Cerataphis orchidearum aptera* aphids found within the ocrea of *K. echinometra* individual 5 from the Nee Soon Swamp Forest. These aphids were also found on *K. echinometra* individuals from the MacRitchie Reservoir (individual 3) and the Bukit Timah Nature Reserve (individual 7; see Table 1). Close-ups of the same aphids found: (B) in the ocrea of *K. echinometra* (Nee Soon Swamp Forest); (C) along the central stem of the *K. echinometra* individual 3 (MacRitchie Reservoir); and (D) yellow juvenile aphids found along the same stem. (E) An *Iridomyrmex* sp. observed to be grasping an adult aphid from *K. echinometra* individual 3. Photographs C, D, and E taken after ocreae containing ants and aphids were frozen. (Photographs by: A. H. B. Loo).

are unsure of the reason, the close proximity of queens to some of these developing larvae can be attributed to chemical communication (in this case, pheromones) between the queen and the developing larva. Queen pheromones have been known to influence larva development, though the majority of the larvae are housed in ocrea 3 (i.e., in the absence of queens) in this study. However, verifying the possibility of the ocreae as specialised chambers for different purposes poses a physical challenge since these ant-inhabited *K. echinometra* are known to reach a height of up to 40 m. Nonetheless, more samples are required to investigate the above postulations.

Of the four *K. rostrata* individuals studied, three are inhabited by *Dolichoderus* sp., while one is inhabited by *Philidris* sp. (see Fig. 5). Although this suggests a possible relationship between the ants and their host plant *K. rostrata*, it is perhaps noteworthy that the possible symbiotic ant species associated with this rattan species is not specific to just one species (as compared to just one ant species in *K. echinometra*). We also noted that both the ocreae sizes and ants associated with *K. echinometra* are larger than those of *K. rostrata*, suggesting that ocrea size correlates with the size of the ants housed inside. More samples are required to verify these postulations.

Korthalsia echinometra in Peninsular Malaysia has been described to be associated with *Camponotus contractus* (Moog et al., 2003). Notably, a search of existing literature showed multiple documentations of myrmecophytic relationships between *Korthalsia* and *Camponotus* and related subgenera (Wheeler, 1936; Mattes, 1998); conversely, associations between *Iridomyrmex* sp. and *Korthalsia* are not documented. Similarly, there is no known documentation of the ant genus in association with *K. rostrata*, even though there have been many scientific documentations of other ants associated with this palm. Underlying reasons for this disparity in ant species hosted by populations of *K. echinometra* and *K. rostrata* in Peninsular Malaysia and Singapore may be elucidated with further research.

Based on the observations of these aphids on individuals of *K. echinometra* that are inhabited by *Iridomyrmex* ants, we propose that there is a possibility of ant-hemipteran associations between *Iridomyrmex* sp. and the aphid *Cerataphis orchidearum aptera*. The incidence of hemipterans in ant-plant relationships has been described in various independent studies (Dransfield, 1981; Delabie, 2001). It is possible that, similar to the role of hemipterans as documented in such hemipteran-myrmecophyte studies, a trophobiotic relationship may exist between *Cerataphis orchidearum aptera* and *Iridomyrmex* sp. with *Cerataphis orchidearum aptera* functioning as the trophobiont. The precise nature of the *Cerataphis orchidearum aptera* and *Iridomyrmex* sp. relationship, however, remains an interesting topic for further study.

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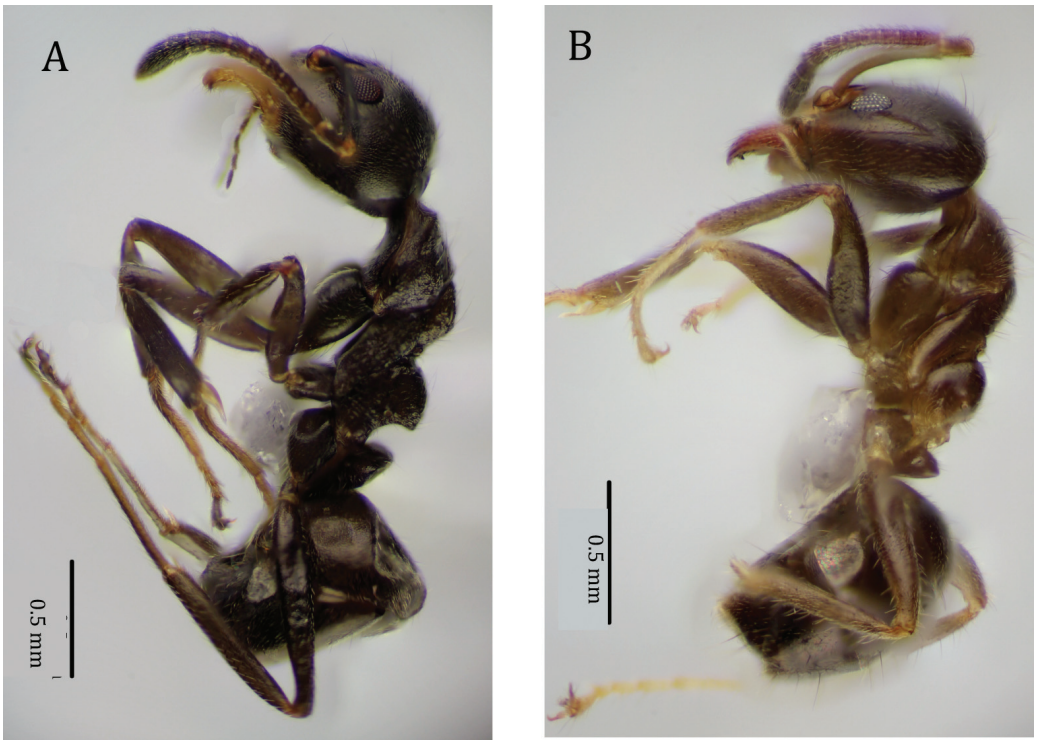

Fig. 5. Worker ants obtained from *K. rostrata*, Bukit Timah Nature Reserve: (A) *Dolichoderus* sp.; and (B) *Philidris* sp.(Photographs by: J. H. Tang).

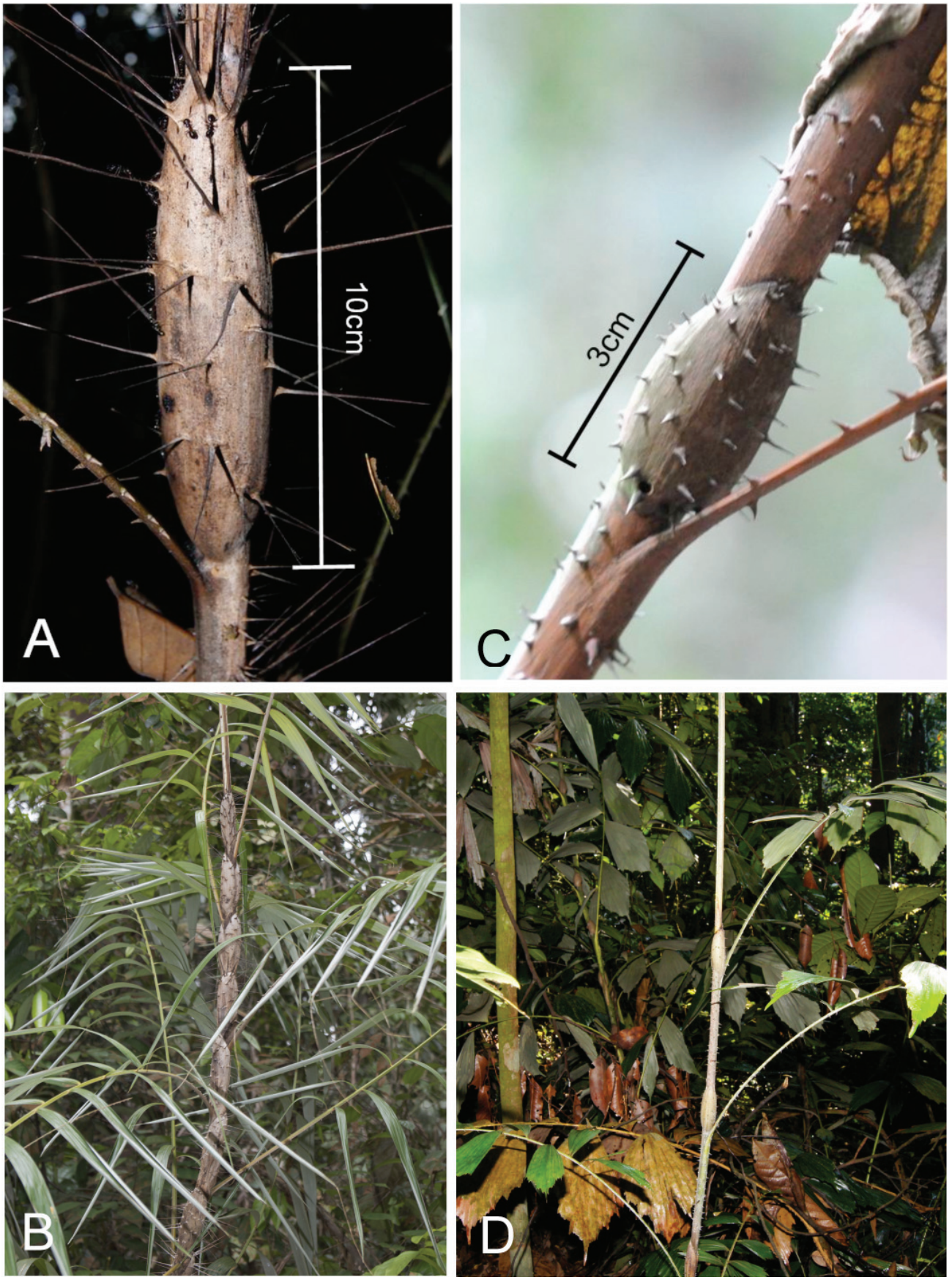

Fig. 6. Individual (A) and multiple (B) ocreae of *K. echinometra* (each approx. 10 cm) in a vertical series along the stem. (Photographs by: A. H. B. Loo). Individual (C) and multiple (D) ocreae of *K. rostrata* (approx. 3 cm). (Photographs by: J. Y. Q. Loh). Note that ocreae of *K. rostrata* are relatively smaller and are situated further apart on the stem.

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