

NEW RECORDS OF INSECTS ASSOCIATED WITH BORNEAN ENDEMIC DIPTEROCARP SEEDLINGS

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CHUNG AYC, MAYCOCK CR, KHOO E, HASTIE A, NILUS R, MAJAPUN R, KIMJUS K & CHEY VK. 2013. New records of insects associated with Bornean endemic dipterocarp seedlings. Insects defoliating Bornean endemic dipterocarp seedlings at the Sepilok nursery were investigated. A total of 12 insect species were documented as new records. Two defoliators were adult beetles while 10 were larvae of moths and butterflies. The most frequently encountered insect species was *Clethrogyna turbata* Butler (Lepidoptera: Lymantriidae), which occurred on four dipterocarp species. Due to its high abundance, the larva caused severe defoliation to *Shorea symingtonii*, *S. waltonii* and *S. kudatensis* seedlings. Defoliation caused by other insects was minor. Some notes on the new records are provided in this paper. The importance and management of insects associated with the dipterocarp seedlings are also discussed.

Keywords: Defoliators, Dipterocarpaceae, Sabah, Lepidoptera, Coleoptera

CHUNG AYC, MAYCOCK CR, KHOO E, HASTIE A, NILUS R, MAJAPUN R, KIMJUS K & CHEY VK. 2013. Rekod baharu serangga yang berkait dengan anak benih dipterokarpa yang endemik di Borneo. Serangga yang meranggas daun anak benih dipterokarpa yang endemik di Borneo dikaji di tapak semaian Sepilok. Sebanyak 12 spesies serangga didokumen sebagai rekod baharu. Dua daripadanya ialah kumbang dewasa dan 10 ialah larva kupu-kupu dan rama-rama. Spesies serangga yang paling kerap dijumpai ialah *Clethrogyna turbata* Butler (Lepidoptera: Lymantriidae) yang ditemui pada empat spesies dipterokarpa. Kepadatannya yang tinggi mengakibatkan peranggasan yang teruk pada anak-anak benih *Shorea symingtonii*, *S. waltonii* dan *S. kudatensis*. Peranggasan oleh serangga yang lain tidak ketara. Nota tentang rekod baharu diberi dan kepentingan serta pengurusan serangga yang berkait dengan anak benih dipterokarpa turut dibincangkan.

INTRODUCTION

Dipterocarps are the most important commercial timber trees in tropical forests (Zul Mukhshar 2003). The Dipterocarpaceae dominates the international tropical timber market and thus plays an important role in the economy of many of the South-East Asian countries (Krishnapillay & Razak 2003). Borneo has a total of 267 dipterocarp species, which accounts for more than half of the world's dipterocarps. With no less than 155 species endemic to this island, Borneo is the centre of the world's diversity for Dipterocarpaceae (Ashton 1982).

In Sabah, East Malaysia, there are 183 species of dipterocarps or about 70% of the total number of dipterocarp species in Borneo. Of the 17 genera, 9 occur in Sabah, namely, *Anisoptera*, *Cotylelobium*, *Dipterocarpus*, *Dryobalanops*, *Hopea*, *Parashorea*, *Shorea*, *Upuna* and *Vatica*. A total

of six species of the Bornean endemics are confined only to Sabah. They are *Shorea micans*, *S. kudatensis*, *S. waltonii*, *S. symingtonii*, *Dipterocarpus ochraceus* and *Hopea ovoidea* (Ashton 2004; PS Ashton, personal communication).

Dipterocarp populations, being highly habitat-specific, are at some levels of endangerment and are often fragmented in nature into an archipelago of habitat-islands (Ashton 2004, Maycock et al. 2012). Deforestation and habitat alterations have adversely affected the dipterocarp diversity. Therefore, it is important to develop *in situ* and *ex situ* conservation strategies for the existing resources, including understanding the ecological and evolutionary processes to maintain the diversity at intraspecific and higher taxonomic levels (Krishnapillay & Razak 2003).

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Research on the ecological aspects of insect–dipterocarp relationship will continually provide a better understanding of some of the conservation issues of dipterocarps, especially with regard to pest (Krishnapillay & Razak 2003). Several studies have documented the association of insects with dipterocarps in Sabah. Among the areas that have been focused include timber pests (Burgess 1966), borers (Thapa 1974), termites (Thapa 1981), plantation pests (Chey 1996), seed predators (Chey 2002) and florivores (Chung et al. 2011). However, there is still lack of information on insect association with Bornean endemic dipterocarp species.

This study was conducted as part of the project on the assessment of population diversity of the endemic dipterocarps in Sabah. It was also in support of the conservation assessment of Dipterocarpaceae undertaken by the Malaysia Plant Red List Project initiated by the Forest Research Institute Malaysia.

MATERIALS AND METHODS

Study site

The study was conducted at the nursery of the Forest Research Centre (FRC), Sepilok in Sandakan. Sepilok is situated on the east coast of Sabah (5° 52' N, 117° 57' E), about 40 m a.s.l. adjacent to the lowland dipterocarp forest of the Kabili–Sepilok Forest Reserve. The annual mean daily temperature is 30 °C. The annual rainfall averages 3100 mm while the maximum relative humidity is about 90%.

Study procedure

Insect survey and monitoring was conducted periodically from July 2010 till December 2011 at the FRC nursery. The survey was intensified in early 2011 when the endemic dipterocarp seedlings were propagated and were growing at the nursery. The focus of the study was on defoliating insects associated with the seedlings. There was no experimental design in this study as this was purely a field observation and documentation of insects causing damage to endemic dipterocarp seedlings.

Dipterocarp species that were monitored for insect defoliation are listed in Table 1. Of

the seven species studied, three are confined to Sabah, namely, *S. kudatensis*, *S. waltonii* and *S. symingtonii*.

Adult insect or larva that was sighted feeding on the endemic dipterocarp seedlings was collected and placed in a plastic container lined with tissue paper. For adult, close-up photographs (including symptom of attack) were taken almost immediately for record and identification purposes. For larva, the life cycle was monitored in captivity at mean temperature of 29 °C. The larva was fed dipterocarp leaves of the same species until it pupated. Photographs of various life stages of the insect were taken to facilitate monitoring and identification. Emerged adults were killed and put in triangle papers, placed in a container and refrigerated at 8 °C. When the insect rearing stage was over, representatives of the insect species were dry mounted and specimens deposited at the insect museum of the FRC.

Identification of insect specimens was based on reference materials listed in Table 2. The new record of insect on the host plant was determined by referring to Robinson et al. (2001) and other sources through internet search.

RESULTS

A total of 12 insect species were recorded defoliating 7 Bornean endemic dipterocarp species at the FRC nursery in Sepilok (Table 2). Two defoliators were adult beetles while 10 were larvae of Lepidoptera, with 6 of them from the Lymantriidae family. All were new records as they had not been documented in the past. The most frequently encountered insect species was *Clethrogyna turbata* Butler (Lepidoptera: Lymantriidae), which occurred on four dipterocarp species. Due to its high abundance, it caused severe defoliation to *S. symingtonii*, *S. waltonii* and *S. kudatensis*. Other defoliators occurred infrequently and in low abundance, hence the low level of defoliation.

DISCUSSION

As all the dipterocarp defoliators in this study are recorded for the first time, some descriptions and ecological information of the new records are provided.

Table 1 Bornean endemic dipterocarp species (Dipterocarpaceae) that were investigated at the Forest Research Centre nursery in Sepilok, Sandakan

Species	Vernacular name (Sabah)	Distribution in Borneo	No. of seedlings examined
<i>Dryobalanops lanceolata</i>	Kapur paji	Sabah, Sarawak, Brunei and Kalimantan	600
<i>Parashorea tomentella</i>	Urat mata beludu	Sabah and East Kalimantan	150
<i>Shorea kudatensis</i>	Seraya kuning	Mainly at north-east of Sabah	4000
<i>Shorea mecistopteryx</i>	Kawang burung	Sabah, Sarawak, Brunei and central Kalimantan	300
<i>Shorea smithiana</i>	Seraya timbau	Sabah, Sarawak, east and south Kalimantan	300
<i>Shorea symingtonii</i>	Melapi kuning	Eastern part of Sabah	2000
<i>Shorea waltonii</i>	Seraya kelabu	Eastern part of Sabah	700

Source: Ashton (2004), PS Ashton (personal communication)

Notes on the new records

Exopholis hypoleuca Wiedemann (Coleoptera: Scarabaeidae)

This is a common cockchafer of the subfamily Melolonthinae and is distributed throughout the Sundaland. Measuring 22–25 mm in length, it is light brown in colour and is often covered with some yellowish white scales at the posterior portion of the body. The beetle feeds on a wide range of plants such as banana, coconut, oil palm, rambutan and durian (Kalshoven 1981). This beetle also feeds on the foliage of coffee, maize and groundnut (Tung 1983). Chung (1998) reported severe defoliation by this beetle on *Dipterocarpus applanatus*. In this study, *Exopholis hypoleuca* is observed feeding on the foliage of *Dryobalanops lanceolata* seedlings which has not been documented previously.

Hypomeces squamosus Fabricius (Coleoptera: Curculionidae)

Measuring about 15 mm in length, this highly polyphagous gold dust weevil is common. The adult weevil can cause considerable defoliation to any of the plant that it is known

to feed on. Feeding pattern is usually from leaf edge inwards forming a semicircle. Khoo et al. (1991) and Chey (1996) provided information on the biology, food plants, economic importance and control measures. This weevil was recorded for the first time feeding on young leaves and shoots of *Parashorea tomentella* seedlings.

Capila phanaeus phanaeus Hewitson (Lepidoptera: Hesperidae)

This skipper is entirely brown with translucent patches on the forewings, measuring 25 mm in length with a wing span of 55 mm. This subspecies is distributed in Borneo and Sumatra while other subspecies are found throughout South-East Asia (Maruyama 1991). There is no host plant information provided by Robinson et al. (2001), hence the defoliation on *S. symingtonii* is a new record.

Setora sp. Walker (Lepidoptera: Limacodidae)

Setora is a polyphagous insect in which the larva feeds on a variety of plants. Description of this genus is given by Holloway (1986). This genus is a serious pest of coconut and oil palm. Known as nettle caterpillar, it was

Table 2 New records of defoliating insects associated with Bornean endemic dipterocarp seedlings

Order	Family	Species	Source of insect identification and reference	Host seedling	Level of defoliation*
Coleoptera	Scarabaeidae	<i>Exopholis hypoleuca</i> Wiedemann	FRC insect collection, Chung (1998)	<i>Dryobalanops lanceolata</i>	Low
Coleoptera	Curculionidae	<i>Hypomeces squamosus</i> Fabricius	FRC insect collection, Chey (1996), Khoo et al. (1991)	<i>Parashorea tomentella</i>	Low
Lepidoptera	Hesperiidae	<i>Capila phanaeus</i> <i>phanaeus</i> Hewitson	Maruyama (1991)	<i>Shorea symingtonii</i>	Low
Lepidoptera	Limacodidae	<i>Setora</i> sp.	Holloway (1986), Chung et al. (2009a), Holloway (2011)	<i>Shorea kudatensis</i>	Low
Lepidoptera	Lymantriidae	<i>Calliteara horsfieldii</i> Saunders	Holloway (1999), Chey (1996), Chung et al. (2008)	<i>Parashorea tomentella</i> <i>Shorea symingtonii</i>	Low Low
Lepidoptera	Lymantriidae	<i>Clethrogyna turbata</i> Butler	Holloway (1999), Chung (2003)	<i>Shorea kudatensis</i> <i>Shorea mecistopteryx</i> <i>Shorea symingtonii</i> <i>Shorea waltonii</i>	High Moderate Very high Very high
Lepidoptera	Lymantriidae	<i>Lymantria ganara</i> Moore	Holloway (1999)	<i>Shorea smithiana</i> <i>Shorea symingtonii</i> <i>Shorea waltonii</i>	Low Low Low
Lepidoptera	Lymantriidae	<i>Olene inclusa</i> Walker	Holloway (1999), Chung et al. (2008), Holloway (2011)	<i>Shorea kudatensis</i> <i>Shorea waltonii</i>	Low Low
Lepidoptera	Lymantriidae	<i>Olene mendosa</i> Hubner	Holloway (1999), Chung et al. (2008)	<i>Shorea waltonii</i> <i>Shorea kudatensis</i>	Low Low
Lepidoptera	Lymantriidae	<i>Orgyia basinigra</i> Heylaerts	Holloway (1999), Chey (1996)	<i>Shorea symingtonii</i>	Low
Lepidoptera	Oeophoridae	<i>Acria</i> sp.	Robinson et al. (1994), Chung et al. (2006)	<i>Shorea kudatensis</i>	Low
Lepidoptera	Tortricidae	<i>Homona</i> nr <i>eductana</i> Walker	Robinson et al. (1994)	<i>Shorea symingtonii</i>	Low

*Low = less than 1% of the total seedlings being defoliated, moderate = 1–20% of the total seedlings being defoliated, high = 21–40% of the total seedlings being defoliated, very high = > 40% of the total seedlings being defoliated; FRC = Forest Research Centre

recorded feeding on the foliage of the indigenous fast-growing timber trees such as *Octomeles sumatrana* (Chung et al. 2008) and *Neolamarckia cadamba* (Chung et al. 2009a) but had been misidentified as *Setora nitens* (Holloway 2011). The species (including the one feeding on the foliage of *S. kudatensis*) could be *Setora cupreiplaga* or *S. cupreistriga*. The former species has been recorded feeding on the foliage of *D. lanceolata* of Dipterocarpaceae (Robinson et al. 2001). *Shorea kudatensis* is a new host plant record for this genus.

Calliteara horsfieldii Saunders (Lepidoptera: Lymantriidae)

Descriptions of this species are provided by Holloway (1999) and Chey (1996). This is a dimorphic species which feeds on a wide range of plants including various timber species in Sabah such as *Shorea argentifolia*, *Acacia mangium*, *O. sumatrana* and *Terminalia copelandii* (Chey 1996, Chung et al. 2006, 2008). The feeding on *P. tomentella* and *S. symingtonii* recorded in this study is new.

Clethrogyna turbata Butler (Lepidoptera: Lymantriidae)

This is the most serious defoliator in this study. It has caused considerable damage to a number of plant species in Sabah because of its high abundance (Chung 2003, Chung et al. 2006, 2009b). For Dipterocarpaceae, it has been recorded feeding on *Hopea odorata* and *Shorea hemsleyana* (Robinson et al. 2001) but the defoliation on *S. kudatensis*, *Shorea mecistopteryx*, *S. symingtonii* and *S. waltonii* is a new record. The adult male is brown with patches of orange on its rather rounded forewings while the hind wings are plain brown. The emerged adults have wing span of about 20 mm and body length of 8–10 mm. The adult female is flightless as illustrated by Chung et al. (2009b).

Lymantria ganara Moore (Lepidoptera: Lymantriidae)

This is a common species in the lowland and heath forests (Holloway 1999). Robinson et

al. (2001) recorded a number of host plants but none on dipterocarps. In this study, this species was recorded from three dipterocarps, namely, *Shorea smithiana*, *S. symingtonii* and *S. waltonii*. The defoliation, however, was not serious. The moth is a lightly-coloured species with description given by Holloway (1999). The emerged adult female is bigger than the male with a wing span of 52 mm and a body length of 25 mm. The male has a wing span of 36 mm and a body length of 15 mm.

Olene inclusa Walker (Lepidoptera: Lymantriidae)

This species is found in a range of lowland forest types and can be found as high as 1670 m (Holloway 1999). It was recorded defoliating *O. sumatrana*. Both adult and larva were illustrated by Chung et al. (2008) but the male was misidentified as *Rhyptoses brooksi* and was pointed out by Holloway (2011). Similar to *Olene mendosa*, this is a polyphagous species feeding on a wide range of plants (Robinson et al. 2001). The defoliation on *S. kudatensis* and *S. waltonii* is a new record.

Olene mendosa Hubner (Lepidoptera: Lymantriidae)

This is a polyphagous species feeding on a wide range of plants including various species of *Shorea* and *Dipterocarpus* (Robinson et al. 2001). The colourful larva can grow up to 40 mm (Chung et al. 2008). The adult moth is variable in appearance with a wing span of about 30–40 mm. Details of this species are provided by Holloway (1999). The defoliation on *S. waltonii* is a new record.

Orgyia basinigra Heylaerts (Lepidoptera: Lymantriidae)

This species is encountered infrequently in natural lowland forest but is more often found in plantation forests (Holloway 1999). The wing span of the emerged moth is 22 mm and the body length, 12 mm. The adult, cocoon and different larval stages of *Orgyia basinigra* were featured by Chey (1996). According to Chey (1996), this was the most common defoliator of *Parashorea malaanonan* in Sook with about 20–30% of the seedlings being attacked.

This species, however, only caused minor defoliation to *S. kudatensis* and *S. symingtonii* at the FRC nursery.

Acria sp. (Lepidoptera: Oeophoridae)

A pupa of this species, measuring 5 mm, was found on the upper side of a partially defoliated *S. kudatensis* leaf, covered with silky membrane. The emerged adult with wing span of 16 mm and body length of 7 mm was identified as *Acria* sp. based on Robinson et al. (1994). Chung et al. (2006) illustrated the adult and larva which was feeding on *T. copelandii*. Other host plants of this genus include *Tectona grandis* and *Elaeis guineensis* but none on dipterocarps (Robinson et al. 2001).

Homona nr *eductana* Walker (Lepidoptera: Tortricidae)

A brown pupa measuring about 25 mm was collected from *S. symingtonii*. Based on Robinson et al. (1994), the emerged brown adult moth was identified as *Homona* nr *eductana*. When resting, it forms a distinctly bell-shaped posture. The specimen has wing span of 22 mm and body length of 11 mm. According to Robinson et al. (1994), the larva is a polyphagous leaf roller and is widely distributed in South-East Asia, from lowland to about 700 m. Robinson et al. (2001) recorded various host plant species for *H. eductana* but none on dipterocarps.

Importance and management of insects associated with endemic dipterocarp seedlings of Borneo

Phytophagous insects are the most important defoliators in tropical forests, consuming more plant material than vertebrate herbivores (Lowman & Moffet 1993). Severe defoliation can lead to mortality and adverse effects on plant health, especially at a young and tender stage. Hence, it is important to monitor the seedling growth and take appropriate action when proliferation of an insect pest population is anticipated.

From this study, most of the insects associated with the Bornean endemic dipterocarp

seedlings occurred in low population. Thus, they were removed manually when encountered. The main concern was the lymantriid caterpillar, *C. turbata*. As in the past, this vigorous species could occur in thousands and could completely defoliate young seedlings, including the tender stem within several days (Chung 2003). When there was a proliferation of this species in early 2011, chemical spraying was applied as control. Monitoring was conducted periodically and enumeration census was used to determine when chemical intervention was necessary until the seedlings were about one year old. At this stage, complete defoliation may not kill the seedlings but may adversely affect the seedling growth. This is because a one-year-old seedling is considered robust and will be able to recoppice and flush new leaves relatively more easily compared with younger seedlings.

Besides *C. turbata* caterpillar, *Setora* sp. and *H. squamosus* are known to be notorious defoliators on other plants. They did not occur in high abundance throughout this study perhaps because endemic dipterocarps were not their preferred choice. Nevertheless, their presence should be monitored as they could be potential threats.

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