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BIODIVERSITY OF TROPICAL PEATLAND IN SOUTHEAST ASIA

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SUMMARY

Natural lowland peat swamps of Southeast Asia support forest vegetation forming a catena of types from their perimeter to centre, a change that is reflected in variations in canopy height, peat thickness, waterlogging and nutrient availability. Recognition of the biological, environmental and economic importance of tropical peatlands has been a slow process. The earliest interest in the peat swamp forests of Southeast Asia was in the 1930s by British foresters working in the former British Protectorates of Malaya, Sarawak and Brunei and Dutch scientists in Kalimantan and Sumatra. The ecological and taxonomic studies of peat swamp forests of northern Borneo by J.A.R. Anderson became a benchmark for all subsequent research on tropical peatland. Many plant species are restricted to this stressful habitat and some are endemic to it. Several historical accounts of the fauna of tropical peat swamp forests suggested that animal diversity was low but more recent ones, for example in the upper Sg. Sabangau catchment of Central Kalimantan, show the opposite that they are vital habitats for many rare and endangered species of animals and plants including orang utan (*Pongo pygmaeus*). By the end of the 1980s, extensive areas of peatland in Indonesia, Malaysia and Thailand had been drained and converted to agriculture for a large range of crops including rice and vegetables and plantations of oil palm and paper pulp trees. Associated problems of peat shrinkage, subsidence, nutrient deficiency, toxicity and low plant productivity are also documented. Deforestation, drainage and conversion of tropical peatland to other land uses has continued apace since then over increasingly larger areas with consequent problems of fire, flooding, greenhouse gas emissions and poverty all of which have had negative impacts on biodiversity. These are now regional and global problems some of which will be the subject of other presentations at this congress.

Keywords: *biodiversity, peat swamp forest, deforestation, plantations*

HISTORICAL PERSPECTIVE

The presence of extensive areas of peatland in Southeast Asia, especially the islands of Borneo and Sumatra and Peninsular Malaysia has been known for over 300 years (Rieley & Page, 1997). These were mostly casual references made by explorers in their pursuit of land exploration and discovery without detailed scientific survey. Even the area of these peatlands was subject to confusion and doubt with early estimates of around one million hectares in Borneo and Sumatra combined. It was not until the 1930s that specific studies were made of these lowland tropical peatland ecosystems over a period of 20 years. These were the basis for later development of some of these peatlands for agriculture and human settlement.

A detailed survey of peatland in Peninsular Malaya, carried out in the 1950s, estimated that there were about 800,000 hectares (approximately 6 per cent of the total area) mostly in poorly draining coastal areas in the centre and south of the country. Most of this peat was classified as 'oligotrophic', which is low in mineral nutrients, especially calcium, and high in acidity. The vegetation of Malayan peat swamp forests was described in detail by Wyatt-Smith (1959). This work was followed by studies carried out in Sarawak and Brunei, including the first ecological appraisal of this ecosystem (Anderson, 1983). Anderson carried out extensive field surveys of peat thickness, surface levels and tree species composition and described a catena of vegetation types on pristine peat swamps that is related to differences in ecological conditions and environmental factors across very extensive peat domes.

Little emphasis was placed upon the study of peatlands during the first quarter century of the Republic of Indonesia but, in the early 1970s, interest accelerated because the need to increase domestic food production was highlighted in a five year development plan (REPELLITA) that promoted increased rice production in coastal areas. As a result, multidisciplinary studies of soils, ecology, agronomy, engineering and social economy were carried out in the coastal peat areas of Riau and Central and West Kalimantan, jointly by Dutch and Indonesian scientists, which identified the principal problems of reclamation of tropical peatlands (Soepraptohardjo and Driessen, 1976).

BIODIVERSITY

Whilst the diversity associated with ombrotrophic peatlands, especially in boreal and temperate parts of the world is usually lower than adjacent dryland ecosystems, many peatland species are specialists, which are not found in other habitats. The inaccessibility of peatlands has also drawn in species that, although not confined to these habitats, are dependent upon the shelter and food peatlands provide. Until fairly recently little was known of the biodiversity of tropical peatlands anywhere in the world and, as a result, it was largely ignored (Rieley & Page, 2007). Early accounts of this ecosystem refer to uninteresting plant and animal communities and their general lack of species. However, as more information on the biodiversity of tropical peat swamp forest accumulated it became clear that this ecosystem had been undervalued for its vast biodiversity and as a habitat for rare and threatened species.

South-east Asia's tropical peat-swamp forests are important for biodiversity conservation, being home to at least 1,524 plants, 123 mammals, 268 birds, 219 fresh-water fish species and an unknown, but very high number of invertebrates not to mention a vast range of bryophytes, ferns and fungi. They also support many threatened species, including the Bornean orang utan, southern Bornean gibbon, Sumatran tiger and Sumatran elephant.

Flora

The vegetation of the peat swamp forests of Southeast Asia has been investigated in more detail than the associated animal communities (Rieley & Page, 1997). The tree species diversity of these forests is lower than in most other types of lowland rain forest in the region, but some are restricted to this ecosystem and make an important contribution to regional. The species composition and vegetation types of peat swamp forest are not uniform across Southeast Asia and there is significant local and regional variation, although there is presently insufficient information available to establish definite phytogeographical trends (Rieley & Ahmad-Shah, 1996).

Within a tropical peatland catchment, there may be a catena of between four and seven different forest types, reflecting differences in peat thickness, hydrology and nutrient availability. These range from a mixed swamp community with up to 240 tree species per hectare to a less diverse, low canopy, small pole forest, usually associated with the wettest, deepest peat in which tree species number declines to 30–55 species per hectare. Local differences in peatland hydrology and nutrient availability probably exert strong influences on forest composition and structure (Brady, 1997; Page *et al.,* 1999). In overall terms, tall peat swamp forest sub-types, which have the greatest tree species diversity and canopy stratification, support the greatest faunal. The lower canopy sub-types are less species diverse.

Fauna

The faunal diversity of tropical peat swamp forests is of great interest but base-line information is very limited and has not been related to the different vegetation types (Page *et al.,* 1997). A few studies have highlighted the role that peat swamp forests play in providing habitats for a number of endangered and rare species, especially birds, fish, mammals and reptiles.

Mammals

Several recent studies have highlighted the role that tropical peat swamp forests play in providing habitats for many species of mammals (Page *et al.,* 1997). Of particular conservation importance is the relatively large population of orang utan (*Pongo pygmaeus pygmaeus*) associated with peat swamp forest in Borneo and Aceh in Sumatra (Morrogh-Bernard *et al.,* 2003), which provide some of the most important remaining habitats for this endangered primate. A study carried out in the upper Sg. Sebangau catchment (Page *et al.,* 1997) revealed 35 species of mammal, the majority of which are arboreal. Twenty nine species were observed in the field whilst six were captured in traps as part of small mammal surveys. Observations at sunrise and sunset ensured that some nocturnal animals (e.g. civets) were recorded; other nocturnal groups, however, notably lorises and bats, were under-represented. The largest number of animals was identified in the mixed swamp forest (26), nearest to the river, followed by tall interior forest on the watershed (20). Only 8 species were encountered in low pole forest from which most arboreal species were absent. Several species are regarded as endangered, threatened or vulnerable by the Convention on Trade in Endangered Species (CITES) and the International Union for the Conservation of Nature (IUCN) (Table 1).

Birds

The avian species diversity of peat swamp forest is considerable and the importance of this habitat as a refuge for a number of rare and threatened species has been demonstrated (Page *et al.*, 1997). It is now evident that peat swamp forest is important for many bird species and some have specific preferences for this habitat, which acts as one of their last refuges. Preliminary observations suggest that the majority of bird species (80%) can survive in selectively logged forest. Whilst a number of birds may utilise regenerating peat swamp forest for feeding, this habitat may be unsuitable at other stages of the avian life cycle. Loss of nesting sites and nesting materials, for

example, may reduce breeding potential of some species and alterations in the forest microclimate may also exclude species.

Studies over several years in peat swamp forest in the upper catchment of Sg. Sebangau in Central Kalimantan revealed more than 150 bird species. These were dominated by insectivores, the main guild being foliage gleaning species. The largest number was recorded in mixed swamp forest (106) followed by tall interior forest (77), while the smallest number of species was recorded in low pole forest (27). In addition, 32 species were observed in deforested, riverine sedge swamp. Six of the bird species recorded is Red Data Book species constituting 50% (six out of 13) of the listed bird species for the island of Borneo (Table 2). Several bird species within the Southeast Asian region are considered to be peat swamp specialists, i.e. they are not associated with any other wetland or forest habitat. This group includes white-winged duck (*Cairina scutulata*), Storm's stork (*Ciconia stormi*) and grey-breasted babbler (*Malacopteran albogulare*).

Table 1: Checklist of rare, endangered and vulnerable mammal species recorded in peat swamp forest in the upper Sg. Sebangau catchment (status according to CITES & IUCN)
(MSF: mixed swamp forest, 1-5 km from river; LPF: low pole forest, 5-12 km from river; TIF: tall interior forest, 12-25 km from river)

Common name	**Scientific name**	**Status**	**Habitat**		
			MSF	**LPF**	**TIF**
Agile gibbon	*Hylobates agilis*	Endangered	*		*
Orang utan	*Pongo pygmaeus pygmaeus*	Endangered	*	*	*
Pig-tailed macaque	*Macaca nemestrina*	Endangered	*	*	*
Red leaf monkey	*Presbytis rubicunda*	Endemic to Borneo	*		*
Sun bear	*Helarctos malayanus*	Endangered	*	*	*
Clouded leopard	*Neofelis nebulosa*	Threatened	*		
Leopard cat	*Felis bengalensis*	Threatened	*		
Marbled cat	*Felis marmorata*	Threatened	*		*
Flat-headed cat	*Felis planiceps*	Rare	*		
Binturong (bear cat)	*Arctitis binturong*	Vulnerable			
Small-toothed palm civet	*Arctogalidia trivirgata*	Status indeterminate	*		*
Plain pygmy squirrel	*Exilisciurus exilis*	Endemic to Borneo	*		*
Painted tree shrew	*Tupaia picta*	Endemic to Borneo	*		*

Fish

The rivers and drainage streams of the Southeast Asian peat swamp forests have long been considered to have low fish biomass, productivity and species diversity owing to low pH, low oxygen concentrations, toxicity from plant-derived chemicals, lack of transparency and hence primary productivity, and depauperate invertebrate communities owing to the lack of minerals such as calcium. In the last twenty years, however, efforts have been made to reassess the fish communities of these habitats. For example, several new species were found associated in a peat swamp habitat in North Selangor, Malaysia (Ng *et al.*, 1994). In addition, 44 species from 17 families, including 10 new species or subspecies, have been identified from blackwater rivers and pools in the upper Sg. Sebangau catchment, Central Kalimantan (Page *et al.*, 1997) demonstrating that the peatland rivers of Southeast Asia have a higher degree of localised endemism of fish species than alluvial rivers in the region.

Invertebrates

There has been little systematic collection of or research on the invertebrates of peat swamp forest. In the Sebangau catchment in Central Kalimantan, preliminary investigations of several invertebrate groups have highlighted the presence of many noteworthy species.

DISCUSSION

Lowland tropical peat swamp forest in Southeast Asia is undoubtedly one of the highest biodiversity ecosystems on this planet. Although a large number of animals and plants has been identified this information has been gathered from relatively few locations and most areas of peat swamp forest have not been investigated. Owing to the high rate of deforestation and conversion to other land uses large numbers of species are likely becoming extinct before they are discovered and described. In addition, it is not possible to extrapolate species existence and numbers from the current restricted database because there are major biogeographical species and population differences across the Southeast Asian region. For example, *Shorea albida*, also known as alan batu or light red meranti, is endemic to the north west of the island of Borneo. It does not occur on either Sumatra or in Central and East Kalimantan where its ecological niche is occupied by other tree species. There are also major species differences between peat swamp forests located near to the coast where they are exposed to off-shore winds and receive sea-spray containing additional nutrients and those forests further inland.

Table 2: Checklist of notable bird species recorded in peat swamp forest, upper Sg. Sebangau catchment (records from 1993, 1994 and 1995)

Common name	Scientific name	Status	Habitat			
			RSS	MSF	LPF	TIF
Storm's stork	*Ciconia stormi*	Red Data Book Peat swamp forest specialist		*		
Lesser adjutant stork	*Leptopilus javanicus*	Red Data Book	*			
Wrinkled hornbill	*Aceros corrugatos*	Red Data Book		*		*
Helmeted hornbill	*Buceros vigil*	Red Data Book				*
Short-toed coucal	*Centropus rectunguis*	Red Data Book		*		*
Wallace's hawk eagle	*Spizaetus nanus*	Red Data Book		*	*	*
Grey-breasted babbler	*Malacopteran albogulare*	Uncommon species of wetlands & swamp forests				*
Hook-billed bulbul	*Setornis criniger*	- as above -		*		*
Great-billed heron	*Ardea sumatrana*	- as above -	*			
Black bittern	*Dupetor flavicollis*	- as above -	*			
Cinnamon-headed green pigeon	*Treron fulvicollis*	- as above -		*		
Striped wren babbler	*Kenopia striata*	- as above -		*		*
Malaysian blue flycatcher	*Cyornis turcosus*	- as above -				*
Crestless fireback pheasant	*Lophura erythrophthalma*	Uncommon species of lowland forests				*
Greater coucal	*Centropus sinensis*	- as above -		*		
Brown wood owl	*Strix leptogrammica*	- as above -				*
Red-naped trogon	*Harpactes kasumba*	- as above -		*		*
Rufous-backed kingfisher	*Ceyx rufidorsa*	- as above -		*		*
Rufous-collared kingfisher	*Actenoides concretus*	- as above -		*		
Asian black hornbill	*Anthracoceros malayanus*	- as above -		*		*
White-bellied woodpecker	*Dryocopus javensis*	- as above -		*		
Lesser cuckoo-shrike	*Coracina fimbriata*	- as above -	*	*		
Grey-bellied bulbul	*Pycnonotus cyaniventris*	- as above -				*
Rufous-tailed shama	*Trichixos pyrropygus*	- as above -		*		*

There is still much that is unknown about these peat swamp forests but, unfortunately, will never be known. Until 1990 the lowland tropical peatlands of Southeast Asia were still relatively undisturbed and in near pristine condition (Hooijer *et al*, 2006). In 1990 the area of industrial plantation on tropical peatland in Peninsular Malaysia, Borneo and Sumatra was only 4% (120,000 hectares) of today's area of 3.1 Mha. Since then the rate of peatland conversion has been extremely high (10% per year) with 70% occurring between 2000 and 2010 (Miettinen *et al.,* 2012). By 2020 it is estimated that 6-9 Mha of peatland in this region will be converted to plantations. Much of what remains will not be in pristine condition but degraded as a result of timber extraction, water table drawdown because of adjacent plantation water management (drainage) activities and fire and with much reduced biodiversity.

The following speakers will add much more to this introduction to the session on 'Tropical Peatland Biodiversity and Conservation in Borneo and Sumatra'.

Wim Giesen will explain that the plants of Southeast Asian peat swamps are mostly not endemic to that ecosystem but most also occur in other habitats including freshwater swamps, heath forests, montane forests and other dryland forest.

Sara Thornton and colleagues will describe the high degree of endemism of the fish that inhabit tropical peat swamp forests and the blackwater flowing from them. Increasing deforestation and pollution are a matter of concern with implications for biodiversity and livelihoods of local people.

Marcel Silvius will highlight that the biodiversity of tropical peat swamp forests is poorly understood and undervalued with little regard given to its conservation. Even protected peatlands are at risk from illegal logging and drainage promoted by timber extraction canals and adjacent plantations.

Susan Cheyne and colleagues will describe the first comprehensive survey of gibbons across Indonesian Borneo to determine population densities and relate these to vegetation characteristics.

Mark Harrison and colleagues present evidence of the impact of recent fires on peat swamp biodiversity in Indonesian Borneo. These fires have had major impact on animal populations through loss of habitat, overcrowding in remaining habitats, toxic haze inhalation and reduction in food sources and water availability.

Doug Cress and colleagues will talk about protection and restoration of tropical peatland in Sumatra for orang utans. The rapid expansion of the palm oil industry is a major driver of loss of peatland and orang utan habitat.

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Figure 1 :
Pristine peat swamp forest in Central Kalimantan

Figure 2:
Deforested, burned peatland in Central Kalimantan