THE ROLE OF SELECTED ANIMALS IN POLLINATION AND DISPERSAL OF TREES IN THE FOREST: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

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LEE, S. S., NORSHAM SUHAINA, Y., BOON, K. S. & CHUA, L. S. L. 2002. The role of selected animals in pollination and dispersal of trees in the forest: implications for conservation and management. The current state of knowledge of the role of some plant-animal interactions in forest regeneration and conservation in Peninsular Malaysia is discussed. In particular, we focused on selected insect pollinators and animals which act as seed dispersers, for example, bats, primates, squirrels and birds. Tree species, including timber trees and endemic tree species utilised by bats, primates, squirrels, birds and selected insect pollinators are listed by their scientific as well as local names. The forest types where such species can be found are also identified. Some of the shortcomings of the currently available data are highlighted and means to overcome the situation are suggested.

Key words: Plant-animal interactions - pollinators - seed dispersers - conservation - forest regeneration

LEE, S. S., NORSHAM SUHAINA, Y., BOON, K. S. & CHUA, L. S. L. 2002. Peranan sesetengah haiwan dalam pendebungaan dan penyebaran pokok di hutan: implikasi untuk pemuliharaan dan pengurusan. Artikel ini membincangkan maklumat terkini mengenai peranan beberapa interaksi tumbuhan-haiwan terhadap regenerasi dan pemuliharaan hutan di Semenanjung Malaysia. Khususnya, kami menumpukan perhatian kepada beberapa serangga pendebungaan dan haiwan yang berperanan sebagai agen penyebaran biji benih, contohnya, kelawar, primat, tupai dan burung. Spesies pokok, termasuk pokok kayu balak dan jenis endemik yang digunakan oleh kelawar, primat, tupai dan burung disenaraikan mengikut nama saintifik serta nama tempatan. Jenis-jenis hutan yang terdapat pokok-pokok tersebut juga dikenal pasti. Beberapa kekurangan dari segi data semasa ditekankan dan cara-cara untuk mengatasinya dicadangkan.

Introduction

Plants have evolved a variety of mechanisms to ensure their successful pollination, dispersal and colonisation of suitable habitats. Some plants depend on wind while others depend on insects and animals for seed dispersal. An animal species may be the pollinator or dispersal agent of a specific plant species only or it may pollinate and disperse many different plant species. Plants, on the other hand, not only provide sources of food for insects and animals but also function as nesting and roosting sites. Less obvious, but more importantly, plants and trees provide organic matter and channel energy into the ecosystem through photosynthesis while animals play a very important role in decomposition and distribution of organic

matter. However, the myriad and complex plant-animal relationships are not the main topic of this paper and are best elaborated elsewhere. Suffice to say that these relationships are even more complex in the tropical rain forests where the diversity of flora and fauna is very high. It is estimated that there are about 15 000 species of flowering plants in Malaysia.

Pollinating and seed dispersal agents are called "mobile link" species (Gilbert 1980, Whitmore 1990) and they perform highly critical functions in the forest as they bridge otherwise unconnected components of the forest ecosystem (Whitmore 1990). In contrast to mobile link species, "keystone species" are plants that provide critical food resources for animals during annual periods of food scarcity which, if prolonged, may cause the extinction of those species which depend on these resources (Leighton & Leighton 1983, Terborgh 1986, Whitmore 1990). Logging changes the forest structure, thereby altering the availability of food and other resources for the animals. Reduced food resources may impact animal abundance and foraging behaviour, which in turn could have an effect on forest regeneration. Reduced populations or the disappearance of such frugivore species may result in the disappearance of plants that depend on these animals for seed dispersal.

This paper focuses on the current state of knowledge of selected insect pollinators and animals that act as seed dispersers and their implications for forest conservation and regeneration. The paper also highlights some of the shortcomings of currently available data and suggests means to overcome the situation.

Insect pollinators of trees in the forest

Insects are considered the most diverse group of living organisms in the world and an estimated 150 000 species are known from Malaysia (Anonymous 1997a). Insects play a variety of roles in the forest, ranging from pests of plants to agents of biological control. They also play a very important role as pollinators of many forest tree species. The bees, in particular the trigonids, and aphids are among the major insect groups responsible for the pollination of many plants in Malaysian forests; 65 species of timber trees and 19 species of non-timber trees have been reported to be pollinated by bees (Appendix 1). Thrips form another important group of insect pollinators (Appanah & Chan 1982, Momose *et al.* 1997). They are known to pollinate 23 species of timber trees and 13 species of non-timber trees in Malaysian rain forests (Appendix 1). Beetles are the third most important group of insect pollinators, they are reported to pollinate 35 species of timber trees and 3 species of non-timber trees in Malaysia (Appendix 1). Butterflies and moths (lepidopterans), insects in the fly order (dipterans), grasshopper order (orthopterans), cockroaches (blattodeans) and true bugs (hemipterans) are also pollinators of some forest trees. In view of the high plant diversity and the limited number of studies that have been carried out in Malaysian forests, the figures reported here represent only a fraction of the insect pollinators to be found in our forests.

Some insects are host specific, pollinating only one species of plant, e.g. the agaonid wasps which pollinate figs, but others, like the bees, are generalists. Bees are known to be important pollinators of a number of timber trees, including

Dryobalanops spp., *Neobalanocarpus heimii*, *Vatica* spp., *Shorea* section *Ovales* (Appanah 1987), *Sindora velutina* (Appanah 1985) and *Koompassia* spp. (Sakai *et al.* 1997a). In a study of 43 timber tree species at Lambir, Sarawak, about 19 species were reported to be pollinated by bees (Sakai *et al.* 1997a). One species of bee can pollinate many species of plants and sometimes one plant species can be pollinated by many species of bees, e.g. *Dryobalanops aromatica* (kapur) is known to be pollinated by 10 different species of bees (Sakai *et al.* 1997a). However, such detailed information is only available for a limited number of tree species. Information on the foraging patterns and feeding behaviour of the insects remains fragmentary.

Bats and birds as pollinators of trees in the forest

Some species of bats are known to be the main pollinators for species of economically important forest trees. Pteropodid bats, *Eonycteris spelaea* and *Macroglossus minimus*, are known as the main pollinators of *Durio* spp. which are important both for fruit as well as for timber (Start & Marshall 1976, Soepadmo & Eow 1976, Gould 1977, 1978, Marshall 1983). Two other species of pteropodids, namely, *Pteropus vampyrus* and *Cynopterus* sp., have also been reported to feed on flowers of *Durio* spp. (Gould 1977, Fujita & Tuttle 1991) but they are probably not important as pollinators as their visits are irregular and destructive. Pollen from 32 plant species have been found in the droppings of the three nectarivorous bats, *E. spelaea*, *M. minimus* and *M. sobrinus* (Start 1974, Start & Marshall 1976, Soepadmo & Eow 1976). These include pollen from the timber tree species *Bombax valetonii*, *D. zibethinus*, *Parkia* spp. including *P. speciosa* (petai), *Artocarpus* spp., *Palaquium* spp. (nyatoh) and *Sonneratia* spp., indicating that these bats are important pollinators for these tree species.

Among the birds, sunbirds and spider hunters (Nectariniidae) as well as white eyes/spectacle birds (Zosteropidae) are known as pollinators. These birds are small, active, arboreal birds that feed on nectar and small insects, as well as spiders. Wells (1988) recorded 10 species of sunbirds from the lowland forest of Peninsular Malaysia and observed that all spider hunters and *Aethopyga* as well as *Nectarinia* sunbirds of the lowland forest also range deeply into montane forests. However, although the characteristics of bird-pollinated flowers are well known (e.g. Meeuse 1961, Faegri & van der Pijl 1966), comprehensive data on the species of trees pollinated by birds is not available. Birds are known to pollinate at least 34 species of timber trees and 119 species of non-timber trees, including many species of climbers and palms (Appendix 1).

Frugivorous mammals and birds

A frugivore is defined as an animal whose diet is composed of 50% fleshy fruits (Terborgh 1986) and in this paper we use the term frugivore to loosely refer to those animals that are both obligatory and opportunistic fruit feeders. We focus on fruit eating bats, primates, squirrels and birds as these animals can be considered as seed dispersal agents.

Fruit eating bats

Bats make up about one third of the total number of mammalian fauna in Peninsular Malaysia and are divided into two suborders, the Megachiroptera and Microchiroptera. The former mainly feed on fruits with a few species feeding on nectar and pollen while the latter is insectivorous and/or carnivorous. In Malaysia, the role of bats as seed dispersal agents is still poorly understood as few studies have been conducted. One species that has been the subject of several studies is *Cynopterus brachyotis* which feeds on fruits. This bat is considered a potential seed dispersal agent because it carries fruits to feeding roosts located 50–70 m away from the fruiting tree (Funakoshi & Zubaid 1997). Fruit remnants, intact seeds, chewed leaves and flowers have been found underneath such roosts (Phua & Corlett 1989, Tan *et al.* 1998). The role of bats as pollinators is, however, well known. From direct observations and fecal samples, bats are known to pollinate many cultivated and forest trees, including timber species (Appendix 1).

Based on past studies, at least 80 plant species from 27 families of trees are known as sources of food (fruits, flowers, nectar) to bats (Appendix 1). Of these, 36 species from 17 families are timber trees and two, *Madhuca selangorica* and *Payena maingayi* (nyatoh durian), are endemic species. Both these species are from the family Sapotaceae and can be found in lowland forests. The latter can also be found in hill forests and is also a timber tree species. Since data on the food habits of bats in primary forests are scarce, we presently only know of a small number of economically important plant species that may be pollinated or dispersed by certain species of bats.

Primates

In Peninsular Malaysia, the primate fauna comprises one prosimian (*Nycticebus coucang*), three gibbons (*Hylobates agilis, H. lar* and *H. syndactylus*), three macaques (*Macaca arctoides, M. fascicularis* and *M. nemestrina*) and three langurs (*Presbytis cristata, P. melalophos* and *P. obscura*). Very little is known of the small, solitary and nocturnal slow loris (*N. coucang*) and it is not surprising that its role in seed dispersal has yet to be determined. Of the three gibbon species, the siamang (*H. syndactylus*) mainly feeds on leaves while the other two species feed on fruits. Figs were found to be an important source of food for all three species of gibbons (Chivers 1974, Gittins & Raemakers 1980). Macaques are reported to be omnivorous, feeding on fruits, leaves and insects (Harrison 1961, Lim 1968, Medway 1983). Of the three langurs, *P. cristata* is mainly folivorous (Kool cited in Laidlaw 1994). Half of the diet of *P. obscura* is made up of leaves while half of the diet of *P. melalophos* is made up of fruits and seeds (Curtin 1980).

Primates obtain food from a total of 410 species of plants, of which 222 are timber species. Plant families which have a high number of species utilised by primates for food are Moraceae (33 species), Annonaceae (32 species), Euphorbiaceae (29 species), Leguminosae (22 species), Meliaceae (19 species), Guttiferae (16 species), Anacardiaceae (15 species), Burseraceae and Ebenaceae

(14 species each), and Sapindaceae (13 species). Of the plants consumed by primates, 23 are endemic species (Appendix 1). However, this data is probably still far from complete.

Figs have been proposed as important keystone species for primates based on their characteristics and prominence in the diet of primates, i.e. large fruit crop and continuous availability due to the large number of species present (Raemakers *et al.* 1980). Studies in the lowland forest at Kuala Lompat, Pahang, Peninsular Malaysia, showed that there are plants other than figs that contribute to the diet of primates during seasons of low food availability and that some of these species are available almost all year round (Curtin 1980, Bennet 1983). It would appear that figs are not the keystone species for most primates with the exception perhaps of the siamang (*H. syndactylus*) where our observations show that figs make up the largest portion of their diet compared with other plant species. Yasuda (1998) reported that figs were not the keystone species for small mammals at Pasoh Forest Reserve, Negeri Sembilan, Peninsular Malaysia as their diversity and density were much lower than at Kuala Lompat. Similarly, Gautier-Horn and Michaloud (1989) found that figs were not the keystone species for mammals in Gabon due to their low densities, unpredictable fruiting patterns and low crown production.

There is presently very little information on the role of primates in seed dispersal. Among them, gibbons are the most likely seed dispersal agents because of their feeding characteristics. They only eat the ripe pulp of fruits, swallowing seeds of most species and excreting them whole, and often at great distances from the source trees. They also often revisit food sources, making them reliable seed transporters. Another potential seed dispersal agent is the long-tailed macaque (*M. fascicularis*) which often drop and spit out larger seeds, and carry more fruit away from the fruiting tree (Corlett & Lucas 1990). In contrast, most of the other primates are highly opportunistic and tend to destroy seeds during feeding (Gittins & Raemakers 1980).

Squirrels

The importance of squirrels as seed dispersal agents is unclear as there is data showing both their roles as seed predators as well as seed dispersal agents. Some species of squirrels are also known to consume unripe fruits which would make them unlikely as effective dispersal agents. The dentition of squirrels also allow them to gnaw through hard tissue thereby destroying the fruit embryo (MacKinnon 1978). On the other hand, some species of squirrels are known to drop seeds and/or consume the seeds far away from the fruiting tree and dropping some during transport. Some squirrels also bury seeds in the ground and unrecovered seeds could germinate and contribute to regeneration far away from the parent tree. More in-depth studies are needed to elucidate the role of squirrels in seed dispersal.

A total of 235 species of trees from 49 families are known to provide sources of food for squirrels. Of these 160 are timber species and 14 are endemic species (Appendix 1). Important families are the Euphorbiaceae (21 species), Leguminosae and Annonaceae (18 species each), Meliaceae and Anacardiaceae (16 species each)

and Burseraceae and Myristicaceae (10 species each). Squirrels generally eat the fruits and seeds of trees but leaves, bark and flowers are also sometimes consumed by some species.

Birds

Frugivorous birds are considered important mobile links by functioning as pollinators and seed dispersal agents. In Peninsular Malaysia, there are 19 species of obligate fruit eating birds, 13 of which are found in the lowlands and six in montane forests (Wells 1988). Of these 19 species, 10 species of pigeons and three species of parrots feed solely on fruits, seeds and flowers. Birds in the following families may be considered partially or wholly frugivorous: Bucerotidae (hornbills), Campephagidae (minivets), Capitonidae (barbets), Chloropseidae (leafbirds), Columbidae (pigeons), Corvidae (magpies and crows), Dicaeidae (flowerpeckers), Irenidae (Asian fairy bluebird), Oriolidae (orioles), Phasianidae (pheasants), Psittacidae (parrots), Pycnonotidae (bulbuls), Sturnidae (hill myna) and Timaliidae (babbler).

Birds are highly dependent on trees not only for food but also for nesting and perching and some birds feed on insects found on the trees. In a study conducted in a hill dipterocarp forest at Sungai Tekam Forest Reserve, Pahang, Peninsular Malaysia, Johns (1983) found that 22 species of birds were intolerant of forest disturbance. These birds are found in unlogged forest but not in older logged forests. Another 20 species only occurred in logged forests and these were categorised as colonising species. Based on his study of fig-eating birds in a lowland forest at Kuala Lompat, Lambert (1989) proposed figs as keystone resources for birds because of their abundance, aseasonal fruiting, enormous crop size, distinctive intra-crown synchrony of fruit ripening, short intervals between fruiting by individual trees, and ease of harvesting by different groups of frugivores. Another important factor is that *Ficus* is the only known plant taxon to which frugivorous birds in Southeast Asia have specialised (Lambert & Marshall 1991).

In comparison with the figs, detailed information on other tree species is lacking. Many trees on which birds depend for food have only been identified to genus level making it difficult to judge the importance of a particular tree family in providing sources of food for the birds. Presently about 153 species of trees from 54 families are known to provide sources of food to various frugivorous birds (Appendix 1), with the Moraceae being the most important family by far. Other tree families which are important as food sources for birds are the Palmae, Burseraceae and Sapindaceae. From the above discussion it is clear that our understanding of pollination and seed dispersal of tropical rain forest trees is very limited.

Discussion

It has been increasingly recognised that within a tropical rain forest, an incredible number of linkages exist between plants and animals, from the food chain to dependence on pollination, dispersal, provision of roosts and nest sites,

chemical defense and other functions. It is feared that if some of these links or interconnections are severed, whole ecosystems may collapse. For example, certain species of bats are the pollinators and dispersal agents for a large number of trees in the forest. If these bats become locally extirpated or severely decimated in numbers as a result of forest harvesting, a whole host of bat-dependent plants could become reproductively impotent. Such an event would threaten the successful regeneration of that group of plants. In addition, if that threatened plant group is economically useful, the fiscal value of the forest would also be considerably reduced. Therefore, for sustainable forest management, tree species that play important roles in animal-plant inter-relationships and that provide important sources of food or habitats for the mobile links, need to be recognised and retained or saved from damage.

An effort to retain some important food source trees during forest operations has been made by the Forestry Department, Peninsular Malaysia. The department's *Manual Kerja Luar Sistem Pengurusan Memilih* (Anonymous 1997b) is a commendable operations manual containing guidelines, rules and procedures aimed at guiding the staff of the Forestry Department in performing their duties and responsibilities in an organised, uniform and effective manner. Among many operational guidelines, this manual contains a list (on page 261) of forest trees which are sources of food for animals. These trees have been reported elsewhere as sources of food for primates and other animals and are not permitted to be girdled except in circumstances where they are likely to have an important impact on the regeneration of the residual stand. We believe that with some modification and improvement, this list can be a very important and useful tool for forest conservation and management purposes. Firstly, the references from which the list were derived should be provided so that the accuracy of the data can be verified. The present list is rather general as the groups of primates, squirrels and birds referred to are not stated. It is known that not all primates, squirrels and birds act as dispersal agents; many just consume and destroy fruits and seeds. Many other important animal food source trees need to be included in the list. In addition it is important to include trees which are vital to specific groups of pollinators whose presence and activity ensure the success of the regeneration of our desired crop trees as well as the continued functioning of the forest ecosystem.

Below we list some suggestions for improvement and usage of the aforementioned list. An example of an improved list is shown in Appendix 1. However, we would like to stress that our list is still far from complete or perfect and that review and modifications would be necessary as more comprehensive data become available.

(1) Local names of trees and forest types where the trees are found should be included.
(2) The list can be made more specific to include only those species which are known to be pollinated and dispersed by the identified mobile link species. (The list shown here is rather extensive and may need to be trimmed down).
(3) Timber and endemic trees as well as non-timber trees should be noted/ highlighted.

(4) As the list is to be used in Peninsular Malaysia, Bornean species need not be included.
(5) Sources of references for the list of tree species and their mobile links should be cited for ease of reference and verification of data.
(6) The inclusion of phenological data on flowering and fruiting seasons should be considered, perhaps as an additional appendix, as such information is important to indicate which sources of food are available when.
(7) Data on the range of the mobile link species need to be collected as this is linked to the issue of forest fragmentation. By so doing, the list can be made more concise with the inclusion of only a minimum set of important or critical food source trees.
(8) Training must be provided to field staff so that they are able to recognise these target trees. However, this is for the future. The more immediate need is to obtain detailed information on the mobile link species and keystone species in our forests so that a minimum set of species can be identified to ensure the continued regeneration and sustainable management of our forests.

Conclusions

Our understanding of the pollination and seed dispersal of many tropical rain forest trees is still very limited. Although we know that the Leguminosae, Moraceae, Annonaceae, Euphorbiaceae and Meliaceae are among the more important plant families that provide food for bats, primates, squirrels and birds, such data is insufficient to elucidate the effectiveness of these animals as efficient pollinators and/or seed dispersal agents. Similarly, although we know that some plants are highly dependent on specific pollinators, such data need to be interpreted carefully in the light of the few studies that have been carried out.

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Appendix 1 Tree species utilised by bats, primates, squirrels, birds and selected insect pollinators for food (timber (T) and endemic (E) tree species)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Alangiaceae	*Alangium ebenaceum* (T)		Mentulang daun bujur	LDF		+	+				
	Alangium ridleyi (T&E)		Mentulang daun lebar	LDF					+		
Anacardiaceae	*Bouea inaquifolia*		Kundang	LF		+					
	Bouea macrophylla (T)		Kundang hutan	LDF, HDF		+	+				
	Bouea oppositifolia (T)		Kundang rumenia	LDF, HDF		+	+				
	Buchanania arborescens (T)		Otak udang daun tumpul	CF, RV		+					
	Buchanania sessifolia (T)		Otak udang daun tajam	LDF, HDF		+	+				+
	Campnosperma auriculatum (T)		Terentang daun besar	LDF, MF	+	+	+		+		
	Dracontomelon dao (T)	*D. mangiferum*	Sengkuang	LDF, RV		+	+				
	Gluta elegans (T)		Rengas	LDF		+					
	Mangifera gracilipes (E)		Macang hutan daun halus				+				
	Mangifera griffithii (T)	*M. microphylla*	Rawa	LDF		+	+	+			
	Mangifera indica (T)		Mangga	Cultivated	+	+	+	+			
	Mangifera laurina (T)	*M. longipes*	Macang api	LDF		+	+	+			
	Mangifera macrophylla (T)		Macang temuor				+				
	Mangifera magnifica (T&E)		Macang						+		
	Mangifera quadrifida (T)		Macang	LDF, HDF		+	+	+			
	Mangifera spp.		Macang	LF	+	+	+				
	Melanorrhoea fulvinervis (T)						+				
	Melanorrhoea inappendiculata		Rengas	LF			+				
	Melanorrhoea malayana (T)		Rengas			+	+				
	Pentaspadon velutinus (T)		Pelong beludu	LDF, HDF		+	+				
	Semecarpus sp.							+			
Annonaceae	*Alphonsea elliptica* (T)		Mempisang, chaget	LDF		+	+				
	Annona squamosa		Buah nona	Cultivated	+			+			
	Cananga odorata (T)		Kenanga	LDFfm		+	+				
	Cyathocalyx carinatus		Antoi daun kecil	LF		+					
	Cyathocalyx pruniferus (T&E)		Antoi	LDF, HDF		+	+				
	Cyathocalyx scortechinii (E)		Antoi			+					
	Cyathocalyx sp.		Antoi	LF		+					
	Desmos sp. (liana)					+					
	Fissistigma sp.		Akar larak			+					
	Mezzetia parviflora (T)	*M. leptopoda*		LDF		+	+				
	Monocarpia marginalis (T)		Mempisang	LDF		+	+				
	Neo-uvaria foetida		Mempisang			+					

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Oxymitra filipes					+					
	Oxymitra sp.					+					
	Polyalthia cauliflora (T)		Mempisang			+					
	Polyalthia cinnamomea (T)		Segumpal hitam	LDF		+	+				
	Polyalthia clavigera		Chagau	LDF, HDF		+	+				
	Polyalthia glauca (T)		Mempisang	LDF(swamp)		+	+				
	Polyalthia hypoleuca (T)		Mempisang	LDF, PSF		+	+				+
	Polyalthia jenkensii		Mempisang	LDF		+	+				
	Polyalthia laterifolia		Pisang pisang	LDF to LMF		+	+				
	Polyalthia longifolia (T)		Mempisang	Cultivated	+						
	Polyalthia obliqua		Gaboi	LDF, HDF		+	+				
	Polyalthia rumphii (T)		Mempisang			+					
	Polyalthia sumatrana (T)			LDF, HDF			+				
	Polyalthia xanthopetala		Mempisang			+					
	Polyalthia sp.			LF, HF		+	+				
	Xylopia caudata (T)		Mempunai, benitan			+					
	Xylopia elliptica (E)		Jangkang			+					
	Xylopia ferruginea (T)		Jangkang bukit			+					
	Xylopia fusca (T)		Jangkang paya			+					
	Xylopia magna (E)			LDF, HDF		+	+				
	Xylopia malayana (T)		Tempunai, jangkang	LDF		+	+				
	Xylopia stenopetala (T)		Jangkang bukit	HDF		+	+				
	Xylopia sp.		Tempunai, mengkupas	LF		+	+				
Apocynaceae	*Alstonia angustiloba* (T)		Pulai	LDF, HDF		+					
	Alstonia pneumatophora (T)		Pulai basong	LDFs, HDF		+					
	Alstonia sp.		Pulai			+					
	Dyera costulata (T)		Jelutong	LDF		+			+		
	Kibatalia maingayi (T)		Jelutong pipit	LDF		+	+	+			
	Parameria sp. (liana)					+					
	Tabernaemontana sp.			LF		+					
	Willughbeia sp.					+					
Aquifolliaceae	*Ilex* sp.			MF				+			
Araliaeae	*Arthrophyllum* sp.			LFb				+			
Bignoniaceae	*Oroxylum indicum*		Bonglai	SF	+						
	Pajanelia longifolia (T)		Beka	LDF, HDFp,s	+						
	Stereospermum fimbriatum (T)		Chicha	LDF, HDF, planted		+	+				

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Blechnaceae	*Stenochlaena palustris* (fern)		Pakis	Open areas		+					
Bombacaceae	*Bombax valetonii* (T)		Kekabu hutan	LDF, HDF	+	+?					
	Ceiba pentandra		Kabu-kabu	Cultivated	+						
	Coelostegia griffithii (T)		Punggai								+
	Durio acutifolius (T)		Durian			+					
	Durio dulcis (T)		Durian			+					
	Durio graveolens (T)		Durian merah	LDF		+					
	Durio griffithii (T)		Durian tupai	LDF		+	+		+	+	
	Durio lowianus (T)		Durian daun	LDF		+					
	Durio oxleyanus (T)		Durian beludu	LDF		+	+				
	Durio singaporensis (T&E)		Durian bujor	LDF, HDF		+	+				
	Durio zibethinus (T)		Durian kampong	Cultivated	+	+	+				
	Neesia synandra (T)		Bengang	LDF		+	+				
Burseraceae	*Canarium decumanum* (T)		Kedondong			+					
	Canarium denticulatum (T)		Kedondong	LDF, HDF		+					
	Canarium dichotomum		Kedondong	LF		+			+		
	Canarium grandifolium (T)		Kedondong			+					
	Canarium hirsutum		Kedondong	LDF		+			+		
	Canarium latispulatum		Kedondong	LF		+			+		
	Canarium littorale (T)		Kedondong bulan	LDF		+	+				
	Canarium megalanthum (T)		Kedondong keruing	LDF		+	+				
	Canarium merrillii		Kedondong	LF		+			+		
	Canarium odontophyllum		Kedondong	LF		+			+		
	Canarium pilosum		Kedondong	LDF, HDF		+			+		
	Canarium sp.		Rawa	LF		+	+	+			
	Dacryodes incurvata (T)		Kedondong						+		
	Dacryodes laxa (T)		Kedondong mempelas						+		
	Dacryode rostrata (T)		Kedondong kerut	HDF			+	+			
	Dacryodes rugosa (T)		Kedondong matahari	LDF			+	+			
	Dacryodes sp.						+				
	Santiria griffithii (T)		Kedondong kerantai						+		
	Santiria laevigata (T)		Kedondong kerantai licin	LDF, MF		+	+	+			
	Santiria rubiginosa (T)		Kedondong kerantai				+				
	Santiria tomentosa (T)		Kedondong kerantai bulu				+				
	Santiria sp.			LF				+			
	Triomma malaccensis (T)		Kedondong kijal	LDF		+	+				+
Capparidaceae	*Capparis* sp.							+			
Caprifoliaceae	*Viburnum* sp.							+			

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Celastraceae	*Bhesa robusta* (T)		Biku-biku	LDF, HDF			+				
	Elaeodendron sp.			LF				+			
	Lophopetalum beccarianum		Mata ulat	LDF		+					
	Lophopetalum floribundum (T)		Mata ulat	LDF		+					
	Lophopetalum pallidum (T)		Mata ulat	LDF		+					
	Salacia macrophylla	*S. flavescens*	Nasi sejuk, hempedal itek	LDF, MF		+					
	Salacia sp.			LF		+					
Chrysobalanaceae	*Maranthes corymbosa* (T)		Merbatu	CF, MF		+	+				
	Parinari oblongifolia (T)		Merbatu	LDF		+	+				
	Parinari parva (T)			LDF, HDF		+	+				
	Prunus polystachys (T)		Pemanis halus			+					
Combretaceae	*Combretum* sp. (liana)					+					
	Terminalia bellirica (T)		Jelawai	LDF		+	+				
	Terminalia catappa (T)		Jelawai ketapang	CF, planted	+	+					
	Terminalia citrina (T)		Jelawai belang rimau	LDF			+				
	Terminalia sp.		Ketapang, jelawai	LF		+					
Compositae	*Vernonia arborea*		Menggambong	LF, MF				+			
Connaraceae	*Agelaea* sp. (liana)							+			
	Connarus sp. (liana)					+					
Convolvulaceae	*Erycibe* sp.							+			
Cucurbitaceae	*Macrozanonia macrocarpa* (liana)					+					
Datiscaceae	*Tetrameles nudiflora* (T)		Mengkundor	LDF			+				
Dilleniaceae	*Dillenia pulchella* (T)		Simpoh paya	LDF		+	+				
	Dillenia reticulata (T)		Simpoh gajah	LDF		+	+				
	Dillenia suffruticosa		Simpoh air	LFb						+	
	Dillenia sumatrana (T)			LDF		+					
	Dillenia sp.		Simpoh	LF		+				+	
	Tetracera (liana)					+					
Dipterocarpaceae	*Anisoptera laevis* (T)		Mersawa durian	LDF		+					
	Anisoptera sp.(T)		Mersawa			+					
	Dipterocarpus baudii (T)		Keruing bulu	LDF		+					
	Dipterocarpus borneensis (T) (Borneo)										+
	Dipterocarpus caudatus (T)		Keruing gasing								+
	Dipterocarpus cornutus (T)		Keruing betul	LDF, HDF, ridges			+				

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Dipterocarpus geniculatus (T) (Borneo)										+
	Dipterocarpus globosus (T) (Borneo)								+		
	Dipterocarpus obtusifolius (T)		Keruing beludu	LDF, Perlis						+	
	Dipterocarpus palembanicus (T)		Keruing temek	LF along streams							+
	Dipterocarpus tempehes (T) (Borneo)								+		
	Dryobalanops lanceolata (T) (Borneo)								+		
	Hopea griffithii (T)		Merawan jantan	HDF							+
	Hopea sp. (T)					+					
	Neobalanocarpus heimii (T)		Cengal	LDF, HDF					+	+	
	Parashorea smythiesii (T) (Borneo)								+		
	Shorea acuminata (T)		Meranti rambai daun	LDF, HDF						+	
	Shorea bracteolata (T)		Meranti pa'ang	LDF, HDF		+	+				
	Shorea beccariana (T) (Borneo)										+
	Shorea curtisii (T)		Meranti seraya	CHF, HDF, ridges						+	+
	Shorea dasyphylla (T)		Meranti batu	LDF, HDF						+	
	Shorea exelliptica (T)		Balau tembaga								+
	Shorea faguetiana (T)		Damar hitam siput	HDF							+
	Shorea falciferoides (T) (Borneo)										+
	Shorea fallax (T) (Borneo)										+
	Shorea ferruginea (T) (Borneo)										+
	Shorea havilandii (T) (Borneo)										+
	Shorea hopeifolia (T)		Damar hitam siput jantan	LDF, HDF		+					
	Shorea kunstleri (T)		Damar laut merah	LDF, north							+
	Shorea lepidota (T)		Meranti langgong	LDF		+	+			+	
	Shorea leprosula (T)		Meranti tembaga	LDF, HDF		+				+	+
	Shorea macrophylla (T) (Borneo)										+
	Shorea macroptera (T)		Meranti melantai	LDF, HDF							+
	Shorea parvifolia (T)		Meranti sarang punai	LDF, HDF						+	
	Shorea platyclados (T)		Meranti bukit	HDF			+				
	Shorea quadrinervis (T) (Borneo)										+
	Shorea scaberrima (T) (Borneo)										+
	Shorea smithiana (T) (Borneo)										+
	Shorea sumatrana (T)		Balau sengkawang air	RV		+					
	Shorea xanthophylla (T) (Borneo)										+
	Vatica bella (T), (E)		Resak keluang	LDF		+	+				
	Vatica spp. (T)		Resak	LDF		+	+				

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Ebenaceae	*Diospyros andamanica*		Kayu arang	LDF		+					
	Diospyros borneensis		Kayu arang	LDF		+					
	Diospyros cf. *pendula*		Kayu arang			+					
	Diospyros curranii (T)		Kayu arang			+					
	Diospyros curraniopsis		Kayu arang			+					
	Diospyros ellipsoidea		Kayu arang	LDF, HDF		+					
	Diospyros foxworthyi (T&E)		Kayu arang	HDF, LMF		+					
	Diospyros hallierii		Kayu arang			+					
	Diospyros laevigata		Kayu arang			+					
	Diospyros macrophylla (T)		Kayu arang			+					
	Diospyros maingayi (T)		Kayu arang	LDF, HDF		+					
	Diospyros perfida		Kayu arang			+					
	Diospyros pilosanthera (T)		Kayu arang			+					
	Diospyros sp.		Kayu hitam	Mostly LF	+	+	+			+	
Elaeocarpaceae	*Elaeocarpus stipularis* (T)			LDF, MF	+						
	Elaeocarpus sp.		Mendong	Mostly LF		+	+				
	Muntingia calabura		Buah ceri	Waste grounds	+			+			
Ericaceae	*Vaccinium* sp.							+			
Erythroxylaceae	*Erythroxylon cuneatum* (T)		Cinta mula	LDF, HDF		+					
Euphorbiaceae	*Antidesma coriaceum* (T)			LDF, MF		+					
	Antisdesma spp.		Tebasah, buni			+	+	+			
	Aporusa spp.		Tebasah	Mostly LF		+	+	+			
	Austrobuxus nitidus (T)		Tebasah terang				+				
	Baccaurea angulata (T)		Jintik-jintik			+					
	Baccaurea brevipes		Rambai	LDF		+	+				
	Baccaurea costulata		Jintik-jintik			+					
	Baccaurea griffithii (E)		Tampoi				+				
	Baccaurea kunstleri (T)		Jintik-jintik	LDF, HDF		+					
	Baccaurea macrocarpa		Tampoi, taban	LF		+					
	Baccaurea macrophylla (T)		Jintik-jintik	LDF		+					
	Baccaurea motleyana		Rambai	LDF, HDF		+					
	Baccaurea parvifolia		Setambun	LF			+				
	Baccaurea pyriformis		Tampoi tunggau, t. burong	Cultivated			+				
	Baccaurea racemosa		Tambun				+				
	Baccaurea trigonocarpa		Jintik-jintik			+					
	Blumeodendron calophyllum		Katong kura, gaharu badak	LDF		+	+				

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Blumeodendron kurzii (T)		Gaham badak	LDF		+					
	Breynia sp.		Open areas					+			
	Bridelia cinnamomea		Pisit				+				
	Bridelia sp.							+			
	Cleidion javanicum		Bayam bali				+				
	Croton argyratus		Kemesat	LFfm, HF		+	+				
	Elateriospermum petiolatus (T)		Kentet			+	+				
	Elateriospermum tapos (T)		Perah	LDF, HDF		+	+				
	Endospermum diadenum (T)	*E. malaccense*	Sesendok	LDF, MF		+	+		+		
	Glochidion sp.			LF, LFb, HF		+					
	Hevea brasiliensis		Pokok getah	Cultivated	+	+					
	Macaranga hypoleuca (T)		Mahang puteh	SF		+	+	+			
	Macaranga recurvata		Tarak	LDFs		+					
	Macaranga sp.		Mahang	LFb				+		+	
	Mallotus leucodermis (T)		Perupok, balik angin	LDF		+	+				
	Mallotus muticus (T)			LDFs		+					
	Mallotus sp.		Balik angin	LFb		+				+	
	Neoscortechinii kingii (T)		Jintik-jintik, tampang paya	LDF		+					
	Phyllanthus sp.							+			
	Pimelodendron calophyllum					+					
	Pimelodendron griffithianum (T)		Perah ikan	LDF		+					
	Pimelodendron macrocarpum (T)		Depor	LDFs		+	+				
	Sapium baccatum (T)		Ludai	LDF, HDF		+	+				
	Sapium discolor (T)		Mamah pelandok				+				
	Sapium sp.						+	+			
Fagaceae	*Castanopsis curtisii* (T&E)		Berangan	LDF		+	+		+		
	Castanopsis inermis (T)		Berangan babi	LDF, HDF		+	+		+		
	Castanopsis megacarpa (T)		Berangan, gertak tangga	LDF, HDF		+	+		+		
	Castanopsis nepheliodes (E)		Berangan babi	LDF, HDF		+			+		
	Lithocarpus cyclophorus (T)			MF		+		+	+		
	Lithocarpus lucidus (T)		Mempening	LDF to MF		+			+		
	Lithocarpus sundaicus (T)		Mempening	LDF		+	+		+		
	Lithocarpus spp.		Mempening			+	+	+	+		
Flacourtiaceae	*Casearia capitellata*		Benglin	LDF		+	+				
	Flacourtia inermis		Rukam masam	Cultivated	+	+					
	Flacourtia rukam		Rukam manis	LDF, MF		+					
	Flacourtia sp.							+			

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Paropsia vareciformis (T)		Mendulang, minyak puteri	LDF, HDF		+	+		+		
	Ryparosa hullettii (T)			LDFs		+					
	Scolopia spinosa (T)			LDF		+	+				
Gesneriaceae	*Aeschynanthus* sp.							+			
Gnetaceae	*Gnetum funiculare*		Belinjau				+				
	Gnetum macrostachyum			LDF		+					
	Gnetum sp.					+					
Guttiferae	*Calophyllum curtisii* (T)					+	+				
	Calophyllum calaba var. *bracteatum* (T)	*C. curtisii*		LDF, HDF		+	+				
	Calophyllum floribundum (T)					+					
	Calophyllum formosum					+					
	Calophyllum hosei (T) (Borneo)								+		
	Calophyllum inophyllum (T)		Bintangor laut	CF	+				+		
	Calophyllum macrocarpum (T)		Bintangor bunut	LDF, HDF		+	+		+		
	Calophyllum nodosum (T) (Borneo)								+		
	Calophyllum tetrapterum var. *tetrapterum* (T)	*C. floribundum*		LDF, HDF		+			+		
	Calophyllum sp.				+	+	+	+			
	Garcinia atroviridis (T)		Asam gelugor	LDF, HDF		+	+			+	
	Garcinia beccarii		Kandis			+			+		
	Garcinia forbesii (T)		Kandis	LDF to MF		+					
	Garcinia griffithii (T)		Kandis	LDF, HDF		+					
	Garcinia nervosa (T)			LDF		+					
	Garcinia parvifolia (T)		Tempiles	LDF, HDF		+	+				
	Garcinia prainiana (E)			LDF		+					
	Garcinia rostrata			LF, HF		+					
	Garcinia sp.			LF, HF		+					
	Mesua ferrea (T)		Penaga					+		+	
	Mesua grandis		Penaga bayan						+		
Hypericaceae	*Cratoxylum arborescens* (T)		Geronggang geronggang	LDFs, HF		+	+		+		
	Cratoxylum cochinchinensis (T)		Geronggang derum seluncor	LDF, HDF		+	+		+		
	Cratoxylum formosum (T)		Geronggang derum	LDF, HDF		+	+		+		
Icacinaceae	*Gomphandra* sp.		Chemperai			+		+			
Ixonanthaceae	*Ixonanthes icosandra* (T)		Pagar anak	LDF		+	+		+		

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Lauraceae	*Actinodaphne* sp.							+			
	Alseodaphne sp.		Berambong daun satu			+	+	+			
	Beilschmiedia spp.		Medang			+					
	Cinnamomum iners (T)		Medang teja	LDF, HDF		+			+		
	Cinnamomum sp. (T)							+			
	Cryptocarya sp.		Gamak	LF, HF		+		+			
	Dehaasia elliptica (T)		Medang			+	+				
	Dehaasia incrassata (T)		Medang	LDFrv		+	+				
	Dehaasia polyneura (T)	*D. elliptica*		LDF		+	+				
	Dehaasia spp.		Medang			+	+				
	Endiandra sp.		Medang			+	+				
	Litsea spp. (T)		Medang			+	+	+			
	Machilus sp.							+			
	Nothaphoebe umbelliflora (T)		Medang	LDF to MF		+	+				
Lecythidaceae	*Barringtonia* spp.		Putat	LF, HF, RV	+						
	Planchonia valida (T)		Putat	LDF		+					
Leguminosae	*Acacia concinna* (liana)	*A. pennata*		LDFfm		+					
	Adenanthera bicolor		Saga	LF, cultivated						+	
	Archidendron bubalinum (T)	*Pithecellobium bulbalinum*	Kerdas	LFb		+	+		+		
	Archidendron clypearia	*Pithecellobium clypearia*	Gonderik buah merah	LF			+	+			
	Archidendron contortum	*Pithecellobium contortum*	Gonderik buah hitam	LF			+	+			
	Archidendron jiringa	*Pithecellobium jiringa*	Jiring	LF, cultivated		+	+				
	Bauhinia purpurea			Cultivated	+						
	Callerya atropurpurea (T)	*Milletia atropurpurea*	Tulang daing	Open areas		+	+		+		
	Cassia fistula			Cultivated	+						
	Cassia javanica ssp. *nodosa* (T)	*C. nodosa*	Bebusok	LDF		+			+		
	Cassia spectabilis			Cultivated	+						
	Cynometra malaccensis (T)	*C. inaequifolia*	Kekatong	LDF, HDF		+	+		+		
	Derris sp. (liana)					+					
	Dialium indum var. *indum* (T)	*D. laurinum*, *D. patens*	Keranji paya	LDF		+	+		+		
	Dialium kuntsleri (T) (Borneo)								+		

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Dialium platysepalum (T)		Keranji kuning besar	LDF		+	+		+		
	Dialium procerum (T)		Keranji tunggal	LDF		+	+				
	Dialium sp.			LF		+					
	Entada sp. (liana)							+			
	Erythrina glauca			Cultivated	+			+			
	Erythrina orientalis (T)	*E. variegata*	Dedap	Cultivated	+			+			
	Erythrina subumbrans			Cultivated	+			+			
	Erythrina variegata			Cultivated				+			
	Inga sp.							+			
	Intsia palembanica (T)		Merbau	LDF		+	+				
	Intsia sp.							+			
	Koompassia excelsa (T)		Tualang	LDF		+	+		+		
	Koompassia malaccensis (T)		Kempas	LDF, HDF		+	+		+		
	Melanoxylon sp.							+			
	Microtropis sp.					+	+				
	Millettia hemsleyana		Jada	RV		+					
	Parkia singularis (T)		Petai meranti	LDF, HDF	+						
	Parkia speciosa (T)		Petai	LDF, HDF	+	+	+	+		+	
	Parkia timoriana (T)	*P. javanica*	Kerayong	LDF, HDF	+	+	+				
	Parkia sp.			LF	+			+			
	Peltophorum pterocarpum (T)		Jemerlang laut	CF	+	+			+		
	Saraca thaipingensis	*S. cauliflora*	Gapis	LDF, HDF		+	+		+		
	Sindora beccariana (T) (Borneo)								+		
	Sindora coriacea (T)		Sepetir licin	LDF		+	+				
	Sindora irpicina (T) (Borneo)								+		
	Sindora velutina (T)		Sepetir beludu besar				+				
	Spatholobus sp. (liana)					+					
Linaceae	*Indorouchera griffithi* (liana)			LDF, HDF		+					
Loganiaceae	*Fagraea auriculata* (liana)			LDF to MF		+					
	Fagraea fragrans (T)		Tembusu	Open and swamp areas, cultivated	+	+			+		
	Strychnos sp. (liana)					+		+			
Loranthaceae	*Loranthus* sp. (hemiparasite)							+			
	Viscum sp. (hemiparasite)							+			
Lythraceae	*Lagerstroemia speciosa* (T)	*L. flos-reginae*	Bungor	Open areas, cultivated		+					

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Magnoliaceae	*Magnolia elegans* (T)	*Aromadendron elegans*		LDF, HDF		+		+			+
	Michelia sp.		Chempaka					+			+
	Talauma gigantifolia					+					+
	Talauma gitingensis					+					+
Malvaceae	*Hibiscus floccosus* (T&E)		Bebaru, kangsar	LDF		+	+		+		
	Hibiscus macrophyllus (T)		Tutor	LDF		+			+		
Melastomataceae	*Memecylon excelsum* (T)	*M. heteropleurum*	Jambu baning, kuku baning	LDF to MF		+					
	Melastoma sp.			Waste ground				+			
	Memecylon garcinoides (T)		Nipis kulit	LDF, HDF		+					
	Memecylon oleifolium		Nipis kulit besar				+				
	Memecylon sp.		Nipis kulit	LF, HF			+				
	Pternandra coerulescens (T)	*P. capitellata*	Hembuyan daun kasar	LDF, HDF		+	+				
	Pternandra echinata (T)		Hembuyan daun halus	LDF, HDF	+	+	+				
	Pternandra sp.		Chenderai, cherang	LF		+					
Meliaceae	*Aglaia affinis*		Pasak, memberas			+					
	Aglaia ?aquea		Pelai tupai			+	+				
	Aglaia domesticum					+					
	Aglaia elliptica						+				
	Aglaia ganggo (T)					+	+				
	Aglaia malaccensis (T)	*Amoora malaccensis*		LDF, HDF		+	+				
	Aglaia odoratissima (T)					+					
	Aglaia oligocarpa							+			
	Aglaia ?pseudolansium					+	+				
	Aglaia rufibarbis (T&E)					+	+				
	Aglaia teysmanniana							+			
	Aglaia sp.	*Amoora* sp.	Bekak, pasak	Mostly LF		+	+	+		+	
	Aphanamixis borneensis					+	+				
	Chisocheton ?annulatus		Ganding bulu				+				
	Chisocheton erythrocarpus (T)		Ganding buah merah	LDF		+				+	
	Chisocheton princeps		Ganding betul				+				
	Chisocheton spp. (5 spp.)					+					
	Dysoxylum acutangulum (T)						+				
	Dysoxylum alliaceum	*D. costulatum*	Lawen	LDF to MF		+	+				

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Dysoxylum cauliflorum (Borneo) (T)								+		
	Dysoxylum spp.		Mersindok	Mostly LF		+	+	+			
	Lansium domesticum (T)		Langsat	LDF, cultivated		+	+			+	
	Melia sp.							+			
	Reinwardtiodendron humile			LDF, HDF		+					
	Sandoricum koetjapi (T)		Sentul	LDF, HDF		+	+				
	Sandoricum sp.			LF		+					
	Walsura pinnata (T)	*W. neuroides*	Mersindok	LDF, HDF		+	+				
Menispermaceae	*Fibraurea* sp. (liana)							+			
Moraceae	*Antiaris toxicaria* (T)		Ipoh	LDF		+	+				
	Artocarpus fulvicortex (T)		Keledang tampang gajah	LDF	+						
	Artocarpus integer var. *silvestris*		Cempedak	LDF to MF		+	+				
	Artocarpus lanceifolius (T)		Keledang keledang	LDF, HDF		+					
	Artocarpus lowii (T)		Miku	LDF		+					
	Artocarpus maingayi (T)		Pudu	LDF	+						
	Artocarpus rigidus (T)		Keledang tampang	LDF, HDF		+	+				
	Artocarpus scortechinii (T)		Terap hitam	LDF		+	+				
	Artocarpus spp.				+	+	+				
	Ficus annulata (T)		Kuap	LDF		+					
	Ficus aurantiacea		Ara	LDF		+		+			
	Ficus benjamina		Ara	LDF, cultivated	+	+		+			
	Ficus binnendykii		Ara	LDF		+		+			
	Ficus bracteata (T)		Ara	LDF		+		+			
	Ficus callophylla		Ara			+					
	Ficus caulocarpa		Ara	Wild and cultivated		+		+			
	Ficus consociata		Ara	LF, RV, seashores		+		+			
	Ficus crassiramea		Ara	LF, villages		+		+			
	Ficus cucurbitina		Ara	BF				+			
	Ficus delosyce		Ara	LDF				+			
	Ficus drupacea		Ara	LDF, HDF		+		+			
	Ficus dubia		Ara	LDF		+		+			
	Ficus fistulosa (T)		Ara	SF, wayside	+						
	Ficus heteropleura		Ara	LDF to MF		+		+			
	Ficus kerkhovenii		Ara	LDF to MF		+		+			
	Ficus obscura var. *borneensis* (T)	*F. obscura*	Ara	LDF				+			
	Ficus parietalis		Ara	LDF		+		+			

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Ficus pellucidopunctata		Ara	LDF		+		+			
	Ficus pisocarpa		Ara	LDFrv				+			
	Ficus religiosa		Ara	Cultivated	+						
	Ficus roxburghii		Ara	Cultivated	+						
	Ficus ruginervia		Ara	LDF		+					
	Ficus sagittata		Ara	LDF			+	+			
	Ficus stricta		Ara	LDF				+			
	Ficus stupenda		Ara	HDF to MF		+		+			
	Ficus subcordata var. *malayana*	*F. subcordata*	Ara	HDF				+			
	Ficus subulata		Ara	LDF, HDF		+					
	Ficus sumatrana		Ara	LDF		+		+			
	Ficus sundaica (T)		Ara	LDF		+		+			
	Ficus sundaica var. *sundaica*	*F. indica*	Ara	LDF		+					
	Ficus trichocarpa		Ara	LDF, HDF				+			
	Ficus vasculosa (T)		Ara	LDF		+					
	Ficus virens (T)		Ara	LDF		+		+			
	Ficus virens var. *glabella*	*F. glabbella*	Ara	LDF, HDF		+		+			
	Paratocarpus bracteatus		Berteh	LDF, HDF		+	+				
	Sloetia elongata (T)		Tebakah			+	+				
	Streblus sp.			Mostly LF				+			
Musaceae	*Musa acuminata* ssp. *malaccensis*	*M. malaccensis*	Pisang	LDF to LMF	+		+				
	Musa acuminata ssp. *microcarpa*	*M. truncata*	Pisang	MF	+						
	Musa sp.		Pisang	Cultivated	+						
Myricaceae	*Myrica* sp.		Telur cicak	CF				+			
Myristicaceae	*Gymnacranthera* sp.				+						
	Horsfieldia irya (T)		Pianggu, penggu	LDF, lowlying RV		+	+	+			+
	Horsfieldia polyspherula (T)		Penarahan					+		+	+
	Horsfieldia sucosa (T&E)		Penarahan	LDF		+	+	+			+
	Horsfieldia superba (T)		Penarahan				+	+			+
	Horsfieldia spp.		Penarahan			+	+			+	
	Knema cinerea		Basong paya			+					
	Knema furfuracea (T)		Penarahan	LF			+	+			+
	Knema hookeriana (T)		Penarahan	LDF, HDF		+	+	+			+
	Knema laurina (T)		Basong bulu	LDF		+	+				
	Knema spp.		Penarahan			+	+	+			
	Myristica gigantea (T)		Penarahan arang bukit	LDF		+	+	+			+

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Myristica iners (T)		Penarahan arang bukit	LDF		+		+			+
	Myristica maingayi (T&E)		Penarahan	LDF		+		+			+
	Myristica spp.		Penarahan			+	+	+			
Myrsinaceae	*Ardisia colorata*		Mata pelandok	LF, HF		+	+				
	Ardisia polyactis		Mata pelandok			+	+				
	Ardisia sp.							+			
	Embelia sp.							+			
Myrtaceae	*Eugenia aquea*		Jambu air	Cultivated	+						
	Eugenia jambos	*Eugenia malaccensis*	Jambu	Cultivated	+						
	Eugenia malaccensis	*Eugenia jambos*	Jambu	Cultivated	+						
	Eugenia variegata		Jambu		+						
	Eugenia spp.					+	+	+			
	Psidium guajava		Jambu batu	Cultivated	+						
	Rhodamnia trinerva (T)					+	+				
	Rhodamnia sp.							+			
	Syzygium grande	*E. grandis*		CF, cultivated	+				+		
	Syzgium spp.					+					
Ochnaceae	*Gomphia* sp. (T)							+			
Olacaceae	*Ochanostachys amentacea* (T)		Petaling	LDF, HDF		+	+				
	Scorodocarpus borneensis (T)		Kulim						+		
	Strombosia javanica (T)		Dedali	LDF		+	+				
Oleaceae	*Olea* sp.							+			
Oxalidaceae	*Sarcotheca griffithii* (T)		Pupoi	LDF		+	+				
	Sarcotheca monophylla		Penondok	LDF		+	+				
Palmae	*Arenga* spp.				+						
	Arenga westerhoutii			HDF		+					
	Calamus edulis (liana)					+					
	Calamus urens (liana)					+					
	Calamus spp. (liana)					+		+			
	Caryota mitis		Tukas, rabok	SF				+			
	Chrysalidocarpus lutescens		Pinang kuning		+						
	Cocos nucifera		Kelapa	CF, cultivated	+						

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Corypha sp.							+			
	Elaeis guineensis		Kelapa sawit	Cultivated		+					
	Iguanura sp.							+			
	Licuala grandis		Pinang kipas		+						
	Licuala spp.							+			
	Livistona chinensis		Serdang		+						
	Livistona rotundifolia (T)				+						
	Nenga sp.							+			
	Oncosperma horridum (T)			LDF, HDF		+					
	Oncosperma tigillarium (T)		Nibong	Near coast				+			
	Phoenix sp.							+			
	Ptychosperma macarthurii			Cultivated	+			+	+		
	Roystonea regia			Cultivated	+						
Passifloraceae	*Cephalandra* sp. (liana)							+			
Piperaceae	*Piper aduncum*			MF, introduced	+						
Polygalaceae	*Xanthophyllum affine* (T)		Bereher	LDF to MF		+			+	+	
	Xanthophyllum amoenum (T)		Minyak berok	LDF, HDF		+			+	+	
	Xanthophyllum excelsum (T)		Minyak berok			+	+		+	+	
	Xanthophyllum rufum (T)		Minyak berok	LDF		+	+		+	+	
	Xanthophyllum scortechinii (T)		Minyak berok			+	+		+	+	
	Xanthophyllum stipitatum (T)			LDF, HDF		+			+	+	
	Xanthophyllum spp. (6 spp.)		Minyak berok			+			+	+	
Proteaceae	*Heliciopsis velutina* (E)		Sawa luka	LDF		+			+	+	
	Heliciopsis sp.		Dumpung				+				
Rhamnaceae	*Rhamnus* sp.							+			
	Ventilago sp. (liana)					+					
	Zizyphus sp.							+			
Rhizophoraceae	*Anisophyllea grandis* (E)		Delek	LDF, HDF		+					
	Carallia brachiata (T)		Meransi	LDF, HDF	+	+	+				
	Gynotroches axillaris (T)		Mata keli	LDF to MF		+	+				
	Pellacalyx saccardianus (T&E)		Membuloh	LDF, HDF	+		+				
	Rhizophora spp.							+	+		

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Rosaceae	*Eriobotrys* sp.							+			
	Maranthes sp.							+			
	Parastemon urophyllus (T)		Nyalas						+		
	Prunus polystachys (T)		Pepijat?	LDF		+					
	Prunus sp.							+			
Rubiaceae	*Canthium confertum* (T)			LDF to MF		+	+				
	Canthium sp.		Babi kurus			+					
	Diplospora malaccensis		Pelung	LDF to MF		+					
	Gardenia carinata (T)			LDF, HDF		+	+				
	Ixora sp.									+	
	Morinda sp.		Mengkudu			+					
	Nauclea, Neonauclea spp.					+					
	Porterandia anisophyllea (T)	*Randia anisophyllea, R. scortechinii*	Tinjau belukar	LDF, HDF		+	+				
	Psychotria sp.							+			
	Wendlandia?					+					
	Uncaria sp.(liana)					+	+				
Rutaceae	*Aegeles* sp.					+					
	Euodia glabra (T)						+				
	Euodia sp.			LF, HF				+			
	Maclurodendron porteri (T&E)	*Acronychia porteri*	Chenderoh daun satu	LDF to MF		+					
	Zanthophyllum sp.							+			
Salvadoraceae	*Salvadora* sp.							+			
Santalaceae	*Santalum* sp.							+			
Sapindaceae	*Allophyllus* sp.							+			
	Cupania sp.							+			
	Dimocarpus fumatus		Longan	LDF		+					
	Dimocarpus longan		Longan	LDF, cultivated		+					
	Dimocarpus longan ssp. *malesianus*	*N. malaiense*		LDF, cultivated	+						
	Glenniea sp.							+			
	Guioa bijuga	*G. plueropteris*		LDF		+					
	Lepisanthes amoena					+					
	Nephelium costatum (E)		Reming	LDF		+	+		+		
	Nephelium cuspidatum		Rambutan	LDF		+					

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Nephelium cuspidatum var. *eriopetalum* (T)	*N. eriopetalum*	Gompal benang	LDF		+	+		+		
	Nephelium cuspidatum var. *ophioides*	*N. ophioides*	Rambutan	LDF, HDF		+	+				
	Nephelium maingayi (T)		Redan	LDFs		+	+		+		
	Nephelium ramboutan-ake (T)	*N. mutabile*	Rambutan hutan, gesiar	RV		+	+		+		
	Paranephelium macrophyllum		Gesiar, gohor	LDF		+	+				
	Pometia pinnata (T)		Kasai daun besar	LDF, HDF		+	+		+		
	Pometia sp.							+			
	Sapindus rarak			Cultivated				+			
	Sapindus sp.			Cultivated	+			+			
	Xerospermum noronhianum (T)	*X. muricatum*, *X. intermedium*, *X. wallichii*	Rambutan pacat	LDF, HDF		+	+		+	+	
Sapotaceae	*Achras zapota*		Ciku	Cultivated	+		+				
	Chrysophyllum roxburghii (T)	*C. lanceolatum*	Pepulut	LDF		+	+		+		
	Madhuca malaccensis		Nyatoh cempelot	LDF		+	+				
	Madhuca selangorica (E)		Nyatoh?		+						
	Mimusops elengi (T)		Bunga tanjung	CF	+						
	Mimusops sp.							+			
	Palaquium clarkeanum (T)		Nyatoh	LDF	+						
	Palaquium endertii		Nyatoh			+					
	Palaquium gutta (T)		Nyatoh taban merah	LDF, HDF	+						
	Palaquium hispidum(T)		Nyatoh tembaga kuning	LDF	+	+	+				
	Palaquium obovatum (T)		Nyatoh puteh	LDF	+						
	Palaquium oxleyanum (T&E)		Nyatoh taban putih	LDF, HDF		+					
	Palaquium sp.			Mostly LF	+	+	+				
	Payena acuminata (T)						+				
	Payena lucida (T)		Nyatoh		+	+	+				
	Payena maingayi (T&E)		Nyatoh durian	LDF, HDF	+	+	+				
	Pouteria malaccensis (T)			LDF to MF	+						
Simaroubaceae	*Eurycoma* sp.							+			
	Irvingia malayana(T)		Pauh kijang	LDF		+	+	+			
Solanaceae	*Solanum* sp.							+			
Sonneratiaceae	*Duabanga grandiflora* (T)		Berembang bukit	LDF, HDF	+						
	Sonneratia alba (T)		Perepat	Mangroves	+						

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
	Sonneratia caseolaris (T)		Berembang	Mangroves	+						
	Sonneratia ovata (T)		Gedabu	Mangroves	+						
Sterculiaceae	*Firmiana malayana*		RV, open forests					+			
	Pterocymbium tinctorium (T)	*P. javanicum*	Melembu	Alluvial		+	+				
	Pterospermum javanicum(T)		Bayur	LDF, HDF		+	+				
	Pterygota alata(T)		Kasah	LDF rv		+	+				
	Scaphium borneensis (T)		(Borneo)						+		
	Scaphium linearicarpum (T)		Kembang semangkok bulat	LDF, HDF		+					
	Scaphium longipetiolatum (T) (Borneo)								+		
	Scaphium macropodum(T)		Kembang semangkok jantong	LDF, HDF		+					
	Sterculia foetida (T)		Kelumpang jari	CF		+		+			
	Sterculia parvifolia (T&E)		Kelumpang	HDF		+		+		+	
	Sterculia stipulata		Kelumpang				+				
	Sterculia sp.							+			
Symplocaceae	*Symplocos* sp.							+			
Styracaceae	*Styrax benzoin* (T)		Kemenyan			+	+				
Taccaceae	*Tacca* sp. (herb)							+			
Theaceae	*Adinandra ?lamponga* (T)		Kelat paya			+					
	Adinandra sp.		Tiup-tiup		+	+					
Thymelaeaceae	*Aquilaria malaccensis* (T)		Karas			+	+				
	Gonystylus confusus (T)		Ramin pinang muda				+				
Tiliaceae	*Microcos antidesmifolia* (T)			LF		+					
	Microcos blattaefolia (T)	*G. blattaefolia*	Chenderai	LF		+	+				
	Microcos crassifolia					+					
	Microcos fibrocarpa (T)	*G. fibrocarpa*	Chenderai, damak bulu	LF		+	+				
	Microcos laurifolia (T&E)	*G. laurifolia*	Chenderai	LDF, HDF		+	+				
	Microcos tomentosa (T)	*G. tomentosa*	Chenderai tanjung	LDF, HDF fm	+	+	+				
	Microcos sp. (5 spp)					+	+	+			
	Pentace floribunda		Ba'ang	HDF		+					
	Pentace triptera (T)		Melunak pusat beludu	LDF		+	+				
	Schoutenia corneri (E)		LDFrv			+					
Trigonaceae	*Trigoniastrum hypoleucum* (T)		Marajali						+		

(continued)

Appendix 1 (continued)

Family	Species	Synonym	Local name	Forest type	Bats	Primates	Squirrels	Birds	Bees	Thrips	Beetles
Ulmaceae	*Celtis rigescens* (T)		Semantit	LDF, HDF		+	+				
	Celtis sp.					+	+	+			
	Gironnieria hirta (T)		Hampas tebu				+				
	Gironnieria nervosa (T)		Hampas tebu				+				
	Gironnieria parvifolia (T)		Hampas tebu LDF, HDF			+	+				
	Gironnieria subaequalis (T)		Hampas tebu LDF, HDF			+	+				
	Gironnieria sp.					+	+				
	Trema orientalis		Menarong	LFb					+		
	Trema sp.							+			
Urticaceae	*Laportea* sp.							+			
	Poikilospermum sp.(epiphyte)					+	+				
	Villebrunea sp.					+					
Verbenaceae	*Callicarpa maingayi*									+	
	Lantana cammara			Cultivated						+	
	Teijsmanniodendron spp.					+					
	Vitex pinnata (T)	*V. pubescens*	Leban	SF, wayside	+	+	+		+		
	Vitex trifoliata					+			+		
	Vitex spp.			Mostly LF		+	+				
Violaceae	*Rinorea* sp.					+					
Vitaceae	*Vitis* sp. (liana)					+					

LDF = Lowland dipterocarp forest; LDFs = Swampy lowland dipterocarp forest; LDFfm = Forest margin; LFb = Belukar
HDF = Hill dipterocarp forest
PSF = Peat swamp forest
LMF = Lower montane forest
RV = Riverbanks
MF = Montane forest
SF = Secondary forest
CHF = Coastal hill forest
CF = Coastal forest
BF = Beach forest
p, s = primary, secondary

Sources: McClure (1966), Madge (1969), Chivers (1974, 1980), Start and Marshall (1976), Curtin and Chivers (1978), MacKinnon (1978), Payne (1979), Appanah (1981, 1987), Appanah and Chan (1982), Bennet (1983), Johns (1983), Appanah *et al.* (1986), Caldecott (1986), Kiew and Davison (1989), Lambert (1989), Momose *et al.* (1996, 1997), Nagamitsu *et al.* (1997), Sakai *et al.* (1997a, b), Tan *et al.* (1998).