



A qualitative study on the diversity and conservation perspectives of pteridophytic flora in homegarden ecosystems in Polgolla in Kandy district, Sri Lanka

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Abstract

Pteridophytes are of minor economic significance to humankind as compared to other groups of plants, especially angiosperms. However, many of them are horticulturally desirable and used for decorations and ornamental purposes and some also as medicines and food. In the present study, the diversity, distribution and conservation perspectives of pteridophytic flora in homegarden ecosystems in the Polgolla Grama Niladhari Division (PGND), Kandy district, Sri Lanka, were investigated. All conceivable habitats of pteridophytes within homegardens and suburb areas in the PGND were visited frequently over a period of one year and representative samples were collected and preserved as herbarium specimens. The species collected were identified using the “Revised Handbook to the Flora of Ceylon” (Vol. XV and XVI) and verified with the specimens deposited at the Herbarium, National Botanic Gardens, Peradeniya, Sri Lanka. The study found 32 species of pteridophytes belonging to 12 families in homegardens and suburbs of three villages in the study area namely Megodagama, Egodagama and Gangewattegama. Although the importance and the conservation measures of pteridophytes have not been understood by the residents, many pteridophytes have been commonly grown as ornamental, crop and medicinal plants in their homegardens. This preliminary survey highlights the species richness of pteridophytes and the importance of conservation of existing species in PGND.

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1. Introduction

Pteridophytes represent an important group of plants in the plant kingdom. Sri Lanka is popular among the Asian countries as an island having exceptionally high level of species diversity and endemism of pteridophytes and this is largely due to the country being an island. A total of 348 pteridophyte species from 30 families have been recorded from Sri Lanka of which 50 are reported to be endemic to the country (Shaffer-Fehre, 2006).

Studies on pteridophytic flora in Sri Lanka had commenced in the late 18th and early 19th centuries and have basically been focused on cataloguing of genera and species based on the taxonomic studies

and the preparation of species inventories for selected ecosystems. Followed research work on pteridophytes continued from the mid-1950s to 1982 included cytological studies and monograph preparations (Manton & Sledge, 1954; Sledge, 1982). With the aim of utilization and *in-situ* and *ex-situ* conservation of ferns in Sri Lanka, many Sri Lankan scientists extended their research work to encompass the aspects of ecology, genetics and reproductive biology of some pteridophytes as well as their ethnobotanical uses, domestication and conservation measures (Ranil *et al.*, 2010a, 2010b, 2011).



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Pteridophytes are non-flowering seedless vascular plants growing densely in moist shady habitats in temperate and tropical forests. The majority of them are terrestrial, but some are epiphytic while others are lithophytic or hydrophytic. Pteridophytes are of minor economic significance to mankind as compared to other groups of plants, especially angiosperms. However, some pteridophytes are used for decoration and ornamental purposes and can be grown as indoor or outdoor plants under varied shade levels. In addition, some members such as *Pteris vittata* L. accumulates arsenic in their fronds, the first fern identified as a natural arsenic hyper accumulator (Xie *et al.*, 2009) and so helps in environmentally friendly phytoremediation processes. Further, several species are used as medicine and food (Mannan *et al.*, 2008).

Tropical homegardens are considered as agro-ecosystems which have a unique micro climate and support rich species and genetic diversity (Agbogidi & Adolor, 2013). These gardens are not only important sources of food, fodder, firewood, medicines, spices, ornamental plants and construction materials, but are also well suited for *in situ* conservation of a wide range of plant genetic resources. A large number of pteridophytes are cultivated as ornamental plants in homegardens due to their aesthetic value stemming from their delicate beauty. Their elegant fronds are used for decorative purposes. Most species are shade and moisture loving and luxuriously grow within interiors of forests. However, as they are strongly adaptable to grow in different environments, sun-loving species can be found growing well in tree canopies and on roadsides. Ranil and Pushpakumara (2005) documented that some of the native pteridophytes such as *Asplenium nidus* L., *Cyathea crinita* (Hook.) Copel., *Cyathea walkerae* (Hook.), *Drynaria quercifolia* (L.) J Smith, *Ophioglossum pendulum* L. and *Huperzia* sp. are grown in both outdoor and indoor environments by local communities. Ranil *et al.* (2015) further documented that the floriculture industry in Sri Lanka is dominated by some exotic pteridophytes such as *Nephrolepis* spp., *Adiantum* spp., *Davallia* spp., *Asplenium* spp. and *Platicerum* spp. Nevertheless, currently many pteridophytic species are under threat due to various anthropogenic activities such as degradation and destruction of their habitats, commercial collection, pathogens, predators and invasive species, climatic changes and environmental pollution (Arcand & Ranker, 2008). Therefore, it is necessary to raise public

awareness on sustainable utilization of the existing pteridophyte taxa, promoting *ex-situ* and *in-situ* conservation and domestication.

There are no documented information on pteridophytes in homegarden ecosystems in Sri Lanka. Therefore the primary objectives of the present study were to inventorize the diversity, distribution and conservation measures of pteridophyte taxa found in selected homegarden ecosystems in Polgolla Grama Niladhari Division and to prepare herbarium specimens for future reference.

2. Materials and Methods

2.1 Study site

The study site is approximately 1/2 km² and includes three villages namely Egodagama, Gangewattegama and Megodagama in Kandy district in the Central highlands of Sri Lanka. The sampled locations are shown in Figure 1.

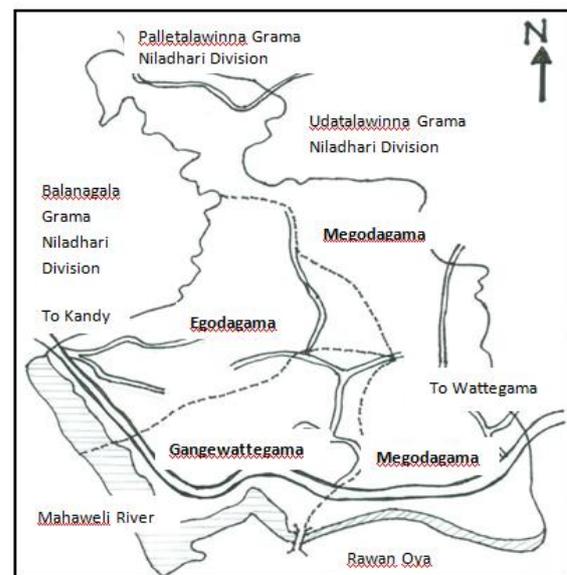


Figure 1. A sketch of the study area showing the locations of the sampling sites - Gangewattegama, Egodagama and Megodagama

The land area of Polgolla is not highly cultivated and hence most of the natural vegetation is still intact. The tropical climate with high humidity (> 0.65 p/pet), evenly distributed rainfall throughout the year (except the dry spell during January to March), moderate temperature (24 °C mean annual) and the soil type provide ideal conditions for a flourishing growth of pteridophytes.

2.2 Collection of fern species

All localities within the homegardens in the Polgolla Grama Niladhari Division (PGND) which are ideally favourable for growth of fern flora were surveyed. During the survey, every conceivable

2.3 Taxonomic Identification

The species were recorded, photographed and identified using the “Revised Handbook to the Flora of Ceylon” (Vol. XV and XVI) and verified with the specimens deposited at the National Herbarium, Royal Botanic Gardens, Peradeniya, Sri Lanka.

3. Results

3.1 Diversity of pteridophytes

The survey revealed the presence of a total of 32 species in 19 genera of pteridophytes within the Polgolla Grama Niladhari Division, representing 12 families (Table 1).

Among the 12 families, Pteridaceae was the dominant family represented by 12 species, which was followed by Polypodiaceae and Nephrolepidaceae consisting of 4 species each (Figure 2). Lycophytes were represented only by two families, Lycopodiaceae and Sellaginellaceae. All species of Pteridaceae were found to be terrestrial. It was evident that the species of Pteridaceae such as *Adiantum caudatum*, *Adiantum capillus-veneris*, *Nephrolepis cordifolia* and *Hemionitis arifolia* thrive well in many homegardens, roadsides and shady and hilly areas of the study site.

3.2 Pteridophytes with ornamental features

Except for a few species of pteridophytes, the majority found in this study site had an ornamental value and showed many of the characteristic features of ornamental pteridophytes such as decorative fronds, attractive leaf arrangements and their overall delicate appearance. Based on the visual observation, species such as *Nephrolepis cordifolia*, *Nephrolepis falcata*, *Nephrolepis hirsutula*, *Adiantum capillus-veneris*, *Pteris vittata*, *Pteris ensiformis* and *Angiopteris evecta* were commonly found in many homegardens. According to the National Red List 2012 of Sri Lanka, *Huperzia squarrosa* was the only endemic ornamental species found and it was present only in a very few homegardens during this study. Those used as ornamentals were *Nephrolepis cordifolia*, *Nephrolepis falcata*, *Adiantum capillus-veneris*, *Huperzia squarrosa*, *Asplenium nidus* and *Drynaria quercifolia* and these plants were more

frequent in homegardens. Commonly known as the bird’s nest fern, *Asplenium nidus* was found in many homegardens growing terrestrially on the ground, in pots and rarely epiphytically on trees. Due to its entire bright green large fronds and the ability to grow well in outdoor and indoor areas, this plant was popular among the residents in the area.

3.3 Habitat distribution of pteridophytic flora

Pteridophytes found in this study area were in diverse habitats. Among them, 24 were terrestrial (75 %), 6 epiphytic or epilithic (19 %) and 2 aquatic species (06 %). The two aquatic fern species were from two genera namely *Salvinia molesta* and *Azolla pinnata*. The latter is the only known fern with a symbiotic association with nitrogen fixing cyanobacterium *Anabaena azollae*. This cyanobacterium shows a high rate of nitrogen fixation and thus this fern is suitable as a biofertilizer, limiting the use of synthetic nitrogen (Kollah et al., 2016). In addition, *Azolla* seems to be an excellent candidate for removal, disposal, and recovery of heavy metals from the polluted aquatic ecosystems (Arora et al. 2006). Their distribution was restricted to the patchy water bodies close to paddy fields and in some man made ponds found in homegardens. The majority was terrestrial ferns and predominantly found along roadsides (lanes, footpaths and main roads) and in some partially exposed or shady areas close to water bodies and in slopes or hilly areas of the study site.

3.4 Conservation perspectives

During this study, in addition to surveying the distribution of pteridophytes in the Polgolla area, some common and obvious threats for growing them in homegardens were also noted. At present some pteridophytic species recorded (e.g. *Huperzia squarrosa*) are listed as Endangered (EN) (MOE 2012) due to various anthropogenic activities or natural causes. However, some species (e.g. *Adiantum caudatum* and *Adiantum capillus-veneris*) were typically found growing luxuriously in wet shady places in many homegardens, slopes and hilly areas, and on roadsides.

Many pteridophytes can grow in diverse soils and a small piece of a healthy rhizome is capable of producing a new plant.

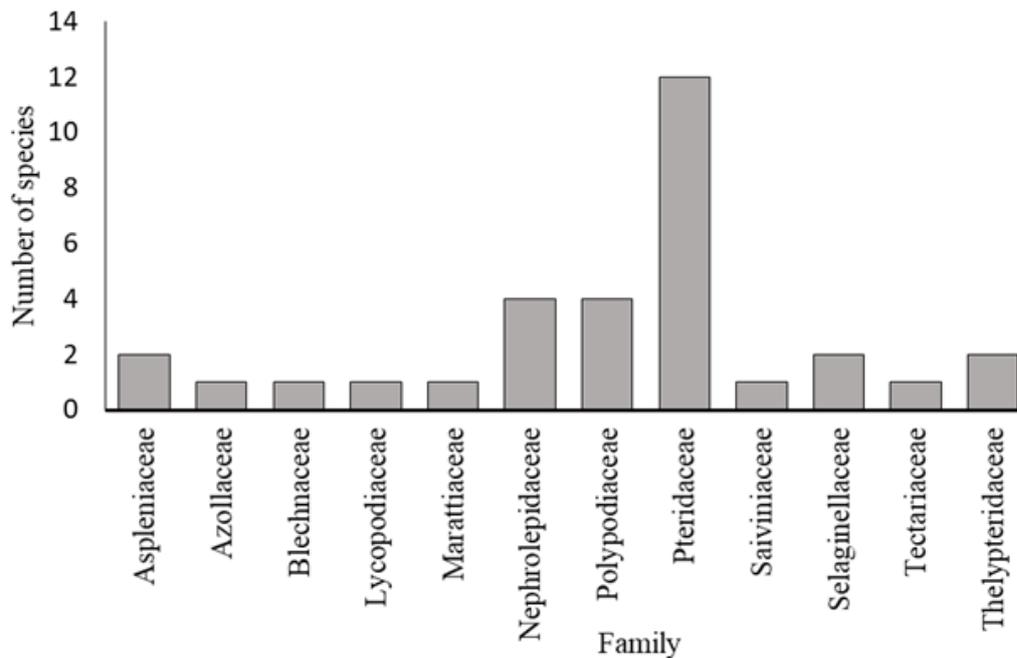


Figure 2. Families of pteridophytes recorded in the Polgolla Grama Niladhari Division and the number of species found in each family

Table 1: List of pteridophytic flora recorded in Polgolla Grama Niladhari Division, their families, common habitats and possible valued features as ornamental plants.

Botanical name	Family	Habitat	Ornamental features
<i>Asplenium decrescens</i> Kunze	Aspleniaceae	EP/EL	BP, DF, PP
<i>Asplenium nidus</i> L.	Aspleniaceae	EP/EL	DF, PP
<i>Azolla pinnata</i> R. Br.	Azollaceae	A	-
<i>Blechnum orientale</i> L.	Blechnaceae	TE	BP, DF, PP
<i>Huperzia squarrosa</i> (G. Forst.) Trevis.	Lycopodiaceae	EP/EL	HP
<i>Angiopteris evecta</i> (Forst.) Hoffm.	Marattiaceae	TE	BP, DF, PP
<i>Nephrolepis biserrata</i> (Sw.) Schott	Nephrolepidaceae	TE	BP, DF, PP
<i>Nephrolepis cordifolia</i> (L.) C.Presl	Nephrolepidaceae	TE	BP, DF, PP
<i>Nephrolepis falcata</i> (Cav.) C.Chr.	Nephrolepidaceae	TE	BP, DF, PP
<i>Nephrolepis hirsutula</i> (G. Forst.) C.Presl	Nephrolepidaceae	TE	BP, DF, PP
<i>Drynaria quercifolia</i> (L.) J. Smith	Polypodiaceae	EP/EL	DF, HP
<i>Pyrrosia heterophylla</i> (L.) Price	Polypodiaceae	EP/EL	DF
<i>Pyrrosia lanceolata</i> (L.) Farw.	Polypodiaceae	EP/EL	DF
<i>Microsorium scolopendrium</i> (Burm. f.) Copel.	Polypodiaceae	TE	DF, PP
<i>Adiantum caudatum</i> L.	Pteridaceae	TE	BP, DF, PP
<i>Adiantum capillus-veneris</i> L.	Pteridaceae	TE	BP, DF, PP
<i>Adiantum hispidulum</i> Sw.	Pteridaceae	TE	BP, DF, PP
<i>Adiantum diaphanum</i> Blume	Pteridaceae	TE	BP, DF, PP
<i>Adiantum latifolium</i> Lam.	Pteridaceae	TE	BP, DF, PP
<i>Pityrogramma dealbata</i> (C. Presl) Tryon	Pteridaceae	TE	BP, DF, PP
<i>Hemionitis arifolia</i> (Burm.) T. Moore (Syn. <i>Parahemionitis arifolia</i> (Burm.) Panigrahi)	Pteridaceae	TE	BP, DF, PP
<i>Doryopteris concolor</i> (Langsd. & Fisch) Kuhn	Pteridaceae	TE	BP, DF, PP
<i>Pteris ensiformis</i> Burm.f.	Pteridaceae	TE	BP, DF, PP
<i>Pteris multiaurita</i> J. Agardh	Pteridaceae	TE	BP, DF, PP
<i>Pteris quadriaurita</i> Retz	Pteridaceae	TE	BP, DF, PP
<i>Pteris vittata</i> L.	Pteridaceae	TE	BP, DF, PP
<i>Salvinia molesta</i> Mitch.	Salviniaceae	A	-

<i>Selaginella crassipes</i> Spring	Selaginellaceae	TE	DF, CR
<i>Selaginella</i> sp.	Selaginellaceae	TE	DF, CR
<i>Tectaria zeilanica</i> (Houtt) Sledge	Tectariaceae	TE	BP, DF, PP
<i>Cyclosorus tylodes</i> (kunze)	Thelypteridaceae	TE	BP, DF, PP
<i>Christella dentata</i> (Forssk.) Brownsey & Jermy	Thelypteridaceae	TE	BP, DF, PP

(Habitats denoted as A – Aquatic, EP- Epiphytic, EL- Epilithic, TE- Terrestrial and ornamental features denoted as DF – Decorative fronds; PP – Pot plants; BP – Bed plants; HP – Hanging plants and CR – Creeping plants)

Since many of these plants have a rapid vegetative growth rate, most gardeners had a concern about the competition between these species and their agricultural crops for nutrients and other growth requirements and are hence considered as a major threat to their economically important crops.

As such competitors can cause damage through displacement of some desirable plants in homegardens, many gardeners used to control the growth or eliminate those that are deemed to be aggressive in growth. *Asplenium nidus* was given prominence as an ornamental plant and is typically found to be grown in pots, particularly when the space is limited. However, unfortunately, assuming that species such as *Asplenium*, *Drynaria* and *Pyrrosia* growing as epiphytes on tree trunks and branches as parasitic pteridophytes (but not so and therefore do not harm the hosts), some gardeners have taken steps to eradicate them from their homegardens. Therefore, conservation of many pteridophytic species is a vital factor and it is almost entirely dependent upon the protection of their habitats. In addition to habitat loss, spreading of invasive plant species, environmental pollution and erosion of soil can be considered as some of the common threats affecting the pteridophytic diversity in the study area. As utilization of ferns is not properly regulated, research on *ex-situ* or *in-situ* conservation of these species may be critical.

4. Discussion

Ornamental plants are plants that are grown for decorative purposes in gardens and landscapes for their beautiful flowers and/or elegant leaves (Kochhar, 2009). Though pteridophytes are non-flowering plants, due to the attractiveness and elegance of their fronds as well as their ability to grow well in different habitats where shade and moisture is prevalent, the majority of them can be used as ornamental plants in floriculture industry in Sri Lanka. Further, in comparison to other plant taxa, pteridophytes show many other favourable features important in the floriculture industry such as year round production, the lower effort needed for production and thus the lower labour cost, the lower susceptibility to pests and diseases and the

ability to grow on the ground, in pots and as epiphytes on tree trunks and hanging baskets.

The species richness of pteridophytes along shady footpaths and narrow lanes connecting neighbouring houses and those leading to paddy-fields and other croplands was considerably high compared to that along the main roads. These species were seen to grow well in moist and shady places in the gardens where other plants generally cannot grow. In terms of abundance, this study recorded that the species such as *Adiantum caudatum*, *Adiantum capillus-veneris*, *Hemionitis arifolia*, *Blechnum orientale*, *Selaginella crassipes* and *Nephrolepis biserrata* were predominant in many homegardens and other shady areas as well as along roadsides in all three villages and were commonly recorded in varied habitats such as on the ground, in pots, as epiphytes tied to tree trunks and in hanging pots. As reported by Arcand & Ranker (2008), the main threat for the pteridophytes are habitat degradation and habitat destruction, commercial collection, pathogens and predators, climate or microclimate change, environmental pollution and competition with invasive species.

Generally a homegarden is an area of land around a family home, where fruit trees, vegetables, foliage and flowering plants and medicinal plants etc. are purposefully cultivated. Many homegardens located within the study area displayed a mixture of different types of such plants, with fruit trees and other agricultural crops being predominant. In such places, the existence of pteridophytic species was highly limited, since priority was given for optimization of economically important agricultural crops, in which the harvest could be used for home consumption or for selling in small quantities for an additional income. Under such situations, steps have to be taken for conservation of at least horticulturally desirable species in the Botanic Gardens in different parts of the country, before many of them become endangered or permanently extinct.

Due to the favourable climatic conditions, there has been an increasing demand particularly for growing ornamental plants (flowering and foliage plants) in both urban and rural areas in Kandy. The

ornamental nursery business has therefore developed on a large scale in areas in and around the Kandy city. Among the different varieties of foliage plants, a large number of pteridophytes are considered to be highly prized for both indoor and outdoor gardening. Planting pteridophytes, whether indoors or outdoors need less attention compared to flowering plants. Hence most of the nursery owners and suppliers collect large quantities of such species for a low price from gardeners which is seen as a threat to rare species as well as for those with small populations.

5. Conclusions

A total of 32 species in 19 genera of pteridophytes were collected within the Polgolla Grama Niladhari Division, which belonged to 12 families. Pteridaceae, represented by 12 species was found to be the dominant family among them. This was followed by Polypodiaceae and Nephrolepidaceae consisting of 4 species each. *Adiantum* is the largest genus with as many as five species being recorded within the study area, followed by *Nephrolepis* and *Pteris* each represented by four species. Currently, many pteridophytic flora are under threat even in rural areas, as a result of anthropogenic activities. This preliminary survey in PGND provides useful information as to the further steps that could be taken to maintain and conserve the respective habitats of pteridophytes in the study area.

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References

- Agbogidi, O.M., Adolor, E.B. (2013) Home gardens in the maintenance of biological diversity. *Applied Science Reports* **1**: 19-25.
- Arcand, N.N., Ranker, T.A. (2008) Conservation Biology. In: T.A. Ranker and C.H. Haufler (eds), *Biology and Evolution of Ferns and Lycophytes*. pp. 257-283, Cambridge University Press, Cambridge.
- Arora, A., Saxena, S., Sharma, D.K. (2006) Tolerance and phytoaccumulation of chromium by three *Azolla* species. *World Journal of Microbiology & Biotechnology* **22**: 97-100.
- Kochhar, S.L. (2009) *Economic Botany in the Tropics*. 3rd Ed. Macmillan Publishers, India Ltd., New Delhi.
- Kollah, B., Patra, A.K., Mohanty, S.R. (2016) Aquatic microphylla *Azolla*: a perspective paradigm for sustainable agriculture, environment and global climate change. *Environmental Science and Pollution Research* **23**: 4358-4369.
- Mannan, M.M., Maridas, M., Victor, B. (2008) A review of the potential uses of ferns. *Ethnobotanical Leaflets* **12**: 281-285.
- Manton, I., Sledge, W.A. (1954) Observations on the cytological and taxonomy of the Pteridophyte flora of Ceylon. *Philosophical Transactions of the Royal Society of London, Series B* **238**: 127-185.
- MOE 2012. The National Red List 2012 of Sri Lanka; Conservation status of the Fauna and Flora. Ministry of Environment, Colombo, Sri Lanka viii + 476pp.
- Ranil, R.H.G., Pushpakumara, D.K.N.G. (2005) Uses of Pteridophyte flora in Sri Lanka. *Proceedings of the Tenth Annual Forestry and Environment Symposium*, Department of Forestry and Environmental Science, University of Sri Jayawardenapura, p. 28.
- Ranil, R.H.G., Pushpakumara, D.K.N.G., Janssen, T., Wijesundara, D.S.A., Dhanasekara, D.M.U.B. (2010a) *Cyathea srilankensis* Ranil: a new fern species from Sri Lanka. *American Fern Journal* **100**: 39-44.
- Ranil, R.H.G., Pushpakumara, D.K.N.G., Janssen, T., Fraser-Jenkins, C.R., Wijesundara, D.S.A. (2010b) *Cyathea sledgei* Ranil (Cyatheaceae): A new species of tree-fern from Sri Lanka. *Fern Gazette by British Pteridological Society*. United Kingdom **18**: 318-325.
- Ranil, R.H.G., Pushpakumara, D.K.N.G., Janssen, T., Fraser-Jenkins, C.R., Wijesundara, D.S.A. (2011) Conservation priorities of tree ferns of Sri Lanka. *Taiwania* **56(3)**: 201 - 209.
- Ranil, R.H.G., Beneragama, C.K., Pushpakumara, D.K.N.G., Wijesundara, D.S.A. (2015) Ornamental pteridophytes: an underexploited opportunity for the Sri Lankan floriculture industry. *Journal of the National Science Foundation of Sri Lanka* **43(4)**: 293-301.
- Shaffer-Fehre, M. (ed.) (2006) A Revised Handbook of the Flora of Ceylon, volume 15: Pteridophyta (Ferns and Fern Allies). Amrind Publishing Company Private Limited, New Delhi, India.

- Sledge, W.A. (1982) An annotated check-list of the Pteridophyta of Ceylon. *Biological Journal of Linnean Society* **84**: 1-30.
- Xie, Q.E., Yan, X.L., Liao, X.Y., Li, X. (2009) The arsenic hyperaccumulator fern *Pteris vittata* L. *Environmental Science and Technology* **43**: 8488–8495.