

Pteridophyte Flora of Thong Pha Phum National Park, Kanchanaburi Province, Thailand

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ABSTRACT.— A total of 26 families, 70 genera, and 175 species of pteridophytes were recorded from Thong Pha Phum National Park, Kanchanaburi Province. Among these, 23 families, 66 genera, and 159 species were ferns, while 3 families, 4 genera and 16 species were fern allies. Among the fern allies, Selaginellaceae had the highest number of species, i.e. 12. Three families of ferns, namely Polypodiaceae, Thelypteridaceae, and Dryopteridaceae were the commonest. There were 37 species of Polypodiaceae; 24 of Thelypteridaceae and 16 of Dryopteridaceae. In according to habitat, there were 97 species of terrestrial plants, 53 epiphytes, 17 lithophytes and one aquatic plants. Seven species of ferns and fern allies were found in more than one habitat. Five species and one variety are new records for Thailand: *Adiantum philippense* L. var. *subjunicum* H. Christ, *Arachniodes coniifolia* (Moore) Ching, *Belvisia spicata* (L.f.) Mirbel ex Copel., *Loxogramme centicola* M.G. Price, *Polystichum pseudotsus-simense* Ching and *Polystichum scariosum* (Roxb.) C. Morton. Three new records, *Arachniodes coniifolia*, *Polystichum pseudotsus-simense* and *Polystichum scariosum* were found only once and in small numbers. These species may be extirpated from the country soon if their present habitats continue to be disturbed. Among the 175 taxa, nine species could not be determined due to the lack of fertile structures. Three out of these nine unidentified species are new taxa for Thailand. We consider that one species of *Cyathea* and two species of *Pteris* are worth investigating further.

KEY WORDS: Thong Pha Phum National Park, Kanchanaburi Province, ferns and fern allies

INTRODUCTION

Thong Pha Phum National Park is located in Kanchanaburi Province, which is a mountainous area in the South-western region of Thailand.

Due to past human activity in the form of mining and logging—that resulted in massive deforestation throughout Thong Pha Phum District, botanists assumed that this area was not suitable for botanical exploration. However, there have been some pteridophyte collections in other protected areas of Kanchanaburi Province that have recorded 127 species. These species comprised upto 20% of the previous records in the Flora of Thailand (Tagawa & Iwatsuki, 1979, 1985, 1988, 1989).

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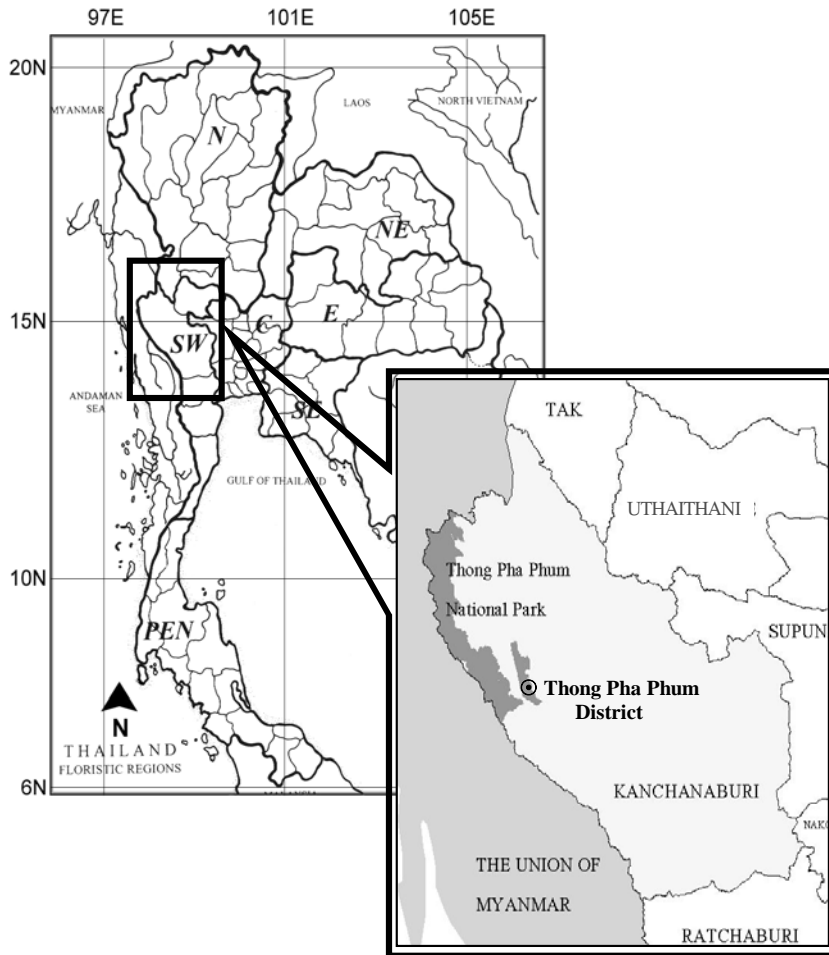


FIGURE 1. Locations of Thong Pha Phum District and Thong Pha Phum National Park.

It is likely that this mountainous province is rich in pteri-dophyte diversity. Botanical enumeration of ferns and fern allies in Thong Pha Phum District is scarce. Botanical exploration may augment our knowledge of biodiversity and pteridophyte diversity in South-western Thailand. The purpose of this present work was to conduct a botanical inventory of ferns and fern allies at Thong Pha Phum National Park, Kanchanaburi Province. The data of pteridophytes obtained from this study may be useful in biodiversity conservation in the future.

Tagawa & Iwatsuki (1979, 1985, 1988, 1989) studied herbarium specimens of pteridophytes from Thailand and their collection from their own field trips. They enumerated 34 families, 121 genera and 630 species. Their contributions to Thai pteridophytes were published in the Flora of Thailand, Vol. III, Parts 1-4. Boonkerd & Pollawatn (2000) compiled data from various sources and their own field trips to produce a checklist of ferns and fern allies in Thailand. They enumerated total of 671 species, 4 subspecies, and 28 varieties belonging to 139 genera and 35

families. This checklist included 27 new records for Thailand.

Study site

Thong Pha Phum District covers an area of 3,655 km². It is located in the Tanao Sri mountain range. It is bounded on the north by Sangkhla Buri District of Kanchanaburi Province, Umphang District of Tak Province, and Ban Rai District of Uthai Thani Province; on the south by Sai Yok District; on the east by Si Sawat District. The park is a natural border between Thailand and Myanmar in the west. Figure 1 shows the location of the study site. It is demarcated by the geographical co-ordinates of 14° 15' to 15° 00' N and 98° 15' to 99° 00' E (Royal Institute, 2002). Recently, Thong Pha Phum National Park was expanded over some parts of the Thong Pha Phum District and covers an area of 1,120 km² (Royal Forest Department, n.d.).

In the last six decades, the biodiversity in this area has been disturbed by forestry concessions resulting in dam construction, a natural gas pipeline, and mining. More than 20 mines, mostly opencast, have been established. They have resulted in massive deforestation throughout the district (N.S. Consultant, 1989). Currently, Thong Pha Phum District has more than 20 mines, covering an area of more than 60 km² (Tuleewan, 2000).

The climate of the area is tropical, with high average annual rainfall. Three seasons are observed; summer season from February-April; rainy season from May-October; and winter season from November-January (Meteorological Department, 2003). The Thong Pha Phum Climatic Station in Kanchanaburi Province is the nearest station.

Climatological data during the period 1973-2003 shows that the average annual relative humidity was about 79%; the average maximum relative humidity was 93%; and the average minimum relative humidity was 56%. The average annual temperature was 26.8°C. The average maximum temperature was 33.4°C in April and the average minimum temperature was 20.4°C in December. The average annual

rainfall was 1,775 mm. The highest average monthly rainfall of approximately 349 mm was observed in August. The lowest average monthly rainfall of about 8.4 mm occurred in December, which is usually the driest month (Meteorological Department, 2003).

The vegetation of Thong Pha Phum National Park, is comprised mainly of moist mixed deciduous forest, and hill evergreen forest (Royal Forest Department, n.d.).

MATERIALS AND METHODS

Field collections of ferns and fern allies were conducted monthly from January 2002 to December 2003 at Thong Pha Phum National Park. Specimens were collected in triplicate and photographs were taken of each species. Specimens were gathered along existing forest trails, extending 5 m from both sides. Some specific moist areas, such as Sattamit Waterfall, Pha Suk pass and nearby sites, were

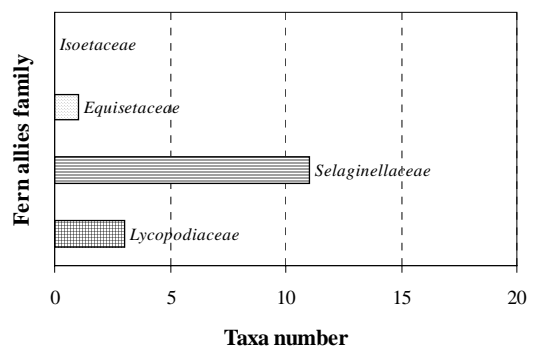


FIGURE 2. Number of species in each family of fern allies.

selected for repeat visits. Field notes viz. ecological data, habit, habitat and diagnostic characteristics of each species were recorded.

Laboratory study was conducted at the Plants of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University. Dry herbarium specimens were prepared as described in Boonkerd et al. (1987) and deposited at Prof. Kasin Suvatabandhu Herbarium, Botany Department, Chulalongkorn University (BCU). Internal and external

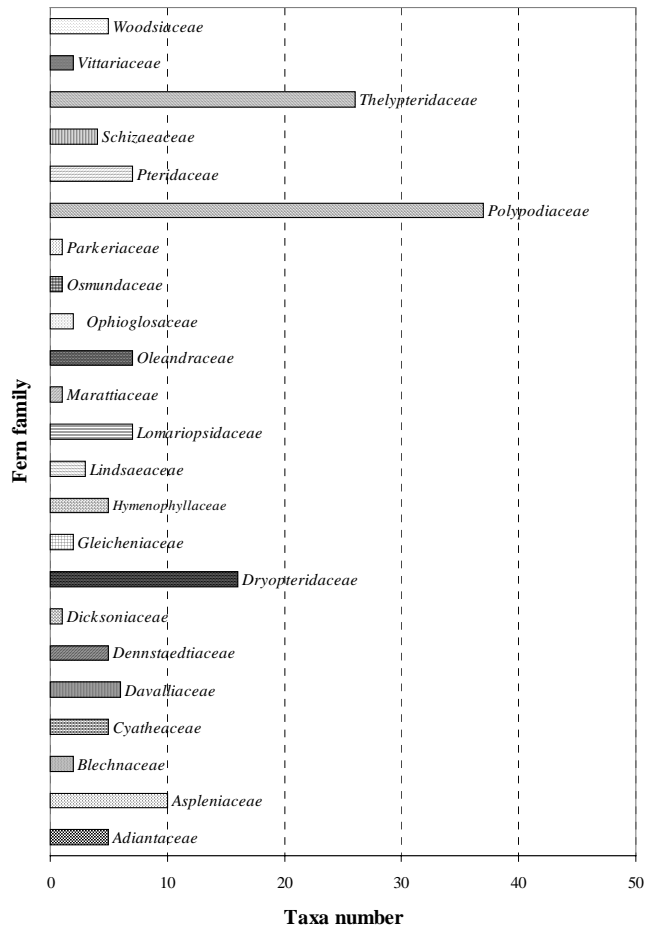


FIGURE 3. Number of species in each family of ferns.

morphological characters of each specimen were studied. Pteridophyte specimens were identified using keys and descriptions from taxonomic literatures: Floras, manuals, monographs, and research papers. Botanical names of each specimen were verified by comparing them with voucher herbarium specimens deposited at BCU, BKF, BM, L and K (Herbarium abbreviations according to Holmgren & Holmgrens, 2005). The authors of scientific names and abbreviations used in this paper are in accordance with the standard procedure for quoting authors of plant names (Brummitt & Powell, 1992). The classification system of pteridophytes in this paper follows that of Boonkerd & Pollawatn (2000).

RESULTS AND DISCUSSION

A taxonomic survey of ferns and fern allies at Thong Pha Phum National Park was conducted from January 2002 to December 2003. In all, 515 specimens were collected. A total of 26 families, 70 genera, and 175 species were recorded. Among them, three families, four genera and 16 species were fern allies (Fig. 2), while 23 families, 66 genera and 159 species were ferns (Fig. 3). Among fern allies Selaginellaceae had the highest number of species, i.e. 12. Three families of ferns, Polypodiaceae, Thelypteridaceae, and Dryopteridaceae were the commonest families. They were 37 species of

Polypodiaceae, 24 of Thelypteridaceae and 16 of Dryopteridaceae (Appendix 1).

1. Habitat and Diversity of Ferns and Fern Allies

Specimen collections were mainly focused in abandoned mines, existing forest in abandoned mine sites, hill evergreen forest near Thong Pha Phum National Park Headquarters, Pha Suk pass and nearby sites. The altitude of these areas ranged from 200 to 1,050 m. The study area is a disturbed forest when compared with other protected areas in Kanchanaburi Province. In hill evergreen forest, tree trunks and branches are usually covered with bryophytes and epiphytic pteridophytes. This forest type has deep, humus-rich and highly humid soils. Pteridophytes include Polypodiaceae, Thelypteridaceae, Dryopteridaceae and Aspleniaceae. It was found that ferns and fern allies thrive in various habitats: terrestrial, on rock (lithophytes), on tree-branches or tree-trunks (epiphytes): and in water (hydrophytes). Some species occur in more than one habitat.

The high pteridophyte diversity at Thong Pha Phum National Park is probably due to the high annual rainfall of about 5,000 mm in the mountainous area of Tavoy in Myanmar and the park area (Bender, 1983; Meteorological Department, 2003) that creates in high air humidity within the park.

2. Terrestrial plants

Ninety nine species of the pteridophytes were terrestrial plants. Terrestrial habitat includes mountain slopes, shady areas, stream banks and open ground. Ferns and fern allies, such as Selaginellaceae, Dennstaedtiaceae, Dryopteridaceae, Thelypteridaceae, Pteridaceae and Woodsiaceae were found. Most ferns were observed on mountain slopes. The common species included *Adiantum philippense*, *Cheilanthes tenuifolia*, *Lygodium polystachyum*, *Pteris biaurita* and *Tectaria polymorpha*. These ferns usually occupy humus-rich mountain slopes in shady places. In contrast, *Blechnum orientale*, *Pityrogramma calo-melanos*, *Sphaenomeris chinensis*, can be found on dry slopes in semi-

shaded areas. Along stream banks, where air humidity is high, large terrestrial ferns or tree ferns, such as *Angiopteris evecta*, *Cibotium barometz* and *Cyathea gigantea* typically grow. *Cyclosorus interruptus*, *Pronephrium nudatum*, and *Diplazium esculentum* were found on wet ground, especially along stream banks where sunlight can penetrate to the forest floor. On exposed ground, for example in mine areas, the two most common terrestrial sun-ferns were *Pteridium aquilinum* var. *wightianum* and *Dicranopteris linearis* var. *linearis*. They form dense long persistent thickets in open places and have become weedy species. Though these two species are sun-loving ferns, they do not normally occur together, because they have different soil preferences. *Pteridium aquilinum* prefers well-drained soil, whilst *Dicranopteris linearis* grows on clay soil (Holttum, 1969).

3. Lithophytes

Twenty five species of ferns and fern allies were lithophytes. These species grew on bare rocks, humus-rich rocks, and muddy rock, in rock crevices or cliffs. Lithophytes were confined to high humidity areas along stream banks. They usually had long creeping rhizomes with numerous clinging roots adhering to the rock surface. Some lithophytes, such as *Asplenium apogamum*, *Bolbitis* spp., *Leptochilus minor* and *Trigonospora ciliata* had become established in muddy rock crevices in partial shade. Some filmy ferns, such as *Crepidomanes christii*, *Crepidomanes latealatum* and *Hymenophyllum exsertum* inhabit muddy rocks or moist cliffs by streams. On exposed bare rocks or cliffs, some ferns, for example *Oleandra undulata*, adapt themselves to the changing environment in the dry season. To achieve this in the dry summer it sheds its fronds to reduce transpiration. Some lithophytes, *Pyrrosia lingua* and *Oleandra undulata*, have long slender creeping rhizomes, they are usually found on bare rocks in full sunlight. They can protect the whole plant from water loss by their dense overlapping scales.

4. Epiphytes

Fifty eight species of ferns and fern allies were epiphytes. In general, these pteridophytes grow on tree trunks, on mossy tree-trunks or on branches of trees. They include common families of ferns, such as Polypodiaceae, Hymenophyllaceae, Aspleniaceae, and Davalliaceae. Examples of common epiphytes are: *Huperzia hamiltonii*; *Hymenophyllum polyanthos*; *Aglaomorpha coronans*; *Asplenium yoshi-nagae*; *Humata repens*; *Oleandra musifolia*; *Araiostegia imbricata*; *Davallia trichomanoides*; *Leucostegia immersa*; and *Crypsinus rhynchophyllus*. Some epiphytes can withstand the dry summer months by reducing the total transpirational frond surface by shriveling. Species such as *Asplenium perakense*, *Pyrrhosia lingua*, and filmy ferns use this strategy to avoid plant death by desiccation.

5. Aquatic plants

Two species of ferns and fern allies were restricted to aquatic habitat. Examples included *Equisetum debile* and *Ceratopteris thalictroides*. In addition, *Trigonospora ciliata*, *Microsorium pteropus* and *Leptochilus minor* usually grow on muddy rocks in streamlets or along stream banks. They experienced and can withstand floods for a considerable period of time, especially during the rainy season. They tend to be rheophytes.

6. New records

Five species and one variety are new records for Thailand. They are: *Adiantum philippense* L. var. *subjunonicum* H. Christ; *Arachniodes conifolia* (Moore) Ching; *Belvisia spicata* (L.f.) Mirbel ex Copel.; *Loxogramme centicola* M.G. Price; *Polystichum pseudotsus-simense* Ching and *Polystichum scariosum* (Roxb.) C. Morton. Three newly recorded species, *Arachniodes conifolia*, *Polystichum pseudotsus-simense* and *Polystichum scariosum* were found only once and in small numbers. They may be wiped out from the country soon if their present habitats continue to be disturbed.

7. Unidentified species

Among the 175 taxa, 9 species could not be determined due to the lack of fertile structures and published taxonomic keys. Three out of the nine unknown species are probably newly recorded taxa for Thailand or new to science. One species of *Cyathea* and two species of *Pteris* are worth further investigation.

Cyathea sp.

Trunks about 1.6 m or more tall. Stipes green, 40-50 cm long, slightly spiny near base and densely covered with scales; scales dark brown and stiff; pneumathodes distinct, elongated, arranged in a single row; main rachis green, scaly throughout. Lamina: lower pinnae reduced to 10 cm in length, upper pinnae up to 70 cm or more in length, 25 cm wide, acuminate at apex; pinnae-rachis scaly; larger pinnules about 2.5 cm apart, 25 in pairs, oblong-lanceolate, to 7 cm long, 1.7 cm wide, gradually narrowing towards acuminate apex, base truncate sessile, lobed nearly to costa; lobes oblique, slightly falcate, round at apex, slightly serrate at margin, to 1 cm long, 3 mm broad; costae scaly throughout; texture papyraceous, deep green, veins simple to forked. Sori dorsal on veinlets, close to costules, naked.

Ecology.- In semi-shade, along stream in moist mixed deciduous forests at 750 m altitude.

Pteris sp. I

This species is similar to *Pteris scabripes*, but differs in having undulate margins instead of dentate margins.

Ecology.- Terrestrial on damp soil, near spring, in mixed deciduous forest, 650 m altitude.

Pteris sp. II

Rhizome short, erect, bearing a few fronds; scales narrow, concolorous brown, apex long acuminate, up to 3.5 cm long. Stipe up to 40 cm long, densely scaly on lower part, light brown. Lamina imparipinnate, elliptic to oblong, widest at middle; pinnae simple, lower ones slightly reduced, no auricles, middle pinnae oblong, sessile or subsessile, 8.5 cm by 1.1 cm, base oblique to rounded or truncate,

apex acuminate, margin serrate, terminal pinnae slightly longer, up to 12 cm long; rachis grooved on upper surface, covered with uniseriate multicellular hairs; veins all free or forked. Sori marginal, not continuous along margin of pinnae; indusia thin.

Ecology.- Terrestrial in fresh water spring at about 250 m altitude.

Note.- This unknown species is similar to *Pteris vittata*, but differs in having uniseriate multicellular hairs along the rachis and costa; base of pinnae oblique or rounded whereas *Pteris vittata* has cordate base. Sori in *Pteris vittata* usually continuous along margin, but this species has some broken marginal sori.

8. Comparisons with Pteridophytes from other areas

Table 1 shows the numbers of pteridophyte species in 5 protected areas of northern Thailand. Species numbers are approximately the same in Doi Inthanon, Doi Suthep-Pui and Thong Pha Phum National Parks. Thong Pha Phum National Park is larger than the two national parks of northern Thailand. Further botanical exploration along the Thailand-Myanmar border may reveal more species. Thong Pha Phum National Park is less fertile than the other protected areas since it is a new national park that has been disturbed by human activity for a long time.

CONCLUSION

The results from this study indicate that Thong Pha Phum National Park in western Thailand is rich in pteridophyte diversity despite forest disturbance, when compared with protected areas of northern Thailand.

Six new records for Thailand and three potential new species were found which compare well with other pteridophyte explorations by Yuyen & Boonkerd (2002), Boonkerd & Ratchata (2002) and Rattanathirakul & Boonkerd (2003) with further botanical explorations of bryophytes and flowering plants in this region, the number of recorded indigenous plant species in Thailand may increase. The potential to record more indigenous plant species is enhanced.

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TABLE 1. Pteridophyte diversity in 5 protected areas of northern Thailand and Thong Pha Phum National Park. WS= Wildlife Sanctuary, NP= National Park. Notes: ¹ Nanakorn (1998); ² Maxwell (1992); ³ Maxwell (1998); ⁴ Koyama (1986); ⁵ Tagawa & Iwatsuki (1979, 1985, 1988 and 1989); ⁶ Maxwell & Elliott (2001); ⁷ Anusarnsunthorn et al. (1999); ⁸ Boonkerd and Rachata (2002).

Protected area	Altitude (m)	Total area (km ²)	Families	Genera	Species
Doi Chiang Dao WS ^{1,2,3}	300-2,225	521	18	46	98
Doi Inthanon NP ⁴	300-2,565	272	24	67	171
Doi Suthep-Pui NP ^{5,6}	350-1,685	261	27	65	174
Doi Luang NP ⁷	400-1,710	1,170	21	48	87
Khun Korn Waterfall Forest Park ⁸	625-1,635	18	24	66	154
Thong Pha Phum NP	200-1,050	1,120	26	70	175

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LITERATURE CITED

- Anusarnsunthorn, V., Rakariyatham, P., Maxwell, J.F., Elliott, S., Kunarak, R., Gardner, S., Sidisunthorn, P., Pakkad G. and Palee, P. 1999. Survey of the species diversity and geographical distribution of vascular plants in Doi Luang National Park, Chiang Rai. Final report, The Biodiversity Research and Training Program (BRT 139029).
- Bender, F. 1983. Geology of Burma. Gebüder Borntraeger, Berlin, 293 pp.
- Boonkerd, T. and Ratchata, P. 2002. Pteridophytes Flora of Khun Korn Waterfall Forest Park, Chiang Rai Province. The Natural History Bulletin of the Siam Society, 50: 195-210.
- Boonkerd, T. and Pollawatn, R. 2000. Pteridophytes in Thailand. Office of Environmental Policy and Planning, Bangkok, 312 pp.
- Boonkerd, T., Vajrabhaya, M., Treratn, S., Maneerat, Y., Thaihong, O. and Laichuthai, N. 1987. Collection and Preparation of Herbarium Specimens. Chulalongkorn University Press, Bangkok, 71 pp.
- Brummitt, P.K. and Powell, C.E.. 1992. Authors of Plant Names. Whistable Litho Printers, Great Britain.
- Holmgrens, P.K. and Holmgrens, N.H. 2005. Index Herbariorum (Available from: <http://sciweb.nybg.org/science2/IndexHerbariorum.asp>., Sep 30, 2003).
- Holtum, R.E. 1969. Plant Life in Malaya. Percetakan Vinlin Sdn. Bhd, Kuala Lumpur.
- Koyama, H. 1986. A Preliminary Checklist of the Pteridophytes and Dicotyledons of Doi Inthanon. Department of Botany, Faculty of Science, Kyoto University, Japan. 146 pp.
- Maxwell, J.F. 1992. Lowland vegetation of Doi Chiang Dao Wildlife Sanctuary, Chiang Mai Province, Thailand. Tiger Paper, 19: 21-25.
- Maxwell, J.F. 1998. Upland vegetation of Doi Chiang Dao Wildlife Sanctuary, Chiang Mai Province, Thailand. Tiger Paper, 25: 5-11.
- Maxwell, J.F. and Elliott, S. 2001. Vegetation and vascular flora of Doi Suthep-Pui National Park, Northern Thailand. Thai Studies in Biodiversity, 5: 1-205.
- Meteorological Department. 2003. Climatological data from Thong Pha Phum Climatic Station, Kanchanaburi Province, 1973-2003. Data Processing Subdivision, Climatology Division, Meteorological Department, Bangkok.
- N.S. Consultant Ltd. 1989. Environmental impact assessment (EIA) report: patent permit no. 18/2532. Gearvanich, Pilok Subdistrict, Thong Pha Phum District, Kanchanaburi Province. (unpublished manuscript)
- Nanakorn, W. 1998. Queen Sirikit Botanic Garden. Vol. 5. O. S. Printing House, Bangkok, 206 pp.
- Rattanathirakul, W. and Boonkerd, T. 2003. Taxonomy of ferns and fern allies at Phu Hin Rong Kla National Park, Phitsanulok Province. In: Baimai, V. and Tantalakha, R. (Eds), BRT Research Report 2003, BRT Program. Chuan Printing Press Ltd. Part., Bangkok, pp. 1-11.
- Royal Forest, Department. (n.d.). National Park: Sai Yok, Khao Laem, Thong Pha Phum. Brochure.
- Royal Institute. 2002. Thai Gazetteer 1. Aroon Publisher Ltd., Bangkok, 410 pp.
- Tagawa, M. and Iwatsuki, K. 1979. Pteridophytes. In: Smitinand, T. and Larsen, K. (Eds.), Flora of Thailand, Vol. 3 part 1. The Tistr Press, Bangkok, pp. 1-128.
- Tagawa, M. and Iwatsuki, K. 1985. Pteridophytes. In: Smitinand, T. and Larsen, K. (Eds), Flora of Thailand, Vol. 3 part 2. Phonphan Printing Company, Ltd., Bangkok, pp. 192-126.
- Tagawa, M. and K. Iwatsuki. 1988. Pteridophytes. In: Smitinand, T. and Larsen, K. (Eds.), Flora of Thailand, Vol. 3 part 3. Chutima Press, Bangkok, pp. 297-480.
- Tagawa, M. and K. Iwatsuki. 1989. Pteridophytes. In: Smitinand, T. and Larsen, K. (Eds), Flora of Thailand, Vol. 3 part 4. Phonphan Printing Company, Ltd., Bangkok, pp. 481-639.
- Tuleewan, A. 2000. Edge of Thailand at Pilok mine. In: Thipanan, S. (Ed.), Advance Thailand Geographic. Rungrueng Printing Ltd., Bangkok. pp. 128-147.
- Yuyen, Y. and Boonkerd, T. 2002. Pteridophyte flora of Huai Yang Waterfall National Park, Prachuap Khirikhan Province, Thailand. The Natural History Journal of Chulalongkorn University, 2: 1-3.

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APPENDIX 1

The Pteridophytes of Thong Pha Phum National Park. Habit: A= Aquatic herb, E= Epiphytic herb, L= Lithophytic herb, T= Terrestrial herb. Habitat: 1 = Moist mixed deciduous forest, 2 = Disturbed mixed deciduous forest, 3 = Hill evergreen forest, 4= Disturbed hill evergreen forest, 5= Spring area. Abundance: A= Abundant, C= Common, L= Locally abundant, R= Rarely found, UC= Uncommon

No.	Family	Botanic Name	Habit	Habitat	Abundance
Lycopodiaceae					
1		<i>Huperzia hamiltonii</i> (Spreng.) Trevis.	E	4	C
2		<i>Huperzia squarosa</i> (G. Forst.) Trevis.	E	2	UC
3		<i>Lycopodiella cernua</i> (L.) Pic. Serm.	T	2	A
Selaginellaceae					
4		<i>Selaginella biformis</i> A. Braun ex Kuhn	T	2	UC
5		<i>Selaginella bisulcata</i> Spring	T	2	UC
6		<i>Selaginella chrysorrhizos</i> Spring	T	2	UC
7		<i>Selaginella delicatula</i> (Desv. ex Poir.) Alston	L	2	L
8		<i>Selaginella helferi</i> Warb.	T	2	UC
9		<i>Selaginella inaequalifolia</i> (Hook. & Grev.) Spring	T	2	L
10		<i>Selaginella lindhardii</i> Hieron.	T	2	UC
11		<i>Selaginella leptophylla</i> Baker	L	2	L
12		<i>Selaginella monospora</i> Spring	T	2	R
13		<i>Selaginella ornata</i> (Hook. & Grev.) Spring	T	2	UC
14		<i>Selaginella willdenowii</i> (Desv.) Baker	T	2	L
15		<i>Selaginella</i> sp. I	T	2	L
Equisetaceae					
16		<i>Equisetum debile</i> Roxb. ex Vauch.	A, T	2	L
Adiantaceae					
17		<i>Adiantum philippense</i> L. var. <i>philippense</i>	T	2	C
18		<i>Adiantum philippense</i> L. var. <i>subjunonicum</i> H. Christ	T	2	UC
19		<i>Cheilanthes tenuifolia</i> (Burm. f.) Sw.	T	2	C
20		<i>Pityrogramma calomelanos</i> (L.) Link.	T	2	A
21		<i>Taenitis blechnoides</i> (Willd.) Sw.	T	2	UC
Aspleniaceae					
22		<i>Asplenium apogamum</i> N. Murakami et Hatanaka	T	3	UC
23		<i>Asplenium confusum</i> Tardieu & Ching	E	1	R
24		<i>Asplenium crinicaule</i> Hance	E	1	UC
25		<i>Asplenium grevillei</i> Wall. ex Hook. & Grev.	L	1	L
26		<i>Asplenium perakense</i> B. Mathew & H. Christ	E	4	UC
27		<i>Asplenium phyllitidis</i> D. Don	L	1	UC
28		<i>Asplenium nidus</i> L.	L	1, 5	UC
29		<i>Asplenium yoshinagae</i> Makino	E	4	UC
30		<i>Asplenium</i> sp. I	L	1	R

APPENDIX 1 (Cont.)

No.	Family	Botanic Name	Habit	Habitat	Abundance
	Aspleniaceae				
31		<i>Asplenium</i> sp. II	L	1	R
	Blechnaceae				
32		<i>Blechnum orientale</i> L.	T	2, 4	A
33		<i>Brainea insignis</i> (Hook.) J. Sm.	T	4	UC
	Cyatheaceae				
34		<i>Cyathea borneensis</i> Copel.	T	2	R
35		<i>Cyathea contaminans</i> (Wall. ex Hook.) Copel.	T	1	UC
36		<i>Cyathea gigantea</i> (Wall. ex Hook.) Holttum	T	1	UC
37		<i>Cyathea latebrosa</i> (C. Presl.) Copel.	T	1	UC
38		<i>Cyathea</i> sp. I	T	1	UC
	Davalliaceae				
39		<i>Araiostegia imbricata</i> Ching	E	3	UC
40		<i>Davallia denticulata</i> (Burm. f.) Mett. ex Kuhn	E	1	UC
41		<i>Davallia solida</i> (G. Forst.) Sw.	E	1	UC
42		<i>Davallia trichomanoides</i> Blume var. <i>lorrainii</i> (Hance) Holttum	E	3	C
43		<i>Humata repens</i> (L. f.) J. Small ex Diels	E, L	3	UC
44		<i>Leucostegia immersa</i> C. Presl	E, L	3	UC
	Dennstaedtiaceae				
45		<i>Histiopteris incisca</i> (Thunb.) J. Sm.	T	2	UC
46		<i>Hypolepis punctata</i> (Thunb.) Mett. ex Kuhn	T	2	L
47		<i>Microlepia hookeriana</i> (Wall. ex Hook.) C. Presl	T	2	R
48		<i>Microlepia speluncae</i> (L.) T. Moore	T	1, 2	A
49		<i>Pteridium aquilinum</i> (L.) Kuhn var. <i>wightianum</i> (J. Agardh) R.M. Tryon	T	2, 4	L
	Dicksoniaceae				
50		<i>Cibotium barometz</i> J. Sm.	T	2	UC
	Dryopteridaceae				
51		<i>Arachniodes coniifolia</i> (Moore) Ching	T	4	R
52		<i>Arachniodes henryi</i> (H. Christ) Ching	T	4	R
53		<i>Dryopteris polita</i> Rosenst.	T	4	R
54		<i>Heterogonium gurupahense</i> (C.Chr.) Holtt.	T	1	R
55		<i>Heterogonium sagenioides</i> (Mett.) Holttum	T	1	R
56		<i>Pleocnemia irregularis</i> (C. Presl) Holttum	T	1	UC
57		<i>Polystichum scariosum</i> (Roxb.) C. Morton	T	4	R
58		<i>Polystichum pseudotsus-simense</i> Ching	T	4	R
	Dryopteridaceae				
59		<i>Pteridrys australis</i> Ching	T	1	L
60		<i>Pteridrys cyrmatica</i> (Willd.) C.Chr. & Ching	T	1	L

APPENDIX 1 (Cont.)

No.	Family	Botanic Name	Habit	Habitat	Abundance
Dryopteridaceae					
61		<i>Tectaria angulata</i> (Willd.) C. Chr.	T	1	UC
62		<i>Tectaria fuscipes</i> (Wall. ex Bedd.) C. Chr.	T	1	R
63		<i>Tectaria impressa</i> (Fée) Holttum	T	1	A
64		<i>Tectaria polymorpha</i> (Wall. ex Hook.) Copel.	T	1	C
65		<i>Tectaria rockii</i> C. Chr.	T	1	R
66		<i>Tectaria</i> sp. I	T	1	R
Gleicheniaceae					
67		<i>Dicranopteris splendida</i> (Hand.- Mazz.) Tagawa	T	4	L
68		<i>Dicranopteris linearis</i> (Burm. f.) Undrew. var. <i>linearis</i>	T	2, 4	A
Hymenophyllaceae					
69		<i>Crepidomanes birmanicum</i> (Bedd.) K. Iwats.	E	1	L
70		<i>Crepidomanes christii</i> (Copel.) Copel.	E, L	1, 5	UC
71		<i>Crepidomanes latealatum</i> (Bosch) Copel.	E, L	1	UC
72		<i>Hymenophyllum exsertum</i> Wall. ex Hook.	E, L	1	L
73		<i>Hymenophyllum polyanthos</i> (Sw.) Sw.	E	3	L
Lindsaeaceae					
74		<i>Lindsaea ensifolia</i> Sw.	T	1	A
75		<i>Sphaenomeris chinensis</i> (L.) Maxon var. <i>divaricata</i> (Christ) Kramer	T	1	UC
76		<i>Sphaenomeris chinensis</i> (L.) Maxon var. <i>rheophila</i> Kramer	T	2	C
Lomariopsidaceae					
77		<i>Bolbitis appendiculata</i> (Willd.) K. Iwats. subsp. <i>appendiculata</i>	L	1	UC
78		<i>Bolbitis appendiculata</i> (Wild.) K. Iwats. subsp. <i>vivipara</i> var. <i>vivipara</i> (Hamilt. ex Hook.) Hennisman	L	2, 3, 4	C
79		<i>Bolbitis deltigera</i> (Bedd.) C. Chr.	L	1	UC
80		<i>Bolbitis heteroclita</i> (C. Presl) Ching	L	1	C
81		<i>Bolbitis sinensis</i> (Baker) Iwats. var. <i>costulata</i> (Hook.) Tagawa & K. Iwats.	L, T	4	UC
82		<i>Bolbitis virens</i> (Wall. ex Hook. & Grev.) Schott var. <i>compacta</i>	L	3	UC
83		<i>Elaphoglossum marginatum</i> (Fée) Moore	E	3	UC
Marattiaceae					
84		<i>Angiopteris evecta</i> (G. Forst.) Hoffm	T	1, 2, 3	C

APPENDIX 1 (Cont.)

No.	Family	Botanic Name	Habit	Habitat	Abundance
	Oleandraceae				
85		<i>Nephrolepis biserrata</i> (Sw.) Schott	T	4, 5	L
86		<i>Nephrolepis cordifolia</i> (L.) C. Presl	T	4	R
87		<i>Nephrolepis delicatula</i> (Decne.) Pic.-Serm.	T	4	R
88		<i>Nephrolepis hirsutula</i> (G. Forst) C. Presl	T	4	L
89		<i>Oleandra undulata</i> (Willd.) Ching	E	3	L
90		<i>Oleandra musifolia</i> (Blume) C. Presl	E	3	C
91		<i>Oleandra wallichii</i> (Hook.) C. Presl	E	3	L
	Ophioglossaceae				
			126		
92		<i>Ophioglossum pendulum</i> L.	E	1	R
93		<i>Ophioglossum petiolatum</i> Hook.	T	2, 4	UC
	Osmundaceae				
94		<i>Osmunda vachellii</i> Hook.	T	2	R
	Parkeriaceae				
95		<i>Ceratopteris thalictroides</i> (L.) Brongn.	A	2, 5	UC
	Polypodiaceae				
96		<i>Aglaomorpha coronans</i> (Wall. ex Mett.) Copel.	E	1, 2, 3, 4	A
97		<i>Belvisia henryi</i> (Hieron. ex C. Chr.) Raymond	E	3, 4	UC
98		<i>Belvisia mucronata</i> (Fée) Copel.	E	3, 4	UC
99		<i>Belvisia spicata</i> (L.f) Mirbel ex Copel.	E	3, 4	UC
100		<i>Colysis hemionitidea</i> (C. Presl) C. Presl	L	2	UC
101		<i>Colysis pedunculata</i> (Hook. & Grev.) Ching	E	1, 5	UC
102		<i>Crypsinus cruciformis</i> (Ching) Tagawa	E	3	UC
103		<i>Crypsinus oxylobus</i> (Wall. ex Kunze) Sledge	E	3	L
104		<i>Crypsinus rhynchophyllus</i> (Hook.) Copel.	E	3, 4	C
105		<i>Drynaria quercifolia</i> (L.) J. Sm.	E	1, 5	C
106		<i>Drynaria rigidula</i> (Sw.) Bedd.	E	1	C
107		<i>Drynaria sparsisora</i> (Desv.) T. Moore	E	1	UC
108		<i>Goniophlebium subauriculatum</i> (Blume) C. Presl.	E	3, 4	UC
109		<i>Lemmaphyllum carnosum</i> (J. Sm. ex Hook.) C. Presl.	E	4	UC
110		<i>Lepisorus bicolor</i> (Takeda) Ching	E	4	R
111		<i>Lepisorus nudus</i> (Hook.) Ching	E	4	UC
112		<i>Lepisorus scolopendrium</i> (Buch.-Ham. ex D. Don) Mehra & Bir	E	4	UC
113		<i>Leptochilus minor</i> Fée	L	1	L
114		<i>Loxogramme centicola</i> M.G. Price	E	3	UC
115		<i>Loxogramme cuspidata</i> (Zenker) M.G. Price	E	3	UC

APPENDIX 1 (Cont.)

No.	Family	Botanic Name	Habit	Habitat	Abundance
Polypodiaceae					
116		<i>Microsorium nigrescens</i> (Blume) Pic. Serm.	E	1	UC
117		<i>Microsorium punctatum</i> (L.) Copel.	E	1, 5	UC
118		<i>Microsorium pteropus</i> (Blume) Copel.	L	1	UC
119		<i>Microsorium zippelii</i> (Blume) Ching	E	1	UC
120		<i>Platyserium coronarium</i> (J.G. Koen. ex C. Muell) Desv.	E	2	R
121		<i>Platyserium wallichii</i> Hook.	E	1, 2	UC
122		<i>Pyrrosia adnascens</i> (Sw.) Ching	E	2, 5	UC
123		<i>Pyrrosia albicans</i> (Blume) Ching	E	2	UC
124		<i>Pyrrosia costata</i> (Presl ex Bedd.) Tagawa & K. Iwats.	E	2	UC
125		<i>Pyrrosia lingua</i> (Thunb.) Farw. var. <i>lingua</i>	E	3, 4	L
126		<i>Pyrrosia lingua</i> var. <i>heteractis</i> (Mett. ex Khun) Hovenkamp	E	3, 4	C
127		<i>Pyrrosia nuda</i> (Gies.) Ching	E	3, 4	UC
128		<i>Pyrrosia nummulariifolia</i> (Swartz) Ching	E	3	UC
129		<i>Pyrrosia piloselloides</i> (L.) M.G. Price	E	3	UC
130		<i>Pyrrosia stigmosa</i> (Sw.) Ching	E	2, 4	UC
131		<i>Pyrrosia varia</i> (Kaulf.) Farw.	E	1	UC
132		<i>Pyrrosia</i> sp. I	E	4	R
Pteridaceae					
133		<i>Pteris biaurita</i> L.	T	1, 2, 3, 4	A
134		<i>Pteris longipes</i> D. Don	T	3	R
135		<i>Pteris mertensioides</i> Willd.	T	1	UC
136		<i>Pteris venusta</i> Kunze	T	2	UC
137		<i>Pteris vittata</i> L.	T	2, 5	A
138		<i>Pteris</i> sp. I	T	1, 5	R
139		<i>Pteris</i> sp. II	T	1	R
140		<i>Stenochlaena palustris</i> (Burm.f.) Bedd.	T	5	UC
Schizaeaceae					
141		<i>Lygodium flexuosum</i> (L.) Sw.	T	2, 5	A
142		<i>Lygodium microphyllum</i> (Cav.) R. Br.	T	2, 4	UC
143		<i>Lygodium polystachyum</i> Wall. ex T. Moore	T	1, 2	C
144		<i>Lygodium salicifolium</i> C. Presl	T	1, 2	C
Thelypteridaceae					
145		<i>Amphineuron opulentum</i> (Kaulf.) Holtt.	T	2	UC
146		<i>Amphineuron immersum</i> (Blume) Holttum	T	2	UC
147		<i>Amphineuron terminans</i> (J. Sm.) Holttum	T	2	UC
148		<i>Christella appendiculata</i> (Presl) Holtt.	T	2	UC
149		<i>Christella arida</i> (D. Don) Holttum	T	2	UC
150		<i>Christella dentata</i> (Forssk.) Brownsey & Jermy	T	2	UC

APPENDIX 1 (Cont.)

No.	Family	Botanic Name	Habit	Habitat	Abundance
Thelypteridaceae					
151		<i>Christella papilio</i> (C. Hope) Holttum	T	2	UC
152		<i>Christella parasitica</i> (L.) H. Lev.	T	2	UC
153		<i>Christella siamensis</i> Tagawa & K. Iwats.	T	2	UC
154		<i>Christella subelata</i> (Baker) Holttum	T	2	UC
155		<i>Christella subpubescens</i> (Blume) Holttum	T	2	L
156		<i>Cyclosorus hirtisorus</i> (C. Chr.) Ching	T	2	UC
157		<i>Cyclosorus interruptus</i> (Willd.) H. Ito	T	2	L
158		<i>Macrothelypteris ornata</i> (Wall. ex Bedd.) Ching	T	4	UC
159		<i>Macrothelypteris torresiana</i> (Gaudich.) Ching	T	4	L
160		<i>Metathelypteris dayi</i> (Bedd.) Holttum.	T	4	R
161		<i>Metathelypteris singalanensis</i> (Baker) Ching	T	4	UC
162		<i>Pneumatopteris truncata</i> (Poir.) Holttum	T	2	UC
163		<i>Pronephrium articulatum</i> (Houlston & T. Moore) Holttum	T	2, 5	UC
164		<i>Pronephrium lakhimpureense</i> (Rosenst.) Holttum	T	2	UC
165		<i>Pronephrium nudatum</i> (Roxb.) Holttum	T	2, 5	A
166		<i>Sphaerostephanos polycarpus</i> (Blume) Copel.	T	2	L
167		<i>Sphaerostephanos</i> sp. I	T	1	R
168		<i>Trigonospora ciliata</i> (Wall. ex Benth.) Holttum	L	1	L
Vittariaceae					
169		<i>Antrophyum callifolium</i> Blume	L	1	UC
170		<i>Vittaria taeniophylla</i> Copel.	E	1	R
Woodsiaceae					
171		<i>Anisocampium cumingianum</i> C. Presl	E	1	R
172		<i>Diplazium esculentum</i> (Retz.) Sw.	T	1, 2	C
173		<i>Diplazium donianum</i> (Mett.) Tardieu	T	3	UC
174		<i>Diplazium simplicivenium</i> Holttum	T	2, 4	UC
175		<i>Diplazium tomentosum</i> Blume	T	1, 3	R