

## **Stick and Leaf Insect (Phasmida: Insecta) Biodiversity in the Nature Reserves of Singapore**

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### **Abstract**

Forty-one species of phasmids found in Singapore extant as well as extinct are listed and aspects of their conservation discussed. Eleven species are still relatively common and are widely distributed especially within the Central Catchment Nature Reserve. Eleven species exist in only very isolated pockets within the Central Catchment Nature Reserve. One species has been found only in the Punggol area. A further ten species are very rare and in almost a decade of studying these insects only one or two specimens have been found in Singapore. An additional eight species have not been seen or recorded for at least 30 years and are best described as extinct in Singapore.

### **Introduction**

Stick and Leaf Insects (order Phasmida) are common but little known insects of tropical and subtropical forests. Indeed, South-East Asia has a large number of species. Most if not all species have an uncanny ability to "disappear" into their surroundings by mimicking sticks and leaves thus earning them their names Phasmida and Spectres, both meaning 'ghost-like'. Phasmids are food plant specific and all species refuse to eat unless the plants offered are acceptable to that particular species. Most species will take only a few species of naturally occurring plants. Similar species may eat similar plants while species from different genera eat totally different plants. In the wild, phasmids are usually located on or near their food plants. This may, therefore, make phasmids a good indicator of forest health. A wide variety of phasmids is an indicator of the presence of a wide variety of plant species.

The order Phasmida is divided into three suborders and six families. The suborder Timematodea consists of one family of small insects with three segmented tarsi and is found only in North and Central America. All other phasmids are therefore divided into one of the other two suborders. The suborder Areolatae consists of insects where the middle and hind tibiae have a sunken triangular region or areola on the underside of the apices. The suborder Anareolatae is made up of insects without this sunken areola. The suborder Areolatae consists of the families Bacillidae,

Pseudophasmatidae and the Phyllidae. The suborder Anareolatae consists of the families Heteronemiidae and the Phasmatidae.

### History and Methods

Prior to the present survey, reports of phasmids from Singapore were scanty and limited to occasional and infrequent accounts (Westwood, 1859; Brunner & Redtenbacher, 1906–08; Ridley, 1894). During the course of this survey, several reports were published including new records and new species (Seow-Choen, 1993a-e, 1995a-d, 1996a-b, 1997a-b; Seow-Choen & Brock, 1996; Seow-Choen *et al.*, 1994a-d; Seow-Choen *et al.*, 1994e; Tay & Seow-Choen, 1996, Seow-Choen & Seow-En, 1994; Seow-Choen *et al.*, 1996 & Brock, 1995)

Details of records from Singapore were based on field observations by the author, friends and colleagues as well as extensive searches of the literature and examination of museum collections. The author started working on Singapore phasmids in 1990. Full details on synonyms and museum records may be found in Brock (1999). Field work consisted mainly of meticulous searching after dark of bushes along paths within the Nature Reserves. These insects are nocturnal and daytime searching is futile. Night-time searching with a powerful hand torch gives the best results. Searches are normally made from ground to a level of about 3 m from ground level. Searches higher up were not made as capture of insects at such levels would have been impossible. It is possible that many insects that are considered rare are present at the top of the canopy but these are impossible to assess at the present time by the current methods employed by the author. Torch lighting obviously allows only for capture of individual insects one at a time and is time consuming and labour intensive.

Phasmid ecology, including food plants and aspects of their life cycle, was also investigated as the author is successful in rearing many of the local species.

### Results

The Phasmida classification of Bradley and Galil (1977) lists three suborders, six families and 17 subfamilies. In our survey of Singapore forests, we have found representatives from two suborders, five families and six subfamilies (Table 1). Altogether 41 species have been found or been recorded in the past from Singapore. In the course of our research into Singapore's Phasmids, 18 new records for Singapore were established, numerous synonyms cleared up and three undescribed species found. Two

species (*Abrosoma xiuyuae* and *Asceles singapura*) have since been described. One species is still undescribed and could possibly represent a new genus.

**Table 1. Checklist of Phasmids in Singapore and their status.**

(C=common, I= isolated pockets, R= rare, E=extinct)

No.	Species	Status
Suborder <b>AREOLATAE</b>		
Family <b>BACILLIDAE</b> — Subfamily <b>HETEROPTERYGINAE</b>		
1.	<i>Datames oileus</i> (Westwood) 1859	C
2.	<i>Datames mouhotii</i> (Bates) 1865	I
3.	<i>Heteropteryx dilatata</i> (Parkinson) 1798	E
4.	<i>Planispectrum bengalensis</i> (Redtenbacher) 1906	R
Family <b>PSEUDOPHASMATIDAE</b> — Subfamily <b>ASCHIPHASMATINAE</b>		
5.	<i>Abrosoma xiuyuae</i> Brock & Seow-Choen 1999	C
6.	<i>Presbistus peleus</i> (Gray) 1835	C
7.	<i>Presbistus flavicornis</i> (de Haan 1842)	E
Family <b>PHYLLIDAE</b>		
8.	<i>Phyllium bioculatum</i> Gray 1832	R
9.	<i>Phyllium siccifolium</i> (Linnaeus) 1758	R
Suborder <b>ANAREOLATAE</b>		
Family <b>HETERONEMIIDAE</b> — Subfamily <b>NECROSCIINAE</b>		
10.	<i>Acacus sarawacus</i> (Westwood) 1859	I
11.	<i>Asceles malacca</i> (Saussure) 1868	C
12.	<i>Asceles larunda</i> (Westwood) 1859	C
13.	<i>Asceles singapura</i> Seow-Choen & Brock 1999	I
14.	<i>Calvisia sangarius</i> (Westwood) 1859	E
15.	<i>Diacanthoidea diacanthos</i> (de Haan) 1842	R
16.	<i>Diesbachia tamyris</i> (westwood) 1859	I
17.	<i>Gargantuoidea phaetusa</i> (Westwood) 1859	E
18.	<i>Gargantuoidea triumphalis</i> Redtenbacher 1908	R
19.	<i>Lopaphus brachypterus</i> (de Haan) 1842	R
20.	<i>Lopaphus iolas</i> (Westwood) 1859	I
21.	<i>Marmessoidea rosea</i> (Fabricius) 1793	E
22.	<i>Necroscia punctata</i> (Gray) 1835	I
23.	<i>Necroscia affinis</i> (Gray) 1835	C
24.	<i>Necroscia roseipennis</i> Audinet-Serville 1838	C
25.	<i>Necroscia westwoodi</i> Kirby 1904	I
26.	<i>Necroscia inflata</i> (Redtenbacher) 1908	C
27.	<i>Phaenopharos struthioneus</i> (Westwood) 1859	E
28.	<i>Sipylloidea sipylus</i> (Westwood) 1859	I
29.	<i>Sipylloidea meneptolemus</i> (Westwood) 1859	R

No.	Species	Status
30.	<i>Sosibia esacus</i> (Westwood) 1859	I
31.	<i>Sosibia solida</i> Redtenbacher 1908	I
32.	<i>Baculofractum insignis</i> (Brunner von Wattenwyl) 1907	R
33.	Undescribed species	R
Family <b>HETERONEMIIDAE</b> — Subfamily <b>LONCHODINAE</b>		
34.	<i>Carausius nodosus</i> (de Haan) 1842	I
35.	<i>Lonchodes brevipes</i> Gray 1835	C
36.	<i>Lonchodes geniculatus</i> Gray 1835	C
37.	<i>Prisomera malaya</i> (Stål) 1875	C
Family <b>HETERONEMIIDAE</b> — Subfamily <b>HETERONEMIINAE</b>		
38.	<i>Bactricia ridleyi</i> Kirby 1904	E
Family <b>PHASMATIDAE</b> — Subfamily <b>PHASMATINAE</b>		
39.	<i>Baculum nematodes</i> (de Haan) 1842	I
40.	<i>Eurycnema versirubra</i> (Audinet-Serville) 1838	E
41.	<i>Phobaeticus serratipes</i> (Gray) 1835	R

All the living phasmids located by the author were found in the Central Catchment Nature Reserve and its surrounding fringe areas such as the forest within the Singapore Island Country Club locality. The full list of phasmid food plants is not discussed here as it has been published (Tay & Seow-Choen, 1996).

Eleven species are still relatively common and are widely distributed especially in the Central Nature Reserve Areas. These are *Datames oileus* (Plate 1a), *Presbistus peleus*, *Abrosoma xiuyuae*, *Asceles malaccaae*, *A. larunda* (Plate 1b), *Necroscia affinis* (Plate 1c–e), *N. roseipennis* (Plate 2a–b), *N. inflata*, *Lonchodes brevipes* (Plate 2c), *L. geniculatus* (Plate 2d) and *Prisomera malaya*. All these species are common because their food plants are very common within the Nature Reserves.

*Datames oileus* is a small ground or low-lying species that feeds mainly on *Curculigo* spp. (Hydrophyllaceae), palms, and various species of aroids. This species is therefore widely distributed in the Nature Reserve and is especially common in Bukit Timah Nature Reserve and the trail leading from Singapore Island Country Club to MacRitchie Reservoir (S-M trail). *Prebistus peleus* feeds only on *Leea indica* (Leeaceae), a very common shrub within the Nature Reserves and its fringes, *A. xiuyuae* is widespread and its feeding marks are found on every *Pternandra echinata* (Melastomataceae) that I have encountered. Strangely this phasmid was undescribed before this survey began. *Asceles malaccaae* and *A. larunda* are very common flying insects that feed mainly on the various *Macaranga* species. These are common along the S-M trail as well as in Upper Pierce

Reservoir Park. *Necroschia affinis* and *N. roseipennis* are also commonly seen. These very pretty insects are beautifully coloured. *Necroschia affinis* occurs in various shades of green, yellow, brown and even red, all with yellow spots. *Necroschia roseipennis* possesses bright rose coloured wings. They feed on *Cinnamomum iners* (Lauraceae) and *N. roseipennis* may also be found on *Gomphandra quadrifida* (Icacinaceae). *Necroschia roseipennis* and *N. affinis* are common at the S-M trail, and may also be found along Rifle Range Road trail. Unfortunately these insects have not spread to roadside cinammon trees as the dryness and heat make the sides of highways and roads very unsuitable for these insects for which high humidity is essential for their survival. *Necroschia inflata* is another very common insect found on the various *Uncaria* species and on *Mussaenda glabra* in the Nature Reserves. It is very common at Rifle Range Road, Upper Pierce Road and along the S-M trail. *Lonchodes brevipes*, *L. geniculatus* and *P. malaya* are also widespread species within the Nature Reserves. Of these three species, *L. geniculatus* is perhaps the most common, especially along the S-M Trail. It feeds on a wide variety of plants, including various *Uncaria* species, *Ilex macrophylla* (Aquifoliaceae) and *Psychotria rostrata* (Rubiaceae). *Prisomera malaya* feeds on various low-growing ferns and it is also commonly encountered along the S-M trail and on Bukit Timah Hill. *Lonchodes brevipes* feeds on these plants as well as *Grewia acuminata* (Tiliaceae) and introduced species such as *Acacia auriculiformis* (Leguminosae) and *Hibiscus rosa-sinensis* (Malvaceae). It is widespread but not as commonly seen as the other two species just mentioned. *Lonchodes brevipes* was found on Pulau Ubin as well as in Labrador Park.

Unfortunately, 11 species exist in only very isolated pockets within the Central Catchment Nature Reserve. These are *Datames mouhotii*, *Acacus sarawacus* (Plate 3a–b), *Asceles singapura* (Plate 3c–d), *Diesbachia tamyris*, *Lopaphus iolas* (Plate 3e), *Necroschia punctata* (Plate 4a–b), *N. westwoodi*, *Sosibia esacus*, *S. solida* (Plate 4c), *Carausius nodosus* (Plate 4d) and *Baculum nematodes* (Plate 4e). Although *D. mouhotii* feeds on the same plants as *D. oileus*, it is found only in a small patch of forest in Upper Seletar Reservoir Park. The reason it has not spread like *D. oileus* is not immediately obvious. Perhaps it is because the species is less prolific or hardy as it is probably a parthenogenetic species. No male has ever been found. *Acacus sarawacus* exists only in one spot along the S-M trail. It is a very difficult species to keep alive in captivity and requires high humidity at all times. It feeds on *Lithocarpus ewyckii* in the wild and *Psidium guajava* when in captivity. *Asceles singapura* also feeds on *Macaranga*, especially *Macaranga gigantea*, but its range seems to be confined to Upper Pierce and the S-M trail. *Diesbachia tamyris* and *C. nodosus* are found in the same general area in MacRitchie Reservoir on the trail to the Shinto Shrine.

*Carausius nodosus* is always found on *Rourea mimosoides* (Connaraceae) along this trail. The wild food plant of *D. tamyris* is not known. *Lopaphus iolas* is only found near the freshwater swamp forest area within the Nature Reserves, although it feeds on a wide variety of plants. *Necroscia punctata* and *N. westwoodi* may be found on Bukit Timah Hill and occasionally along the S-M trail. The former feeds on *Cinnamomum iners* (Lauraceae) and the latter on *Psychotria malayana* (Rubiaceae). Again the reason for the isolation of *N. punctata* is not obvious as *Cinnamomum iners* is a common tree. *Necroscia punctata* may also be found along the Upper Pierce Road. *Sosibia esacus* and *S. solida* are both limited to areas where their food plant grows. *Sosibia esacus* may be found along Upper Pierce Road, and Bukit Timah Hill whereas *S. solida* is found along the S-M trail. *Sosibia esacus* feeds on *Salacia macrophylla* and *Ixonanthes reticulata*. The food plant of *S. solida* is still unidentified. *Baculofractum nematodes* is a very long species in the female reaching up to 190 mm. It was found on *Grewia acuminata* (Tiliaceae) along Upper Pierce Road and near the freshwater swamp forest area.

*Sipylodea sipylus* has been found only in the Punggol area feeding on cultivated guava. It had not been encountered within the Nature Reserves.

A further ten species are very rare and in almost a decade of studying these insects, only one or two specimens have been found in Singapore. These are *Planispectrum bengalensis*, *Phyllium bioculatum*, *P. siccifolium* (Plate 5a), *Diacanthoidea diacanthos* (Plate 5b), *Gargantuoidea triumphalis*, *Lopaphus brachypterus* (Plate 5c-d), *Sipylodea meneptolemus*, *Baculofractum insignis* (Plate 6a), *Phobaeticus serratipes* and an undescribed species of Necrosciinae (Plate 6b). *Planispectrum bengalensis* is very tiny and is ground dwelling and this may explain its rarity. *Phyllium* species are very difficult to find as they are tree top dwellers. The winged phasmids; *D. diacanthos*, *G. triumphalis*, *L. brachypterus*, *S. meneptolemus* and *B. insignis* are very specialised feeders and this may explain their rarity. The female *B. insignis* is not winged but is a very fussy feeder nonetheless. *Phobaeticus serratipes* is a very common insect in West Malaysia and feeds on a wide variety of plants including *Mangifera indica*, *Macaranga* spp., *Uncaria* spp. and many others, which explains its frequency. In Singapore, however, it is very rare in spite of the presence of its food plants. Perhaps its long length has to do with its rarity as it may make the insect more readily detectable by both human and animal predators. The longest female on record measured 555 mm from tip of front claw to tip of the hind claw. The undescribed species is currently being researched but its rarity may make work on this species very difficult.

An additional eight species have not been seen or recorded for at

least 30 years and are best described as extinct in Singapore. These are *Heteropteryx dilatata*, *Presbistus flavicornis*, *Calvisia sangarius* (Plate 6c), *Gargantuioidea phaetusa*, *Marmessoidea rosea*, *Phaenopharos sthruthioneus* (Plate 6d), *Bactricia ridleyi* and *Eurycnema versirubra*. *Heteropteryx dilatata* and *E. versirubra* are large impressive species and may have been destroyed by farmers clearing land in the early days. These insects were also kept in the past by Malays and Chinese as their droppings were used for a variety of ailments including diarrhoea and as an aphrodisiac. Perhaps they were overcollected for this purpose. The other insects are probably all very specialised feeders and occurred only in isolated pockets where their food plants were found. Entire populations may have been destroyed when the original forest was cleared. *Bactricia ridleyi* is known only from the holotypic specimen found by H.N. Ridley in the Singapore Botanic Gardens.

### Discussion

Singapore has only about 2675 ha of forest left which includes reservoir areas in the Central Catchment Nature Reserve as well as 164 ha of forest at Bukit Timah Nature Reserve (National Parks Board, *pers. comm.*). A well thought-out and planned conservation programme for these forested areas is of utmost importance, if Singapore's remaining flora and fauna are to survive.

Phasmids are phytophagous and indeed very particular about the species of leaves they eat. Many species of phasmids will only feed on a very few species of plants. Destruction of these plants will therefore result in the elimination of food plant dependent insect species. Many species, which have particularly specific food plant requirements, are therefore either extinct, at serious risk of extinction or occur only in very isolated pockets where these plants may be found. In primary rain forests, many hundreds of species of plants are found and an individual of a particular species may be widely separated from the next. Destruction of our natural forest trees is an important cause of the disappearance of some of our indigenous stick-insect species as when forests are cleared stick-insect food plants are lost. The resulting effect is that the stick-insect species dependent on these food plants are eliminated and are not to be found at the cleared sites anymore.

The continual encroachment of man into the fringes of forested areas also has had very negative effects on our insect populations. The building of houses near the Nature Reserves poses a very serious problem. Many of the flying insect species including phasmids are attracted to light and many are therefore eliminated in this manner. This threat is far more damaging

than collection by insect enthusiasts. Lights from street lamps and houses probably attract and result in the death of far more insects than all insect enthusiasts can collect in their combined life times.

Combined with the building of roads and houses adjacent to the forests is mankind's general dislike for insects and his rampant use of insecticides, pesticides and herbicides. Phasmids are very sensitive insects and will not tolerate any amount of insect poison with the result that indiscriminate spraying of pesticides had eliminated most of Singapore's phytophagous insects.

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Plate 1a.

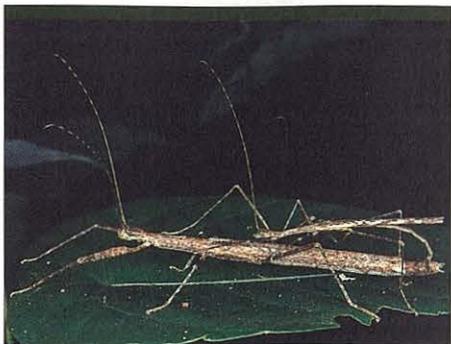


Plate 1b.



Plate 1c.

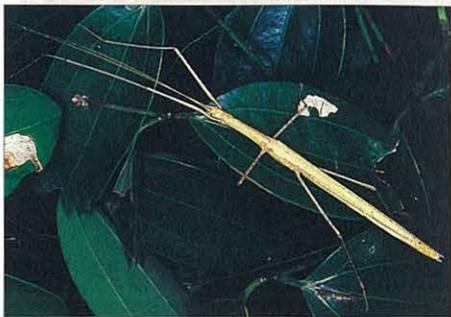


Plate 1d.



Plate 1e.

**Plate 1.** Some of the common and widely distributed species in the Nature Reserves. **a.** A mating pair of the common *Datames oileus*. These small insects feed on the Money plant (*Epipremnum aureum*, Araceae). **b.** A mating pair of the common *Asceles larunda*. All *Asceles* species are *Macaranga* feeders. **c.** A red specimen of *Necroschia affinis*. This species has several colour varieties. It may be seen along Upper Pierce Road feeding on wild cinnamon. **d.** A brown variety of *Necroschia affinis*. **e.** A mating pair of the green variety of *Necroschia affinis*.



Plate 2a.

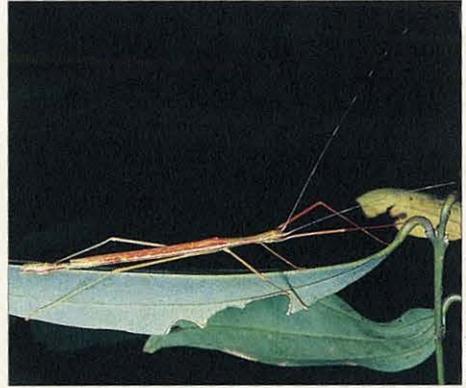


Plate 2b.



Plate 2c.



Plate 2d.

**Plate 2.** Some of the common and widely distributed species in the Nature Reserves. **a.** A green adult female *Necrosia roseipennis*. **b.** A brown adult male *Necrosia roseipennis*. **c.** A female *Lonchodes brevipes* resting among leaves. This common species is very easily reared in captivity as it feeds on a wide variety of garden-plants including guava, hibiscus, rose and bramble. **d.** A mating pair of *Lonchodes geniculatus*. It is common in all parts of the Nature Reserve but does not feed on any common garden-plants.



Plate 3a.



Plate 3b.

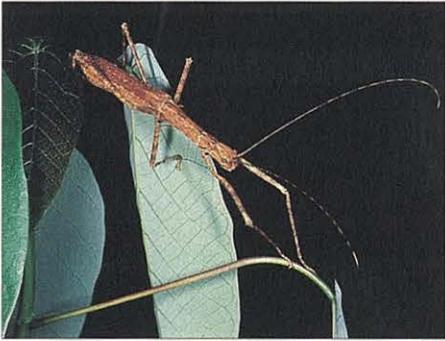


Plate 3c.

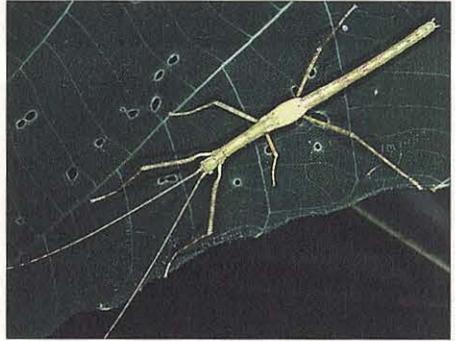


Plate 3d.



Plate 3e.

**Plate 3. Species found in only isolated pockets within the Central Catchment Nature Reserve.**

**a.** A male *Acacus sarawacus* shows the white knees typical of the sex. This species is found only in a very small patch of forest along the MacRitchie to the Singapore Island Country Club trail. **b.** A female *Acacus sarawacus* lies very still in a state of thanatosis after being disturbed in the hope of escaping detection. **c.** A female *Asceles singapura* on *Macaranga*. This species was described recently from specimens found in Singapore. It is found along isolated pockets of forest in Upper Pierce and along the MacRitchie-Island Club trail. **d.** A nymphal *Asceles singapura*. **e.** *Lopaphus iolas* is common all over Peninsular Malaysia but is found only near the fresh water swamp forest in Singapore. This is a female adult.



Plate 4a.



Plate 4b.



Plate 4c.

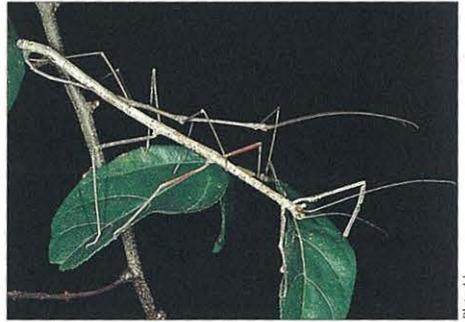


Plate 4d.



Plate 4e.

**Plate 4. Species found in only isolated pockets within the Central Catchment Nature Reserve.**

**a.** *Necroscia punctata* is a very colourful species that is occasionally encountered. This is a green variety. **b.** This is a red *Necroscia punctata*. **c.** Another view of an adult *Sosibia solida*. **d.** *Carausius nodosus* is found only in isolated pockets along the MacRitchie trail to the old Shinto Shrine. The female bears a pair of tufts on the head. Both sexes have bright red mid femurs. **e.** *Baculum nematodes* is found only along Upper Pierce Road and the fresh water swamp forest area.



Plate 5a.

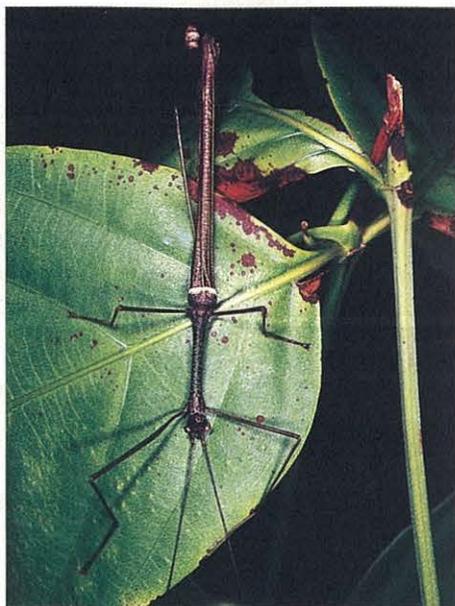


Plate 5b.



Plate 5c.



Plate 5d.

**Plate 5.** Some of the rare species encountered in the Nature Reserves. **a.** *Phyllium siccifolium* is another leaf insect that may be found in Singapore albeit very rarely. **b.** A male *Diacanthoidea diacanthos* is very rare. Only one specimen has ever been found in Singapore and that at Upper Pierce Road. **c.** *Lopaphus brachypterus* is a rare insect found only very occasionally. This is a male. **d.** A female *Lopaphus brachypterus* feeding on guava.



Plate 6a.



Plate 6b.



Plate 6c.



Plate 6d.

**Plate 6.** Some of the rare species encountered in the Nature Reserves (a–b). Two of the extinct species (c–d). **a.** *Baculofractum insignis* is very rare in Singapore and may be found only around the fresh water swamp forest. **b.** An unidentified Necrosiinae which may represent a new genus. **c.** *Calvisia sangarius*, now extinct in Singapore, is a very specialized feeder and as far as is known feeds only on a very pungent forest tree. **d.** *Phaenopharos struthioneus* is extinct in Singapore and has not been seen for many decades now.