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Report

Short notes on saproxylic arthropods of Muaya, Sipitang, Sabah

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Abstract
A short study to look at the occurrence of saproxylic arthropods was conducted in Muaya, Sipitang from 12th to 14th May, 2012. Two pieces of deadwood (45 cm and 26 cm in diameter respectively) were examined randomly. Arthropods collected were classified to class level. For Class Insecta, specimens were then identified up to order level. A total of 7 insect orders and 4 other classes of arthropods were recorded. Beetles (Coleoptera) were further identified to family level while termites (Isoptera) and ants (Hymenoptera: Formicidae) were identified to genus level. Among non-social insects, beetles were the highest in terms of individuals collected in 6 families. In terms of species, ants had the highest number with at least 12 species recorded.

Keywords: Tropical rainforest, Deadwood, Saproxylic, Arthropods, Sabah

Introduction
Arthropods are a group of organisms that have an external skeleton (exoskeleton) or "cutical". They comprise Crustacea (crabs and shrimps), Chelicerata (spiders, scorpions and mites) and Uniramia (insects, centipedes and millipedes). Arthropods are the most specious and successful animals ever to have evolved and are found in sea, fresh water, and on land. They have functional importance and play significant roles in ecosystems.

Saproxylic arthropods have at least part of their life cycle associated with deadwood, fungi or microorganisms that decompose them (Grove & Stork, 1999). Saproxylic organisms include xylophages (wood-eaters), predators, detritivores and parasites that share an association with mature timber habitats (Grove, 2002a). They play a significant role in decomposing organic matter of decaying wood. Recent studies in various parts of the world suggest that approximately 20 % of the entire forest insect fauna is associated with old trees and the deadwood they generate (Grove, 2002b).

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Deadwood is important in nutrient dynamics as it contributes nitrogen, carbon, phosphorus, potassium, calcium, magnesium and other nutrients to forest soils. Deadwood is also important because it provides specific microhabitats to saproxylic organisms. This diversity of microhabitats generates high species diversity, not only for invertebrates but also to other groups of animals, such as birds, mammals and reptiles which build their nests in cavities of deadwood (Trave, 2003).

Scientifically, very little attention has been given to these types of arthropods in tropical countries (Grove & Stork, 1999). For this reason, very little information about these organisms is available in Malaysia and not much is known about their taxonomy, biology and conservation, although these arthropods are functionally important to the forest ecosystem due to their role in breaking down coarse woody materials and nutrient cycling (Hammond et al., 2001). In western countries, studies have shown that saproxylic species are high in species number and trophic roles, and they are sensitive to forest harvesting and other management activities (Hammond et al., 2001). For example, in the United Kingdom, 1,800 species (6 % of total fauna known to Britain) of invertebrates are known to be dependent on the process of wood decay. In addition, 38 % of saproxylic invertebrate species have conservation status in Britain, with Coleoptera having the highest figure of any taxonomic group (54 %) (Keith, 2003).

Materials and Methods

A survey was conducted in Muaya Forest Reserve (4°53'52.0"N, 115°45'48.9"E), Sipitang, Sabah (820 m above sea level). The vegetation is of lowland mixed dipterocarp with some kerangas forests growing in certain areas. The altitude range is between 873 m to 1,040 m above sea level. During the day, the temperature is 24 °C–26 °C and at night, it is 18 °C–21 °C. The study site where saproxylic arthropods were collected was about 725 m above sea level.

Two pieces of deadwood were examined randomly in the study area. The length and width of the examined wood were recorded. The width of the wood was recorded at three different parts – at both ends and at the middle to get the mean width. A small axe was used to break the wood into pieces in order to collect arthropods living in the wood. Deadwood was broken randomly into small pieces so that arthropods living in it could be extracted.

All forms of arthropods (adults, pupae and larvae) were collected and kept in 70 % ethanol. Specimens were then brought to the lab for identification. All insects were identified to order level. Beetles were identified further to family level while social insects, such as termites (Isoptera) and ants (Hymenoptera: Formicidae) were identified to generic level. Other arthropods were identified to class level.

Results and Discussion

The diameter and length of the wood pieces, and arthropods that were collected are shown in Table 1.

Table 1: Diameter and length of the wood pieces from which saproxylic species and number of individuals were collected.

Deadwood no. 1 **Mean diameter = 45 cm** **Length = 12 m**	**Deadwood no. 2** **Mean diameter = 26 cm** **Length = 8 m**
Isopoda (2 indv.) Chilopoda (1 indv.) Diplopoda (1 indv.) Arachnida • Acarina o Morphospecies 1 (1 indv.) o Morphospecies 2 (1 indv.) o Morphospecies 3 (1 indv.) o Morphospecies 4 (2 indv.) Insecta • Orthoptera sp. 1 (1 indv.) • Orthoptera sp. 2 (2 indv.) • Orthoptera sp. 3 (1 indv.) • Hemiptera (1 indv.) • Coleoptera o Tenebrionidae (4 indv. larvae) o Lucanidae (1 indv. larva) o Colydiidae (1 indv. larva) o Staphylinidae (6 indv. adults) • Hymenoptera o Formicidae - *Pachycondyla* sp. 1 - *Rhytidoponera* sp. - *Odontomachus* sp. - *Diacamma* sp. - *Pheidole* sp. 1 - *Pheidole* sp. 2 - *Aphaenogaster* sp. - *Cerapachys* sp.	Chilopoda (3 indv.) Arachnida • Acarina (1 indv.) • Araneae (4 indv.) Insecta • Dictyoptera sp. 1 (2 indv.) • Dictyoptera sp. 2 (1 indv.) • Lepidoptera (1 indv. larva) • Hemiptera (2 indv.) • Coleoptera o Staphylinidae (1 indv.) o Carabidae (1 indv. larva) o Cerambycidae (1 indv. larva) o Colydiidae (1 indv. larva) • Hymenoptera o Formicidae - *Myrmicaria* sp. - *Pachycondyla* sp. 2 - *Plagiolepis* sp. - *Diacamma* sp. - *Pachycondyla* sp. 3 - *Rhoptromyrmex* sp. - *Odontomachus* sp. - *Pheidole* sp. 3 - *Vollenhovia* sp. • Isoptera o Termitidae - *Pericapritermes* sp. - *Globitermes* sp. - *Havilanditermes* sp. o Rhinotermitidae - *Schedorhinoteremes* sp. - *Parrhinotermes* sp.

Although the second deadwood was smaller in diameter (26 cm, compared to the larger one, 45 cm in diameter), it contained almost the same number of arthropods as the larger one. In addition, five different species of termites were also found in the smaller deadwood, while no termites were recorded from the bigger deadwood.

Beetles were further identified to family level. Six families of saproxylic beetles were sampled throughout the survey. However, most of the beetles collected were larvae, with only one adult. In fact, many beetle larvae are xylophagous, that feeding on wood (Lawrence et al., 1994).

Arthropods use snags, stumps, logs, and other forms of coarse woody materials for food, shelter, foraging, or reproductive activities (Hammond, 1997). Many of these arthropods can be found living in or using the same woody materials. However, our observations throughout the fieldwork have found that arthropods living in decaying woody materials usually avoid interacting with each other by living in different parts of the wood or in their own galleries. This means that they can be found living in the same rotten wood piece but rarely make any contact with each other. Resources partitioning by insects have also been reported by other researchers (White, 1980; Ranta & Lundberg, 1980; McLain, 1981).

Many saproxylic arthropods actually do not dwell in deadwood for their entire life, while some use deadwood as their nest, such as ants and termites. Unlike termites, ants do not consume cellulose so they use deadwood mainly for building nests. Other saproxylic arthropods, such as Isopoda, Orthoptera and Collembola are non-obligate saproxylic arthropods which only use woody materials as a hiding site when moving between different areas (Kelly & Samways, 2003). Adult centipedes are commonly found together with their young in cavities within the deadwood. They use deadwood as a nursery for their young so that they are protected, and at the same time prey on other saproxylic invertebrates (Hervey & Yen, 1989).

In this short study carried out in Muaya Forest Reserve, although only two pieces of deadwood were examined randomly, quite a number of arthropods were collected from them. This shows that a small portion of deadwood can house quite a number of saproxylic arthropods. In a study conducted in Switzerland, Schiegg (2001) pointed out that limbs hosted more species and had a higher diversity of saproxylic insects than tree trunks.

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