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RESEARCH ARTICLE

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Assessing conservation status of Peninsular Malaysian *Begonias* (*Begoniaceae*)

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Key words

conservation measures
endemicity
threat assessment

Abstract Following the revision of Peninsular Malaysian *Begonia*, a project that involved extensive fieldwork, we now have sufficient data to assess their conservation status. Out of 54 taxa, 48 are endemic to Peninsular Malaysia. No fewer than 30 taxa are known from fewer than five localities; 24 taxa are Critically Endangered (CR), 3 are Endangered (EN) while 4 are Vulnerable (VU). One taxon is Extinct (EX), the 22 remaining are Near Threatened (NT), Least Concern (LC) and Data Deficient (DD). We discuss how the assessment was carried out and the implications for the long-term conservation of *Begonia*. The most significant conservation measure proposed here is the gazettement of limestone hills as totally protected areas.

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INTRODUCTION

The Malaysia Plant Red List Project was initiated in 2005. The vast changes in land-use patterns through the decades necessitated an assessment of the conservation status of species. The family *Begoniaceae* was a logical first choice as the family has a high degree of endemicity in Malaysia and is confined to pristine forest habitats. The recently published revision of the Peninsular Malaysian taxa (Kiew 2005) indicates that out of the 54 indigenous taxa, 48 are endemic to Peninsular Malaysia; 30 of these are known from fewer than five localities while 21 taxa are known from a single locality only. Knowing the status of each taxon, particularly of the narrow endemics, is the first step towards identifying practical conservation measures. In Malaysia, the conservation of biological diversity is largely in situ, through a extensive network of National and State Parks, Wildlife Sanctuaries and Permanent Reserved Forests. This approach which conserves habitats of the climatic forest formations, is a generalised approach and does not specifically target habitats where narrow endemics are found. For example, Taman Negara, a national park of c. 4 300 km^2 contributes little to the conservation of *Begonia*: only four taxa are found there of which only *Begonia longicaulis* is endemic to Taman Negara. The present assessment, undertaken in 2006, aims to demonstrate the need to refine conservation policies in order to offer better protection for narrow endemic taxa. The first results are presented here.

METHODS

Each taxon was assessed based on information gathered by the assessor on the questionnaire, Taxon Data Information Sheet (TDIS). TDIS comprises a minimal but fundamental set of information to support the Red List category given to the taxon concerned: scientific name, taxonomy details, habitat preferences (developed specifically for Malaysia), geographical range, general distribution pattern, population decline, threats, Red List category and criteria, arguments for the listing (including any numerical data used or inferences made), current conservation measures and utilisation. The primary focus of the Malaysia Plant Red List Project are indigenous species, subspecies and varieties.

The information was compiled from herbarium specimens, field observations and published information on the extent of forest cover such as provided by the National and State Inventories spanning four decades.

The assessment also includes information gathered from literature, and makes use of spatial information, such as topography, forest cover etc. It was done following the IUCN Red List Categories and Criteria v3.1 (2001). Guidelines to use the IUCN Red List Categories and Criteria v3.1 are provided in the IUCN Guidelines for Using the IUCN Red List Categories and Criteria and IUCN (2005) and Guidelines for Application of IUCN Red List Criteria at Regional Levels: v3.0 (2003). These documents are available from the IUCN website (http://www.iucn.org).

For each taxon a map with its range within Malaysia is given (Fig. 1). The range includes both historic and current locations. Historic locations include locations where the taxon was once found, but had since undergone changes that led to the extinction of the population. The identity of specimens was checked by an assessor, who was also required to include information from herbaria outside Malaysia. On the resulting maps, a polygon was drawn surrounding the locations. In case the locations were gathered into two or more clusters, more than one polygon was drawn. These polygons represent the 'Extent of Occurrence' as in the IUCN Red List Categories and Criteria v 3.1 (2001): "the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. Extent of occurrence may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g., large areas of obviously unsuitable habitat)". With the aid of spatial information, such as topography and forest cover, the 'Area of Occupancy' was then constructed. As defined by IUCN Red List Categories and Criteria v3.1 (2001), the area of occupancy is the area within its extent of occurrence occupied by the taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence which may contain unsuitable or unoccupied habitats.

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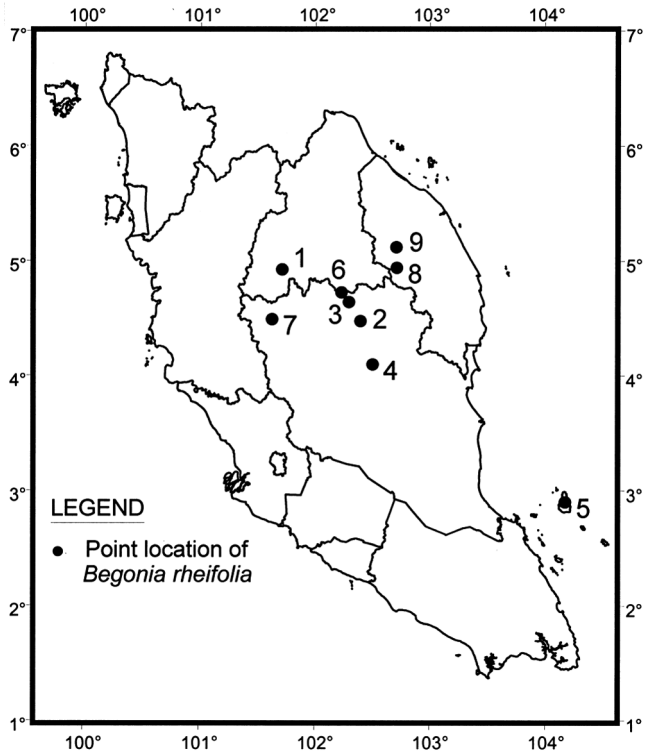

Fig. 1 An example of a geographic distribution map showing the extent of occurrence (EOO).

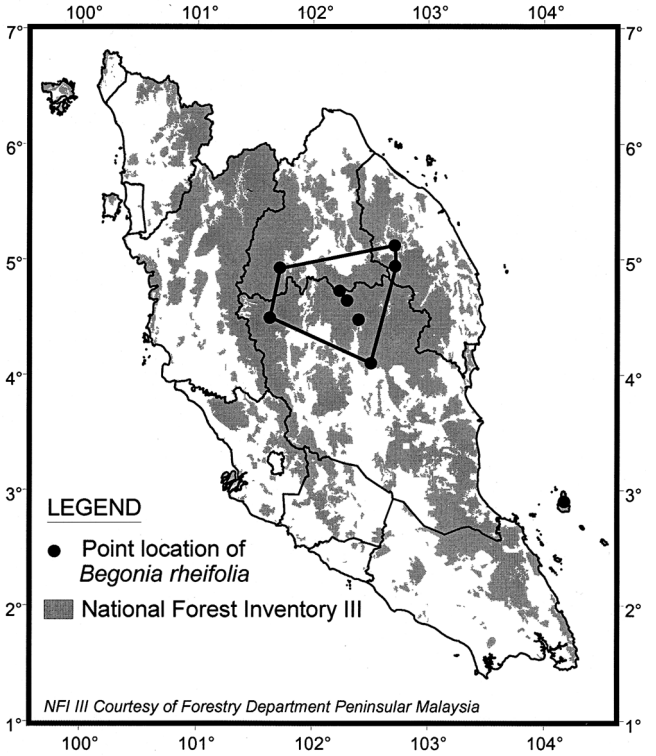

Fig. 2 An example of the Area of Occupance (AOO), denoting the present coverage of forest area within the polygon.

Such maps help to provide a dependable assessment. Forest cover is a good measure of habitat extent and quality. Fortunately, Peninsular Malaysia has kept forest cover data since the 1970s. National inventories are conducted every 10 years (Chin et al. 1997). In addition, state departments maintain annual data on changes that have taken place. All these data are published and used to estimate population decline. For many taxa, site visits by the assessor were undertaken to check if the taxon was locally still extant. Wherever such visits were not possible, the local occurrence was inferred from forest cover data etc., a practice allowed by the IUCN Red List Categories and Criteria v3.1 (2001). The amount of population decline, if any, was then inferred from the extent of habitat loss. In case the taxon is common and highly adaptable to environmental changes, then we assumed it is stable.

Threats are sometimes difficult to demonstrate conclusively. We tried to identify the threats most likely to be relevant to each taxon in order to provide a basis for assessment. The assessment further takes into account conservation measures that were taken to benefit the habitat in which the taxon occurs as well as to benefit the taxon itself.

The IUCN v3.1 (2001) guidelines concerning Criteria and Red List Categories are given in Appendix 1. Criterion E was not used, because no quantitative analysis was performed on any taxon. As for Criterion A, only A3 and A4 are deemed relevant for *Begonia*. According to Appendix 1, a taxon is Near Threatened (NT) if it does not qualify the Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) status at present but may qualify in the near future. A taxon is Least Concern (LC) if it does not qualify the CR, EN or VU status; such taxa are widespread in distribution, often abundant where found and occur within the network of Totally Protected Areas. A taxon is Data Deficient (DD) when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

In Part 2 of the Malaysia Plant Red List Project (Chua & Saw 2006), taxa that have been identified as Critically Endangered (CR) will be subjected to a monitoring approach under which extant populations will be mapped and demographically studied. Species assigned to other categories cannot be included in this project due to lack of financial resources and manpower.

RESULTS

Table 1 provides the conservation status for each native taxon. *Begonia eiromischa* is now Extinct (EX). Some examples of the extent of occurrence and the area of occupancy of CR taxa, such as *Begonia abdullahpieei*, *B. corneri* and *B. jiewhoei* are presented in Fig. 3, Fig. 4 and Fig. 5, respectively.

From the five criteria, criterion B: 'geographic distribution', was most often used.
Criterion D: 'very small or restricted population' was also used frequently, largely based on surveys done by Kiew (2005). During these surveys, some taxa that had remained uncollected for the past 100 years, such as *Begonia forbesii* and *B. herveyana*, were rediscovered either in the same vicinity or elsewhere. Criterion D implies the need for long-term monitoring.

For the Malaysian *Begonias*, there are two factors that may cause a taxon to fall in a threatened category:

1. Limited resources to conduct extensive surveys. Many *Begonia* taxa are currently known from less than three populations while a handful are only known from the type

Table 1 Summary of the Red List assessment for *Begonia* spp.

	Category	No. taxa (%)	Summary
	EX	1 (1.9)	
Threatened	CR	24 (44.4)	
	EN	3 (5.6)	31 (57.4)
	VU	4 (7.4)	
Not threatened	NT	12 (22.2)	
	LC	9 (16.7)	21 (38.8)
Inadequate data	DD	1 (1.9)	

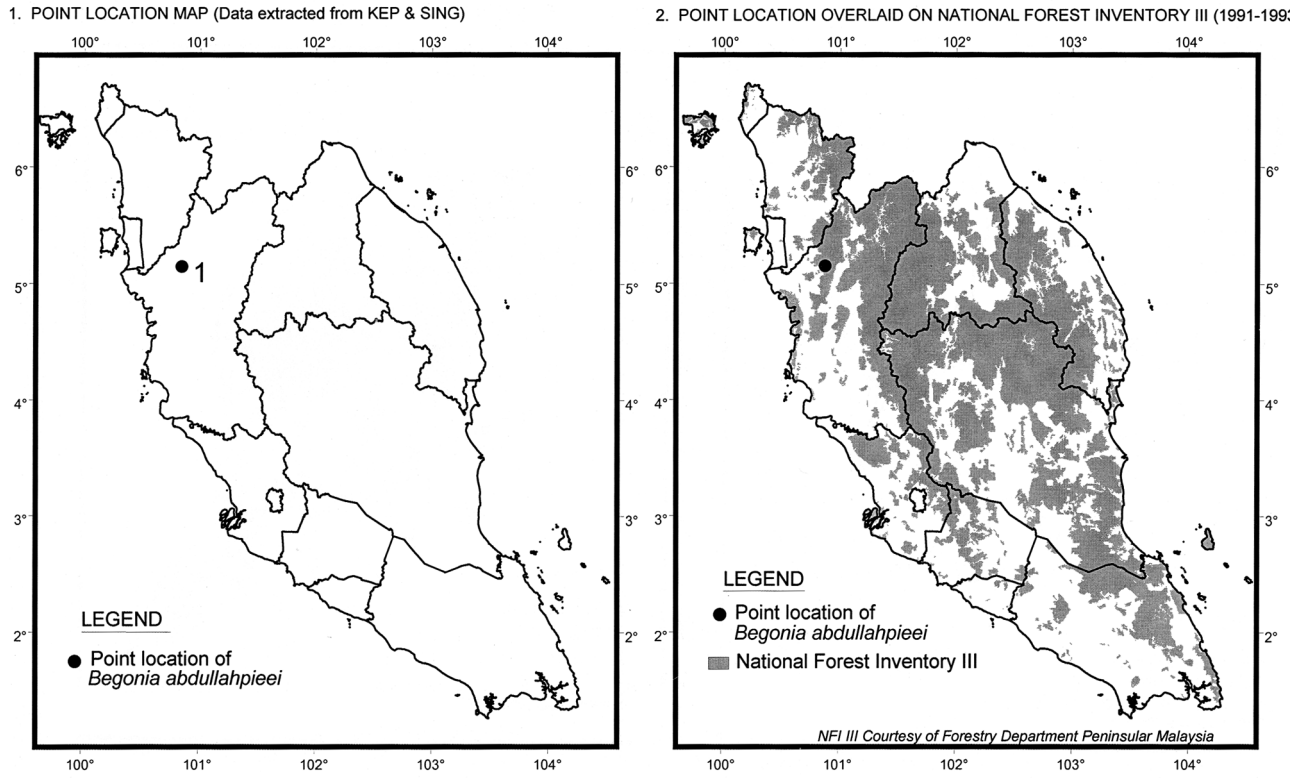

Fig. 3 Geographical distribution of *Begonia abdullahpieei* in Peninsular Malaysia. Left: 1 = Kelian Gunong. Right: EOO = 10 km^2; AOO = 10 km^2.

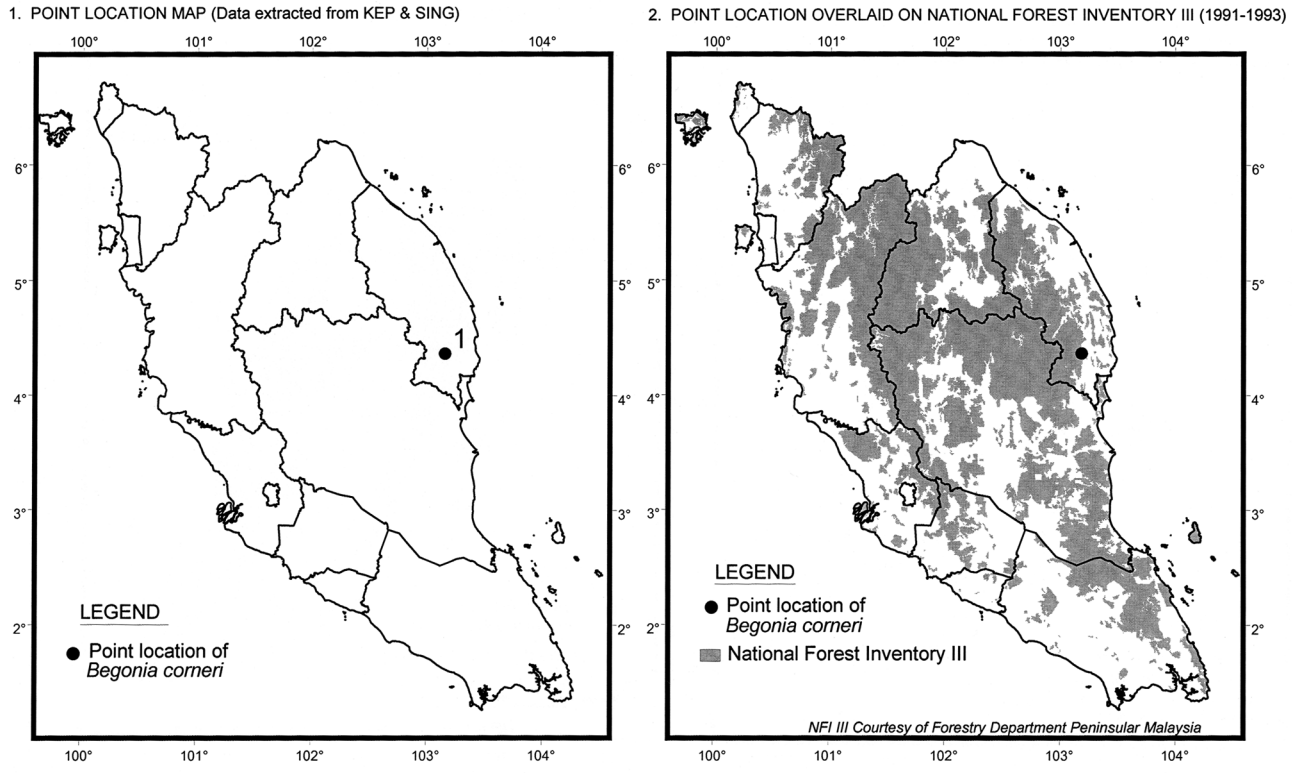

Fig. 4 Geographical distribution of *Begonia corneri* in Peninsular Malaysia. Left: 1 = Sg. Nipah. Right: EOO = 10 km^2; AOO = 10 km^2.

locality. In several cases this information is based on herbarium specimens with labels (sometimes backed up by field diaries) giving only the most general information as to where the plant was found. Even when the specific environment favoured by the taxon can be estimated, it is often impossible to find such taxa back in the field. They are categorized as CR; examples are *B. isopteroidea*, *B. martabanica* var. *pseudoclivalis* and *B. scortechinii.*

2. Degradation of pristine environments. Altogether 47 out of the 54 Peninsular Malaysian taxa are herbs in primary forests. Most of these grow on rocks near small streams and waterfalls; a few are found on steep earth slopes or on forest floor. The remaining 7 taxa occur on limestone only. All require a pristine habitat; degradation adversely affects the populations. Forest taxa like *B. corneri, B. herveyana* and *B. koksunii* are examples of species threatened by

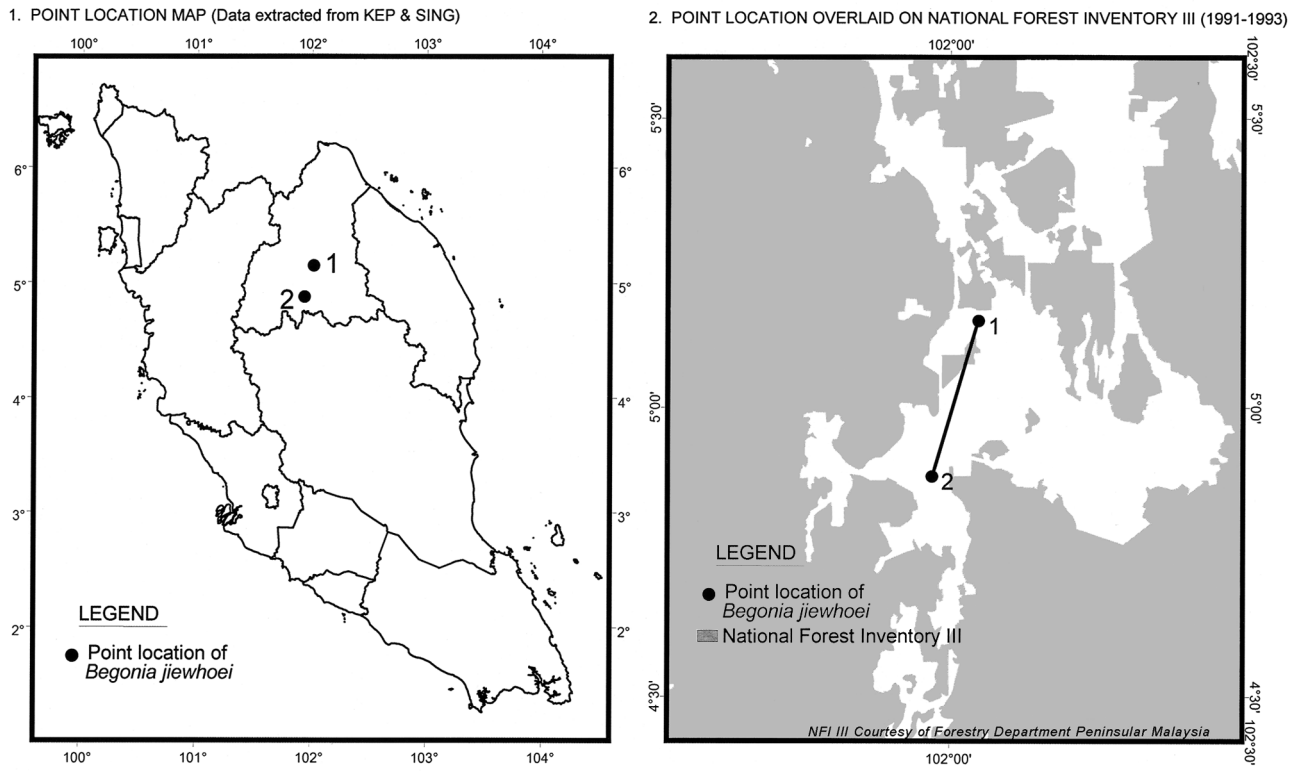

Fig. 5 Geographical distribution of *Begonia jiewhoei* in Peninsular Malaysia. Left: 1 = Bertam; 2 = Gua Musang. Right: EOO = 19.46 km²; AOO = 19.46 km².

changes in the environment. For limestone taxa, fires caused by illegal clearing are a major threat. Several other species, such as *B. reginula* and *B. tampanica* are threatened by recreation activities. *Begonia fraseri* occurs along forest trails that are regularly used by nature lovers.

Table 1 lists 21 taxa that are considered not threatened (NT and LC). Some, e.g., *B. lengguanii* and *B. longicaulis*, are single-locality taxa with very small population size, but their habitats are well-protected and the species are not collected for the trade in ornamentals.

DISCUSSION

Our conservation work on *Begonia aequilateralis* shows the importance of knowledge of niche requirements for a successful survey. It is endemic to the state of Selangor, and previous to this study, was only known from a single stream of Sungai (River) Buloh with about 20 plants (Kiew 2005). Our knowledge of the environment in which the extant population occurs made possible the identification of localities with a similar environment along other tributaries of the river network. In this way we discovered two additional populations. One of the recently encountered populations was close to the original, but now surrounded by residential estates. It is healthy, with many fruiting adults and juveniles, displaying resilience towards environmental change not often seen in the genus. Yet, its long-term survival is not certain. The second population has a similar story, but this site is in the grounds of the Forest Research Institute Malaysia and therefore well protected. It is close to the locality where the population is now extinct. As a result of these findings, *Begonia aequilateralis* is downgraded from CR to VU.

Recent findings of several other taxa, such as *Begonia forbesii* and *B. herveyana*, demonstrate the need to protect the integrity of the primary forest habitats for the long-term survival of *Begonia*.

Many *Begonias* are obligate riparian or rheophytic lithophytes, often requiring a certain level of pristine habitat for survival. In Malaysia, harvesting is subjected to many regulations. One of these is that 20 m on both sides of streams is left untouched. This benefits the largely riparian *Begonias* less than expected because in harvested areas, widespread and intense tropical thunderstorms are no longer cushioned by main canopy vegetation and without the buffering effect , large fluctuations in the water level and siltation occur on stream beds. Little is known of the negative effects of rapid and frequent water fluctuation and siltation on sensitive riparian species such as *B. corneri*, *B. koksunii* and *B. yappii*.

Most limestone hills are classified as Stateland Forest and not legally protected. *Begonias* endemic to limestone are threatened by quarrying and fires caused by land clearance at the foot of the hills. The most significant conservation measure proposed here is the gazettement of limestone hills as totally protected areas. For examples, many limestone hills dot the boundary of Taman Negara in the state of Pahang. These hills, although adjacent to a totally protected area, are excluded – we suggest that these be included. Other limestone hills should also be gazetted under the Permanent Reserved Forest network. Where settlements, buffer zones and recreational areas are close to limestone hills, close monitoring by district authorities of land development and other related activities are necessary.

We develop recommendations to conserve separate taxa in line with practicing protocols. These protocols depend on the legal status of the land, and are governed through legislation and management procedures. Knowledge of the distribution and of the environmental requirements of species is important to identify threats and to arrive at a Red List Categories assessment and measures towards effective conservation.

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Appendix 1 Summary of the five criteria (A–E) used to evaluate if a taxon belongs in a threatened category (Critically Endangered, Endangered or Vulnerable) (extracted from IUCN 2001).

Criterion	Critically Endangered	Endangered	Vulnerable
A Population reduction	Declines measured over the longer of 10 years or 3 generation		
A1	> 90 %	> 70 %	> 50 %
A2, A3 & A4	> 80 %	> 50 %	> 30 %
A1 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction are clearly reversible and understood and ceased based on and specifying any of the following: a) direct observation b) an index of abundance appropriate for the taxon c) a decline in area of occupancy, extent of occurrence and/or habitat quality d) actual or potential levels of exploitation e) effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.			
A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of reduction may not have ceased or may not be understood or may not be reversible based on any of a–e under A1.			
A3 Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on any of b–e under A1.			
A4 An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future and where the causes of reduction may not have ceased or may not be understood or may not be reversible based on any of a–e under A1.			
B Geographic range in the form of either B1 (extent of occurrence) or B2 (area of occupancy)			
B1 Either extent of occurrence	< 100 km^2	< 5 000 km^2	< 20 000 km^2
B2 Or area of occupancy	< 10 km^2	< 500 km^2	< 2 000 km^2
and 2 of the following 3:			
a) severely fragmented or # location	= 1	= 2–5	= 6–10
b) continuing decline in: i) extent of occurrence; ii) area of occupancy; iii) area, extent and/or quality of habitat; iv) number of locations or subpopulations; v) number of mature individuals			
c) extreme fluctuations in any of: i) extent of occurrence; ii) area of occupancy; iii) number of locations or subpopulations and; v) number of mature individuals.			
C Small population size and decline			
Number of mature individuals and either C1 or C2	< 250	< 2 500	< 10 000
C1 An estimated continuing decline of at least up to a maximum of 100 years	25% within 3 years or 1 generation	20% within 5 years or 2 generations	10% within 10 years or 3 generations
C2 A continuing decline and a) and/or b)			
a i) # mature individuals in largest subpopulation	< 50	< 250	< 1 000
a ii) or % individuals in one subpopulation	90–100 %	95–100 %	100 %
b) extreme fluctuations in the number of mature individuals			
D Very small or restricted population			
Either 1) number of mature individuals	< 50	< 250	< 1 000
Or 2) restricted area of occupancy	Na	Na	Typically AOO < 20 km^2 or #locations £5
E Quantitative analysis			
Indicating the probability of extinction in the wild to be at least	50% in 10 years or 3 generations (100 years max)	20% in 20 years or 5 generations (100 years max)	10 % in 100 years