



Economically diverse pteridophytes from sacred groves of central Kerala

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Abstract

Sacred groves of Kerala are commonly called 'Kavukal' which are untouched forest patches protected traditionally as a part of cultural beliefs. The central Kerala groves are the biodiversity hotspots with a diverse range of RET, endangered, and medicinal plants. The microclimatic conditions of the primitive groves provide an ideal environment for the development of Pteridophytic flora. The current study records the distribution of pteridophyte species along selected Sacred groves in central Kerala districts. The dominant families of pteridophytes found are Polypodiaceae, Pteridaceae, Selaginellaceae and Adiantaceae. At generic level, maximum diversity is noticed in *Selaginella*, *Adiantum*, *Pteris*, *Pyrrosia* and *Microsorium*. This sacred place also harbours endangered species like *Leptochilus axillaris* and some rare species like *Asplenium decrescens*, *Microsorium punctatum* and *Microsorium scolopendria*.

Keywords: pteridophytes, diversity, sacred groves, conservation, central Kerala

Introduction

The majority of plant diversity research focuses on flowering plants, with lower plant classes being overlooked. Pteridophytes are a well-known flora that plays an important role in plant phylogeny. They are estimated to number over 12,000 species and are found across India's biogeographic regions. Microclimatic conditions of particular preference are part of the desired habitat. Despite the fact that many pteridophyte species prefer moist environments, there are some that can withstand severe drought and grow in direct sunlight. Those belonging to the Pteridaceae and Selaginellaceae families are classified as resurrection plants in the literature. Minor disturbances can result in the extinction of these species.

Furthermore, urbanization and high utilization factors have resulted in habitat fragmentation, posing a serious threat to pteridophytes, especially endemic species. Pteridological research has transformed in recent years due to its economic importance, and further research is needed to establish in situ and ex situ conservation strategies for this primitive vascular plant group. They are ecologically adapted to almost all possible circumstances, from the tropics to the temperate zones, with the exception of the Polar regions and deserts. They flourish in moist tropical and temperate forests, and their occurrence in various eco-geographically endangered regions, ranging from sea level to the highest peaks is of great interest^[1]. Nair and Bhargavan^[2] prepared a detailed review on the pteridological studies of the Peninsular India. There are several invaluable contribution towards the documentation of the pteridophyte diversity of Kerala. Nair *et al*^[3, 4, 5, 6] had brought out a detailed account on the ferns and fern-allies of Kerala, which contains 250 taxa. Sequiera^[7] made a detailed study on the epiphytic pteridophytes of Kerala part of the Western Ghats. Pteridophytes are of immense economic importance and there is a great need for their exploitation towards the economic utility in daily life^[8]. Mathew *et al*^[9] provided an account of the ethnomedical importance of some

pteridophytes of Kerala. Easa^[10] summarised data on the pteridophyte diversity of Kerala. Sujanalal and Sasidharan^[11] recorded ethnobotanical Information on 17 taxa of pteridophytes from Parambikulam wild life sanctuary. Pteridophytic flora of the Western Ghats-South India by Manickam and Irudayaraj^[12] is one of the best source book on the subject from the area.

However, the pteridophytes of sacred groves of the central part of Kerala State have not received much attention by plant explorers. High level of litter degradation and elemental recycling in sacred groves is due to the presence of microclimatic conditions which is provided by special physical and biological factors. The physical factors like temperature and humidity of atmosphere and soil can also help the growth of lower herbaceous species, as well as microbial floras especially the mycorrhizal associations and rhizobial bacteria's in the root mats of tree species should produce some growth inducing factors. This micro-environment provides a shelter for many endemic plants which are survive and exist here. Along with this all of the selected groves have its own water shed conservation practices.

This might be a unique ancient practice for conserve the nature as a part of religious beliefs. Many of the pteridophytic species are grown up in the marshy banks of such ponds, streams and wells. In this scenario, the aim of the present study was to document the pteridophyte diversity of selected groves of central Kerala.

Materials and Methods

Study area

Study area includes selected six Sacred groves with an appreciable extent from agro climatically different five central Kerala districts (Table 1). Dominant forest type of these groves are tropical evergreen, moist deciduous and these diverse habits are favorable to the growth of pteridophytic flora.

Table 1: Location and Deities of Sacred groves.

Sl. No	Sacred groves, District and Geographical Zone	Area in Ha.	Latitude/ Longitude	Deities
1.	Nagampoozhimana Sarpakavu (Kotayam)- Low land	1.20	9.7216°N 76.3927°E	Nagaraja, Nagayekshi.
2.	Amaram Kavu (Idukki)- Mid land	1.57	9.89027°N 76.69081°E	Bhadrakali, Naga.
3.	Pinmattom Bhagavathi Kavu (Ernakulam)- Mid land	2.10	9.86393°N 76.57419°E	Bhadrakali, Sastha
4.	Ponnakudom Kavu (Ernakulam)- Mid land	4.59	10.04846°N 76.3619°E	Vanadurga, Nagaraja
5.	Sangukulangara Kavu (Thrisure)- Low land	0.50	10.2771°N 76.1713°E	Rajarajeswari, Sasthavu, Naga.
6.	Parakkotu Bhagavathi Kavu (Palakkad)- Mid land	19	10.65591 °N 76.51996 °E	Sreebhagavathi

Documentation

The comprehensive field works was undertaken in the Sacred groves of 5 districts, of central Kerala from December 2019 to April 2020. During the field visits, specimens were collected with their fertile parts and herbarium-specimens were prepared according to standard method [13]. The correct identity of such specimens were revealed with the help of available Floras and Literature [12, 14, 15]. The various economic values of such species were obtained by the discussion with local inhabitants and traditional healers of the study area. The voucher specimens were deposited in the Herbaria of Department of Botany, St. Teresa's College, (Autonomous) Ernakulam for future reference. The nomenclature of taxa and species has been given according to Fraser-Jenkins [16, 17]. Species were

arranged alphabetically and categorized into rare, common and very common on the basis of their occurrence in the study area. The photographs of some collected plants are given in Plate 1, Plate 2 and Plate 3 figures.

Results and Discussion

The present study in the selected Sacred groves of central Kerala had resulted in the documentation of 29 species of economically important Pteridophytes belonging to 21 genera of 13 families (Table 2). The table includes the botanical name, family, economic value, medicinal application or uses and status of collected pteridophytic species. Out of the collected plants, 24 species are medicinal, 16 species are ornamental and 3 species are edible (Figure 4).

Table 2: Species recorded from sacred groves and Economical uses.

Sl. No	Name of species and Family	Economic and Ecological status	Medicinal application/Uses
1.	<i>Acrostichum aureum</i> L. (Pteridaceae)	Very common Medicinal and ornamental fern commonly called as golden leather fern.	The powdered or grated leaves and rhizomes are applied as a paste to wounds, ulcers and boils. The rhizome is used against worms. Leaves Cure cloudy urine in women. Burkill IH [18]
2.	<i>Adiantum caudatum</i> L. (Adiantaceae)	Very common medicinal fern.	The leaves are used in diabetes, and as a cure for coughs, skin disease and fevers. It gives relief in internal heat or fever due to cooling action. Frond extract is used for wound healing and also shows antibacterial properties. Thomas T [20]
3.	<i>Adiantum latifolium</i> Lam. (Adiantaceae)	Very common medicinal and ornamental fern.	Used in traditional medicine as analgesic and anti-inflammatory and also antibacterial potentials against urinary tract infections. Johnson <i>et al</i> [21]
4.	<i>Adiantum philippense</i> ssp. <i>philippense</i> L. (Adiantaceae)	Common medicinal fern.	Called as walking maiden hair fern, used in treatment of blood diseases, epileptic fits, rabies, diarrhea, dysentery, elephantiasis, pimples, and poisonous effect due to insect bite, wound, herpes, cough, dysuria and hoarseness of voice. It is also known for its antimicrobial activity.
5.	<i>Asplenium decrescens</i> Kze. (Aspleniaceae)	Rare medicinal epiphyte.	It possesses antimicrobial properties. Irudayaraj and Johnson [22]
6.	<i>Blechnum orientale</i> L. (Blechnaceae)	Common medicinal and ornamental fern.	Fresh fronds are used as poultice for boils, urinary bladder complaints, diaphoretic and aromatic. Rhizome is used as antihelminthic and as cure for intestinal wounds. Dixit and Vohra [23]; Vasudeva [24]
7.	<i>Bolbitis appendiculata</i> (Willd.) K. Iwats (Dryopteridaceae)	Common medicinal fern.	It is a lithophyte having several bio- potentials like anti-inflammatory, anti-diabetic and anti-toxicity activity. Manivannan <i>et al</i> [25]
8.	<i>Dicranopteris linearis</i> (Burm. f.) Underwood (Gleicheniaceae)	Common medicinal fern.	Fronds used for asthma, women sterility, external application of a poultice of crushed leaves to combat fever and for wound dressing. Fluid extracted from the fronds show antibacterial properties. The rhizomes are used as antihelminthic. Asolkar <i>et al</i> [26]; Manickam and Irudayaraj [12]; Vasudeva [24]; Revathi <i>et al</i> [27]
9.	<i>Drynaria quercifolia</i> (L.) J. Sm. (Polypodiaceae)	Very common, epiphytic medicinal, ornamental species commonly known as "Oak leaf fern".	The aqueous extracts of rhizome possess antibacterial properties and also in the treatment of typhoid fever, phthisis, dyspepsia, cough, arthralgia, cephalalgia, diarrhoea, ulcers and other inflammations. It is very specific in the treatment of migraine. Fronds are used against swellings. Dixit and Vohra [23]; Warriar <i>et al</i> [28]; Vasudeva [24]; Sonia <i>et al</i> [29]
10.	<i>Haplopteris elongata</i> (Sw.) E.	Common medicinal fern.	Epiphytic medicinal fern shows anti-bacterial and anti-fungal

	H. Crane (Pteridaceae)		potential. Sathish <i>et al</i> [30]
11.	<i>Leptochilus axillaris</i> (Cav.) Kaulf (Polypodiaceae)	Rare Endangered ornamental fern.	Epiphytic, known as climbing fern and used as terrarium plant.
12.	<i>Lygodium flexosum</i> (L.) Sw. (Lygodiaceae)	Very common medicinal fern.	Widely used in treatment of various ailments like jaundice, dysmenorrhea, wound healing and eczema, aqueous rhizome extract is used for treatment of gonorrhoea. Singh KK [31], Dixit and Vohra [23], Manandhar PN [32]
13.	<i>Marselia minuta</i> L. (Marseliaceae)	Very common aquatic medicinal, ornamental and edible fern.	The extract of whole plant is used as aphrodisiac and for increased fertility. The leaves are pounded, cooked with rice and then eaten as a treatment for indigestion. Leaf juice is used to stop nose bleeding. Leaf extract is to cure swollen gums. It is useful in psychopathy, ophthalmia, diarrhea, leprosy, skin disease, dyspepsia and fever. Warriar <i>et al</i> [28]
14.	<i>Microsorium punctatum</i> (L.) Copel. (Polypodiaceae)	Rare medicinal fern.	Leaf juice are used as purgative, diuretic and for healing wound. Benjamin and Manickam [8]
15.	<i>Microsorium scolopendria</i> (Burm. f.) Copel. (Polypodiaceae)	Rare medicinal and ornamental fern commonly known as musk fern.	Fronde are widely used in traditional medicine. They were investigated for the presence of ecdysteroides. Eva S <i>et al</i> [33]
16.	<i>Nephrolepis cordifolia</i> (L.) C. Presl (Oleandraceae)	Very common Medicinal and ornamental fern.	Rhizome has antibacterial property and used in treatment of coughs, rheumatism, chest congestion, anorexia. Pinnae used for coughs, wounds and treatment of jaundice. Juice of root tubers taken for fever, indigestion, headache, cough, cold and hematuria. Whole plant used for kidney, liver and skin disorders. Singh HB [34]
17.	<i>Parahemionitis cordata</i> (Roxb. ex Hook. & Grev.) Fraser-Jenk. (Pteridaceae)	Common medicinal and dwarf ornamental fern commonly known as Rabbit ear fern.	Leaf extract is applied to centipede bite and wounds. Vasudeva [24]; Sonia <i>et al</i> [29]; Revathi <i>et al</i> [27]
18.	<i>Pityrogramma calomelanos</i> (L.) Link (Pteridaceae)	Very common medicinal and ornamental species known as Golden fern.	Plant decoction is used for renal disorders. Tea prepared out of fronds are used as a cure for hypertension, cough and fever. Frons decoction is used as a remedy for boils in mouth and nose. Rhizomes are antihelminthic. Sonia <i>et al</i> [29], Dixit and Vohra [23]
19.	<i>Pteris biaurita</i> L. (Pteridaceae)	Very common Medicinal fern.	The rhizome is ground into paste and applied over the affected places to get relief from body pain and effective antibacterial properties. John De Britto <i>et al</i> [35]
20.	<i>Pteris vittata</i> L. (Pteridaceae)	Very common ornamental plant possesses pollution control properties like hyperaccumulator of arsenic used in phytoremediation.	Plant extract is used as hypotensive tonic, antibacterial and antiviral. Singh HB [34]
21.	<i>Pyrrosia heterophylla</i> (L.) M. Price (Polypodiaceae)	Very common, medicinal, epiphyte called as Dragon scales.	It is used as a cooling agent for the treatment of swellings, sprains and also reported for its anti-bacterial, anti-oxidant and cytotoxic activities. Mini <i>et al</i> [36]
22.	<i>Pyrrosia porosa</i> (C. Presl) Hovenk. (Polypodiaceae)	Common medicinal Epiphyte.	The whole plant paste is applied over cuts and wounds. Revathi <i>et al</i> [27]
23.	<i>Salvinia molesta</i> Mitch. (Salviniaceae)	Common aquatic ornamental plant and used as a mulch for crops in dry areas.	Used as an antifungal agent.
24.	<i>Selaginella apoda</i> (L.) Spring (Selaginellaceae)	Common aquatic fern called as Meadow spikemoss,	
25.	<i>Selaginella ciliaris</i> (Retz.) Spring (Selaginellaceae)	Very common medicinal and ornamental species.	Fresh plant juice is used for itchy on the skin.
26.	<i>Selaginella delicatula</i> (Desv. Ex Poir.) Alston (Selaginellaceae)	Very common medicinal and ornamental species.	Plant juice is antibacterial and is used for healing off wounds by the tribals. Pratibha <i>et al</i> [37]; Singh <i>et al</i> [38]; Priya <i>et al</i> [39]
27.	<i>Selaginella tenera</i> (Hook. & Grev.) Spring (Selaginellaceae)	Very common medicinal and ornamental fern.	It shows diuretic property and used in the treatment of gonorrhoea diseases. Maridass and Raju [40]
28.	<i>Stenochlaena palustris</i> (Burm. fil.) Bedd (Blechnaceae)	It is a common edible medicinal fern species with ornamental value.	In the folk medicines the leaves are used as remedies for fever, skin diseases, ulcers, and stomachache. Rhizomes are used as cooling agent in the treatment of burns and ulcers. Singh HB [34]
29.	<i>Thelypteris dentata</i> (Forssk.) E.St. John (Thelypteridaceae)	Common ornamental, edible fern known as Downy maiden fern.	Folk remedy for skin diseases and the fronds of plant shows antibacterial activity in various extracts. Thomas T [20]

(Table added separately as a document. Check the attached documents.)

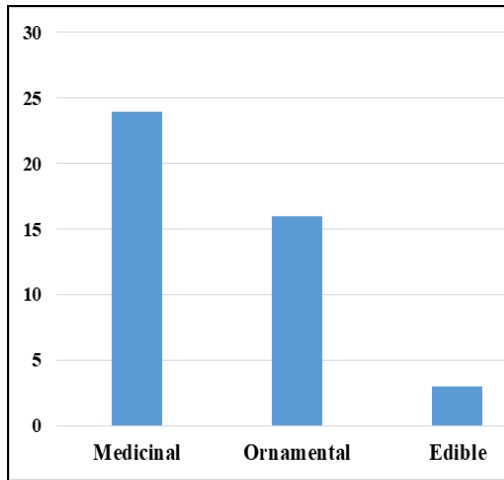


Fig 1: Number of Medicinal, Ornamental and Edible Pteridophytes in Sacred groves of central Kerala.

Among the recorded families, Pteridaceae and Polypodiaceae are the dominant families with 6 species each, followed by Selaginellaceae 4 and Adiantaceae with 3 species (Figure 5).

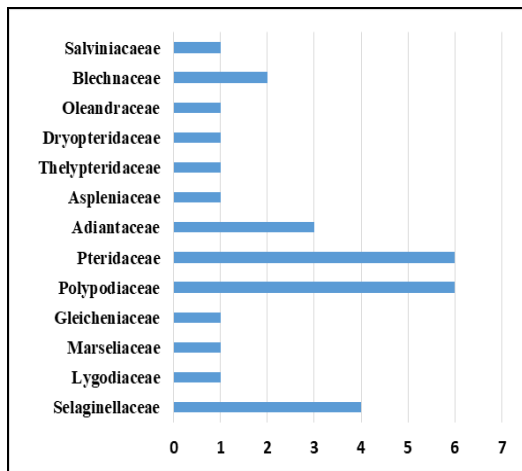


Fig 2: Number of Economically useful Pteridophytes in each families.

Dominant genera in the study area are *Selaginella*, *Adiantum*, *Pteris*, *Pyrrisia* and *Microsorium* (Figure 6).

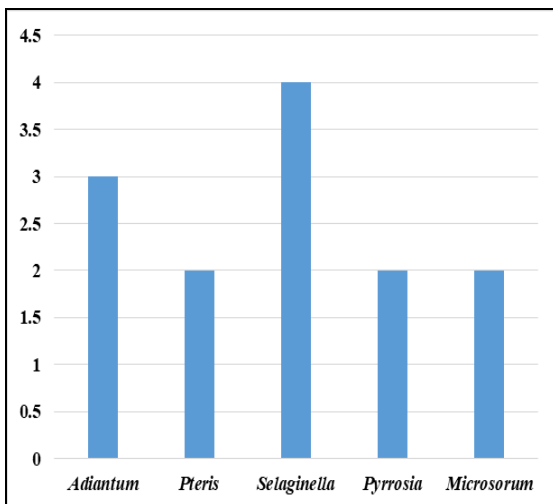


Fig 3: Dominant genera of Pteridophytes in the Sacred groves of central Kerala.



Fig 4



Fig 5



Fig 6

Medicinal

There are 24 species occurring in Sacred groves that are medicinally useful. Many of them have traditional folk uses for various ailments such as jaundice, fever, cough, cut and wounds, skin diseases, inflammation, diuretic and resistant to several fungal and bacterial strains. Some of the medicinally important species are *Blechnum orientale* L., *Selaginella delicatula* (Desv. ex Poir.) Alston, *Stenochlaena palustris* (Burm. f.) Bedd., *Pyrrosia porosa* (C. Presl.) Hovenk., *Pteris biaurita* L., *Parahemionitis cordata* (Roxb. ex Hook. & Grev.) Fraser-Jenk., *Microsorium punctatum* (L.) Copel., *Lygodium flexosum* (L.) Sw., etc.

Edible

Stenochlaena palustris (Burm. fil.) Bedd, *Thelypteris dentata* (Forssk.) E. St. John and *Marselia minuta* L., etc. are the three edible Pteridophytes reported from the study area.

Ornamental

Ferns have got great aesthetic value for their elegant fronds and a large number of them are cultivated as ornamental plants in houses and gardens. Some of the ornamental potential species reported are *Acrostichum aureum* L., *Adiantum latifolium* Lam, *Drynaria quercifolia* (L.) J. Sm., *Parahemionitis cordata* (Roxb. ex Hook. & Grev.) Fras. Jenk., *Pityrogramma calomelanos* (L.) Link., *Blechnum orientale* L., *Microsorium scolopendria* (Burm. f.) Copel., *Nephrolepis cordifolia* (L.) Presl.g, *Pteris vittata* L. *Selaginella delicatula* (Desv.) Alston, *Selaginella ciliaris* (Retz.) Spring, *Thelypteris dentata* (Forssk.)E. St. John, *Salvinia molesta* Mitch., etc.

Currently many pteridophytic species are under threat to a large extent due to various anthropogenic activities. The most commonly identified causes of global pteridophytes extinction are fragmentation, degradation and habitat destruction, commercial collection, pathogens, predators and invasive species, climate change and pollution. In the study area, the Sacred groves of central Kerala faces an extreme level threat to angiosperms and lower class of floral diversity. It is mainly due to the developing and sanskritization activities. Present work helps to make a database to undertake conservation strategies on pteridophytes in the area. The present preliminary survey also may be a helpful tool for the further depth study on pteridophytes and their conservation aspects.

Conclusion

Thus the ethanobotanical studies and surveys were conducted among the selected Sacred groves of central Kerala districts revealed the diversity and medicinal aspects of pteridophytes. The paper enumerates 29 economically useful pteridophytes with their distribution and various aspects of uses. Many pteridophytes are known to be used by humankind in various ways. Pteridophytes ferns and fern allies as they are called and of great ornamental values. Because of their elegance and grace, these are highly prized as foliage ornamentals, both indoors and out. Moreover, many of them are used for medicinal and nutritional purposes, due to their nutraceutical values.

Pteridophytes are easily vulnerable to human interactions due to their susceptibility and lack of adaptiveness to even the slightest environmental disturbances. The present study helps to understand the microclimatic features of Sacred

groves and its ability to provide a shelter for this delicate plant group from the extinction. Pteridophytes of Sacred groves of central Kerala are facing serious threat due to anthropogenic pressures and biotic interference. Hence, further studies are required for developing in situ conservation strategies for this economically important group of plants.

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