WOODY PLANTS ON DUNE LANDSCAPE OF TERENGGANU, PENINSULAR MALAYSIA

MS Jamilah*, AG Nur-Faiezah, A Siti Kehirah, MN Siti Mariam & MS Razali

School of Marine Science and Environment, Universiti Malaysia Terengganu, Mengabang Telipot, 21030 Kuala Terengganu, Terengganu, Malaysia

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JAMILAH MS, NUR-FAIEZAH AG, SITI KEHIRAH A, SITI MARIAM MN & RAZALI MS. 2014. Woody plants on dune landscape of Terengganu, Peninsular Malaysia. The coastal landscape of Terengganu is dominated by dune landscape formed on dune ridge-originated soil. It supports three distinct natural vegetation types, namely, lowland mixed dipterocarp forest, heath vegetation and *Melaleuca* swamp. A study was conducted to update the checklist of woody plant species in the first two formations. A belt transect plot of 50 m × 100 m was set up at the Jambu Bongkok Forest Reserve to enumerate trees with 5 cm and larger diameter at breast height (dbh). In the heath vegetation, two belt transect plots of 20 m × 20 m were established at each site of Jambu Bongkok and Lembah Bidong. A total of 44 species from 22 families of woody plants were documented with *Shorea materialis* (Dipterocarpaceae) dominating in Jambu Bongkok, suggesting that site soil conditions might favour this species over other common coastal species. Most trees had stem diameter of 6–15 cm dbh with only 18 from 451 stems measuring > 50 cm. Soil conditions might limit tree growth resulting in a more uniform stem size. Heath vegetation in Jambu Bongkok supported higher diversity of woody plants than Lembah Bidong. Woody species from 10 families present at both sites could be indicator species for dune landscapes. This paper provides an updated checklist of woody plants on dune landscape of Terengganu.

Keywords: Beach ridges, wetland, *Melaleuca cajuputi*, coastal vegetation

INTRODUCTION

Natural vegetation on dune landscape in Terengganu is one of the lesser-known edaphic-related vegetation formations in Malaysia. This vegetation thrives on dune ridge soil originating from sandy marine deposit parent materials and locally named as Beris which is referred to the acronym Beach Ridges Interspersed with Swales (BRIS). Hereafter, ecosystems (forest, swamp and heath vegetation) on dune ridge or BRIS soil will be addressed collectively as dune landscape. Dune ridge soil is a nutrient-poor soil exposed to extreme physical environment and is considered as degraded or waste land. Dune ecosystems have many functions such as protecting coastal areas against storm surge (Maun 2009). Likewise, natural vegetation on dune ridges of Terengganu protects the inland from the strong South China Sea wind. *Melaleuca cajuputi* swamp, which is scattered on dune landscape, acts as sponge to mitigate flood during monsoon. Meanwhile, honey, various plant resources and freshwater fish are harvested by the local community for livelihood. Despite its ecosystem services and economic values, natural vegetation on dune ridge soil of Terengganu receives little interest from the scientific community.

Dune ridge forms an extensive coastal dune confined only to the east coast of Peninsular Malaysia. The absence of coastal dunes in the west coast of Peninsular Malaysia is likely due to the inability of beaches to dry out long enough to enable sand to be carried away inland by wind to form dunes (Maun 2009). Total cover of dune ridge soil in Peninsular Malaysia is approximately 155,400 ha and distributed across Kelantan (17,806 ha), Terengganu (67,582 ha), Pahang (36,017 ha) and a small part of Johore (Mohd Ekhwan et al. 2009). In Terengganu, natural dune ridge vegetation types (forest, swamp and heath) are found parallel to the coastal main road, beginning from north-south Besut to as far as the end of the Kemaman district, only a few metres from the coastline.

**jamilah@umt.edu.my*

Dune ridge soil in Malaysia is formed by wave action on resident materials and transported materials brought in by streams and tidal currents (Shamsuddin 1990). Geological processes uplift coastal plains and soil development occurs during succession in dry dune and wet interdunal areas. Soil series and water tables of dune ridges vary across landuses (Mohd Ekhwan et al. 2009). According to the classification system of the American Department of Agriculture, dune ridge soil can be divided into two orders, namely, Entisol and Spodosol (MARDI 2010). Entisol is a younger soil type found nearer to the sea and more sandy compared with Spodosol.

Chemical and physical attributes of dune ridge soil contribute to their oligotrophic conditions. Dune ridge soil is structurally weak with more than 95% sand and very low percentage of clay and silt (Roslan et al. 2011). As a result, this soil has high infiltration rate, low water holding capacity and high soil surface temperature. Dune ridge soil is considered as unproductive and problematic for agriculture (Lim 2002). However, tremendous effort has been put in to improve soil for cash crops such as melons, mango and kenaf (MARDI 2010) as well as agroforestry species (Wan Rasidah et al. 2010). The combination of acidic soil (pH < 5), infertile soil with low macronutrient, organic matter and cation exchange capability (CEC) as well as high temperature (mean 31.2 °C) (Mohd Ekhwan et al. 2009) is not at all favourable for plant growth on dune ridge soil. However, variation in vegetation composition can be observed, possibly due to differences in nutrient availability (Jamilah et al. 2009) and water levels (Mohd Ekhwan et al. 2009). Low water retention causes dune ridge area to be exposed to drought during non-monsoon months in areas with low water table (dry dune) but flooded during monsoon months, particularly for wet interdunal areas which are inundated throughout the year (MARDI 2010).

The distinct formations of natural vegetation on dune landscape of Terengganu comprise lowland mixed dipterocarp forest, *Melaleuca* swamp and heath vegetation (Jamilah et al. 2011). Lowland mixed dipterocarp forest forms higher stature of vegetation confined to the forested area gazetted as Jambu Bongkok Forest Reserve (JBFR), classified as Beris soil forest. This forest reserve supports edaphic-associated forest where vegetation greatly depends on soil formation (Whitmore 1983). JBFR is dominated by *Shorea materialis* (balau pasir), an endemic species to Peninsular Malaysia and listed as critically endangered by the International Union for Conservation of Nature (IUCN). Census conducted in 2007 revealed that there were at least 168 individuals of woody tree and sapling in three 40 m × 30 m plots in JBFR (Jamilah et al. 2011). The majority of trees were in the class of 6–25 cm diameter at breast height (dbh), with rare occurrence of large trees of > 25 cm dbh.

Some areas with BRIS soil, particularly areas with Rusila soil series, become waterlogged with rain or flood from nearby river, forming seasonal freshwater swamp. The water has high content of dissolved organic components, slightly acidic (pH of 4.8) with 6.3 ± 1.2 mg L^{-1} dissolved oxygen and supports a reasonably high number of freshwater fish and dragonfly (Amiruddin et al. 2011a, b). This swamp is dominated by *M. cajuputi* almost as a pure stand. The old trees of *M. cajuputi* form a distinct and attractive coastal landscape of Terengganu. One of the associated species which is abundant during monsoon months is an endemic submerged sedge, *Websteria confervoides* (Cyperaceae). It is reported to occur only at two places in Peninsular Malaysia—Jambu Bongkok (Terengganu) and Tasik Bera (Pahang). *Lepironia articulata* (Cyperaceae) or rumput kercut, carnivorous plant *Nepenthes* (*N. gracilis*, *N. mirabilis* and *N. rafflessiana*) and *Drosera burmannii* have been found to be associated with *M. cajuputi* swamp (Jamilah et al. 2009).

Heath vegetation, another distinct formation on dune landscape of Terengganu, consists of stunted vegetation in stature and physiognomy, similar to true heath land vegetation found in temperate countries (Barry 2010, Calvo & Luis 2012), common vegetation on tropical mountain plateau (Chua et al. 1995) and kerangas forest (Katagiri et al. 1991). Heath plants tend to clump at more fertile sites with better availability of nutrients and water (Jamilah et al. 2011).

Due to soil conditions, dune landscape is a fragile landscape where slight modifications to its physical environment can lead to degradation of the original vegetation. Disturbed and degraded dune soil turns into sparse or open field. It is then dominated by *Imperata cylindrica* (lalang) and easily colonised by exotic *Acacia mangium* or indigenous species *Catunaregam tomentosa* (Rubiaceae) (Jamilah et al. 2009). Fragmentation through reclamation for housing and settlement is one of the major threats to dune landscape due to its location on flat terrains as well as it being

considered as waste and unproductive land for agriculture. The latest threat is perhaps coming from sand mining activity. Dune landscape as a wetland and edaphic-based ecosystem should receive more attention for its ecosystem services. Thus, this study was aimed at investigating the woody plant species diversity and composition on the dune landscape of Terengganu as an effort to establish a record of plants on threatened and neglected natural landscapes.

MATERIALS AND METHODS

At JBFR, a belt transect plot of 50 m × 100 m was established in Compartment 34 (Figure 1). The selection was made based on the fact that no similar census was conducted in this compartment before. All trees with 5 cm dbh and larger were marked, identified and their dbh measured. Identification of the plants was conducted in-situ. Specimens consisting of complete plant, stem with attached leaf, flower and fruit were collected and voucher specimens were deposited at the Universiti Malaysia Terengganu. To update heath vegetation checklist, census was conducted at two sites of dune ridge landscape: Jambu Bongkok in the district of Dungun (4° 54' N, 103° 22' E) and Lembah Bidong in the district of Setiu (5° 32' N, 102° 51' E) (Figure 1). These two sites were selected not only to update the previous woody plant checklist but also to compare the diversity and composition of plants between the two sites. At each site, two belt transect plots of 20 m × 20 m were established from north to south. Non-woody plants were sampled randomly inside and outside the study plots at both study sites. Voucher specimen for each plant species was prepared. Plant diversity and similarity index calculation for woody plants were determined using Shannon diversity index and Simpson's index (Krebs 2009).

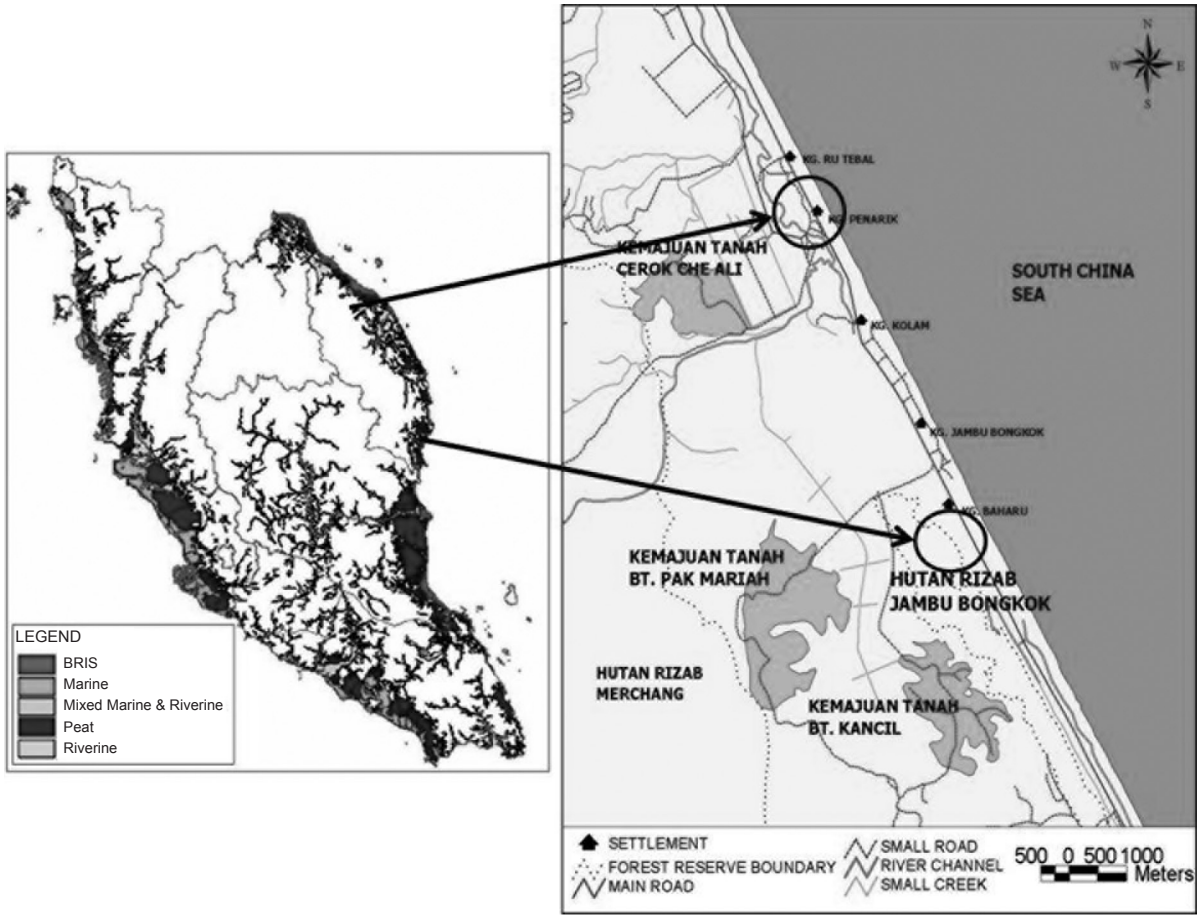

Figure 1 Beach Ridges Interspersed with Swales (BRIS) soil distribution and location of study sites for heath vegetation on BRIS soil ecosystem of Terengganu, Peninsular Malaysia; in the north is Lembah Bidong (upper circle) and south, Jambu Bongkok (lower circle); maps on the left and right are from Ministry of Agriculture and Forestry Department of Terengganu respectively

RESULTS AND DISCUSSION

In the forest formation, a total of 41 genera of woody plants from 22 families were recorded (Table 1). This comprised 44 identified species with 451 individual stems. In the list, 14 species were also recorded in the census in 2007. This compartment was dominated by *S. materialis* (Dipterocarpaceae), followed by *Knema pseudolaurina* (Myristicaceae), *Hopea megarawan* (Dipterocarpaceae) and *Diospyros ferrea* (Ebenaceae). The remaining species had abundance in the range of 0.2–5.8% of the total abundance, indicating a fairly low distribution of these species across the plot. The five most dominant families were Dipterocarpaceae, Myristicaceae, Ebenaceae, Annonaceae and Sapindaceae. Most other families were represented by less than 30 individuals. It is clear that this coastal forest is more favourable to *S. materialis* and this forest composition is different from other coastal forests that are mostly dominated by *Syzygium* (Myrtaceae) (Mat-Salleh et al. 2003). In terms of stem diameter, two-thirds of the trees were in the lowest diameter class of 5–15 cm dbh with only 18 trees measuring more than 50 cm dbh (Figure 2). Stiff competition for limited soil resources may have halted tree growth resulting in a more uniform tree size (Richards 1996).

A total of 48 woody plant species were recorded in the heath vegetation formation at both study sites (Table 2). Heath vegetation of Jambu Bongkok (38 species) had more species than Lembah Bidong (19 species). The most dominant families at Jambu Bongkok and Lembah Bidong were Euphorbiaceae and Myrtaceae respectively. The dominance of Euphorbiaceae is not surprising as Euphorbiaceae is commonly known to dominate or co-dominate many lowland forests of Malaysia and other short stature vegetation formations, bushes and secondary vegetation (Whitmore 1983, Newbery et al. 1992, Rahmad et al. 2009). Meanwhile, Myrtaceae or myrtles are among the common shrubs found in the coastal area of Peninsular Malaysia (Mat-Salleh et al. 2003) and South-East Asia, particularly in southern Thailand and Cambodia (Sridith & Laongpol 2003, Hiramatsu et al. 2007). Together with Ericaceae, myrtles make up common vegetation in other oligotrophic or xeromorphic ecosystems in the tropics such as montane forests (Kiew 1992, Culmsee & Pitopang 2009) and peat swamps (Mashhor & Asyraf 2012). Of the 27 families, only 10 were found at both study sites, suggesting that species from these families (Epacridaceae, Ericaceae, Myrsinaceae, Myrtaceae, Opiliaceae, Pittosporaceae, Rhizophoraceae, Rubiaceae, Sapindaceae and Sapotaceae) could be indicator plants for the dune landscape of Terengganu.

The disparity in the abundance and diversity of woody plants between the studied sites could be due to variation in soil resources (nutrients, oxygen and water) across the dune landscape as dune ridge soil was reported to be associated with 21 soil series (Mohd Ekhwan et al. 2009). It is also in accordance with vegetation types on other beach ridge sites, where a close association between species and interdependency is important (Aroujo & Pereira 2012). The result partly supports our earlier prediction that heath vegetation may hold site-specific species. However, this question needs to be clarified further. A number of woody species recorded in this study were also common on the sandbar along the eastern coast of Thailand peninsula (Sridith & Laongpol 2003) and open woodland patches in Kampong Thom, Cambodia (Hiramatsu et al. 2007). This co-occurrence of species suggests the possible history of connectivity among plant communities on the coastal dune ecosystem of Peninsular Malaysia, south of Thailand and Cambodia.

In terms of woody plant diversity, Jambu Bongkok had greater diversity index value as measured by both indices used in this study (Table 3). This showed that there was a higher probability of finding two different woody plant species in Jambu Bongkok compared with Lembah Bidong. The greater diversity observed in Jambu Bongkok could also be contributed by its location, which was in the vicinity of the protected area of JBFR. Disturbances in Lembah Bidong site were likely to be associated with equestrian activities nearby and the location of the plot which was located near the beach front. Only a few areas of heath vegetation were left as more and more areas were being disturbed and invaded by indigenous invasive species of *C. tomentosa* or exotic invasive species of *A. mangium* following disturbances (Jamilah et al. 2009). Severely disturbed areas on the dune landscape dominated by later seral species in the

Table 1 Family composition and species abundance of trees with 5 cm and larger diameter (breast height) recorded in 50 m × 100 m plot at Jambu Bongkok Forest Reserve, Dungun, Terengganu

Family	Species	Abundance	Occurrence in 2007
Anacardiaceae	*Bouea oppositifolia*	5	√
	Buchanania arborescens	2	
	Buchanania sessifolia	2	
	Canarium sp.	1	
	Drimycarpus luridus	1	
	Melanochlyla sp.	7	
Annonaceae	*Desmos* sp.	1	
	Goniothalamus ridleyii	6	
	Monocarpia marginalis	16	
	Polyalthia sp.	3	√
	Xylophia sp.	1	
Burseraceae	*Santiria laevigata*	4	
Clusiaceae	*Garcinia euginiifolia*	3	
	Garcinia hombroiniana	2	
	Mesua ferrea	10	
Dipterocarpaceae	*Hopea megarawan*	40	
	Shorea collina	4	
	Shorea materialis	96	√
	Vatica sp.	1	
Ebenaceae	*Diospyros ferrea*	30	√
Erythroxylaceae	*Erythroxylum cuneatum*	1	
Euphorbiaceae	*Cleistanthus sumatranus*	21	
	Croton laevifolius	3	√
	Pimelodendron griffithianum	1	
Fabaceae	*Sindora velutina*	1	
Fagaceae	*Lithocarpus* sp.	1	
Icacinaceae	*Stemonurus* sp.	1	
Lauraceae	*Alseodaphne* sp.	2	
	Beilschmiedia sp.	3	
	Litsea sp.	12	√
Lecythidaceae	*Barringtonia acutangula*	23	√
Meliaceae	*Aglaia* sp.	18	√
	Chisocheton sp.	2	
	Dysoxylum cauliflorum	4	
Myristicaceae	*Knema pseudolaurina*	47	√
	Myristica gigantea	3	
Myrtaceae	*Syzygium grande*	13	√
Polygalaceae	*Xanthophyllum* sp.	8	√
Rutaceae	*Maclurodendron porteri*	1	
Santalaceae	*Scleropytum pentandrum*	1	
Sapindaceae	*Xerospermum noronhianum*	26	√
Sapotaceae	*Madhuca* sp.	5	
	Palaquium sp.	3	√
Verbenaceae	*Vitex pinnata*	16	√
	Total abundance	451	

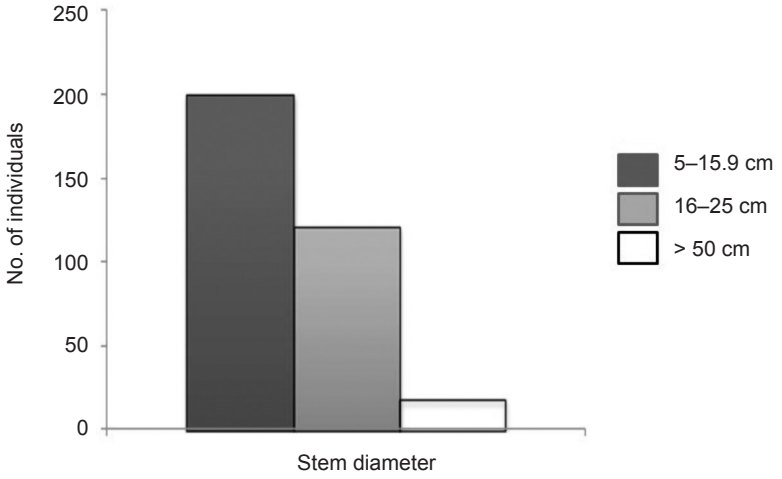

Figure 2 Tree diameter classes for trees sampled in 50 m × 100 m plot of Jambu Bongkok Forest Reserve, Dungun, Terengganu

disturbed areas included *Leptocarpus disjunctus* (Restionaceae), *Rynchospora brownii* (Cyperaceae) and *Eriachne pallescens* (Gramineae). Biotic interactions seemed important, for example plant–plant interaction observed between *Ficus deltoidea* and *Rhodomyrtus tomentosa* (Jamilah et al. 2011).

CONCLUSIONS

The vegetation was low in diversity and abundance but well adapted to prevailing soil conditions. The occurrence of endemic species and biological interactions here are worth given attention. Considering continuous threats to this ecosystem, mainly from fragmentation and degradation, it is highly recommended that vegetation formations outside forest reserves should be protected by law and monitored by the relevant authority possibly through in-situ conservation. This may be the only way to ensure that its biodiversity and ecosystem functions are maintained.

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Table 2 Comparison of woody plant species in heath vegetation formation in Jambu Bongkok and Lembah Bidong, Terengganu, Peninsular Malaysia

Family	Species	Local name	Habit	Jambu Bongkok	Lembah Bidong
Ancistrocladaceae	*Ancistrocladus tectorius*	Akar julong hitam	Liana	+	
Annonaceae	*Desmos* sp.	Kenanga akar	Shrub	+	
	Goniothalamus sp.	Mempisang	Shrub	+	
	Goniothalamus umbrosus	Kenerak	Tree	+	
Araliaceae	*Schefflera elliptica*	NA	Epiphyte		+
Clusiaceae	*Garcinia hombroniana*	Beruas	Tree	+	
	Garcinia nigrolineata	Kandis jantan	Tree	+	
	Garcinia scortechinii	Kandis	Tree	+	
Dipterocarpaceae	*Hopea megarawan*	Merawan hitam	Tree	+	
	Shorea materialis	Balau pasir	Tree	+	
Dracaenaceae	*Dracaena* sp.	Senjuang hutan	Shrub	+	
Ebenaceae	*Diospyros ferrea*	Kayu arang	Tree	+	
Epacridaceae	*Styphelia malayana*	Choreng atap	Shrub	+	+
Ericaceae	*Vaccinium bracteatum*	Mempadang	Small tree	+	+
Euphorbiaceae	*Antidesma cuspidatum*	Bruni	Tree	+	
	Croton laevifolius	NA	Tree	+	
	Phyllanthus oxyphyllus	NA	Shrub	+	
	Suregada multiflora	Limau hantu	Small tree	+	
Fabaceae	*Acacia auriculiformis*	Akasia kuning	Tree		+
	Acacia mangium	Akasia daun lebar	Tree		+
Gnetaceae	*Gnetum cuspidatum*	Akar anyang	Liana		
Lauraceae	*Neolitsea zeylanica*	Medang pasir	Tree	+	
Lecythidaceae	*Barringtonia acutangula*	Putat	Tree	+	
Melastomataceae	*Melastoma malabathricum*	Senduduk	Shrub		+
Moraceae	*Ficus deltoidea*	Mas cotek	Shrub		+
Myristicaceae	*Knema globularia*	Penarahan padi	Tree	+	
Myrsinaceae	*Ardisia crenata*	Mata ayam	Shrub	+	
	Rapanea porteriana	Kichar kichar	Tree	+	+
Myrtaceae	*Baeckea frutescens*	Cucur atap	Tree		+
	Melaleuca cajuputi	Gelam	Tree		+
	Rhodomyrtus tomentosa	Kemunting	Shrub		+
	Syzygium grande	Jambu laut	Tree	+	
	Syzygium zeylanicum	Gelam tikus	Tree		+
	Syzygium palembanicum	Kelat samak	Tree	+	+
	Syzygium sp. 1	Jambu	Tree	+	
	Syzygium sp. 2	Jambu	Tree	+	
Opiliaceae	*Champereia manillana*	Chemperai	Small tree	+	+
Pittosporaceae	*Pittosporum ferrugineum*	Belalang puak	Tree	+	+
Rhizophoraceae	*Carallia brachiata*	Meransi	Tree	+	+
Rubiaceae	*Canthium cochinchinense*	NA	Small tree	+	
	Ixora concinna	Jejarum	Shrub	+	+
	Psydrax sp.	Tulang-tulang	Small tree	+	
Rutaceae	*Atalantia monophylla.*	Empenai	Tree	+	
Sapindaceae	*Guioa bijuga*	Senyamok	Small tree	+	+
	Mischocarpus sundaicus	Sugi	Small tree	+	
	Xerospermum noronhianum	Rambutan pacat	Tree	+	
Sapotaceae	*Pouteria obovata*	Nyatoh puteh	Tree	+	+
Verbenaceae	*Vitex pinnata*	Leban	Tree	+	

NA = not available, + = presence of species

Table 3 Diversity indices of woody plant communities on heath vegetation of BRIS soil ecosystem of Terengganu, Peninsular Malaysia

Study site	No. of species	No. of individuals	Shannon index (H')	Simpson's index
Jambu Bongkok	38	444	3.16	0.94
Lembah Bidong	20	489	2.17	0.84

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