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The Family Polypodiaceae of Western Ghats of India - An Overview

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Abstract

The Western Ghats of India, known as one of the world's mega biodiversity hotspots, is home to numerous rare and endemic species of plants, mammals, birds, and reptiles. It holds equal significance regarding fern diversity, particularly within the family Polypodiaceae. In this region, the Polypodiaceae family is represented by 15 genera and a total of 45 taxa, which includes 43 species and 3 subspecies. Remarkably, *Pyrrosia beddomei* (C.B.Clarke) Hovenkamp ex Fraser-Jenk., *Grammitis austroindica* Parris and *Grammitis pilifera* Ravi & J.Joseph are strictly endemic to the Western Ghats. This research work provides a comprehensive overview of the diversity of Polypodiaceae members in the Western Ghats. It delves into their ecological roles, taxonomy, and distribution patterns. Importantly, this study serves as a foundational resource for applied researchers in the field of Pteridophyte biology, facilitating efforts toward the conservation and sustainable utilisation of Polypodiaceae members in this ecologically vital region.

Keywords: Pteridophytes, Conservation, Distribution, Taxonomy, Endemic, Western Ghats

Introduction

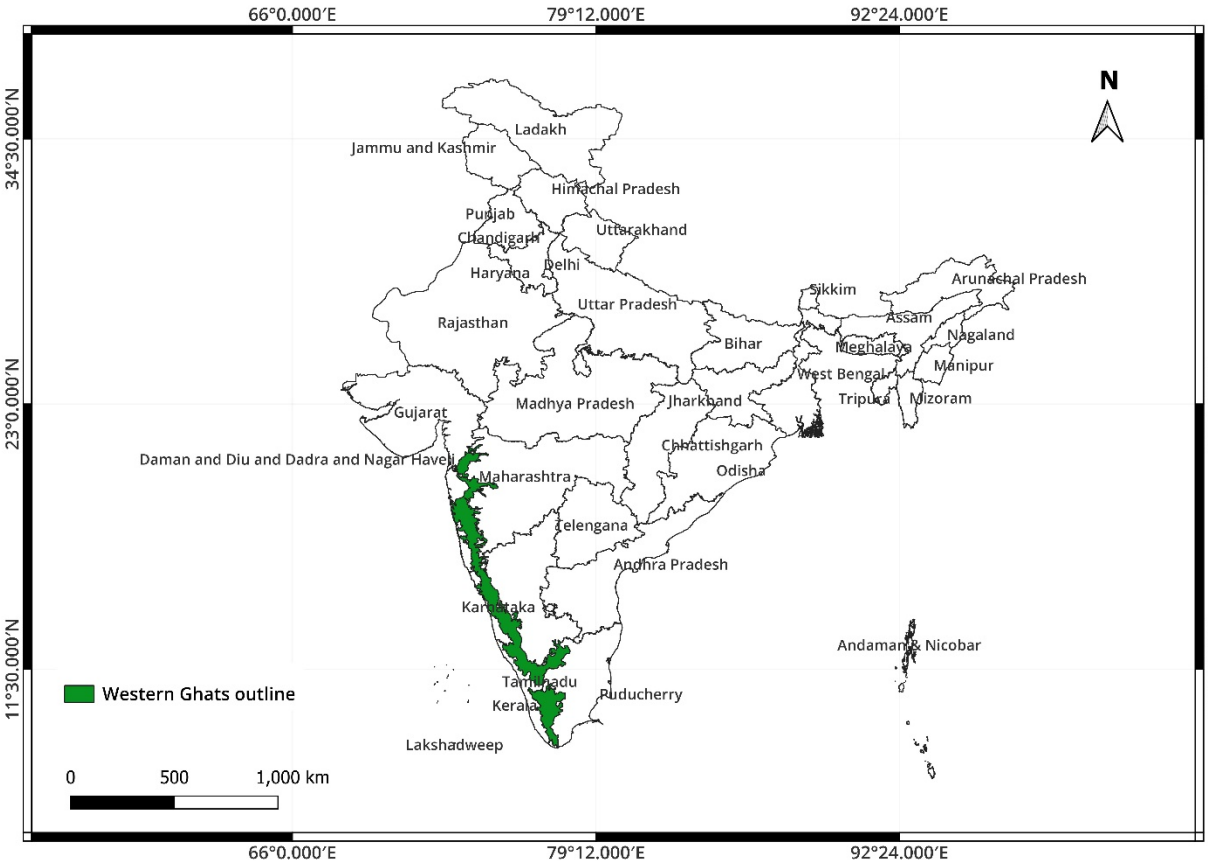
Pteridophytes, an ancient group of vascular plants, exhibit remarkable global diversity, comprising 11,916 species across 337 genera, 51 families, and 14 orders, classified into two classes according to the Pteridophyte Phylogeny Group (PPG I, 2016). In India, this diversity includes 1,107 species within 130 genera and 34 families, making the country a significant contributor to pteridophyte richness. Among these, polypodioid ferns, particularly the family Polypodiaceae, represent a major component of India's fern flora, thriving primarily as epiphytes in tropical and warm-temperate forests. Characterized by their rhizomatous growth, epiphytic or lithophytic habits, siphonostelic vascular structures, and exindusiate sori, Polypodiaceae members exhibit exceptional diversity and ecological adaptability.

Globally, the family Polypodiaceae, as classified by PPG I (2016), comprises approximately 1,652 species across 65 genera and six subfamilies, following the monophyletic circumscription established by Smith et al. (2006) and Schuettpelz and Pryer (2007). In India, the family is represented by 27 genera and 142 taxa, including members of the previously separate Grammitidaceae (Fraser-Jenkins et al.,2017).The Western Ghats, a globally recognized biodiversity hotspot, is home to numerous endemic Polypodiaceae species. These include *Pyrrosiabeddomei* (C.B. Clarke) Hovenkamp ex Fraser-Jenk., *Grammitis austroindica* Parris, and *Grammitis pilifera* Ravi & J. Joseph, emphasizing the ecological and evolutionary importance of this region. South India has a rich legacy of contributions to the taxonomy and ecology of polypodioid ferns, beginning with the pioneering work of Col. R.H. Beddome in the 19th century. His monumental publications, including Ferns of Southern India (1864) and Ferns of British India (1866), laid the foundation for pteridological studies in the region. Later works by Nampy and Madhusoodanan (1998), Manickam and Irudayaraj (1992, 2003), and Rajagopal and Bhat (2016) significantly expanded the understanding of Polypodiaceae in South India and the Western Ghats. Recent contributions by Benniamin and Sundari (2020) have further enriched the knowledge base, providing updated taxonomic and distributional accounts.

This study presents a comprehensive checklist of Polypodiaceae members in the Western Ghats, aligned with the advanced classification of PPG I (2016) and nomenclature validated by Plants of the World Online (POWO). It includes taxonomical and nomenclatural revisions, distributional analyses, and statistical evaluations of diversity and patterns. The findings offer crucial insights for conservation efforts, emphasizing the need to protect these ecologically vital species in one of the world's most significant biodiversity hotspots.

Materials and Methods

Study area: The Western Ghats is a 1600 km mountain range that runs parallel to India's west coast, stretching from the Tapti River in Gujarat to Kanyakumari in Tamil Nadu. It traverses the states of Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa, and Gujarat. The range is located between 8°20′-8°40' N latitude and 73°-77° E longitude and is part of the ancient Indian plateau of Gondwana land origin. The Western Ghats significantly influence the ecology of Peninsular India and have many peaks that rise above 2,000 m, with Annamudi being the highest at 2,695 m. Major River systems, such as the Godavari, Kaveri, and Krishna, originate in the Western Ghats. This region is important in determining India's climate and seasons, with mean temperatures ranging from 20 °C in the south to 24 °C in the north. The annual rainfall in this region averages 100 cm to 900 cm, with an average of 250 cm. The Western Ghats meet the Eastern Ghats at Nilgiris before continuing south, contributing to a high degree of biodiversity around Nilgiris. The Western Ghats region is a biodiversity hotspot, containing many different species of flora and fauna, many of which are endemic to this region. It was declared a UNESCO World Heritage Site in 2012.



Map 1. Western Ghats

Literature review

The taxonomic identification and checklist of the members of Polypodiaceae in the Western Ghats were prepared by consulting relevant literature, including the works of Beddome (1863–1864), Manickam and Irudayaraj (1992, 2003), Nampy and Madhusoodanan (1998), Madhusoodanan (2015), Rajagopal and Bhat (2016), Fraser-Jenkins et al. (2021), and Benniamin and Sundari (2020). Herbarium studies were conducted through visits to several key herbaria, including BSI, MH, CAL, KFRI, TBGT, CALI, PND, XCH, RPH, and BLAT. Additionally, digital consultations were carried out with major international herbaria such as JCB, K, BM, MICH, P, and NY. The classification framework strictly adhered to the Pteridophyte Phylogeny Group's system (PPG I, 2016), while nomenclatural updates were based on Plants of the World Online (POWO) and the International Plant Names Index (IPNI). A study area map was generated using QGIS (Version 3.34.7), an open-source Geographic Information System (GIS) software (Map – 1). Digital photo plates were carefully prepared, capturing key observations and specimen characteristics to ensure accurate and reliable visual documentation (Figure – 1 & 2).

The checklist of Polypodiaceae in the Western Ghats of India and the state-wise distribution in this area are provided below:

Family – Polypodiaceae J.Presl & C.Presl

Sl.No	Name of the Species	Distribution
1.	*Loxogramme chinensis* Ching	Kerala, Tamil Nadu
2.	*Loxogramme cuspidata* (Zenker) M.G.Price	Karnataka, Kerala, Tamil Nadu
3.	*Loxogramme parallela* Copel.	Tamil Nadu
4.	*Platycerium alcicorne* (P.Willemet) Desv.	Karnataka, Kerala, Tamil Nadu, Maharashtra (Cultivated species in Western Ghats)
5.	*Platycerium bifurcatum* (Cav.) C.Chr.	Kerala (Cultivated species in Western Ghats)
6.	*Pyrrosia adnascens* (Sw.) Ching	Goa, Karnataka, Maharashtra
7.	*Pyrrosia beddomei* (C.B.Clarke) Hovenkamp ex Fraser-Jenk	Tamil Nadu (Endemic to Western Ghats)
8.	*Pyrrosia ceylanica* (Giesenh.) Sledge	Karnataka, Kerala, Tamil Nadu (Endemic to Western Ghats and Sri Lanka).
9.	*Pyrrosia glabra* (Desv.) Fraser-Jenk.	Karnataka, Kerala
10.	*Pyrrosia heteractis* (Mett.) Ching	Kerala, Tamil Nadu (Occurrence of the species in India is doubtful).
11.	*Pyrrosia heterophylla* (L.) M.G.Price	Karnataka, Kerala, Tamil Nadu
12.	*Pyrrosia lanceolata* (L.) Farw.	Goa, Gujarat, Karnataka, Kerala, Maharashtra, Tamil Nadu
13.	*Pyrrosiaporosa* (C.Presl) Hovenkamp	Karnataka, Kerala, Tamil Nadu
14.	*Drynaria quercifolia* (L.) J.Sm.	Karnataka, Kerala, Maharashtra, Tamil Nadu
15.	*Selliguea montana* (Sledge) Hovenkamp	Karnataka, Kerala, Tamil Nadu (Endemic to Western Ghats and Sri Lanka)
16.	*Selliguea lehmannii* (Mett.) Christenh.	Tamil Nadu
17.	*Leptochilus axillaris* (Cav.) Kaulf.	Karnataka, Kerala, Tamil Nadu
18.	*Leptochilus decurrens* Blume	Karnataka, Kerala, Tamil Nadu, Maharashtra
19.	*Leptochilushemionitideus* (C.Presl) Noot	Karnataka, Kerala, Tamil Nadu
20.	*Leptochilus lanceolatus*Fée	Karnataka, Kerala, Tamil Nadu, Maharashtra
21.	*Leptochilus metallicus* (Bedd.) C.Chr.	Kerala (Endemic to Western Ghats and Sri Lanka)
22.	*Leptochilus pteropus* subsp. *pteropus* (Blume) Fraser-Jenk.	Maharashtra

23.	*Leptochilus pteropus* subsp. *minor* (Bedd.) Fraser-Jenk.	Karnataka, Kerala, Tamil Nadu
24.	*Leptochilus thwaitesianus*Fée	Karnataka, Kerala, Tamil Nadu, Maharashtra
25.	*Lepisorus contortus* (Christ) Ching	Karnataka, Kerala, Tamil Nadu
26.	*Lepisorus nudus* (Hook.) Ching	Karnataka, Kerala, Tamil Nadu, Maharashtra
27.	*Phymatosorus cuspidatus subsp. beddomei* (S.R.Ghosh) Fraser-Jenk	Kerala, Tamil Nadu
28.	*Phymatosorus grossus* (Langsd. & Fisch.) Brownlie	Karnataka, Tamil Nadu (Exotic species in India)
29.	*Phymatosorus membranifolius* (R.Br.) S.G.Lu	Kerala, Tamil Nadu
30.	*Phymatosorus scolopendria* (Burm.f.) Pic.Serm.	Karnataka, Kerala, Tamil Nadu, Maharashtra
31.	*Bosmania membranacea* (D.Don) Testo	Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Goa
32.	*Lecanopteris linguiformis* (Mett.) Perrie & Brownsey	Kerala, Tamil Nadu
33.	*Microsorum punctatum* (L.) Copel.	Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Goa
34.	*Microgramma mauritiana* (Willd.) Tardieu	Tamil Nadu (Possibly Extinct in India as well as from Asia)
35.	*Phlebodium aureum* (L.) J.Sm.	-Karnataka, Tamil Nadu (Cultivated species in India)
36.	*Phlebodium pseudoaureum* (Cav.) Lellinger	Kerala (Cultivated species in India)
37.	*Pleopeltis macrocarpa* (Willd.) Kaulf.	Karnataka, Kerala, Tamil Nadu
38.	*Grammitis blechnoides*Grev.	Karnataka, Kerala, Tamil Nadu
39.	*Grammitis attenuata*Kunze	Karnataka, Kerala, Tamil Nadu (Endemic to Western Ghats and Sri Lanka)
40.	*Grammitis austroindica*Parris	Tamil Nadu (Endemic to Western Ghats; Possibly Extinct)
41.	*Grammitis pilifera*Ravi &J.Joseph	Karnataka, kerala, Tamil Nadu (Endemic to Western Ghats)
42.	*Grammitis alata* (Blume) C.V.Morton	Tamil Nadu
43.	*Grammitis contigua*(G.Forst.) Christenh. ex C.S.Chang, H.Kim&K.S.Chang	Kerala, Tamil Nadu
44.	*Grammitis obliquata*(Blume) Hassk.	Kerala, Tamil Nadu
45.	*Grammitis perplexa*(Parris) Christenh.	Kerala, Tamil Nadu (Endemic to Western Ghats and Sri Lanka)

Results and Discussion

The Western Ghats, a globally renowned biodiversity hotspot, is home to a rich diversity of ferns from the family Polypodiaceae. A total of 45 species belonging to 15 genera have been documented from the region. The genera **Pyrrosia**, **Leptochilus**, and **Grammitis** dominate, each represented by eight species. These are followed by **Phymatosorus** (4 species), **Loxogramme** (3 species), **Lepisorus** (2 species), **Platycerium** (2 species), **Phlebodium** (2 species), **Selliguea** (2 species), and one species each of **Pleopeltis**, **Drynaria**, **Microsorum**, **Lecanopteris**, **Bosmania**, and **Microgramma**. An additional species of the genus **Selliguea**, namely *Selliguea lehmannii* (Mett.) Christenh., reported as *Arthromeris lehmannii* (Mett.) Ching from Srivilliputhur Hills, Tamil Nadu, was added to the checklist after consulting an herbarium sheet deposited at St. Xavier's College, Palayamkottai (XCH). Tamil Nadu exhibits the highest species diversity within the Polypodiaceae family, with 40 species, followed by Kerala (35 species), Karnataka (27 species), Maharashtra (12 species), Goa (4 species), and Gujarat (3 species). This variation is attributed to environmental factors such as altitude, annual rainfall, climate, and moisture, which are conducive to fern diversity and richness in Tamil Nadu, whereas Goa represents poor diversity due to less favorable conditions. Among the subfamilies, **Microsoroideae i**s the richest in the Western Ghats, consisting of six genera and 17 species. Out of the 45 species documented, five are exclusively cultivated or ornamental plants, three are endemic to the Western Ghats, and five are endemic to both the Western Ghats and Sri Lanka. Unfortunately, *Microgramma mauritiana* (Willd.) Tardieu and *Grammitis austroindica* Parris are possibly extinct in India.

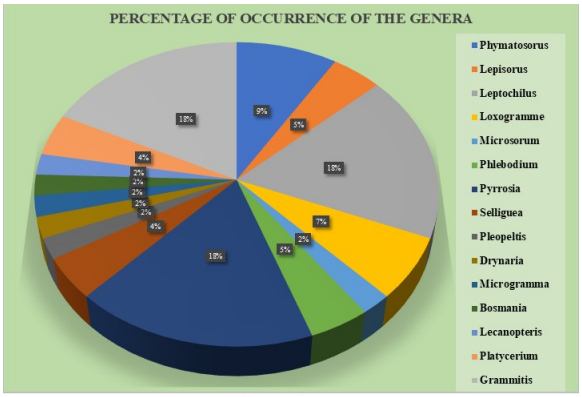


Chart - 1

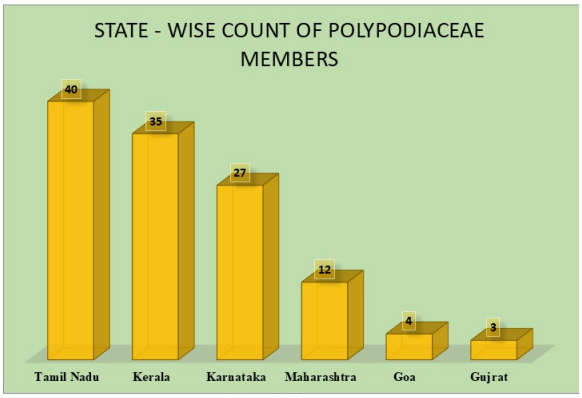


Chart - 2

Graph: 1- Distribution of the family Polypodiaceae

Figure – 1:(A) *Drynaria quercifolia* (L.) J.Sm., (B) *Loxogramme cuspidata* (Zenker) M.G.Price, (C) *Grammitis pilifera* Ravi & J. Joseph, (D) *Phymatosorus cuspidatus* subsp. beddomei (S.R.Ghosh) Fraser-Jenk., (E) *Pyrrosia ceylanica* (Giesenh.) Sledge, (F) *Selliguea montana* (Sledge) Hovenkamp

Figure – 2: (A) *Leptochilus lanceolatus* Fée,(B) *Leptochilus axillaris* (Cav.) Kaulf., (C) *Leptochilus decurrens* Blume, (D) *Leptochilus thwaitesianus* Fée, (E) *Lepisorus nudus* (Hook.) Ching, (F) *Pyrrosia porosa* (C.Presl) Hovenkamp

Conclusion

The Polypodiaceae species in the Western Ghats face numerous threats due to human activities and environmental changes. Direct threats include the expansion of tea and coffee plantations, habitat loss and fragmentation, deforestation, and urbanization. Natural disasters such as droughts, floods, landslides, and heat waves, exacerbated by global warming, also contribute to habitat degradation. Illegal mining, unsustainable building practices in hilly areas, and excessive fossil fuel consumption have further compounded these issues. As a result, most Polypodiaceae species are now classified as Endangered (EN) under IUCN criteria.

To address these challenges, immediate conservation measures are necessary to halt the extinction of these species. Strategies should include habitat restoration, species monitoring, promoting sustainable land-use practices, and raising public awareness about the ecological importance of Polypodiaceae. The rich diversity of Polypodiaceae in the Western Ghats not only reflects the ecological significance of the region but also underscores the urgent need for conservation to ensure the stability and survival of these vital fern species.

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Declaration: "We declare that the manuscript has not been published in any journal/book or proceedings or in any other publication, or offered for publication elsewhere in substantially the same or abbreviated form, either in print or electronically."

- A. Benniamin, M. Shunmuga Sundari, Rajat Mondal, Sakshi Pandey and Sampada Kank

Conflict of interest Statement: Authors declare no conflict of interest.

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