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# Distribution of vegetation in present day wetlands: some applications in geoscience

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**Abstract:** Wetland vegetation occupies several unique habitats that are host for diverse flora and fauna. In this region, some of the common wetland habitats are freshwater swamp, mangrove, Nipa swamp and peat swamp. Some plants have developed adaptation such as special breathing root systems, a means to reduce excessive salinity, and mechanism to ensure successful propagation of young seedlings, to name a few.

Wetlands have important natural functions such as regulating flood flow, supply of water to reservoirs during dry season, filter pollutants from air and water, and breeding grounds for some marine live. Some wetland plants produce large quantities of pollen that become well preserved in fine-grained rocks. In this manner, the records of past vegetation history may be uncovered by retrieving the fossil pollen from the rocks. Based on these principles, records of fossil pollen have often been used to solve certain stratigraphic and geological issues.

The main aim of this paper is to demonstrate the vegetation distribution and pollen records from some selected present day wetland habitats in Malaysia and Borneo. Some applications of wetland-derived fossil pollen records in geoscience are briefly discussed.

**Abstrak:** Kawasan tumbuhan paya merangkumi beberapa habitat unik yang menjadi perumah kepada pelbagai flora dan fauna. Di rantau ini, beberapa habitat yang biasa ditemui adalah seperti paya air tawar, paya bakau, paya nipah dan paya gambut. Sesetengah tumbuh-tumbuhan ini telah mengalami perubahan adaptasi (penyesuaian) seperti sistem pernafasan akar yang khusus, sistem untuk mengurangkan lebihan garam/kemasinan dan mekanisme yang menjamin kejayaan pembiakan biji benih.

Kawasan paya memainkan fungsi semulajadi yang penting seperti mengawal aliran banjir, menjadi sumber air bagi takungan ketika musim kering, menapis bahan cemar dari air dan udara dan menjadi tempat pembiakan untuk sebahagian hidupan laut. Terdapat tumbuh-tumbuhan kawasan paya ini yang menghasilkan sejumlah debunga yang terawet di dalam batuan berbutir halus. Dengan itu, rekod mengenai sejarah tumbuh-tumbuhan masa lampau dapat diketahui dengan memperolehi fosil debunga dari batuan tersebut. Berdasarkan kepada prinsip-prinsip ini, rekod fosil debunga kerap kali digunakan untuk menyelesaikan isu-isu stratigrafi dan geologi.

Kajian ini bertujuan untuk menunjukkan taburan tumbuhan dan rekod debunga dari beberapa habitat kawasan paya masa kini yang terdapat di Malaysia dan Borneo. Beberapa kegunaan/aplikasi dalam geosains hasil dari fosil debunga kawasan paya juga dibincangkan secara ringkas.

## INTRODUCTION

Wetlands are habitats that are primarily controlled by fluctuation of water level. The water in wetlands can either be freshwater or brackish and flowing or static. In Malaysia, wetlands comprised mainly of freshwater swamp, peat swamp, mangrove and Nipa swamp. Freshwater swamps (Paya air tawar) can be found in the upper reach of Sungai Sedili, Johor and in Tasek Bera and Tasek Cini in Pahang. Peat swamp (Paya gambut) is now limited to certain parts of Johor, Selangor and Perak. Large areas of peat swamp can still be seen in Sarawak and the Klias Peninsular in Sabah. 640,000 ha of Mangrove swamp (Hutan paya laut) exists in Malaysia, half of which is in Sabah. Nipa swamp occupies the area immediately behind the mangrove, often lining the tidal reaches of rivers. It is less extensive than mangrove.

Wetlands are important ecosystems for several reasons. For instance, during the wet season, a large volume of water can be stored in the wetland system to be released to adjacent reservoirs during the dry season. In this manner, wetlands act as a natural flood regulator and maintain continuous supply of water. Another important function of wetlands is in controlling air and water pollution by acting as a carbon sink and toxicant removal agent. Within the coastal area, the mangrove protects the coastline from wave and tidal erosion. Mangroves also support the local fishing industry by providing refuge and breeding grounds for marine life.

## ADAPTIVE MECHANISMS IN WETLAND VEGETATION

Wetland supports a diverse stand of vegetation. Being frequently waterlogged, wetland represents a 'harsh' environment for plants. In addition, the substrates are soft and poorly oxygenated and constant pounding by wave and tidal action necessitates the plants to develop special adaptation. For instant, in the case of the mangrove plant, some trees have special root systems that allow breathing

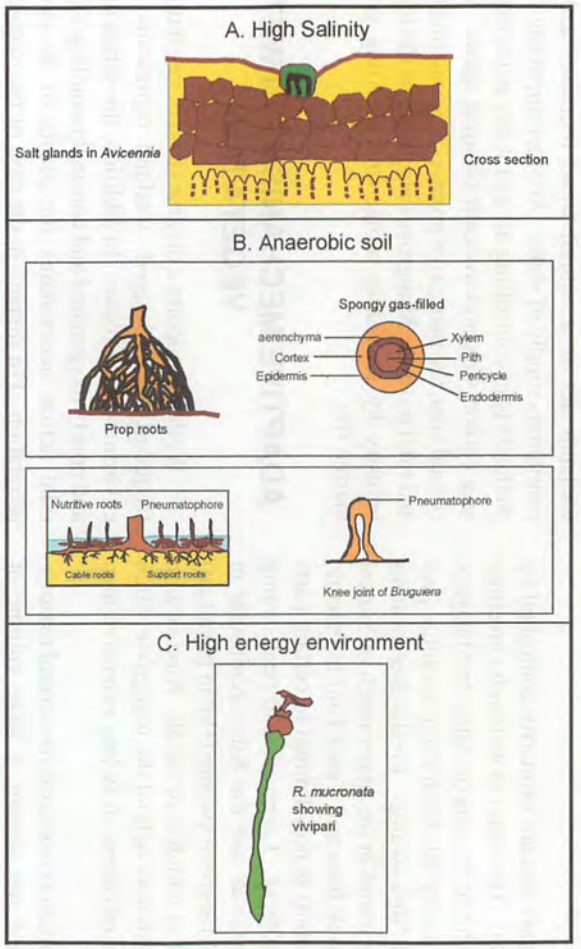


**Figure 1**. Adaptive mechanisms in mangrove plants. A) Salt glands in *Avicennia* sp. (Api api). B) Breathing root systems. C) "Vivipary" fruit of *Rhizophora* sp and *Bruguiera* sp (from Malayan Nature Society).

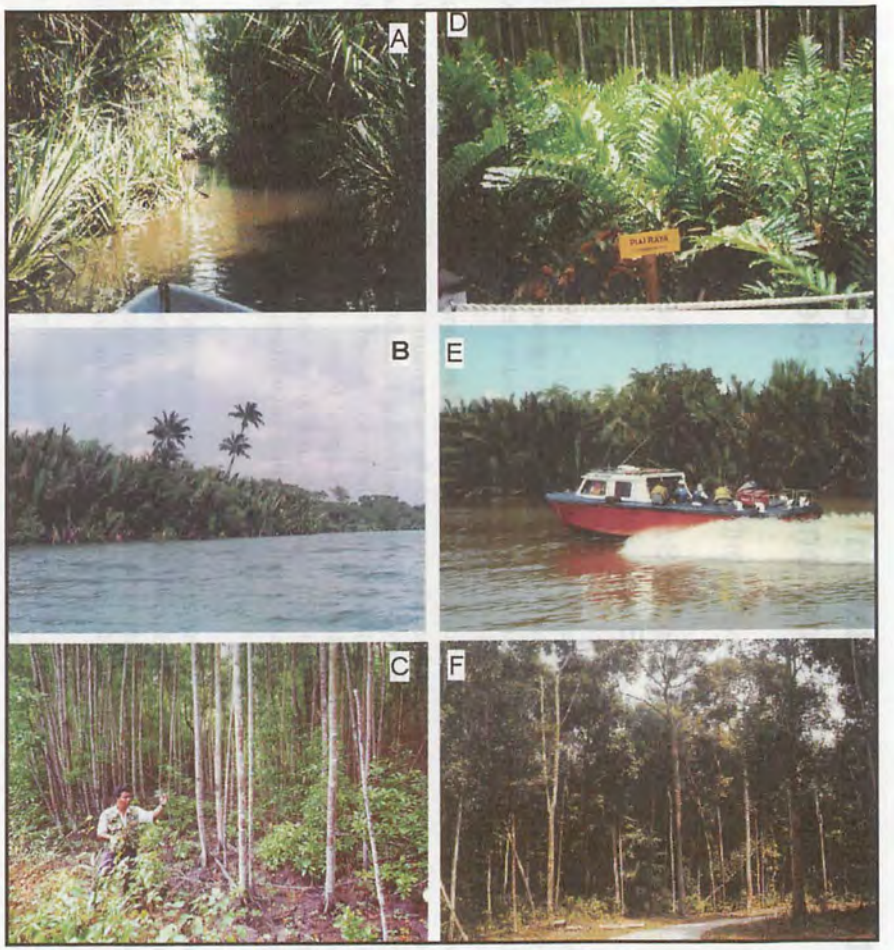


**Figure 2**. Present day wetlands habitats. A) Rasau (*Pandanus* sp) stands, Tasek Bera, Pahang. B) Nipa swamp, Sg Sedili, Johor. C) Straight poles of *Rhizophora* sp, Kuala Selangor. D) Piai (*Acrosthicum* sp), Kuala Sepetang, Perak. E) Extensive Nipa swamp, Mahakam Delta, Kalimantan. F) Peat swamp forest, Kuala Rompin, Pahang.

in wet substrates (Fig. 1). In addition, to ensure the seeds germinate and are not washed away by flowing water, a vivipary fruiting system was developed.

The leaves of mangrove plants are of different shape and size. For adaptation purpose, the *Excoecaraia* sp. (Bebuta) stores salt in older leaves and sheds them to reduce excess salinity from their system.

## PAST RECORDS OF WETLANDS

The past distribution of wetland vegetation is often manifested in fossil pollen records that can be retrieved from fine-grained rocks such as shale. This is possible partly due to the good preservation properties of pollen grains and high pollen production of some wetland plants. Mangroves produce large quantities of pollen and they have a very comprehensive pollen record. Pollen of mangrove plants has certain characteristics and can easily be identified. All species of *Sonneratia* sp. (*Sonneratia alba*, *Sonneratia caseolaris*, *Sonneratia grifithii*) for instance, can be differentiated on their pollen characters (Germeraad *et al.*, 1968). Many trees of peat swamps produce abundant pollen and being close to marine depositional environment, are well preserved.

## COMMON VEGETATION IN WETLAND HABITATS

The modern analogues of South East Asian wetlands (Fig. 2) can be seen in several places:

- Fresh water swamp — Tasek Bera.
- Mangrove — Sg. Sedili, Kuala Sepetang, Kuala Selangor and Kuala Kemaman.
- Nipa swamp — Sg. Sedili and Mahakam Delta.
- Peat swamp — coastal Pahang.

Tasek Bera is a fresh water swamp system located in southwest Pahang. It covers an area of approximately 7,000 ha. The three main habitats at Tasek Bera are:

- Open water (lakes, rivers, streams). This may be fringed by stands of *Utricularia* (in the surface water) and Water Lily.
- Swamps (reed-sedge swamps and swamp forest). This covers mostly the lake margin area of Tasek Bera and comprises mainly of *Pandanus* sp. (Rasau) and *Eugenia* sp. (Kelat).
- Lowland forests. This comprises the large trees of Diptercarpaceae and other tropical forest taxa.

Mangrove swamps proliferate along muddy and protected coastlines. It may extend upstream and fringe the banks of the river up to the upper reach of tidal saline influence. A transect along the Sedili River in Johor shows a gradual change in the pollen components of mangrove plants in response to changing salinity (Fig. 3). The mangrove swamp is typically dominated by several species of *Avicennia* sp. (Api-api), *Rhizophora* sp. (Bakau kurap, Bakau minyak), *Bruguiera* sp. (Tumu) and *Sonneratia* sp. (Gedabu, Berembang, Perepat).

Nipa swamp occupies the area behind the mangrove and is often referred as the back mangrove swamp. At Sedili, up to a kilometer stretch of Nipa stands can be observed along the banks of the river. However, in the Mahakam River, the Nipa stands are much more extensive and better developed. The trees are taller and bigger. The entire lower delta complex is covered by only Nipa stands. This is partly due to the delta being equally influenced by both strong fluvial flow and by tides.

Peat swamp occurs in lowland area where water level is maintained only by rainfall. In fully developed peat swamp, such as around the Baram River of Sarawak, the peat surface is slightly convex, and the plants are developed in a concentric pattern called a phasic community (Anderson and Muller, 1975). The peat swamp in Rompin, Pahang, occurs in a narrow strip behind the back mangrove area. Some peat swamp forest, such as in the district of Kuala Langat, Selangor (Paya Indah Wetlands), have been developed into recreational park.

## SOME APPLICATIONS IN GEOSCIENCE

The understanding of present day and past distribution of wetland vegetation, via modern analogues and fossil pollen record respectively, have several applications in geoscience.

From observation of modern environment and understanding of pollen distribution in these environments, a depositional model (Fig. 4) was developed to assist geologists in interpreting geological data (Azmi *et al.*, 2001). The model has been frequently referred to for interpretation of paralic depositional environment, particularly in the Miocene and Pliocene of Malay basin.

Since peat swamp is restricted to an ever-wet climate, the pollen record there in can be used as an ever-wet climate index. In the Malay basin, a relatively high abundance of peat swamp pollen occurs prior to the Middle Miocene lowest sea level. Variation in mangrove abundance is often associated with climatic change that may be induced by fluctuating sea levels. This is often used as a climatic bio signal (Chow, 1996). In the Malay basin, an increase in the abundance of mangrove pollen occurs at the base of Miocene. This may reflect a change from a seasonal climate to more ever wet.

Increased abundance of mangrove is often associated with a marine microfossil abundance peak. From a sequence stratigraphic perspective, this occurs during the transgressive/highstand phase. In contrast, a lowstand phase may be characterized by reduced abundance of mangrove pollen and marine microfossils. A close examination of delta plain pollen composition during transgressive/high stand phase may reveal that mangrove pollen is relatively more dominant during transgressive phase, while peat swamp/fresh water swamp pollen during highstand phase. Thus, transgressive system tract (TST) and highstand system tract (HST) may be differentiated on the basis of relative abundance of these delta plain wetland taxa (Morley, 1995).

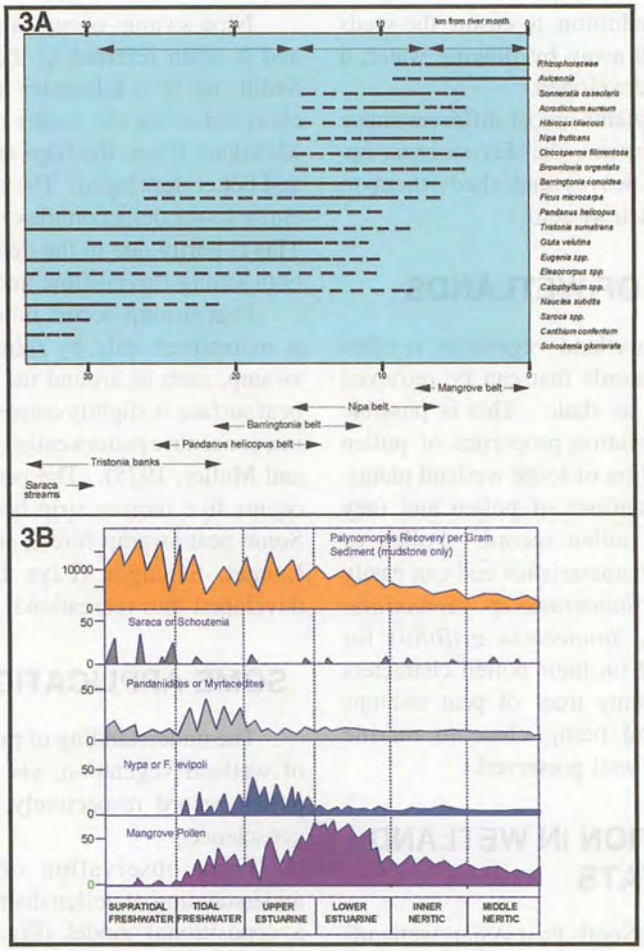


**Figure 3**. A) Riverside plant succession at Sungai Sedili Besar (Corner, 1978). B) Pollen concentrations at transect along Sungai Sedili Besar (Morley, personal comm.).

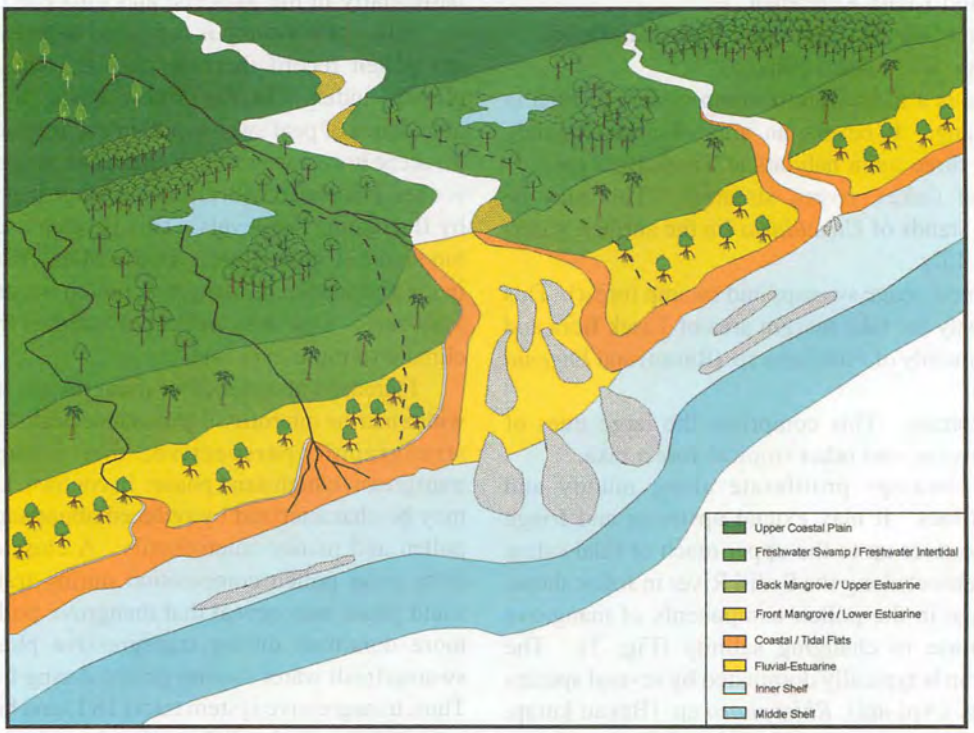


**Figure 4**. Model commonly used for interpreting depositional environment of post-Oligocene sediments in the Malay basin (Azmi *et al.*, 2001).

The fossil pollen of mangrove species *Sonneratia* sp shows a clear evolutionary lineage and is often used for stratigraphic interpretation. For example, the evolutionary appearance of *Florschuetzia levipoli* (*Sonneratia caseolaris*) marks the later part of Lower Miocene, the evolutionary appearance of *Florschuetzia meridionalis* (*Sonneratia alba*) delineates the basal Middle Miocene and the extinction of *Florschuetzia trilobata* (*Sonneratia grffithii*) indicates Middle Miocene age.

## CONCLUSIONS

Wetlands are a very important ecosystem that function to control flood, regulate water supply, filter pollutants, protect coastline and also support local fishing industry. They contain an extensive range of plant species that may be differentiated not only on their apparent physical characters such as their fruit, leaves and root system but also on pollen characteristics. A good understanding of the present day distribution of wetland plants and their fossil pollen records proves useful for several geological applications.

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## REFERENCES

ANDERSON, J.A.R. AND MULLER, J., 1975. Palynological study of a Holocene peat and a Miocene coal deposit from N.W. Borneo. *Rev. Palaeobot. Palynol., 19*, 291-351.

AZMI MOHD YAKZAN, MAHANI MOHAMED, M. RAPI M. SOM, OOI CHIT MENG AND ANYI NGAU, 2001. Stratigraphic framework and palaeoenvironment interpretation of PM303 and adjacent areas, North Malay Basin (abstract), *Petroleum Geology Conference, 2001*, 58-61.

CHOW, Y.C., 1996. Palynological climatic biosignal as a high resolution tool for sequence stratigraphical studies, offshore Sabah and Sarawak, Malaysia (abstract). *9th International Palynological Congress, Houston, USA.*

CORNER, E.J.H., 1978. The freshwater swamp-forest of south Johore and Singapore. *Gardens Bulletin Supplement 1*, 266p.

GERMERAAD, J.H. *ET AL.*, 1968. Palynology of Tertiary sediments from tropical areas. *Rev. Palaeobot. Palynol., 6*, 189-348.

MALAYAN NATURE SOCIETY. Visitors pamphlet of Taman Alam Kuala Selangor.

MORLEY, R.J., 1995. Biostratigraphic characterisation of systems tracts in Tertiary sedimentary basins. *Proceedings of the International Symposium on Sequence Stratigraphy in South East Asia*, 49-71.

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