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The vegetation structure on the granitic inselberg in Songkhla province, Peninsular Thailand

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ABSTRACT. Plant communities were studied and floristic surveys of vascular plants carried out on Khao Reng, a small "inselberg" in Songkhla province from October 2008 to February 2010. Seventy three species were recorded with the three most commonly encountered families being Orchidaceae (12 species), Rubiaceae (7 species), and Poaceae (7 species). Profiles of the vegetation on its microhabitats were made. The microhabitats on the rock platform of the inselberg of Khao Reng are categorized into seven types, rock crevices and clefts, rock falls, shallow depressions, deep depressions, exposed rock slopes, shady flat rocky slopes, and rock platform fringes. The rock platform fringes which possess various conditions of soil accumulation and light intensities, have accommodated the highest plant species numbers.

KEY WORDS: Vascular plants, granitic inselberg, peninsular Thailand.

INTRODUCTION

The term "inselberg" was first used by Bornhardt (1900) to describe the isolated rock outcrops which are characterized by large areas of bare rocky slopes that are found in southern Africa. In general, inselbergs are an isolated hill or groups of hills that rise abruptly from the surrounding plains. They are widely distributed in tropical and subtropical regions but can be found in temperate zones as well (e.g. Australia, USA) (Porembski et al., 1993; Hunter & Clarke, 1998; Pigott & Sage, 1997; Oosting & Anderson, 1937, 1939; McVaugh, 1943; Baskin & Baskin, 1988; Wyatt & Stoneburner, 1982; Sarthou & Villiers, 1998). In general, precambrian granites and gneisses are the major rock types of inselbergs and granite inselbergs occur as dome-shaped rock outcrops (Porembski et al., 1997). Studies on the vegetation of these granitic outcrops have been undertaken throughout the world particularly in Africa and America (e.g. Oosting & Anderson, 1937, 1939; McVaugh, 1943; Wyatt & Fowler, 1977; Wentworth, 1981; Walters & Wyatt, 1982; Wyatt & Stoneburner, 1982; Baskin & Baskin, 1988; Houle & Phillips, 1989; Barthlott et al., 1993;Porembski et al., 1993; Groger & Barthlott, 1996; Beard, 1997; Pigott & Sage, 1997; Porembski et al., 1997; Porembski et al., 1998; Hunter & Clarke, 1998; Sarthou & Villiers, 1998; Porembski & Barthlott, 2000; Burke, 2002a, 2002b, 2003, 2004, 2005; Parmentier, 2003; Parmentier et al., 2005; Müller, 2007; Scarano, 2007). On the other hand, the granitic inselbergs in Tropical Asia have not attracted many biologists yet, especially the local ones.

Inselbergs can be regarded as terrestrial habitat islands because they have unique ecological characteristics. In contrast to oceanic islands, terrestrial habitat islands have been rather neglected in the study of species diversity (Porembski, 2007). This habitat may house many particular plant species which can thrive on these rock platforms. Unfortunately, floristic information on inselbergs, especially in Southeast Asia, is very sparse. In Thailand, inselbergs or isolated hills are sparsely distributed throughout the country (though they are absent from the central part) and there are no publications whatsoever on their vegetation. Unfortunately, many of the areas where granitic inselbergs occur in Thailand have been disturbed or modified by human activities (e.g. selected reforestation programs which introduce alien species), agriculture (e.g. rubber plantations),

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granite mining and so on. The vegetation and flora of the inselberg granitic hills, especially in peninsular Thailand, should urgently be surveyed and recorded before it is permanently altered or destroyed. The present study aims to document the diversity of vascular plants and their habitats on the undamaged inselberg of Khao Reng hill, Songkhla province, peninsular Thailand.

MATERIALS AND METHODS

STUDY AREA

Location

Khao Reng hill is located in Songkhla province, southern Thailand (Fig. 1). This area lies approximately between 6°54'27.49"–6°55'58.23" North and 100°36'33.24"–100°37'48.12" East. The ridge of this hill forms the boundary between the Chana and Namom districts of Songkhla province being bounded on the East by Chana district and on the West by Namon district. It is 35.45 km from Songkhla and 965.90 km from Bangkok. In terms of biogeography, this area is close to the Kangar-Pattani demarcation line (sensu Whitmore 1975) which is an imaginary line drawn from Kangar on the northwestern coast of peninsular Malaysia to the eastern coast of peninsular Thailand in Pattani. This line is believed to be a close approximation to the boundary between the two main floristic regions i.e. the subcontinental Southeast Asian region and the Malesian region.

Topography and geology

Khao Reng hill is a small dome-shaped inselberg, 55–559 m above sea level, which is part of the Bantad range (Fig. 2). The inselberg is mainly composed of two types of rock, i.e. Triassic granites and Lower Carboniferous sandstones (Mineral Resource Department, 2007), with granite the dominant rock type. Granitic rock platforms (sloping areas with much bare rock) are scattered over this inselberg, especially in the eastern and middle parts of the hill. These rock platforms have many features including crevices, cliffs, boulders, thin and thick layers of soil, as well as small streams and their slopes vary between 30–80º.

Climate

According to Köppen's classification system of climatic region analysis in Kottek et al. (2006), the climate of Songkhla belongs to the tropical rainforest climate (Am). There are two distinct seasons, a dry season from February to September and a rainy season from October to January (Fig. 3). The precipitation in this area is affected by the southwest and northeast monsoons with the average annual rainfall being about 2,400 mm [Climatic data relating to our period of study are taken from the Songkhla Climatic Station in Had Yai district which is nearest climate station to the hill.]. During the study period (October 2008 to February 2010), the average annual temperature was about 27.7 ºC with the average maximum temperature 29.5º C in June 2009, and the average minimum temperature 26.2ºC during December 2008 and January 2009. The average monthly rainfall was about 227.4 mm with the highest monthly rainfall of 1,044 mm occurring in November 2008, and the lowest monthly rainfall of 1.3 mm in February 2010. A total of 224 rain days were recorded and heavy rainfalls occurred in November 2009 (24 days) (Meteorological Department, 2010).

DATA COLLECTION

Floristic study

All vascular plants specimens were collected at intervals (at least once a month from October 2008 to February 2010) from Khao Reng hill, and all were prepared as described by Bridson & Forman (1998).

The abundance of each species was estimated by the percentage cover following Kent & Coker (1992) and the percentage cover values were given average scores as follows: 5 = most abundant (76–100% cover), 4 = more abundant (51–75% cover), 3 = common (26–50% cover), 2 = few (6–25% cover), 1 = rare (1–5% cover), 0 = absent

Laboratory study

All plant collections were identified as far as possible with the available taxonomic literature. Voucher specimens have been deposited at the Herbarium, Department of Biology (**PSU**), Princess Maha Chakri Sirindhorn Natural History Museum, Faculty of Science, Prince of Songkla University, Songkhla and the Forest Herbarium (**BKF**), Department of National Parks, Wildlife and Plant Conservation, Bangkok, Thailand.

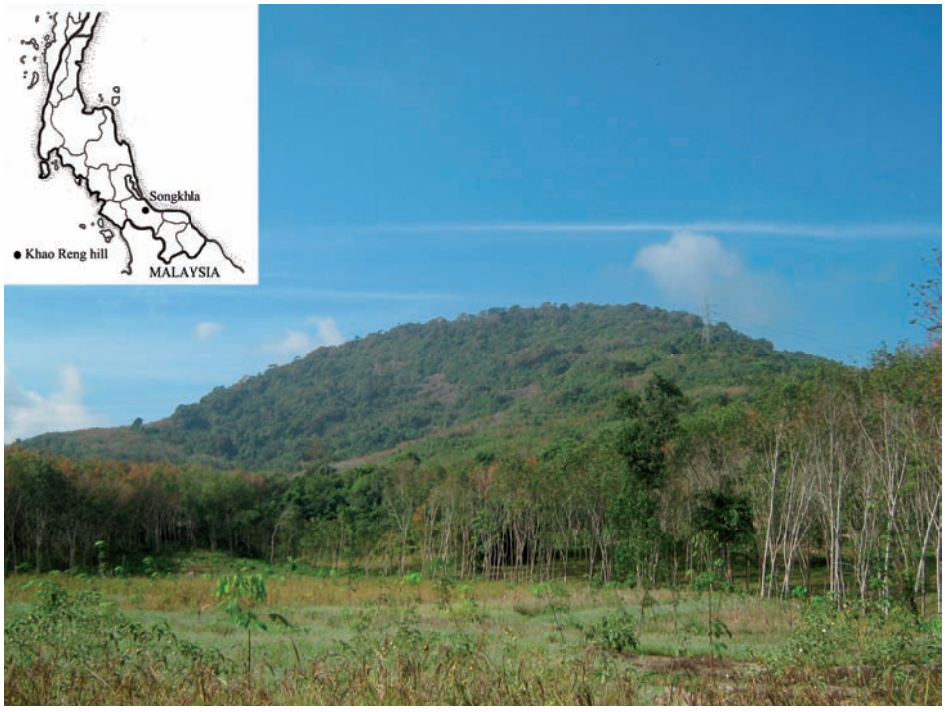


Figure 1. The small dome-shaped granitic hill of Khao Reng.

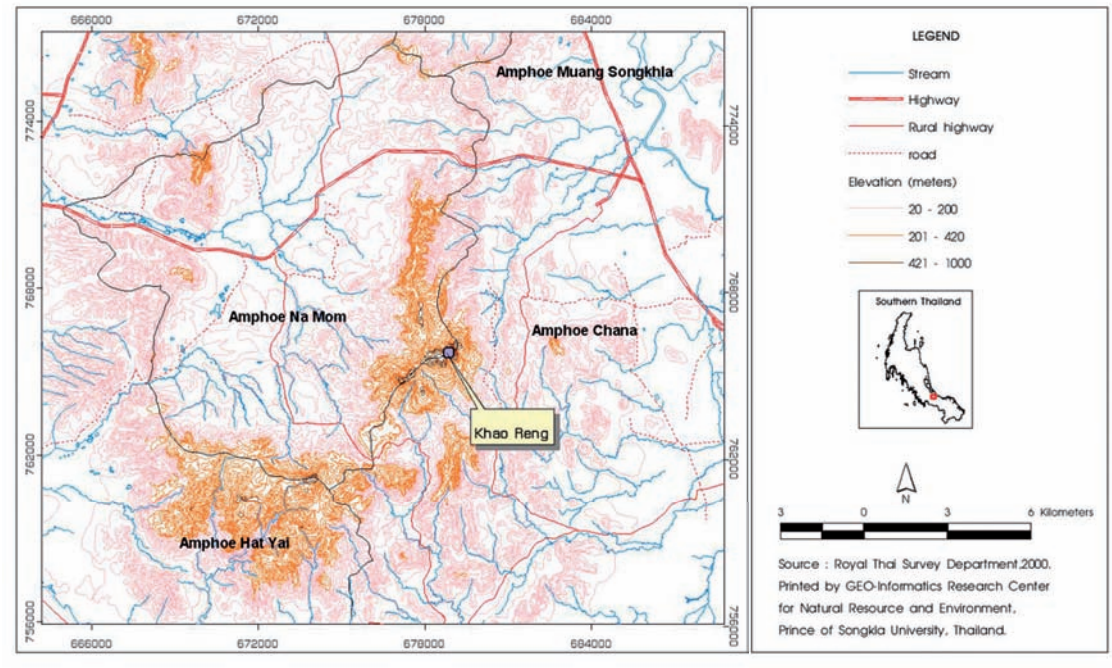


Figure 2. Topographic map of Songkhla province showing the position and elevation of Khao Reng hill.

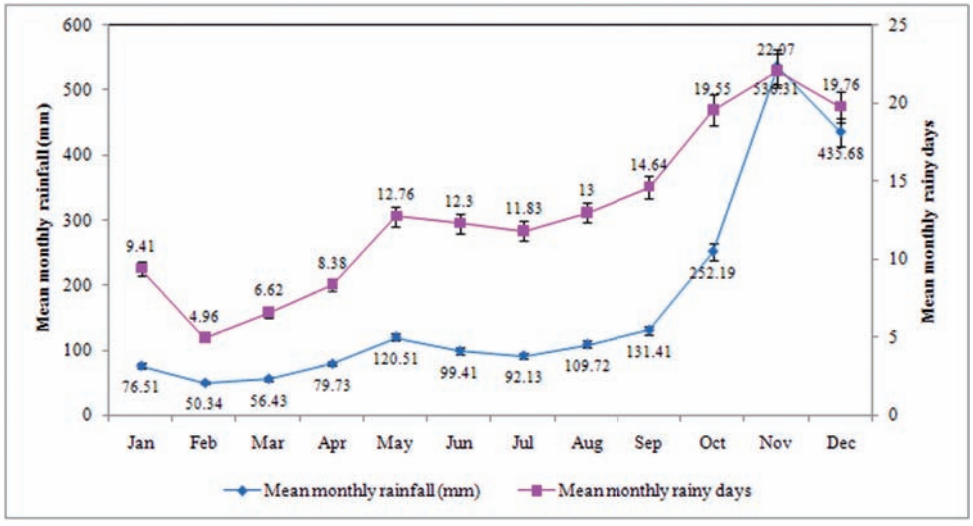


Figure 3. Climatological data during the period, 1981–2010, from Songkhla Climatic Station in Had-Yai district (568501) (Data from the Meteorology of Songkhla province, Thailand).

Figure 4. Typical microhabitat types on the granitic inselberg of Khao Reng hill: A. Rock crevices and clefts; B. Shallow depressions; C. Deep depressions; D. Rock platform fringes.

Vegetation study

A representative transect leading from the foothills upwards to the top of Khao Reng Hill with slope of 45–75º was selected for detailed study. Along it, three sampling plots (100 m x 30 m) were selected for detailed vegetation studies, namely plots A, B and C. These plots were at elevations of 125–189 m, 240–305 m and 337–386 m, respectively. The distance between the three plots A–B, B–C, and C–A was about 500 m. The vegetation profiles of the three plots along the slope of this dome-shaped granitic inselberg were illustrated.

RESULTS AND DISCUSSION

Species richness

Seventy-three species of vascular plants on Khao Reng granitic inselberg are identified and listed in Table 1. The families containing most species of monocotyledons are Orchidaceae (12 species), Poaceae (7 species) and Cyperaceae (4 species), whilst the families containing most species of dicotyledons are represented by the families Rubiaceae (7 species) and Asclepiadaceae (3 species).

Life forms

Of 73 vascular plant species, four forms of plant habit were encountered: herbs (42 species or 57.53%), trees (16 species or 21.92%), shrubs (11 species or 15.07%), and climbers (4 species or 5.48%) (Fig. 5).

Microhabitat types and species compositions on granitic rock platforms of the inselberg of Khao Reng

Based on the topography of Khao Reng hill, six categories of microhabitat type plus a rock platform fringe habitat were recognised. Each microhabitat accommodates varying floristic composition as follows:

1. Rock crevices and clefts. The vegetation in rock crevices and clefts varies depending on the degree of exposure, the presence or absence of soil pockets as well as humidity, from a bare crevice (in the case of no soil pockets) to a dense vegetated crevice with mostly herbaceous plants or sometimes with shrubs and small trees. The vegetation is mostly composed of herbaceous plants e.g. *Paraboea minor* (Barnett) B.L.Burtt, *Cymbopogon flexuosus* (Nees ex Steud.) W.Watson. (both species are the most abundant), *Cyperus dubius* Rottb. and *Fimbristylis hookeriana* Boeck. In this study, we consider that ‘clefts’ are, in general, broader and deeper than ’crevices‘, and the former usually contain some woody shrubs and tree species e.g. *Helicteres hirsuta* Lour., *Homalium dasyanthum* (Turcz.) W.Theob., *Canthium horridum* Blume and *Gardenia coronaria* Buch.-Ham.. Under shady conditions, clefts allow establishment of *Eria javanica* Blume, *Globba pendula* Roxb. and pteridophytes (Fig. 4.A).

2. Rock falls. This habitat type is a place where

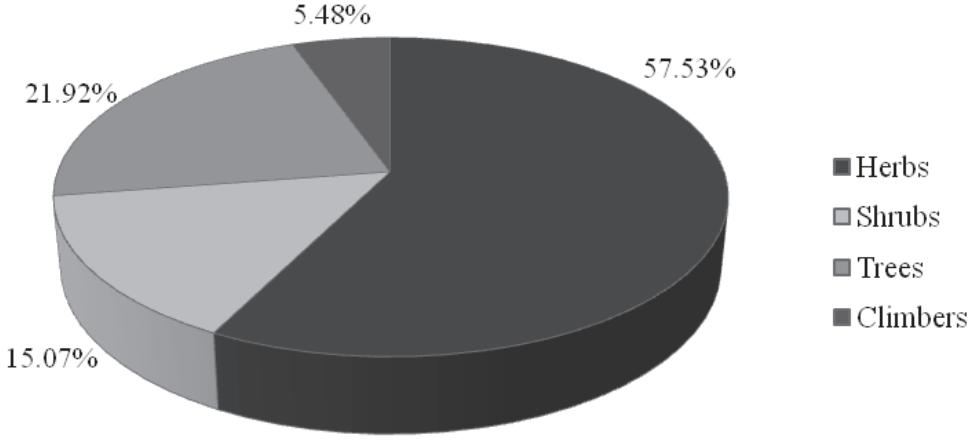


Figure 5. Pie chart showing the percentage of life forms of vascular plants on the granitic inselberg of Khao Reng hill.

there is an accumulation of many big fallen rocks, varying in size and shape (0.5–3 m in diameter). It can be found at the foothills or near the borders of the rock platforms. In this particular habitat, accumulations of boulders, organic matter and general debris occurs. The thin layer of soil, present among those fractured rocks, is covered with many epiphytic orchids e.g. *Flickingeria convexa* (Blume) A.D.Hawkes and *Aerides odorata* Lour. and some woody shrubs e.g. *Memecylon edule* Roxb. and *M. campanulatum* C.B.Clarke.

3. Shallow depressions. This habitat type occurred on inclined rock surfaces (45–75º). They consist of a small hollow, filled with some moist litter (up to 10 cm depth), covered with herbaceous plants and epiphytic orchids, dominated by *Paraboea minor* and some epiphytic orchids e.g. *Aerides odorata* and *Dendrobium crumenatum* Sw (Fig. 4.B). However, the soil is not deep enough to support large woody trees. In this microhabitat, soil depth is probably important in terms of humidity conservation. Generally, shallow depressions are isolated and surrounded by open areas of exposed rock, though the plant species of such shallow depressions could be also found in large contiguous mats. Typical plant mats are mainly composed of the families Poaceae, Cyperaceae, pteridophytes and many mosses. This type of microhabitat is widely distributed throughout the granitic rock platforms all over this inselberg. There are high diversity of ecological niches in this habitat due to varying conditions of soil depth and light.

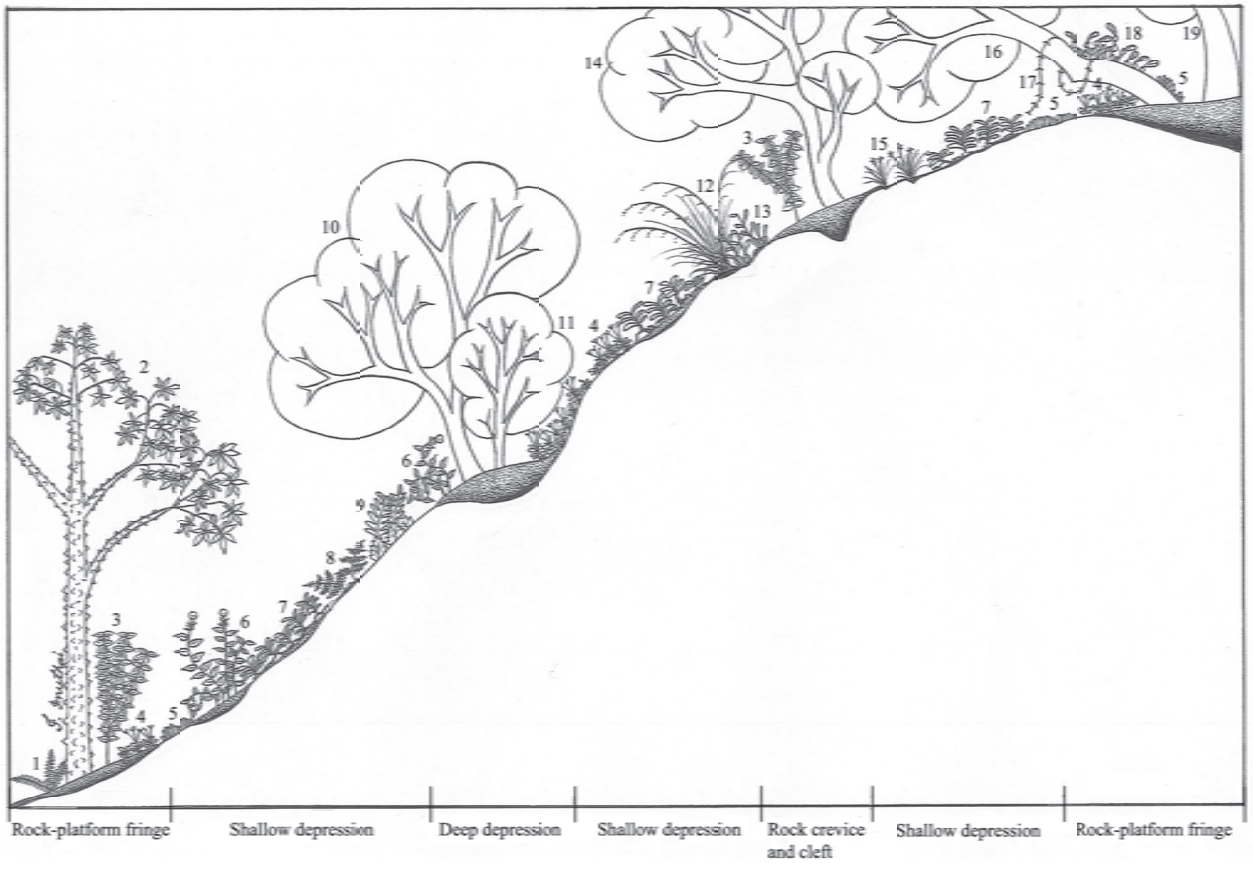
4. Deep depressions. This habitat type has a gentle slope, which allows more soil accumulation (up to 1 m depth) than the shallow depressions, therefore more shrubs and woody trees are found there. Species composition varies depending on the thickness of the substrate. The habitat includes a number of tree species, but each is represented by a few individuals. The ground species are abundant with herbaceous plants e.g. *Paraboea minor*, *Davallia solida* (G.Forst.) Sw. and *Cheilocostus speciosus* (J.König) C.D.Specht. The shrubs and trees include *Memecylon campanulatum*, *Cladogynos orientalis* Zipp. ex Span., *Ochna integerrima* (Lour.) Merr., *Wrightia pubescens* R.Br. and *Vitex pinnata* L. (Fig. 4.C).

5. Exposed rock slopes. The dry bare rock surfaces are strongly exposed to sunlight with the angles of inclination of their slopes varying from 30–80º. This habitat is usually covered with lichens which apparently turn the colors of the rock surface brownish to black. Water films often occur. In wet periods, water continuously flows throughout the rocky slopes, however, it soon dries off. The exposed rock slopes with no cracks or crevices do not support any vegetation (i.e. they are bare rock).

6. Shady flat rocky slopes. This habitat is located within the forest and therefore there is less sunlight than out in the open and the atmospheric humidity and soil moisture is likely to be higher than in exposed areas. Isolated small patches of moss develop on some rock surfaces where in the wet period water drainage occurs. The herbaceous plant layer is dominated by many orchids e.g. *Cleisostoma subulatum* Blume and *Dienia ophrydis* (J.König) Seidenf. and pteridophytes e.g. *Microlepia speluncae* (L.) T.Moore and *Hemionitis arifolia* (Burm.f.) T.Moore.

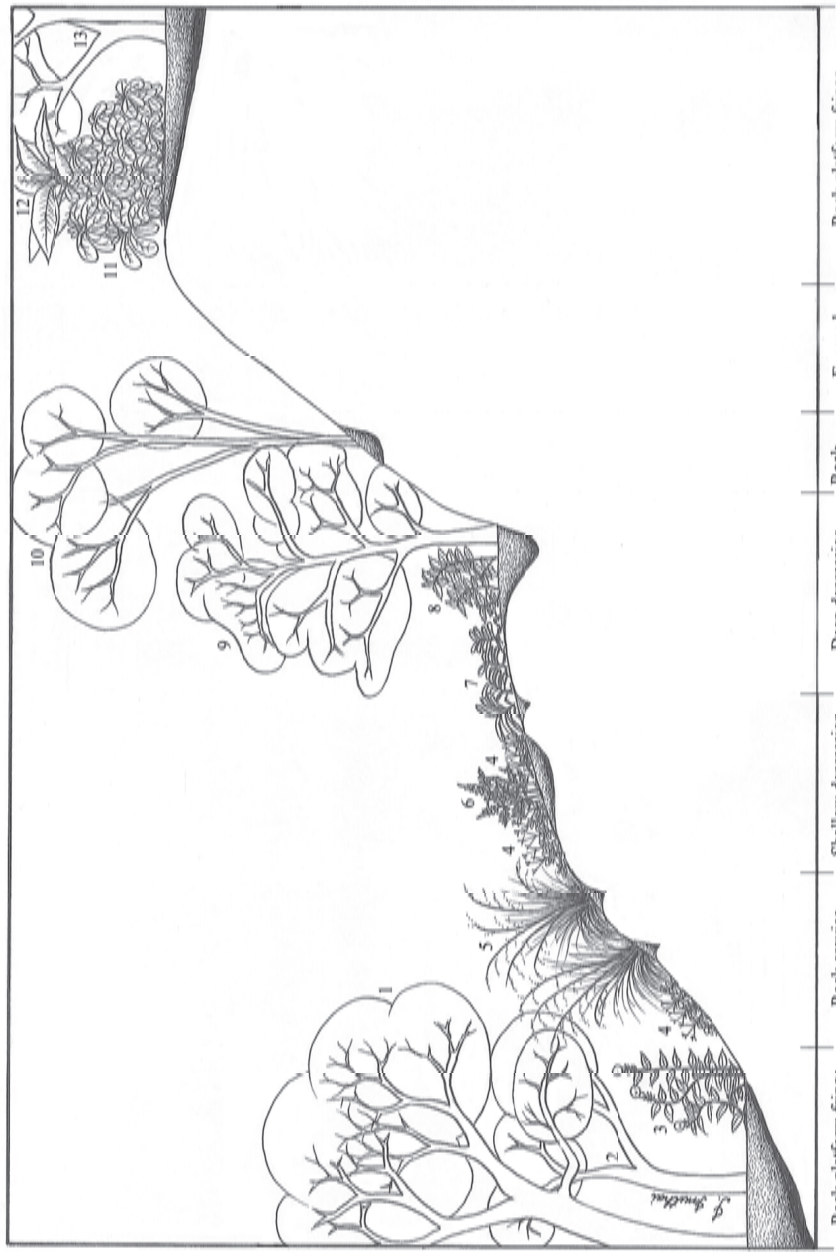
7. Rock platform fringes. This habitat is located along the fringe of the forest and the foothills. We define it as a band 2–3 m wide between the two habitats (forest *versus* rock platform). The soil layer is thick enough to allow the growth of some trees (up to 15 m tall). Rocks and boulders of different sizes and shapes are abundant. The vegetation is dominated by shrub and tree species e.g. *Memecylon campanulatum*, *M. edule*, *Cladogynos orientalis*, *Sterculia cordata* Blume, *Fagraea auriculata* Jack, *Secamone elliptica* R.Br., as well as epiphytes including orchids e.g. *Plocoglottis quadrifolia* J.J.Sm., *Doritis pulcherrima* Lindl. and *Eria javanica* Blume and pteridophytes such as *Davallia solida*, *Asplenium pellucidum* Lam., *Drynaria bonii* H.Christ. and *Drynaria sparsisora* (Desv.) T.Moore. The abundance of epiphytes is likely to be due to the high light availability and humidity (Fig. 4.D).

When the habitat types of Khao Reng Hill and adjacent areas are taken into account, two major habitat types, where more accumulation of litter has occurred, may be recognized. These are the rock platforms and the forests (dry evergreen forest). The present study concentrated on the rock platforms; however, it is clear that many plant species can be found in both habitats (see also Table 1). As indicated above the zone between the rock platforms and the forest habitats is termed, in the



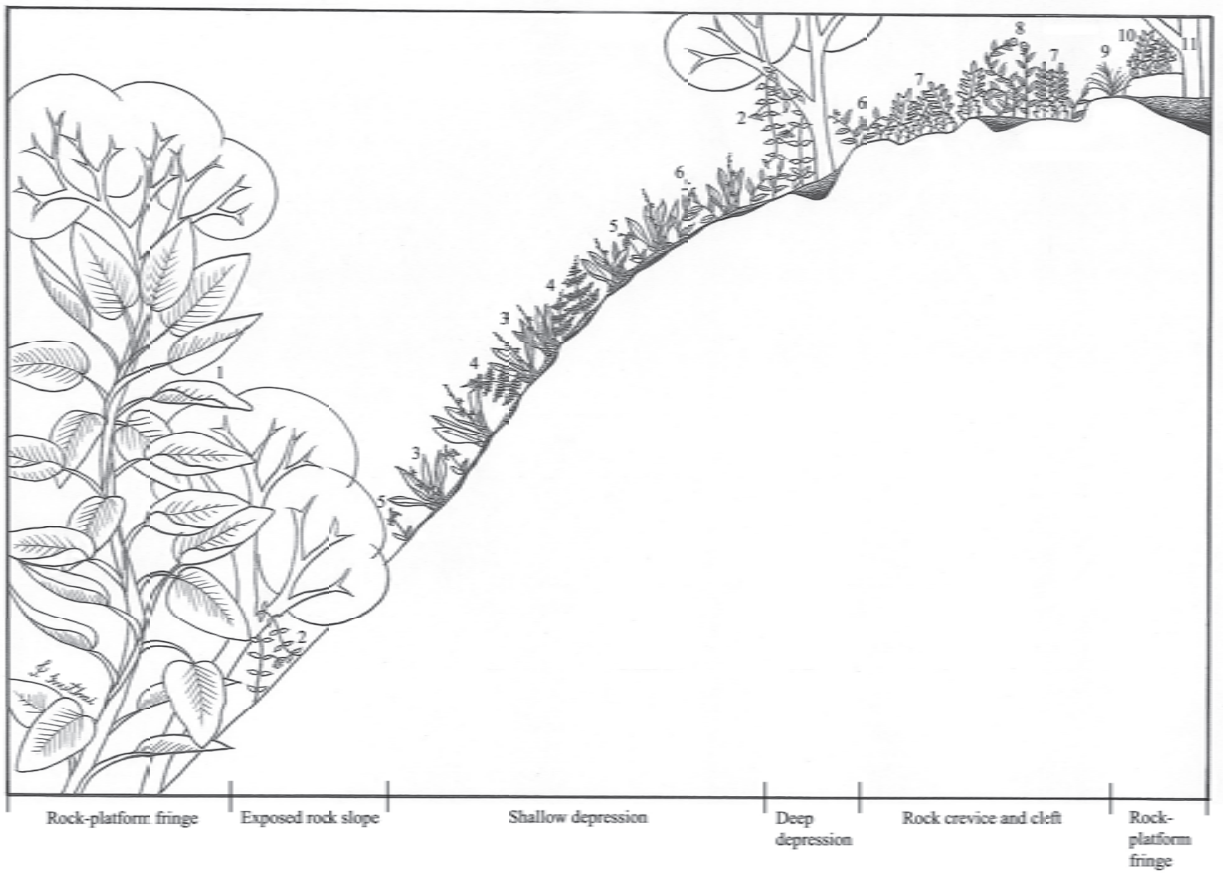
1. *Asplenium pellucidum* Lam.
2. *Bombax anceps* Pierre
3. *Memecylon campanulatum* C.B. Clarke
4. *Paraboea minor* (Barnett) B.L.Burtt
5. *Pyrrosia adnascens* (Sw.) Ching
6. *Cheilocostus speciosus* (J.König) C.D. Specht
7. *Aerides odorata* Lour.
8. *Davallia solida* (G.Forst.) Sw.
9. *Drynaria sparsisora* (Desv.) T.Moore
10. *Vitex pinnata* L.
11. *Memecylon edule* Roxb.
12. *Cymbopogon flexuosus* (Nees ex Steud.) W.Watson
13. *Dendrobium crumenatum* Sw.
14. *Ochna integerrima* (Lour.) Merr.
15. *Fimbristylis hookeriana* Boeck
16. *Sterculia cordata* Blume
17. *Dischidia bengalensis* Colebr.
18. *Flickingeria convexa* (Blume) A.D. Hawkes
19. *Homalium dasyanthum* (Turcz.) W.Theob.

Figure 6. Schematic diagram of vegetation profile on plot **A** at Khao Reng hill.



1. *Sterculia cordata* Blume
2. *Vitex pinnata* L.
3. *Cheilocostus speciosus* (J.König) C.D. Specht
4. *Paraboea minor* (Barnett) B.L.Burtt
5. *Cymbopogon flexuosus* (Nees ex Steud.) W.Watson
6. *Cheilanthes tenuifolia* (Burm.f.) Sw.
7. *Aerides odorata* Lour.
8. *Cladogynos orientalis* Zipp. ex Span.
9. *Ochna integerrima* (Lour.) Merr.
10. *Gardenia coronaria* Buch.-Ham.
11. *Fagraea auriculata* Jack
12. *Epipremnum giganteum* (Roxb.) Schott
13. *Homalium dasyanthum* (Turcz.) W.Theob.

Figure 7. Schematic diagram of vegetation profile on plot **B** at Khao Reng hill.



1. *Epipremnum giganteum* (Roxb.) Schott
2. *Hoya micrantha* Hook.f.
3. *Eria javanica* Blume
4. *Davallia solida* (G.Forst.) Sw.
5. *Doritis pulcherrima* Lindl.
6. *Globba pendula* Roxb.
7. *Drynaria sparsisora* (Desv.) T.Moore
8. *Cheilocostus speciosus* (J.König) C.D. Specht
9. *Coelorachis helferi* (Hook.f.) Henrard
10. *Drynaria bonii* H.Christ
11. *Wrightia pubescens* R.Br.

Figure 8. Schematic diagram of vegetation profile on plot **C** at Khao Reng hill.

Table 1 List of vascular plants occurring at Khao Reng hill in Songkhla province.

Family	Scientific name	Life form[2]	Rock platform microhabitat type[3]							Forest[4]	Voucher
			1	2	3	4	5	6	7		
Dicotyledons											
Acanthaceae	*Pseuderanthemum graciliflorum* Ridl.	H							x	x	*Inuthai* 482
Apocynaceae	*Wrightia pubescens* R.Br.	T				x			x	x	*Inuthai* 574
Asclepiadaceae	*Hoya micrantha* Hook.f.	C							x		*Inuthai* 494
	Dischidia bengalensis Colebr.	C							x		*Inuthai* 511
	Secamone elliptica R.Br.	T							x		*Inuthai* 536
Bignoniaceae	*Stereospermum fimbriatum* DC.	T							x		*Inuthai* 630
Bombacaceae	*Bombax anceps* Pierre	T							x		*Inuthai* 469
Clusiaceae	*Mesua kunstleri* var. *curtisii* (King) Whitmore	S								x	*Inuthai* 556
Euphorbiaceae	*Cladogynos orientalis* Zipp. ex Span.	S				x			x		*Inuthai* 521
Fabaceae	*Acacia megaladena* var. *indo-chinensis* I.C.Nielsen	T							x		*Inuthai* 534
Flacourtiaceae	*Homalium dasyanthum* (Turcz.) W.Theob.	T	x						x		*Inuthai* 480
Gesneriaceae	*Paraboea minor* (Barnett) B.L.Burtt	H	x	x	x				x	x	*Inuthai* 560
Hydnocarpaceae	*Hydnocarpus ilicifolia* King	T								x	*Inuthai* 515
Lamiaceae	*Vitex pinnata* L.	T	x		x	x			x	x	*Inuthai* 510
Loganiaceae	*Fagraea auriculata* Jack	S							x		*Inuthai* 614
Memecylaceae	*Memecylon campanulatum* C.B.Clarke	S				x			x	x	*Inuthai* 507

[2] Life form: H = Herbaceous plant, S = Shrub, T = Tree, C = Climber

[3] Rock platform microhabitat type: 1 = Rock crevices and clefts, 2 = Rock falls, 3 = Shallow depressions, 4 = Deep depressions, 5 = Exposed rock slopes, 6 = Shady flat rocky slopes, 7 = Rock platform fringes

[4] Forest refers specifically to the forest on Khao Reng hill.

Family	Scientific name	Life form[2]	Rock platform microhabitat type[3]							Forest[4]	Voucher
			1	2	3	4	5	6	7		
Memecylaceae	*Memecylon edule* Roxb.	T				x			x		*Inuthai* 522
Moraceae	*Streblus taxoides* Kurz	S								x	*Inuthai* 484
	Ficus hispida L.f.	T								x	*Inuthai* 610
Ochnaceae	*Ochna integerrima* (Lour.) Merr.	T	x			x			x		*Inuthai* 475
Oleaceae	*Chionanthus microstigma* (Gagnep.) P.S.Green	S							x		*Inuthai* 545
	Jasminum sp.	S							x		*Inuthai* 623
Rubiaceae	*Canthium horridum* Blume	S				x			x		*Inuthai* 505
	Catunaregam sp.	T	x						x	x	*Inuthai* 588
	Gardenia coronaria Buch.-Ham.	T	x						x	x	*Inuthai* 584
	Ixora javanica (Blume) DC.	S								x	*Inuthai* 594
	Pavetta indica L.	T							x		*Inuthai* 514
	Prismatomeris tetrandra subsp. *malayana* (Ridl.) T.Johanss.	S	x	x							*Inuthai* 583
	Psydrax sp.	T				x					*Inuthai* 495
Sterculiaceae	*Helicteres hirsuta* Lour.	S	x		x	x			x	x	*Inuthai* 561
	Sterculia cordata Blume	T				x			x		*Inuthai* 502
Vitaceae	*Cissus nodosa* Blume	C			x						*Inuthai* 549
Monocotyledons											
Araceae	*Scindapsus scortechinii* Hook.f.	H							x	x	*Inuthai* 485
	Epipremnum giganteum (Roxb.) Schott	H							x		*Inuthai* 629
Costaceae	*Cheilocostus speciosus* (J.König) C.D. Specht	H			x	x			x		*Inuthai* 542

Family	Scientific name	Life form[2]	Rock platform microhabitat type[3]							Forest[4]	Voucher
			1	2	3	4	5	6	7		
Cyperaceae	*Carex helferi* Boeck	H							x	x	*Inuthai* 573
	Cyperus dubius Rottb.	H	x		x						*Inuthai* 581
	Fimbristylis hookeriana Boeck	H	x		x						*Inuthai* 586
	Scleria lithosperma var. *linearis* Benth.	H								x	*Inuthai* 604
Orchidaceae	*Aerides odorata* Lour.	H	x		x				x		*Inuthai* 552
	Cleisostoma subulatum Blume	H						x			*Inuthai* 633
	Cymbidium finlaysonianum Lindl.	H			x	x				x	*Inuthai* 401
	Dendrobium crumenatum Sw.	H	x		x				x		*Inuthai* 497
	Dienia ophrydis (J.König) Seidenf.	H						x		x	*Inuthai* 516
	Doritis pulcherrima Lindl.	H							x		*Inuthai* 421
	Eria javanica Blume	H			x				x		*Inuthai* 563
	Flickingeria convexa (Blume) A.D.Hawkes	H	x	x	x				x		*Inuthai* 632
	Plocoglottis quadrifolia J.J.Sm.	H				x			x		*Inuthai* 402
	Rhynchogyna luisifolia (Ridl.) Seidenf. & Garay	H								x	*Inuthai* 656
	Tainia penangiana Hook.f.	H						x			*Inuthai* 628
	Vanilla aphylla Blume	H								x	*Inuthai* 406
Palmaceae	*Livistona speciosa* Kurz	H								x	*Inuthai* 575
Poaceae	*Coelorachis helferi* (Hook.f.) Henrard	H							x	x	*Inuthai* 596
	Cymbopogon flexuosus (Nees ex Steud.) W.Watson	H	x		x	x			x		*Inuthai* 582
	Cyrtococcum oxyphyllum Stapf	H	x		x						*Inuthai* 569
	Cyrtococcum patens A.Camus	H	x		x						*Inuthai* 449

Family	Scientific name	Life form[2]	Rock platform microhabitat type[3]							Forest[4]	Voucher
			1	2	3	4	5	6	7		
Poaceae	*Elymus* sp.	H	x								*Inuthai* 451
	Melinis repens (Willd.) Zizka	H	x		x	x					*Inuthai* 543
	Ottochloa nodosa (Kunth) Dandy	H			x						*Inuthai* 499
Stemonaceae	*Stemona tuberosa* Lour.	C							x		*Inuthai* 478
Zingiberaceae	*Globba pendula* Roxb.	H		x					x		*Inuthai* 562
Pteridophyte											
Aspleniaceae	*Asplenium pellucidum* Lam.	H							x		*Inuthai* 627
Davalliaceae	*Davallia solida* (G.Forst.) Sw.	H			x				x		*Inuthai* 550
Dennstaedtiaceae	*Microlepia speluncae* (L.) T.Moore	H								x	*Inuthai* 598
Lygodiaceae	*Lygodium polystachyum* Wall.	H								x	*Inuthai* 592
Polypodiaceae	*Drynaria bonii* H.Christ	H	x		x				x		*Inuthai* 578
	Drynaria sparsisora (Desv.) T.Moore	H			x				x		*Inuthai* 565
	Pyrrosia adnascens (Sw.) Ching	H		x	x				x	x	*Inuthai* 585
Pteridaceae	*Adiantum caudatum* L.	H								x	*Inuthai* 539
	Cheilanthes tenuifolia (Burm.f.) Sw.	H			x						*Inuthai* 532
	Parahemionitis cordata (Hook. & Grev.) Fraser-Jenk.	H						x			*Inuthai* 435
Thelypteridaceae	*Thelypteris opulenta* (Kaulf.) Fosberg	H								x	*Inuthai* 599
Lycophyte											
Selaginellaceae	*Selaginella willdenowii* (Desv.) Baker	H								x	*Inuthai* 593

present study, "rock platform fringe", so as to indicate the boundary between the rock platform and the adjacent dry evergreen forest. These fringes form the ecotone between those two major habitats. Despite their differences, the two major habitats contain many similar species including e.g. *Cymbidium finlaysonianum* Lindl., *Vitex pinnata*, *Ochna integerrima* and *Catunaregam* sp. Many orchid, shrub and tree species can grow in these areas, probably due to the fact that the fringes have a high diversity of ecological niches as a result of the varying conditions of soil depth and light intensity (Porembski, 2003). The species in these rock platform fringes possibly play important roles as buffer elements between the different plant groups in the two habitats. More detailed study of the physiological and ecological roles of plant elements in these rock platform fringes are required.

Edaphic and topographic factors, including the substrate thickness as well as the inclination of the platforms, are likely to have the most direct effect on the species composition of the microhabitats on the granitic rock platforms of Khao Reng Hill. According to Porembski et al. (1993), the degree of inclination of rock faces is an important determinant responsible for the distribution of habitat types. At Khao Reng hill, steep slopes with inclinations of 45–60º bear mats of *Cymbopogon flexuosus* in crevices and clefts that facilitate long-term establishment. In the middle of the rock platforms, there are open areas that are exposed to the sunlight. Here the soil is not thick enough to support big trees, and there are many small herbaceous species such as *Paraboea minor* and *Cissus nodosa* Blume.

Inselberg-like hills are, in most cases, xeric habitats as there are always long dry periods with high temperatures. Thus, little moisture is available for plant growth and there is little soil or substrate to hold any moisture. Perhaps, therefore, plants of these areas are typically herbaceous. Plants that grow in this environment have been exposed to the water stress for a period of time in a year. According to Chandler & Bartels (2003), they resist drought stress using two different processes: drought avoidance and drought adaptation. Drought avoiding species avoid drought by growing or living during the rainy season when sufficient water is available. This strategy has been adopted by annual plants. Drought adapted plants decrease transpiration and improve water uptake and have adopted several appropriate strategies. These include succulence in leaves and roots of some orchids and a thick waxy cuticle in some trees e.g. *Memecylon edule*, *Fagraea auriculata* and *Gardenia coronaria* or plants may form dense mats on the rock surface e.g. *Cymbopogon flexuosus* and *Fimbristylis hookeriana*. These characteristics are not strictly restricted to inselbergs, they can also be found elsewhere under similar ecological condition (Porembski et al., 1993; Porembski et al., 1997).

Conservation aspects

In adjacent areas, plants on inselbergs have been critically affected not only by rubber plantations, but the granitic rock itself has been taken out for construction purposes. The inselberg is a unique landscape feature in this area of Thailand. Therefore further study of this relatively undamaged inselberg and development of effective measures to ensure its conservation form an indispensable core for effective future natural resource management.

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