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Pteridophyte Diversity in the Tropical Lowland Rainforest of Khao Nan National Park, Nakhon Si Thammarat Province, Thailand

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ABSTRACT.– An enumeration of the pteridophytes in the lowland (60-600 m) part of a tropical rain forest of Khao Nan National Park, Nakhon Si Thammarat Province, southern Thailand, is presented and is the first report for the area. A total of 418 specimens of pteridophytes were collected and classified into 205 species from 27 families, the highest pteridophyte biodiversity in lowland Thailand and likely highest overall biodiversity region for pteridophytes in Thailand. Although ferns dominated at all taxonomic levels, fern allies were significant accounting for ~7% of all species found. According to habitat types, the specimens can be classified into 4 groups: terrestrials (116 species), epiphytes (27 species), lithophytes (81 species), and aquatic plants (1 species), although 19 species were found in more than one habitat. Two species are new records for Thailand, i.e. *Huperzia carinata* (Desv. ex Poir.) Trevis. var. *laxum* (C. Presl) Christ and *Selaginella commutata* Alderw., but were found only once and in rather small numbers suggesting they are vulnerable. Five additional species (from five genera) could not be determined to species level due to the lack of fertile structures and nine other species (from six genera) require further observations and investigation to determine their correct status, either as new species to science or new records for Thailand.

KEY WORDS: Khao Nan National Park, Nakhon Si Thammarat Province, Ferns and fern allies, Lower tropical rain forest.

INTRODUCTION

Tagawa and Iwatsuki (1979, 1985, 1988, 1989) studied herbarium specimens of pteridophytes from Thailand and their collections 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. Later, Boonkerd and Pollawatn (2000) compiled data from various sources as well as from

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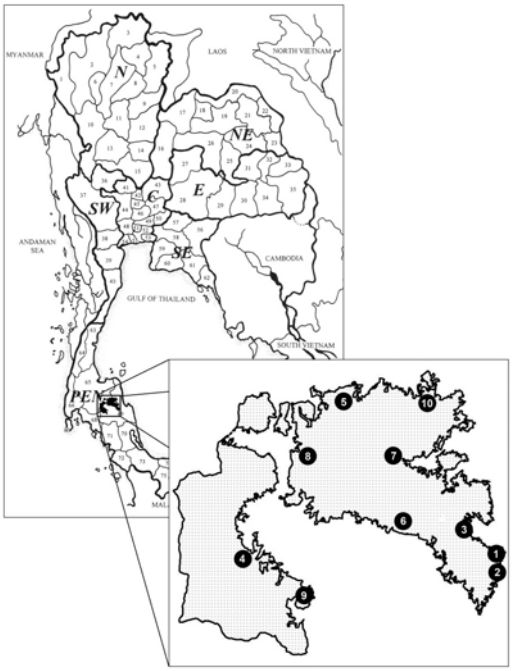

FIGURE 1. Map of Thailand showing locations of Khao Nan National Park, Nakhon Si Thammarat Province and a selection of 10 pteridophyte collecting sites (1. Bua Chake Yai nature trail; 2. Sunantha Fall; 3. Hin Toh Fall; 4. Klong Klai; 5. Huai Keaw; 6. Klong Kun; 7. Tha Ton; 8. Huai Lhek (Pa Pra); 9. Klong Lum Pan; 10. Klong Yod Nam).

their own field trips to complete a checklist of ferns and fern allies in Thailand adding a further 41 species (including 27 new records for Thailand), 18 new genera and one new family.

Previously, field collections of plants in peninsular Thailand have mainly been focused at Khao Luang National Park where 225 species of pteridophytes were recorded but with many species restricted in their distribution. These species comprised approximately 35% of the previous records of the Flora of Thailand (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989). It, therefore, seems likely that this mountainous province is rich in pteridophyte diversity including the neighboring Khao Nan National Park, but a lack of previous information, resulting from rare botanical explorations in the area, prevents reliable extrapolations especially given the previous human activity oriented disturbances within Khao Nan National Park.

Khao Nan National Park is located in the Nakhon Si Thammarat Range, on the East Coast of peninsular Thailand (Fig. 1), and covers an area of approximately 436 km^2. The park occupies the Kung Ching, Nopphitam and Taling Chun Subdistricts of the Tha Sala District and the Plain, Chalong, Theparaj and Khao Noi Subdistricts in the Sichon District, of Nakhon Si Thammarat Province. It is marked out, approximately, by the geographical coordinates of 8° 41´ - 8° 58´ N latitude and 99° 30´ - 99° 99´ E longitude. It is bounded on the north by Sikead National Park and agricultural lands in Kanchanadit District, Surat Thani Province, to the south by Khao Luang National Park and Plai Kratoon Wildlife Sanctuary, at the east by agricultural lands in Sichon and Tha Sala Districts, and on the west by Tai RomYen National Park, Surat Thani Province. The park, with an altitude range from 60 to 1,438 m (summit of Khao Nan) provides heterogeneous habitats for various flora and fauna. Located in the area are also a watershed and streams flowing into waterfalls such as Sunantha Waterfall, Nhan Chong Fah Waterfall, and Klong Klai Waterfall (Boonnuang, 2000).

The main objective of this present work was to conduct a botanical inventory of ferns and fern allies in the lower regions (60-600 m asl) of the tropical rain forest of Khao Nan National Park, Nakhon Si Thammarat Province and conduct a species-

composition comparison with the larger neighboring Khao Luang National Park. The data on pteridophytes obtained from this study may be useful in biodiversity conservation in the near future.

MATERIALS AND METHODS

Field collections of ferns and fern allies were conducted at monthly intervals from 10 selected sites (Fig. 1) at Khao Nan National Park during March 2006 to January 2007 with altitudes ranging from 60-600 m. Three duplicates of specimens were collected and photographs were taken of each species. Specimens were gathered along existing forest trails, extending about five metres from both sides. Some specific fern-rich sites, such as Nature forest trail, waterfalls and limestone hills, were selected for repeated visits. Field notes *viz.* ecological data, habit, habitat and some diagnostic characters of each species were recorded. Some common species were observed in the field by the authors without voucher specimens being collected; they were referred to as sight records.

Laboratory study was conducted at the Plants of Thailand Research Unit, Department of Botany, Faculty of Science, Chulalongkorn University. Dried herbarium specimens were prepared as described in Boonkerd et al. (1987) and deposited at BCU. Internal and external morphological characters of each specimen were studied. Pteridophyte specimens were identified using keys and descriptions from taxonomic literature, such as Floras, manuals, monographs, as well as research papers, etc. Botanical names of all specimens were verified by comparison with voucher herbarium specimens deposited at BCU, BKF, BM, L, P and K. Abbreviations used in this manuscript for herbaria (location) follow Holmgren and Holmgren (2007), and authors of scientific names and abbreviations follow the standard procedure for quoting authors of plant names (Brummitt and Powell, 1992). The classification system of pteridophytes in this paper follows that of Boonkerd and Pollawatn (2000).

RESULTS AND DISCUSSION

A total of 418 specimens of fern and fern allies were collected and were classified into 27 families, 67 genera, 205 species, 1 subspecies and 7 varieties (Appendix). Among these, 24 families, 63 genera, 190 species, 1 subspecies and 6 varieties were ferns, while 3 families, 4 genera, 15 species and 1 variety were fern allies. Selaginellaceae had the highest number of species among fern allies, i.e., 10. Three families of ferns, namely Polypodiaceae, Dryopteridaceae, and Aspleniaceae, were the most frequent families encountered with 25, 20 and 16 species, respectively.

Habitats and diversity

Khao Nan National Park is rather rich in pteridophyte diversity as compared with Khao Luang National Park. At Khao Nan, 205 species were collected from 60-600 m altitudes, whereas 225 species were collected from all elevations of Khao Luang National Park (Tagawa and Iwatsuki, 1979, 1985, 1988, 1989).

According to habitat types, the specimens can be classified into four broad groups (Fig. 2): terrestrial plants (116 species), epiphytes (27 species), lithophytes

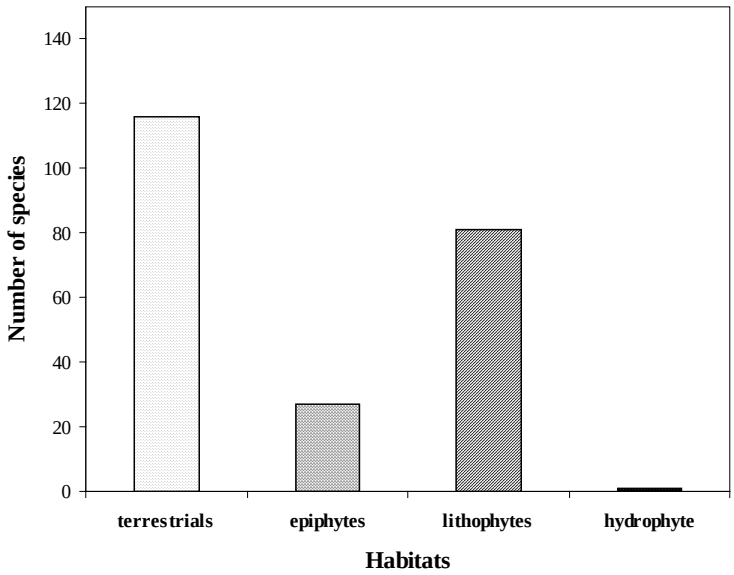

FIGURE 2. Diversity of pteridophytes with regard to habitats

(81 species), and hydrophyte (1 species). However, 16 and three species of ferns and fern allies, respectively, were found in more than one habitat (Appendix). It can be seen that the numbers of terrestrials and lithophytes (52% and 36%, respectively, of all species) are rather high while the number of epiphytes and hydrophytes (12% and < 1%, respectively, of all species) are fairly and exceedingly low, respectively. It seems likely that the wet forest floor and moist rocks by streams in lowland area of this tropical rain forest are suitable places for most pteridophytes to thrive. It will thus of interest to survey the mid and higher altitudes of this national park to confirm this proposed trend as well as to survey for further pteridophyte biodiversity. Within this lowland section, however, the most widespread terrestrial genera, which include 10 or more terrestrial species, are *Pteris*, *Lindsaea*, *Tectaria* and *Diplazium* with 12, 10, 10 and 10 species, respectively (Appendix). They usually occupy wet and shady forest floors or hill slopes. However, the most frequently observed species was *Blechnum orientale* L., perhaps since this species can adapt to growing in both shady and open areas and so greatly increase the number of available niches.

There are also terrestrial sun-loving ferns present at this location, the most frequently observed species include *Dicranopteris linearis* (Burm. f.) Underw. var. *linearis*, which colonized the fully exposed areas of abandoned mines, and typically at the forest margins, *Dicranopteris curranii* Copel., *Dicranopteris speciosa* (C. Presl) Holttum and *Gleichenia truncata* (Willd.) Spring, which form dense long persistent thickets and have become weedy species. Tagawa and Iwatsuki (1989) noted that

Dipteris conjugata Reinw. usually occurs on mountain ridges or summits at altitudes higher than 1,000 m where there is sufficient sun-light. Its occurrence at Khao Nan National Park is therefore not surprising, but the finding of a colony of *Dipteris conjugata* at lower elevation, in a mountain bog at 400 m altitude is unexpected. This species appears to have adapted to the low light conditions of the bog by extending its stipes up to 2 m long, while the plant growing on mountain ridges in open areas has stipes of less than 0.5 m tall.

Lithophytes in lower tropical rain forests usually occur on moist or muddy rocks by streamlets where the sun-light more or less penetrates to the forest floor. Although only the lithophyte genera *Asplenium* had reasonably high species diversity (nine species) at this site, families with five or more lithophytic species (other than Aspleniaceae of course) included Hymenophyllaceae (12 species from four genera), Polypodiaceae (11-16 species, five are also epiphytic, from eight genera) and Oleandraceae and Lomariopsidaceae (both with five species from two genera). The most frequently found species of filmy fern was *Crepidomanes bipunctatum* (Poir.) Copel. whilst *Crepidomanes maximum* (Blume) K. Iwats., a big-sized filmy fern that is rather rare, was found only at one site. The most abundant member of the genus *Asplenium* was *A. tenerum* G. Forst., a species that is usually restricted to wet rocks in a shady micro-habitat and has a variety of pinnae-forms. Interestingly, there are also some fern species present that are typically restricted to wet rocks in streamlets or nearby waterfalls, such as *Bolbitis heteroclita* (C. Presl) Ching and *Lomariopsis lineata* (C. Presl) Holttum.

Most epiphytes found at these lower elevations were polypodaceous ferns and members of the family Vittariaceae (Appendix), but the most abundant epiphytic species was *Pyrrosia adnascens* (Sw.) Ching, which was found in all ten survey sites, usually on shady branches or tree trunks. The most striking epiphytic species, a massive Staghorn fern, *Platycerium coronarium* (J. G. Koen. ex C. Muell) Desv., was frequently found on the upper branches of the tallest tree in the primitive forest. It is recognized by its long and pendulous fertile leaves, being up to 200 cm long and repeatedly dichotomous. The other outstanding Staghorn fern observed at this national park was *Platycerium ridleyi* Christ, which was previously thought to be restricted to a few localities in peninsular Thailand (Hennipman and Roos, 1982) and unknown to occur at either Khao Nan National Park or Khao Luang National Park (Tagawa and Iwatsuki, 1989).

The only true aquatic fern found in this survey of lowland Khao Nan National Park was *Salvinia cucullata* Roxb. ex Bory. This is a floating fern commonly found in open water-bodies. There are also rheophytic ferns, which occur on rocks in streambeds or on stream banks which are regularly subject to flooding after heavy rains. Examples include *Bolbitis appendiculata* (Willd.) K. Iwats., *Cephalomanes javanicum* (Blume) Bosch, *Microsorum pteropus* (Blume) Copel., *Trigonospora ciliata* (Wall. ex Benth.) Holttum, *Leptochilus minor* Fée, and *Osmunda javanica* Blume. These fern species can withstand flooding from swift-flowing streams for a considerable period.

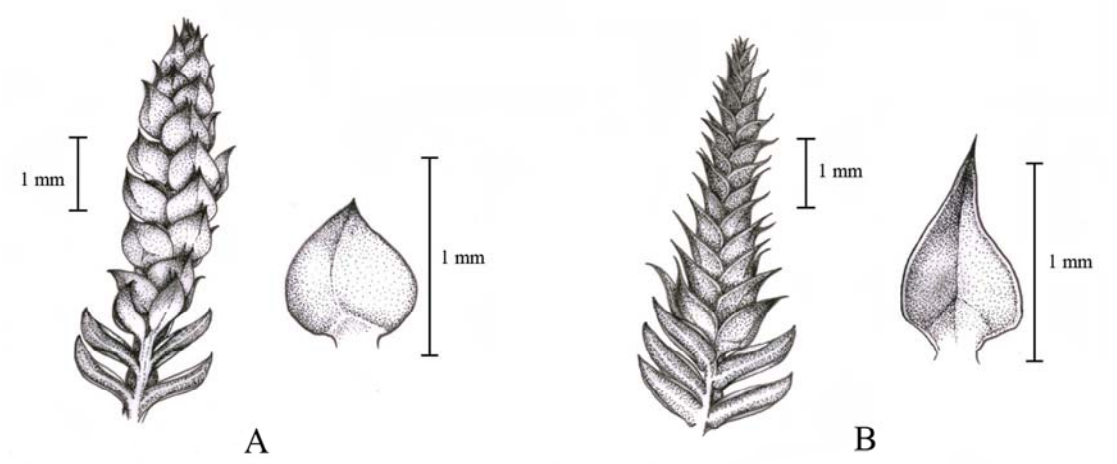

FIGURE 3. Strobili and sporophylls of *Selaginella willdenowii* (Desv. ex Poir.) Baker (A), and *S. helferi* Warb. (B)

Calciphytes

Limestone is a hard sedimentary rock formed under the sea in ancient times from the shells of small sea creatures. Through movements in the earth's crust, rock formed under the sea can be uplifted over millions of years and become land (Royal Institute, 2002). Limestone hills can be found throughout the park, such as Huai Keaw, Thum Luang, Thum Hong, etc. The action of acidic rainfall exploiting weaknesses and cracks in the limestone rock under the soil has led to the erosion of rock to calcareous soil. It was found that some fern species associated with limestone, thrive in or are adapted to living in soils rich in calcium carbonate. Common species include *Selaginella delicatula* (Desv. ex Poir.) Alston, *Adiantum caudatum* L., *Adiantum malesianum* Ghatak, *Adiantum zollingeri* Mett. ex Kuhn, *Doryopteris ludens* (Wall. ex Hook.) J. Sm., *Antrophyum callifolium* Blume, *Asplenium macrophyllum* Sw., *Asplenium salignum* Blume, *Heterogonium pinnatum* (Copel.) Holttum, *Heterogonium gurupahense* (C. Chr.) Holttum, *Tectaria devexa* (Kunze ex Mett.) Copel., *Tectaria griffithii* (Baker) C. Chr., *Tectaria manilensis* (C. Presl) Holttum var. *manilensis*, *Tectaria siifolia* (Willd.) Copel., *Macrothelypteris torresiana* (Gaudich.) Ching, and *Microsorum punctatum* (L.) Copel.

Disjunct distributions

Selaginella helferi Warb. was previously recorded from northern, north-eastern, south-eastern and central Thailand and its occurrence in Thailand is matched with its present distribution in Assam, Myanmar, South China and Indochina (Tagawa and Iwatsuki, 1979). In contrast, *Selaginella helferi* was found to occur naturally at Khao Nan National Park, peninsular Thailand, indicating a disjunct distribution. However, *Selaginella helferi* occurred in peninsular Thailand a long time ago and it is likely to have been wrongly identified as *Selaginella willdenowii* (Desv. ex Poir.) Baker, since the two species are similar in their scandent

habit (Tagawa and Iwatsuki, 1979). We found that only *Selaginella willdenowii* has an iridescent blue colour and broad ovate sporophylls, whilst *S. helferi* has ovate-lanceolate sporophylls (Fig. 3). It is important to note that our finding of *S. helferi* in peninsular Thailand is the first record of this species on the Malay Peninsula (Parris and Latiff, 1997).

Alien species

The present data reveal that *Adiantum latifolium* Lam. has escaped from cultivation and become naturalized in Khao Nan National Park. It is common amongst the undergrowth and is a weedy species elsewhere in the lowlands. This glaucous maiden hair fern is indigenous to Central America and Northern South America, but is not common there except as a weed in plantations (Piggott, 1988).

New records

It was found that one variety and one species each are new records for Thailand, i.e. *Huperzia carinata* (Desv. ex Poir.) Trevis. var. *laxum* (C. Presl) Christ and *Selaginella commutata* Alderw. It is important to note that these two newly recorded species were found only once at one location and in rather small numbers. Suggesting they are local and uncommon and thus may be extirpated from the country soon if their present habitats continue to be disturbed.

Undetermined species

Among the 206 taxa, five samples (*Cephalomanes* sp., *Hymenophyllum* sp., *Cyathea* sp., *Nephrolepis* sp., and *Tectaria* sp.) could not be determined to species level due to the lack of fertile structures. Therefore, additional field-collections are required in order to be able to collect fertile fronds which are probably produced seasonally.

Tentative new records and/or new species

There were nine species of the 206 taxa which require further observations and investigation to determine their correct species and global status, that is either as new species to science or new records for Thailand. These include two species each from the genera *Adiantum*, *Asplenium* and *Nephrolepis* and one species each from the genera *Oleandra*, *Dryopteris* and *Vittaria*. Regarding the genus *Oleandra* Cav., the specimens of *Oleandra* sp. from Khao Nan National Park matched very well with the type specimen of *Oleandra cumingii* Hook. & Baker kept at Kew herbarium. This species was treated as a synonym of *Oleandra undulata* (Willd.) Ching in the Flora of Thailand (Tagawa and Iwatsuki, 1985), but after extensive comparisons between these two species we are confident that, in contrast, *Oleandra cumingii* Hook. & Baker and *Oleandra undulata* (Willd.) Ching are not synonyms but in fact are two distinct species. However, further revision of the genus is required to solve this problem of determination.

Comparisons with Pteridophytes from other areas

Table 1 shows the numbers of pteridophyte species in six protected areas of Thailand. However, no information is available for the exact surveyed area of each park. It can be seen that species numbers are nearly the same for Khao Luang and Khao Nan National Parks despite the higher areas

TABLE 1. Pteridophyte diversity in five protected areas of Thailand and the lower tropical rain forest of Khao Nan National Park. NP = National Park.

Protected area	Altitude (m)	Total area (km^2)	Families	Genera	Species
Doi Inthanon NP[1]	300-2,565	272	24	67	171
Doi Suthep-Pui NP[2,3]	350-1,685	261	27	65	174
Khao Luang NP[2,6]	100-1,835	571	25	61	225
Si Phangnga NP[4]	60-350	246	17	29	49
Khun Korn Waterfall Forest Park[5]	625-1,635	18	24	66	154
Khao Nan NP	60-600	436	27	67	205

Notes: [1]Koyama (1986); [2]Tagawa and Iwatsuki (1979, 1985, 1988 and 1989); [3]Maxwell and Elliott (2001); [4]Leeratiwong and Jornead (2005); [5]Boonkerd and Rachata (2002); [6]Graham (1991).

of Khao Luang. In addition, this paper reports only the collection of pteridophytes from the lower elevation (60-600 m asl) levels of Khao Nan National Park. Noting that 154 species of pteridophytes were collected from Khun Korn Waterfall Forest Park from 625-1,635 m altitude, and the similar habitat and proximal location of Khao Nan National Park, it would seem reasonable to assume that at least 100 additional pteridophytes species would be collected from the middle and higher altitude zones (600-1,438 m altitude) of Khao Nan National Park making the total number of species over 300 species. If so, this number of species in only one protected area would be the highest number of all known protected areas.

CONCLUSION

In summary, the results from this study indicate that Khao Nan National Park of southern Thailand is one of the areas in the country that is rich in pteridophyte biodiversity despite its previous forest disturbance, as compared with the important well-protected area of Khao Luang National Park. Two new records of occurrence for Thailand and nine potential new records and/or new species were found which are the highest numbers in comparison with other recent pteridophyte explorations, such as Yuyen and Boonkerd (2002), Boonkerd and Rachata (2002), and Rattanathirakul and Boonkerd (2003). So, if there are further botanical explorations in this area, especially in mountain areas higher than 600 m above mean sea level, it is expected that the total number of indigenous plant species recorded in Thailand will increase. New records and new species are likely to be found in this national park.

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APPENDIX

List of pteridophytes found at low elevations in Khao Nan National Park, Nakhon Si Thammarat Province, Thailand. Habitat: A = aquatic herb, E = epiphytic herb, L = lithophytic herb, T = terrestrial herb; Study area: 1 = Bua Chake Yai nature trail, 2 = Sunantha Fall, 3 = Hin Toh Fall, 4 = Klong Klai, 5 = Huai Keaw, 6 = Klong Kun, 7 = Tha Ton, 8 = Huai Lhek (Pa Pra), 9 = Klong Lum Pan, 10 = Klong Yod Nam; Abundance: A = abundant, C = common, L = locally abundant, R = rarely found, UC = uncommon.

Taxa	Habitat	Study Area	Abundance
Fern allies			
LYCOPODIACEAE			
Huperzia carinata (Desv. ex Poir.) Trevis. var. *laxum* (C. Presl) Christ	L	1	R
Huperzia hamiltonii (Spreng.) Trevis.	L	1,6	UC
Huperzia phlegmaria (L.) Rothm.	E,L	1,6	UC
Lycopodiella cernua (L.) Pic. Serm.	T	1,2,3,5,6	C
SELAGINELLACEAE			
Selaginella argentea (Wall. ex Hook. & Grev.) Spring	L	2,4,5,7,10	C
Selaginella commutata Alderw.	L	4	R
Selaginella delicatula (Desv. ex Poir.) Alston	L,T	2,4,9	UC
Selaginella helferi Warb.	T	4,8	UC
Selaginella intermedia (Blume) Spring	T	6,7	UC
Selaginella kurzii Baker	L	5	R
Selaginella repanda (Desv. ex Poir.) Spring	L	4	R
Selaginella roxburghii (Hook. & Grev.) Spring	L	5,6,8	UC
Selaginella wallichii (Hook. & Grev.) Spring	T	6	R
Selaginella willdenowii (Desv. ex Poir.) Baker	L,T	1,2,3,4,5,6,7,8,9,10	A
PSILOTACEAE			
Psilotum nudum (L.) Beauv.	L	4	R
Ferns			
MARATTIACEAE			
Angiopteris evecta (G. Forst.) Hoffm.	T	2,3,4,5,7,8,9	A
Helminthostachys zeylanica (L.) Hook.	T	7	R
OPHIOGLOSSACEAE			
Ophioglossum pendulum L.	E	4	R
Ophioglossum petiolatum Hook.	T	3,5,8	UC
HYMENOPHYLLACEAE			
Cephalomanes javanicum (Blume) Bosch	L	1,2,3,5,8	C
Cephalomanes meifolium (Bory ex Willd.) K. Iwats.	L	1,2	UC

Taxa	Habitat	Study Area	Abundance
Cephalomanes obscurum (Blume) K. Iwats.	T	5	R
Cephalomanes sp. I	L	8	R
Crepidomanes bipunctatum (Poir.) Copel.	E,L	1,2,3,6,7,8,10	A
Crepidomanes digitatum (Sw.) K. Iwats.	L	1	R
Crepidomanes latemarginale (Eaton) Copel.	L	6,8	UC
Crepidomanes maximum (Blume) K. Iwats.	L	6	R
Crepidomanes minutum (Blume) K. Iwats.	L	1,5,6	UC
Hymenophyllum polyanthos (Sw.) Sw.	L	6	L
Hymenophyllum sp. I	L	5	R
Trichomanes bimarginatum Bosch	L	2,6,7,8	UC
Trichomanes motleyi Bosch	L	1,2,4,6,7,8	C
Trichomanes sublimbatum Mull. Stuttg.	L	7	R
OSMUNDACEAE			
Osmunda javanica Blume	L,T	5,7	UC
DIPTERIDACEAE			
Dipteris conjugata Reinw.	T	1	L
GLEICHENIACEAE			
Dicranopteris curranii Copel.	T	5,6	UC
Dicranopteris linearis (Burm. f.) Underw. var. *linearis*	T	1,2,5,6	UC
Dicranopteris speciosa (C. Presl) Holttum	T	5,6	UC
Gleichenia truncata (Willd.) Spring	T	1,5	UC
SCHIZAEACEAE			
Lygodium circinatum (Burm. f.) Sw.	T	1,8,9	UC
Lygodium flexuosum (L.) Sw.	T	1	R
Lygodium microphyllum (Cav.) R. Br.	T	2	R
Lygodium polystachyum Wall. ex T. Moore	T	1,2,3	UC
Lygodium salicifolium C. Presl	T	1,2,3,5	UC
Schizaea dichotoma (L.) Sm.	T	1	R
Schizaea digitata (L.) Sw.	T	1,6,8,9	UC
DENNSTAEDTIACEAE			
Microlepia herbacea Ching & C. Chr. ex Tardieu & C. Chr.	T	1	R
Microlepia speluncae (L.) T. Moore	T	2,3,7,8	UC
Pteridium aquilinum (L.) Kuhn var. *yarrabense* Domin	T	1	R
DICKSONIACEAE			
Cibotium barometz J. Sm.	T	1	R
LINDSAEACEAE			
Lindsaea bouillodii Christ	T	1	R
Lindsaea cultrata (Willd.) Sw.	T	8	R

Taxa	Habitat	Study Area	Abundance
Lindsaea ensifolia Sw.	T	2,5	UC
Lindsaea heterophylla Dryand.	T	1,5,8	UC
Lindsaea lucida Blume	L	2,6,8	UC
Lindsaea oblanceolata v.A.v. Ros	T	7	R
Lindsaea odorata Roxb.	L	8	R
Lindsaea orbiculata (Lamk.) Mett. ex Kuhn var. *commixta* (Tagawa) Kramer	T	1	R
Lindsaea orbiculata (Lamk.) Mett. ex Kuhn var. *orbiculata*	T	5	R
Lindsaea parallelogramma v.A.v. Ros.	T	1	R
Lindsaea parasitica (Roxb. ex Griff.) Hieron.	T	5,8	UC
Lindsaea repens (Bory) Thwaites var. *pectinata* (Blume) Mett. ex Kuhn	T	4	R
CYATHEACEAE			
Cyathea contaminans (Wall. ex Hook.) Copel.	T	2	R
Cyathea gigantea (Wall. ex Hook.) Holttum	T	1,2	UC
Cyathea latebrosa (C. Presl) Copel.	T	7,8	UC
Cyathea sp. I	T	6	R
SALVINIACEAE			
Salvinia cucullata Roxb. ex Bory	A	6	L
ADIANTACEAE			
Adiantum caudatum L.	T	2,9	UC
Adiantum latifolium Lam.	T	2,3	UC
Adiantum malesianum Ghatak	L,T	5	R
Adiantum philippense L.	T	2	R
Adiantum stenochlamys Baker	L	1	R
Adiantum zollingeri Mett. ex Kuhn	L	4,5,6	UC
Adiantum sp. I	L	4	R
Adiantum sp. II	L	4	R
Doryopteris ludens (Wall. ex Hook.) J. Sm.	T	5	R
Hemionitis arifolia (Burm. f.) T. Moore	T	2,3,5,7,9	C
Pityrogramma calomelanos (L.) Link.	T	2,7	UC
Taenitis blechnoides (Willd.) Sw.	T	1,2,3,8	UC
PTERIDACEAE			
Pteris biaurita L.	T	9	R
Pteris cretica L.	T	7,8	UC
Pteris dalhousiae Hook.	T	1	R
Pteris ensiformis Burm. f.	T	2,3,9,10	UC
Pteris grevilleana Wall. ex J. Agardh	T	5,6,8	UC
Pteris longipinnula Wall. ex J. Agardh	T	8	R
Pteris mertensioides Willd.	T	8,6,7,10	UC
Pteris multifida Poir.	T	3,5	UC
Pteris scabripes Wall. ex J. Agardh	T	2,7,8,9,10	C
Pteris semipinnata L.	T	7	R
Pteris tripartita Sw.	T	4,9	UC
Pteris vittata L.	T	3	R
Stenochlaena palustris (Burm. f.) Bedd.	T	2,3,5,7	UC

Taxa	Habitat	Study Area	Abundance
VITTARIACEAE			
Antrophyum callifolium Blume	E,L	1,6,8,9	UC
Vittaria angustifolia Blume	E,L	6,7	UC
Vittaria elongata Sw.	E,L	1	R
Vittaria ensiformis Sw.	E,L	1,5,6,8	UC
Vittaria flexuosa Fée	E	7	R
Vittaria scolopendrina (Bory) Schkuhr ex Hook. & Thwaites	E,L	1,8	UC
Vittaria sp. I	E	5	R
ASPLENIACEAE			
Asplenium affine Sw.	L	5,6	UC
Asplenium apogamum Murakami et Hatanaka	T	3,7,8,10	UC
Asplenium batuense v.A.v. Ros.	E	8	R
Asplenium excisum C. Presl	T	4,8	UC
Asplenium grevillei Wall. ex Hook. & Grev.	T	7,8	UC
Asplenium hondoense Murakami et Hatanaka	T	4	R
Asplenium longissimum Blume	L	4,6,10	UC
Asplenium macrophyllum Sw.	L	4,5,7,10	UC
Asplenium nidus L.	L	2,7,10	UC
Asplenium nitidum Sw.	L	6	L
Asplenium salignum Blume	L	4,8,7	UC
Asplenium simonsianum Hook.	E	5	R
Asplenium tenerum G. Forst.	L	3,6,7,8	UC
Asplenium unilaterale Lam.	T	6,8	UC
Asplenium sp. I	L	5	R
Asplenium sp. II	L	8	R
BLECHNACEAE			
Blechnum orientale L.	T	1,2,3,4,5,6,7,8,9,10	A
LOMARIOPSIDACEAE			
Bolbitis appendiculata (Willd.) K. Iwats ssp. *appendiculata*	L	6,7,8	UC
Bolbitis heteroclita (C. Presl) Ching	L,T	1,2,3,4,5,7	C
Bolbitis sinuata (C. Presl) Hennipman	L	8	L
Bolbitis virens (Wall. ex Hook. & Grev.) Schott var. *virens*	L	7	R
Lomariopsis lineata (C. Presl) Holttum	L	1,2,7,8	UC
Teratophyllum aculeatum (Blume) Mett. ex Kuhn	T	6	R
WOODSIACEAE			
Diplazium bantamense Blume	T	8	R
Diplazium cordifolium Blume	T	6,7,8	UC
Diplazium crenatoseratum (Blume) T. Moore	T	1,7,8	UC
Diplazium esculentum (Retz.) Sw.	T	2	R
Diplazium polypodioides Blume	L,T	7	R
Diplazium riparium Holttum	T	5,7,8	UC

Taxa	Habitat	Study Area	Abundance
Diplazium silvaticum (Bory) Sw.	T	5,7,8	UC
Diplazium simplicivenium Holttum	T	8	R
Diplazium sorzogonense (C. Presl) C. Presl	T	7,8	UC
Diplazium tomentosum Blume	T	5,6,7,8	UC
DRYOPTERIDACEAE			
Dryopteris sp. I	T	8	R
Heterogonium gurupahense (C. Chr.) Holttum	T	2,9	UC
Heterogonium pinnatum (Copel.) Holttum	T	4,8	UC
Heterogonium sagenioides (Mett.) Holttum	T	8	R
Pleocnemia hemiteliiformis (Racib.) Holttum	T	8	R
Pleocnemia irregularis (C. Presl) Holttum	T	2,3,7,8	UC
Pteridrys syrmatica (Willd.) C. Chr. & Ching	T	2,3,8	UC
Pteridrys australis Ching	T	6,8	UC
Tectaria brachiata (Zoll. & Moritzi) Morton	T	8,9	UC
Tectaria decurrens (C. Presl) Copel.	T	8,9	UC
Tectaria devexa (Kunze ex Mett.) Copel.	T	4	L
Tectaria griffithii (Baker) C. Chr.	T	2,4,5,6,7,8	C
Tectaria keckii (Luerssen) C. Chr.	T	5	R
Tectaria manilensis (C. Presl) Holttum	L	4	R
Tectaria polymorpha (Wall. ex Hook.) Copel.	T	7,8	UC
Tectaria singaporeana (Wall. ex Hook. & Grev.) Ching	T	1,2,3,5,6,7,8	C
Tectaria semipinnata (Roxb.) Morton	T	1,2,3,7,8	C
Tectaria siifolia (Willd.) Copel.	T	4	R
Tectaria vasta (Blume) Copel.	T	8	R
Tectaria sp. I	T	4	R
THELYPTERIDACEAE			
Amphineuron immersum (Blume) Holttum	T	8, 9	UC
Amphineuron terminans (J. Sm.) Holttum	T	2,3,7	UC
Christella dentata (Forssk.) Holttum	T	5,8,9	UC
Christella papilio (C. Hope) Holttum	T	5,7	UC
Christella parasitica (L.) H. Lev.	T	2	R
Christella siamensis Tagawa & K. Iwats.	T	10	R
Christella subpubescens (Blume) Holttum	T	5	R
Macrothelypteris torresiana (Gaudich.) Ching	T	6,8	UC
Mesophlebion chlamydophorum (Rosenst.) Holttum	T	5	R
Pronephrium nudatum (Roxb.) Holttum	T	6,7,8	UC
Pronephrium repandum (Fée) Holttum	T	1,2,7,8	C
Sphaerostephanos polycarpus (Blume) Copel.	T	2,6,7,8	L
Trigonospora ciliata (Wall. ex Benth.) Holttum	L	6	UC
DAVALLIACEAE			
Davallia denticulata (Burm. f.) Mett. ex Kuhn	L	2	R
Davallia embolostegia Copel.	E,L	4,6,7	UC
Davallia solida (G. Forst.) Sw.	T	1,6,8,10	UC
Davallia trichomanoides Blume	L	7	R
Humata heterophylla (Sm.) Desv.	T	1,8	UC

Taxa	Habitat	Study Area	Abundance
Humata pectinata (Sm.) Desv.	L	1,8	UC
Humata repens (L. f.) J. Small ex Diels	L	1,8	UC
OLEANDRACEAE			
Nephrolepis acutifolia (Desv.) H. Christ	T	1	R
Nephrolepis biserrata (Sw.) Schott	T	2,3,6,7,8	L
Nephrolepis brownii (Desv.) Hovenkamp & Miyam.	L	6	L
Nephrolepis falcata (Cav.) C. Chr.	E	4,9	UC
Nephrolepis sp. I	L	4	R
Nephrolepis sp. II	L	10	R
Nephrolepis sp. III	L	10	R
Oleandra pistillaris (Sw.) C. Chr.	T	1	L
Oleandra sp. I	L	6	L
POLYPODIACEAE			
Belvisia annamensis (C. Chr.) S. H. Fu	E	7,8	UC
Belvisia mucronata (Fée) Copel.	E	7	R
Belvisia spicata (L. f.) Mirbel ex Copel.	E	9	R
Colysis pedunculata (Hook. & Grev.) Ching	E,L	1,2,3,7,8	C
Drynaria quercifolia (L.) J. Sm.	E	5,10	UC
Drynaria rigidula (Sw.) Bedd.	E	2	R
Drynaria sparsisora (Desv.) T. Moore	E	1,2,6,8	UC
Goniophlebium verrucosum (Hook.) J. Sm.	L	6	R
Lecanopteris sinuosa (Wall. ex Hook.) Copel.	E	6	R
Lepisorus longifolius Holttum	L	6,7	UC
Leptochilus decurrens Blume	L	7,8	UC
Leptochilus minor Fée	L	8	L
Loxogramme avenia (Blume) C. Presl	L	2,6,7,8	UC
Microsorum dilatatum (Bedd.) Sledge	L	7,8	UC
Microsorum pteropus (Blume) Copel.	L	2,3,4,6,7,8,9	C
Microsorum punctatum (L.) Copel.	E,L	1,2,3,4,5,6,7,8,9,10	A
Microsorum rubidum (Kunze) Copel.	L	6	L
Phymatosorus nigrescens (Blume) Pic. Serm.	L	2,3,6,7,8,9	C
Phymatosorus scolopendria (Burm. f.) Pic. Serm.	L	6	R
Platycerium coronarium (J. G. Koen. ex C. Muell) Desv.	E	1,5,10	UC
Pyrrosia adnascens (Sw.) Ching	E,L	1,2,3,4,5,6,7,8,9,10	A
Pyrrosia longifolia (Burm. f.) C. V. Morton	L	1,2,6,7	UC
Pyrrosia nummularifolia (Sw.) Ching	E,L	1,8,9	UC
Pyrrosia piloselloides (L.) M. G. Price	E,L	1,2,6,7,9	C
Selliguea heterocarpa (Blume) Blume	L	1,5	UC