

Conservation of some rare and endangered plants from Peninsular Malaysia

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Summary. Malaysia has approximately 15,000 species of vascular plants. Its flora is distributed between two major geographical regions; Peninsular Malaysia on mainland Asia and the states of Sabah and Sarawak on the island of Borneo. Peninsular Malaysia has over 8,300 plant species and Sabah and Sarawak in a recent estimate have about 12,000 species. Total species endemism for Peninsular Malaysia is about 30%; its tree endemism is 26.3%. For Sabah and Sarawak, the endemism level is higher, recently revised figures gave a tree species endemism of 42.1%. Malaysia has recently published its national strategy for plant conservation, which now forms the basis of conservation activities for the country. Since 2004, we have been running a project entitled “Conservation Monitoring of Rare and Threatened Plants of Peninsular Malaysia”, in which conservation status assessment is scored for a number of families. Results of the assessment of 458 taxa included 46.1% in some threat category. Detailed conservation studies are in progress for 33 species of threatened plants. Initial work on these species include spatial distribution studies at regional level based on herbarium records, and at a more local level, population studies to determine demography of populations. Regular phenological observations were also made for many of the species.

Key Words. Conservation assessment, Dipterocarpaceae, Malaysia.

Introduction

Malaysia is located close to the equator, lying between 0°51'N and 7°33'N, with an equatorial climate, characterised by annual south-west (April to October) and north-east (November to February) monsoons. The country has no distinct dry season except for north-west Peninsular Malaysia (in the states of Perlis and Kedah); rainfall averages 200 – 300 cm/yr in the lowlands and 300 – 350 cm/yr in the mountains. Lowland temperature averages about 30° C throughout the year. Malaysia has two major geographical regions; Peninsular Malaysia with its connection to mainland Asia and the states of Sabah and Sarawak on the island of Borneo, sited on the continental Sunda Shelf. The highest mountains are Mount Kinabalu (4,100 m) in Sabah and Mount Tahan (2,188 m) in Peninsular Malaysia.

The flora of Malaysia is estimated to be about 15,000 species (Saw & Chung 2007), with 8,300 species for Peninsular Malaysia and about 12,000 species for the states of Sabah and Sarawak. In spite of a long history of botanical exploration, the Malaysian flora is not fully documented. A review of the botanical history of Malaysia, including collections and publications of revisions, in the two regions of Peninsular Malaysia and Sabah and Sarawak is provided in Saw & Chung (2007). Peninsular Malaysia with a longer botanical history now has a working checklist (Turner

1997) which is regularly updated (Turner 2000; Latiff & Turner 2001a, b, c, d; 2002a, b; 2003; Kamarudin & Turner 2004). For the states of Sabah and Sarawak, although there is no recent checklist, there are two important (but obsolete) compilations for Bornean plants (Merrill 1921; Masamune 1942, 1945). Masamune's compilations enumerated 8,164 species of Bornean vascular plants. In addition to the revisions from the *Flora Malesiana* project, there are many other revisions, checklists and manuals for different purposes. These include the *Plants of Kinabalu* project led by Beaman and his collaborators who completed the project with the publication of five volumes of the series covering about 4,000 species (Parris *et al.* 1992; Wood *et al.* 1993; Beaman & Beaman 1998; Beaman *et al.* 2001a; Beaman & Anderson 2004). Modern identification manuals, amounting to floristic enumerations, of the rattans of Sabah and Sarawak (J. Dransfield 1984; 1992), and the bamboos of Sabah (S. Dransfield 1992) have been published. More charismatic groups such as orchids and *Nepenthes* continue to attract interest with a checklist of the *Orchids of Borneo* (Wood & Cribb 1994), *Slipper Orchids of Borneo* (Cribb 1997) and the *Orchids of Borneo* (Beaman *et al.* 2001b), and *Nepenthes* of Borneo (Clarke 1997). produced. A richly illustrated *Etilingera* (Zingiberaceae) of Borneo was also recently published (Poulsen 2006). The *Tree Flora of Sabah and Sarawak* project has now

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published six volumes, which have enumerated 1,750 of the estimated 3,500 tree species found in these two states.

There are differences in the flora of Peninsular Malaysia and Borneo. Borneo has a much larger land area: the states of Sabah and Sarawak constitute 60.4% (200,565 sq. km) of the land area of Malaysia; Peninsular Malaysia makes up 36.6% (131,598 sq. km). Sabah and Sarawak have higher mountains and a greater diversity of soils and geological formations. Mount Kinabalu, the highest mountain in Sabah is 4,095 m high; in Peninsular Malaysia the highest peak, Gunung Tahan, is only 2,187 m high. Sabah and Sarawak have extensive areas of heath vegetation which is less prominent in Peninsular Malaysia. Soils over ultramafic and basic volcanic rocks are particularly well developed in Sabah (Wong 1998). In Peninsular Malaysia, these areas are very limited in distribution and no specialised vegetation is recorded in such outcrops. Limestone hills extend right up to montane forest in Gunung Mulu in Sarawak, while in Peninsular Malaysia, all limestone hills are restricted to the lowlands. This has resulted in a richer flora in Sabah and Sarawak compared to Peninsular Malaysia. Using tree families revised by the *Tree Flora of Sabah and Sarawak* and the *Tree Flora of Malaya*, Sabah and Sarawak have on average 44% more species than Peninsular Malaysia (Malaya) (Saw & Chung 2007; Table 1). The level of endemism is also different. There are about 2,500 species of vascular plants endemic to Peninsular Malaysia (30.1%). For Sabah and Sarawak, we have accurate data only for trees species and figures revised under the project so far gave an endemism of 42% (735 of the 1,750 species revised). Tree endemism for Peninsular Malaysia is only about 26.4% (746 species) (Ng *et al.* 1990).

Malaysian national strategy for plant conservation

Following the Global Strategy for Plant Conservation (GSPC), Malaysia has developed its own national plant

conservation strategy (Saw *et al.* 2009). The Malaysian strategy follows closely the GSPC's 5 objectives and 16 targets. This paper deals with only Objective 1 of the strategy, "Understanding and Documenting Plant Diversity", in particular Targets 2 (A preliminary assessment of the conservation status of all known plant species of the nation) and 3 (Development of models with protocols for plant conservation and sustainable use, based on research and practical experience).

In 2005, the Forest Research Institute Malaysia was awarded a grant to conduct conservation assessment and monitoring on threatened plants for Peninsular Malaysia. The project was awarded together with the *Flora of Peninsular Malaysia* project. The projects run in tandem — as families are revised for the Flora, conservation assessments are made. At the same time for the first phase of the project, a number of families and groups that are not yet the target of immediate revision were identified as priority for conservation assessment. The families and group include Dipterocarpaceae, Begoniaceae, Palmae and endemic tree species of Peninsular Malaysia.

Methods used for conservation assessment

The conservation assessment follows the IUCN *Red List Categories and Criteria version 3.1* (2001). There are nine categories: Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD) and Not Evaluated (NE). Taxa that are CR, EN and VU are collectively referred to as threatened. To assign a category for a threatened taxon objectively, five criteria are used: population decline, geographic range in the form of extent of occurrence or area of occupancy, small population size and decline, very small or restricted population, and quantitative analysis. For the purpose of this assessment, Malaysia is regarded as having two distinct phytogeographical regions: Peninsular Malaysia and Sabah and Sarawak. Any taxon that is common to

Table 1. Comparison of tree species diversity revised under the *Tree Flora of Sabah and Sarawak* (TFSS) volumes and similar families of *Tree Flora of Malaya* (Saw & Chung 2007 and updated for volume 6).

TFSS Volumes	Tree Flora of Sabah & Sarawak			Tree Flora of Malaya		
	Families	Genera	Species	Families	Genera	Species
1	31	99	306	31	91	227
2*	21	73	243	21	63	186
3	4	30	357	4	27	246
4	6	21	292	6	21	202
5	4	28	361	4	27	225
6	4	18	189	4	21	128
Total	70	265	1748**	70	250	1214**

* Two families Scyphostegiaceae and Winteraceae are not recorded in Peninsular Malaysia and are excluded in the comparison

** Sabah & Sarawak have roughly 44% more tree species than Peninsular Malaysia

Peninsular Malaysia and Sabah and Sarawak is assessed separately for each region. The higher Red List category is then selected to describe that taxon for Malaysia as a whole.

Assessors obtain basic information for the taxon to be assessed and this is entered into a standardised format called Taxon Data Information Sheet (TDIS) (Chua & Saw 2006). The TDIS is available from <http://www.tfbc.frim.gov.my> and comprises five parts: Taxon Attributes, Geographic Range and Demographic Details on Population, Red List Category and Criteria Assessment, Current Conservation Measures for the Taxon, and Utilisation. This set of information provides the rationale to support the Red List category given to the taxon concerned. The information is maintained as a database by the Forest Research Institute Malaysia (FRIM). A taxon's biological information is obtained from published accounts and field surveys. As part of the assessment, the taxonomy and nomenclature of each taxon were checked by experts and against principal accounts. For example for Dipterocarpaceae the principle references were: Ashton (1982, 2004) and Symington (2004, revised by Ashton & Appanah); for Begoniaceae, Kiew (2005).

A taxon's geographical information was obtained from geo-referenced herbarium and voucher specimens based at FRIM's Herbarium (KEP), the Herbarium at Sarawak Forest Department (SAR) and the Herbarium of the Forest Research Centre, Sabah Forest Department (SAN). The databases on Dipterocarpaceae at the Singapore Herbarium (SING) and the Nationaal Herbarium Nederland (L) were also consulted and relevant botanical records included in the master database. The database also contained voucher specimens made during the project and from another project entitled "To determine the optimum size of Virgin Jungle Reserves to enhance the conservation of flora and their attended management prescriptions for each of the ecological forest types". In the map, localities derived from herbarium and voucher specimens are denoted separately. Localities that appeared in published accounts but cannot be verified at present from specimen collection are included in the TDIS but do not appear in the geographical map. All verified localities of the taxon were thus used in the generation of its map and this includes localities no longer under forest cover. The coordinates for locations without Global Positioning Systems (GPS), especially those from historical collections, were approximated.

Data from permanent sample plots, growth and yield plots and long-term ecological research plots were consulted and included where relevant. This includes data from the 50 ha plot in Pasoh Forest Reserve, Negeri Sembilan (Manokaran *et al.* 1992). Data giving the extent of forest cover are obtained from published annual reports and National Forest

Inventories (NFIs). Information on areas under total protection is obtained from various institutional reports and related government gazettes. Literature sources for policies and legislation are wide-ranging and trade statistics were consulted for the level of utilisation.

The calculation for the Extent of Occurrence (EOO) follows the IUCN Red List guidelines. To calculate Area of Occupancy (AOO), we used a 2 × 2 km grid (area of 4 km²). The values for EOO and AOO were generated using the Conservation Assessment Tools software produced by the Royal Botanic Gardens, Kew (Moat 2007). The forest cover generated by the Third National Forest Inventory, provided here graphically and as an estimation of percentage area under forest cover, was used to infer population reduction. In the map, selected localities are areas that form the boundary of the taxon's distribution; localities inside the boundary are not listed. An example of the map generated is provided for *Anisoptera laevis* Ridl. (Map 1).

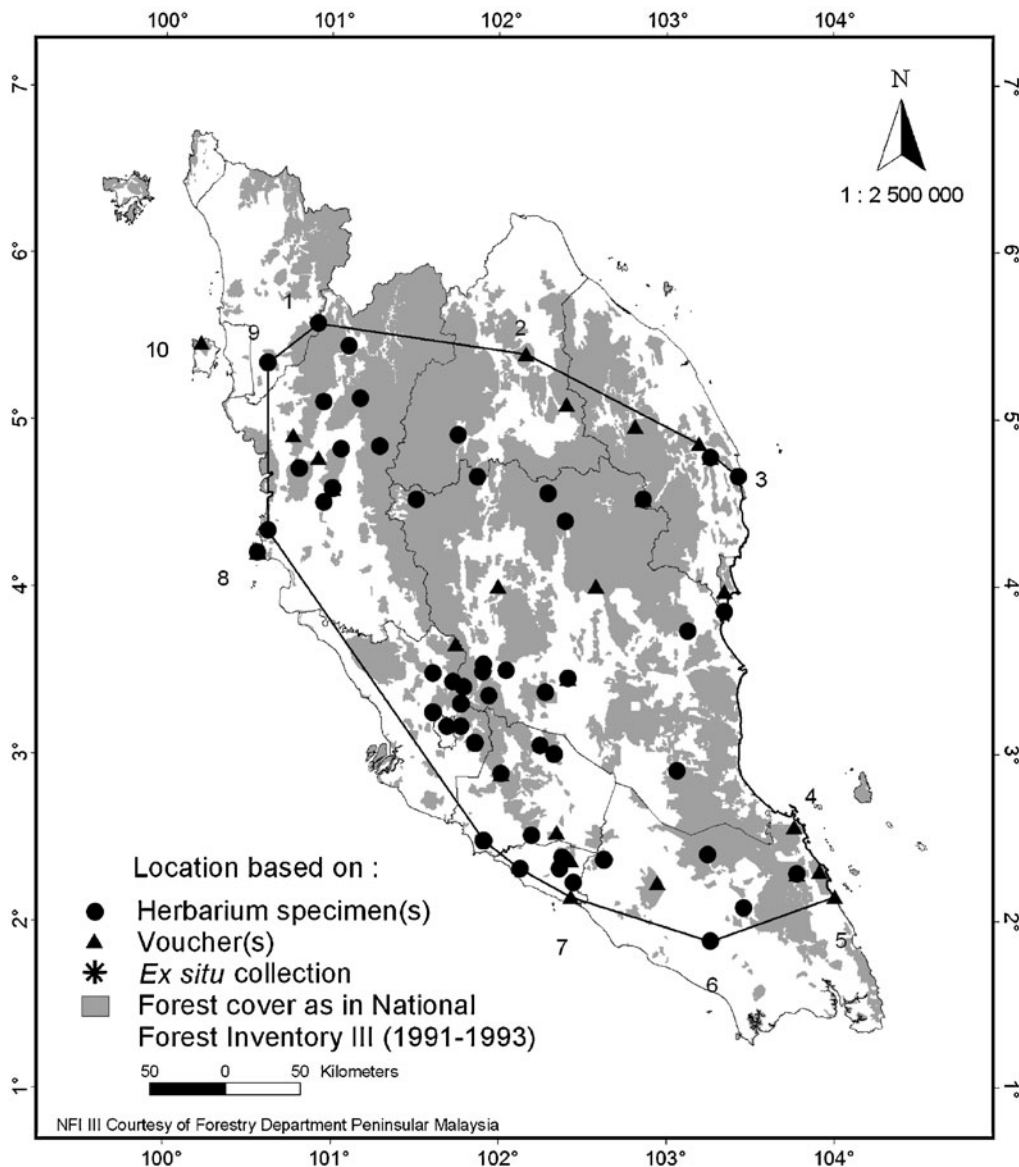
During the assessment, the status of habitats, current threats and current conservation measures for the majority of taxa were ground-checked and, where required, checked with the relevant local district offices. In addition, species previously identified as highly threatened were monitored. Surveys, demographic enumeration of populations, spatial distribution patterns including phenology, and reproductive biology observations were conducted. Several taxa previously declared as possibly extinct were investigated.

Results of the conservation assessments

In our initial conservation assessments of vascular plants, 458 taxa were analysed (including 23 varieties and subspecies). The assessments included nine families of ferns and lycophytes, three families of gymnosperms, 28 families of dicots and two families of monocots. The results are summarised in Table 2 and give a sampling of possible threat levels likely to be encountered by the Peninsular Malaysian flora. The families involved in the assessments ranged from a large timber family (Dipterocarpaceae) to herbs and understorey plants (e.g. Begoniaceae and Zingiberaceae), climbers (e.g. Nepenthaceae), and ferns and lycophytes (e.g. Grammitidaceae and Selaginellaceae). The best represented families assessed included Dipterocarpaceae (164 taxa), Begoniaceae (54 taxa), Grammitidaceae (52 taxa), Selaginellaceae (32 species), Symplocaceae (30 taxa) and Zingiberaceae (24 taxa, mostly *Scaphochlamys* and *Geostachys*).

In the assessment, four species were assessed Extinct (EX), 0.9% of the taxa assessed (Table 3). All four species were narrow endemics. The two ferns *Oreogrammitis crispata* and *O. kunstleri* are believed to be extinct

Geographical Distribution of *Anisoptera laevis* (Dipterocarpaceae) in Peninsular Malaysia



Map 1. Distribution of *Anisoptera laevis* with areas for Extent of Occurrence (EOO) and Area of Occupancy (AOO).

in their original habitats and could not be located in recent surveys. The causes of their extinction are not entirely clear. Sites where the species were found previously are in popular mountain resort areas. It is possible that development in these sites adversely impacted the habitats to a point that threatened the

ferns' survival. The original forest habitats of the two dicots have since been converted to other land uses. Neither species could be relocated in recent surveys. Based on this, we have assessed them as extinct. Nearly half (46.1%) of the taxa assessed were in some level of threat: 62 taxa (13.5%) are listed as Critically Endan-

Table 2. Conservation assessment of vascular plants of Peninsular Malaysia (*435 species with 23 additional varieties and subspecies).

Conservation status	Number of taxa*
Extinct (EX)	4 (0.9%)
Critically Endangered (CR)	62 (13.5%)
Endangered (EN)	69 (15.1%)
Vulnerable (VU)	80 (17.5%)
Threatened total	211 (46.1%)
Near Threatened (NT)	87 (19.0%)
Least Concern (LC)	143 (31.2%)
Data Deficient (DD)	13 (2.8%)
Total	458 (100%)

gered (CR), 69 taxa (15.1%) as Endangered (EN) and 80 taxa (17.5%) as Vulnerable (VU).

The *IUCN Red List Categories and Criteria version 3.1 (2001)* applies five criteria in the assessment of threats on taxa. The results of the criteria used in the assessments from the study are summarised in Table 4. The most common criterion used was Criterion B, which is the geographic range in the form of either extent of occurrence (EOO) or area of occupancy (AOO). Here 136 or 64.4% of the threatened taxa were qualified using this criterion. This was followed by criterion A (reduction in population size) for 55 taxa or 26.1% of the threatened taxa. A small number of taxa were scored under criterion D, that is with a small number of mature individuals (19 taxa or 9.0% of the threatened taxa).

The case of Dipterocarpaceae

Dipterocarpaceae is the most important timber family for Malaysia. Peninsular Malaysia has 165 taxa in 155 species in nine genera. Of these, 34 species are endemic to Peninsular Malaysia and 39 species have narrow distribution, that is they are found within one or two adjacent states. The family is predominantly

lowland in distribution with 106 species ranging into the lowland dipterocarp forest. The rarest and most threatened species are those found in the coastal hills, numbering 29 species.

The family Dipterocarpaceae has the most number of taxa assessed in this study. We analysed its conservation status further (Chua *et al.* 2010) and compared the current results to two previous assessments of the family (Oldfield *et al.* 1998; Symington 2004), in particular Symington (2004). Both previous assessments were made by P. S. Ashton. In the latter assessment, Ashton & Appanah (Symington 2004) depended mainly on the range of species based on herbarium data and their personal experiences of the species' distribution and silviculture, and the degree of threat to the survival of each species.

The overall conservation assessment for Dipterocarpaceae is provided in a summary (Table 5). One species was assessed as extinct (i.e. *Shorea kuantanensis*). A total of 92 taxa (56.1%) were in some level of threat, with 15 taxa critically endangered, 35 taxa endangered and 42 taxa vulnerable. Further analysis of criteria used for conservation assessments are given in Table 6. For the threatened taxa, 36.3% showed reduction in population size (A) and 63.7% exhibited limited geographic range in EOO or AOO. For many dipterocarps, it was possible to infer population size reduction from their estimated original range based on forest cover maps. It was possible to estimate the extent of occurrence or area of occupancy for species with restricted distribution using similar means.

In Symington (2004), 12 taxa of dipterocarps were assessed as being possibly extinct (Table 7). Our study successfully relocated 9 taxa. Only one species, *Shorea kuantanensis* could not be found. It was only known from two collections from Bukit Goh Forest Reserve made in 1936. The site is now an oil palm estate.

Results of this study indicate that the remaining 9 taxa are still under threat. Four taxa are now placed as critically endangered and seven have sufficient population size and distribution to fall under the lesser

Table 3. Peninsular Malaysia species assessed as extinct.

Species	Notes
<i>Oreogrammitis crispata</i> (Holttum) Parris (Grammitidaceae)	Only known from Bukit Larut (Maxwell Hill) on the isolated Bintang Range, last collected in 1952 and since then not collected. Maxwell Hills and its adjacent hills and valleys have been repeatedly botanised in the 20th century. The fact that the species has never been re-collected indicates a degree of rarity.
<i>Oreogrammitis kunstleri</i> Parris (Grammitidaceae)	G. Ledang (Mount Ophir) is an isolated mountain and is a well collected area. The species was last collected in 1880 in G. Ledang (Mount Ophir), and since then has not been seen or collected. G. Ledang has been repeatedly botanised.
<i>Begonia eirmischa</i> Ridl. (Begoniaceae)	Known only from one locality in Penang, now a farm.
<i>Shorea kuantanensis</i> P. S. Ashton (Dipterocarpaceae)	Known only from one locality in Pahang, now an oil palm estate.

Table 4. Analysis of the criteria applied in the conservation assessments of taxa from Peninsular Malaysia.

Criteria	CR	EN	VU	Total	%
A reduction in population size	17	10	28	55	26.1
B geographic range in EOO or AOO or both	38	55	43	136	64.4
C declined or declining mature individuals	0	1	0	1	0.5
D small number of mature individuals	7	3	9	19	9.0
E probability of future extinction in the wild	0	0	0	0	0
Total	62	69	80	211	100

threatened category of endangered. Upon further comparison, only 16 of the 164 taxa assessed have similar scores. Most taxa have a higher threat category in Symington (2004) compared to the current assessment. Symington (2004) did not have the formal undertaking and resources of a project to update what was already known of the geographical distribution. The complete dependence on existing records (here mainly herbarium specimens) and, to a lesser extent, the application of a stricter assessment, made the species appear more threatened in Symington (2004). During the course of our project, many new location points were added to the species distribution, thus providing an update of its population range. In some of the original sites, sizeable populations were found. The overlay of forest cover maps onto EOO and AOO provided a better estimate of decline in its range. A case in point was *Cotylelobium melanoxydon* (Hook. f.) Pierre. The species was assessed as possibly extinct based on historical collections; however, sizeable populations were discovered in the coastal forests of north-east Johor in both original and new locations, leading us to downgrade its conservation status to EN.

We considered the more threatened categories of critically endangered (CR) and endangered (EN) as having higher priority for conservation action. For the Dipterocarpaceae, 49 species (30.4%) are in this group. These species are targeted for more detailed conservation studies.

Further analysis of the threatened categories distributed over the states in Peninsular Malaysia,

revealed that Pahang, Johor, Perak and Terengganu have the greatest number of threatened species (Table 8). For the most threatened groups (categories CR and EN), Perak has the most taxa, i.e., 25 taxa. The detailed studies show that the populations of almost all of Perak's critically endangered taxa are extant but the population sizes are small to extremely small and hence they are exceedingly vulnerable to extinction. The case is similar for Johor, Pahang and Terengganu.

Species subjected to detailed conservation studies

Together with the conservation assessment, detailed studies were conducted on some critically endangered and endangered species. These included population studies (location of extant populations, spatial mapping and enumeration of population, population structure and ecology), phenology and reproductive biology. Output of the studies include *ex situ* conservation collection and planting of these threatened species in the Kepong Botanic Gardens. Table 9 provides a summary of the families studied. The majority of the species were Dipterocarpaceae. Findings, including conservation recommendations, were forwarded to the relevant stakeholders. In the case of Dipterocarps, the forest areas are under the jurisdiction and management of the Forest Department. The conservation team worked closely with the Forest Department to identify locations and populations of critically threatened species. These areas are then

Table 5. The number of taxa in Peninsular Malaysia, grouped according to genus, under their respective IUCN categories.

Genus	EX	CR	EN	VU	NT	LC	DD	Total
<i>Anisoptera</i>	0	0	1	4	0	1	0	6
<i>Cotylelobium</i>	0	0	1	0	1	0	0	2
<i>Dipterocarpus</i>	0	3	7	10	7	4	1	32
<i>Dryobalanops</i>	0	0	1	0	1	1	0	3
<i>Hopea</i>	0	4	6	11	9	3	0	33
<i>Neobalanocarpus</i>	0	0	0	0	1	0	0	1
<i>Parashorea</i>	0	1	0	0	1	1	0	3
<i>Shorea</i>	1	5	12	12	19	12	1	62
<i>Vatica</i>	0	2	7	5	7	1	0	22
Total	1	15	35	42	46	23	2	164
Percentage	0.6	9.1	21.3	25.6	28.0	14.0	1.2	100

Vatica sp. "A" was not evaluated

Table 6. Criteria used in the assessment of threatened taxa of Dipterocarpaceae from Peninsular Malaysia.

Criteria	CR	EN	VU	Total	%
A reduction in population size	12	5	16	33	36.3
B geographic range in EOO or AOO or both	3	25	30	58	63.7
C declined or declining mature individuals	–	–	–	–	–
D small number of mature individuals	–	–	–	–	–
E probability of future extinction in the wild	–	–	–	–	–
Total	15	30	46	91	100

included in the high conservation value forest (HCVF) or annexed into the totally protected area network under Sustainable Forest Management (SFM). Among the species now protected are *Dipterocarpus sarawakensis*, *D. tempehes* Slooten, *Dryobalanops beccarii* Dyer, *Hopea subalata* Symington, *Hopea polyalthioides* and *Hopea auriculata* Foxw.

At least one species has been found on private land. This is the case with *Dipterocarpus semivestitus*, which has a very restricted distribution in Peninsular Malaysia but is not an endemic. The species is currently known in only two very disjunct locations, one in Marabahan district, Central Kalimantan (Ashton 1982), and the other in the freshwater swamp forest of Parit in the state of Perak. Much of the area has been developed into urban sites leaving very tiny fragments of isolated swamps. In 2006, the team was fortunate enough to stumble upon the species in a remnant freshwater swamp forest in the grounds of the Mara University of Technology (UiTM), Seri Iskandar. The excitement of the discovery quickly turned into a major concern when it was learnt that the university, as part of the campus's expansion programme, had plans to develop a portion of the swamp forest. The team acted quickly and through numerous meetings and appeals, changes to the building plans were made to accommodate the swamp forest with the threatened species. Although there was the inevitable loss of a few trees, the majority of trees now remain intact in the swamp forest. The commitment shown by the university to conserve the swamp

forest, which is also home to three other very rare and endemic species, is highly commendable. FRIM continues to work very closely with the university authorities and conducts regular phenological observations and population studies.

Discussion and conclusion

In a country with rich botanical diversity such as Malaysia, the identification of taxa at risk of extinction is an extremely useful tool for setting priorities in conservation. Prioritisation becomes difficult, however, if the assessment produces a very high number of threatened taxa. In this first-phased assessment, there are already a high percentage of threatened taxa — overall, 46% of those assessed are threatened. This finding is due to many factors arising both from natural and human-derived causes. We highlight here three factors that impacted the assessment significantly — the first is the choice of families treated in the first phase, the second is the nature of the IUCN (2001) criteria and the last is the land use change patterns in Malaysia. The families chosen for assessment in this phase — Begoniaceae, Zingiberaceae, Grammitidaceae and Selaginellaceae, with the exception of Dipterocarpaceae and Symplocaceae — have many rare taxa of restricted distribution. When the IUCN criteria are applied strictly, species that are rare or restricted in distribution have the highest probability of being placed in a threatened category. In addition, where long-living perennial trees such as the

Table 7. Species assessed as possibly extinct in Symington (2004) compared with current assessment, the criteria following IUCN (2001) are provided with the conservation category.

Species	Current assessment	Symington (2004)
<i>Cotylelobium melanoxyton</i> (Hook. f.) Pierre	EN B2ab(iii)	EX (possibly)
<i>Dipterocarpus coriaceus</i> Slooten	CR A4c	EX (may now be)
<i>Dipterocarpus obtusifolius</i> Teijsm. ex Miq. var. <i>subnudus</i>	EN B2ab(iii)	EX (may now be)
<i>Dipterocarpus sarawakensis</i> Slooten	CR A4c	EX (possibly)
<i>Dipterocarpus semivestitus</i> Slooten	CR A4bc, B2ab, C1	EX (possibly)
<i>Hopea coriacea</i> Burck	EN B2ab(iii) + c(iii)	EX (may now be)
<i>Hopea pachycarpa</i> (F. Heim) Symington	EN B2b(iii) + c(ii)	CR & perhaps EX
<i>Hopea polyalthioides</i> Symington	EN B2ab(iii)	EX (may be)
<i>Shorea inappendiculata</i> Burck	EN B1b(iii) + c(iii)	EX (possibly)
<i>Shorea kuantanensis</i> P. S. Ashton	EX	EX (may now be)
<i>Vatica flavida</i> Foxw.	CR A4c, B1ab(iii)	EX (may now be)
<i>Vatica havilandii</i> Brandis	EN A4c, B2b(iii) + c(ii)	CR, possibly EX

Table 8. The number of threatened Dipterocarp taxa, including extinct taxon, occurring in each Peninsular Malaysian state ranked according to the total number of threatened taxa.

State	EX	CR	EN	VU	Total
Pahang	1	1	20	37	59
Johor	0	2	17	35	54
Perak	0	10	15	28	53
Terengganu	0	1	15	31	47
Selangor	0	3	6	25	34
Kedah	0	0	5	23	28
Negeri Sembilan	0	1	3	21	25
Kelantan	0	0	3	21	24
Malacca	0	0	1	8	9
Penang	0	1	1	8	10
Perlis	0	0	2	7	9

dipterocarps are concerned, the definition and use of generation time with 3 generation time extending between 80 to 120 years (up to a maximum of 100 years) inadvertently result in most tree species falling into a threatened category. This is exacerbated by the loss of a sizeable percentage of the Peninsular Malaysian lowland forests to agriculture and other land uses between the early 1970s and early 1990s. What remains pristine is confined to the national and state parks and wildlife sanctuaries and other areas declared as totally protected.

In our efforts to integrate conservation comprehensively into Sustainable Forest Management, we now concentrate on critically endangered and endangered taxa. In this respect, the transfer of information is critical to the success of incorporation. To date we have received positive and committed responses and actions from the various stakeholders. The Forest Department Peninsular Malaysia, for example, has taken decisive actions towards protecting highly threatened species. Such steps significantly progress Malaysia towards achieving the targets identified in the National Strategy for Plant Conservation. In the future, we aim to establish a framework that allows monitoring, recovery programmes and direct conservation intervention using science-based approaches.

Table 9. Summary of families subjected to detailed conservation studies.

Families	Number of species
Dipterocarpaceae	21
Begoniaceae	5
Cycadaceae (<i>Cycas</i>)	4
Palmae (<i>Johannesteijsmannia</i>)	2
Gesneriaceae (<i>Senyumia</i>)	1
Total	33

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