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Biodiversity: Western Ghats rivers and wetlands **06**

# Conservation Strategies for the Hygrophilous Pteridophytes of Central Western Ghats

**Sumesh N. Dudani**[1, 2], M. K. Mahesh[2], M. D. Subash Chandran[1] and T. V. Ramachandra[1*]

[1]Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore – 560 012

[2]Department of Botany, Yuvaraja's College (Autonomous), University of Mysore, Mysore – 57005

**Tel:** 91-80- 22933099/22933503 (extn 107)
**Fax:** 91-80-23601428/23600085/23600683[CES-TVR]
Email: sumesh@ces.iisc.ernet.in; mds@ces.iisc.ernet.in; cestvr@ces.iisc.ernet.in

http://ces.iisc.ernet.in/energy

Pteridophytes, the most primitive vascular plants which originated in the Silurian Period 438 million years ago constitute a significant part of the vegetation next only to the angiosperms. They occur all over the lands barring snow-covered regions and many associated with water-bodies. *Acrostichum aureum* is a fern found in mangrove swamps of tropics. The Indian Western Ghats with about 320 species of ferns and fern-allies is one of the richest regions in pteridophytes. The pteridophyte richness in the Western Ghats tends to decline from southern to northern latitudes in correlation with progressive reduction in number of rainy months with higher latitudes. Thus the 8-12°N latitude, with 8-10 rainy months, shelters 230 species, the central Western Ghats (12-16°N) with 5-8 rainy months 174 species and northern portion (16-20°N) with 3-4 rainy months having just 64 species. Of the terrestrial ferns the species that tend to taper off towards more north are several epiphytic and lithophytic ones of shaded and damp forests, of cooler and shaded sholas, spray zones of waterfalls, of perennial water courses, swamps etc. Our study in central Western Ghats indicates that if humid microhabitats such as Myristica swamps, dipterocarp dominated relic primary forests, perennial waterfalls, sholas etc., most sought after for hydro-electric projects, expansion of coffee and tea plantations, betelnut gardens etc. are prioritized for conservation, the continuance of even relatively rarer pteridophytes like *Cyathea nilgiriensis, Psilotum nudum, Lycopodium squarrosum, Stenochlaena*

*palustris, Lindsea odorata, Hymenophyllum polyanthose* and *Asplenium crinicole* etc. will be reassured.

***Key words**: Western Ghats, pteridophytes, conservation, relic forests*

## 1.0 INTRODUCTION

Pteridophyta (*pteron* = feather, *phyton* = plants), also known as 'vascular cryptogams,' are the most primitive vascular plants. The earliest of them appeared on the earth, in the mid-Paleozoic Era during the Silurian Period around 438 million years ago. The pteridophytes attained their peak of luxuriance during the Carboniferous and started declining in diversity and richness thereafter. Their decline continued with the evolution and dominance of flowering plants so much so what is left today of the primitive pteridophytes groups, many of them of arborescent nature that dominated the Carboniferous forests, are merely seven herbaceous living genera: *Psilotum*, *Tmesipteris*, *Equisetum*, *Lycopodium*, *Phylloglossum*, *Selaginella* and *Isoetes*, all being miniatures of their past. The development of xylem with woody elements for water conduction enabled the pteridophytes to be successful colonizers of drier lands, a big step forward from the amphibious bryophytes. These vascular plants evolved from the bryophytes, which may be called as the 'amphibians of the plant kingdom'. The Bryophytes, mainly the mosses and liverworts, primarily lived in wet and humid conditions, and had no advanced conducting tissues like xylem or phloem. The arrival of pteridophytes, with specialized water and food conducting tissues, heralded an era of greater colonization of land surfaces, so much so many of them could attain great heights like the flowering trees. Yet the early pteridophytes had greater dependence on watery habitats, as during the Carboniferous Period, when the land was dominated by pteridophytes, the major groups of which the Lycophytes and Euphyllophytes, many of them attaining up to 40 m height, dominated swampy lands. When their golden era ended and the Carboniferous arborescent pteridophytes perished en masse these swamps were drained and the burial deposits of these ancient pteridophytes are today the major sources of coal.

The arrival and dominance of land during later times by gymnosperms and angiosperms found the near end of arborescent pteridophytes and greater desiccation of land surfaces, which required more superior water conducting elements in the xylem, which bulk of the ancient pteridophytes lacked. More diminutive pteridophytes co-evolved with gymnosperms and flowering plants, better equipped to live in drier conditions. Yet their prolific development happened in humid tropical forests in the shade and microclimatic conditions furnished by the modern forest ecosystems. Those of modern pteridophytes which can live independent of the microclimates of forests are mainly hydrophytic ones (like members of Marsiliales, Isoetales and Salviniales). Many others are annuals that come up gregariously on wet soils, damp walls and rocks etc. especially during the rainy season (eg. Ophioglossales, Selaginellales, Adiantales, etc.). The aquatic pteridophytes and the seasonal annuals seldom faced any threats as they could last as long as their wet habitats remain or the season of rains last. It is the others, a great number of species which are perennial pteridophytes that constantly require dampness and shade of forests, of stream-sides and of marshes and swamps that constitute the subject matter of this paper, the hygrophilous pteridophytes.

The pteridophytes, even the perennial ones, had to retain their evolutionary links with hydrologically rich habitats because of their fragile gametophytic generation which live independent of the

dominant, larger sized sporophytic generations that are successful in colonizing drier landscapes. The male gametes produced by the gametophytes are ciliate requiring a watery medium to swim about for reaching the archegonium, inside which the female gamete is lodged. Therefore, understandably, to this day, the highest diversity of pteridophytes is found in the humid tropics, their numbers in general declining with increasing latitudes because of pronounced seasonality of climates. In the light of these generalizations on the water-relationships of pteridophytes, reviewing their distribution in Western Ghats, and particularly based on field studies in the central parts of this mountain range, this paper highlights the importance of conserving all hydrologically significant natural habitats for conservation of especially perennial pteridophyte diversity. Pteridophytes have highest speciation in moist tropical forests, followed by temperate regions and their decline in diversity is more pronounced with further increasing latitudes. Each fern species has its own preferences for temperature, humidity, soil type, moisture, etc. Admitting the need for much more rigorous work needed to substantiate the microclimatic requirements of pteridophytes, the importance of moisture conditions, apparently is the most singular decisive criterion for high diversity of perennial land pteridophytes in any given region. The range of habitats sheltering pteridophytes include fresh water bodies, including marshes and swamps, even mangrove swamps, forest floors and edges, alongside perennial streams, deep ravines and gorges, grasslands and cultivation areas of various crops, specially of tea, coffee and cardamom.

### 1.1 PTERIDOPHYTES OF CENTRAL WESTERN GHATS

The Western Ghats of the Indian peninsula constitute one of the 34 global biodiversity hotspots along with Sri Lanka, on account of exceptional levels of plant endemism and by serious levels of habitat loss (Conservation International, 2005). The rugged range of hills stretching for about 1600 km along the west coast from south of Gujarat to the end of the peninsula (lat. 8° and 21° N and long. 73° and 78° E), is interrupted only by a 30 km break in Kerala, the Palghat Gap (Radhakrishna, 2001). Covering a geographical area of about 160,000 $km^2$, the Western Ghats have an average height of 900 m, with several cliffs rising over 1000 m. The Nilgiri Plateau to the north and Anamalais to the south of the Palghat Gap exceed 2000 m in many places. Towards the eastern side the Ghats merge with the Deccan Plateau which gradually slopes towards the Bay of Bengal. The Western Ghats of Karnataka state encompasses the areas of Uttara Kannada, Shimoga, Chikmagalur, Hassan, Kodagu and Dakshina Kannada. These areas together form the Central Western Ghats, a region endowed with a wide range of vegetation types and extremely rich biodiversity.

The Western Ghats form one of the important habitats for pteridophytes due to the presence of perennial streams, evergreen forests, grasslands and many other habitats, all supporting ferns and fern-allies and some , the damper ones their luxuriant growth. Approximately 320 species of ferns and fern-allies have found their abode in the varied habitats of Western Ghats. The major families of the pteridophytes of the Western Ghats are Thelypteridaceae, Aspleniaceae, Pteridaceae, Selaginellaceae, Polypodiaceae, etc. Western Ghats also support luxuriant growth of important endemic species such as *Cyathea nilgirensis*, *Polystichum manickamii, Bolbitis semicordata, Osmuda huegeliana,* etc. and endangered species such as *Helminthostachys zeylanica, Grammitis medialis, Tectaria zeylanica, Psilotum nudum,* etc. in their preferred microclimates. The pteridophytes tend to increase in number in the north-south direction in Western Ghats, obviously due to the more number of rainy months and higher altitudes with cooler climates, which prevail more towards the central and southern sectors. Thus whereas

Maharashtra has 64 species of Pteridophytes, most of them confined to northern Western Ghats, (Manickam et al., 2003), Karnataka has about 174 species of pteridophytes, mostly growing in central Western Ghats (Rajagopal and Bhat, 1998) and Kerala and Tamil Nadu together, especially in a block south of Palghat gap account for 239 species (Manickam and Irudayaraj, 1992) (Table 1).

The Karnataka State, encompassing central Western Ghats, is a rich region in biodiversity due to its diversity of climatic conditions, soil and topographic variations. The different environmental regimes support their own characteristic set of plants and animals. Notable studies here began with listing of 75 species of ferns from North Canara (Uttara Kannada) district by Matchperson (1890). Later, in 1922, Blatter & Almeida included 90 species of ferns from Uttara Kannada district, then a part of Bombay Presidency, in their "Ferns of Bombay". After a long lapse of time Alston (1945) gathered 4 species of *Selaginella* from the State contributing to his collection pool 58 species from India. Kammathy *et al* (1967) listed 25 species of ferns and fern-allies in their "Contribution towards a Flora of Biligirirangana Hills". Razi & Rao (1971) published an artificial key to the Pteridophytes of Mysore city and its neighbouring areas in which they included 70 species of ferns and fern-allies spread over 41 genera. Bhaskar & Razi (1973) recorded 7 species of ferns and one species of *Selaginella* from aquatic and semi-aquatic habitats of Mysore district. Holttum (1976) included 10 members of Thelypteridaceae in the "Flora of Hassan District". Yoganarsimhan *et al* (1981) described 12 species of ferns in their "Flora of Chikmagalur District". However, the only in depth and comprehensive work on the pteridophytes of Karnataka was carried out by Rajagopal and Bhat (1998). Their work spanning a period from 1988-1995 culminated in the "*Pteridophytic Flora of Karnataka State, India*" published in 1998 listed 174 species. Ramachandra *et al* (2010) documented 54 species of pteridophytes from the Gundia river basin in Hassan district. The important pteridophytes hot-spots in Karnataka include Kemmangundi and Bababudan hills (Chikmagalur district), Bisle Ghat and adjoining areas (Hassan district), Agumbe Ghats (Shimoga district) and Gerusoppa Ghats, Kaiga and Castle Rock (Uttara Kannada district).

**1.2 HYDROLOGICAL AFFINITIES**

The era of inventorisation of pteridophytes in central Western Ghats has, understandably, come to an end with the monumental work of Rajgopal and Bhat (1998), and it is high time that in future ecology and conservation are given greater importance. Our routine observations in the field, especially during forest ecological studies, and reviews of sporadic mention of pteridophytes habitats in literature bring to the fore the fact that among the most sensitive of the ferns, that are prone to early eliminations from their natural habitats, are the ones that are associated with very humid conditions (especially rainy season fern communities). The focus of this work is on gross affinities of pteridophytes with humid habitats. Figure 1 shows the similarity between the 8 different major habitats of pteridophytes based on species occurrence. The habitats can be divided into two major groups A (which includes Aquatic, brackish water habitat) and B (which includes remaining 7 habitats). Group A is totally different from group B and includes a mangrove fern (*Acrostichum aureum*), found growing gregariously in the tidal backwaters in the costal swamps and marshes; it is the only species of fern known so far growing in the brackish water environs of the State. Group B can be further sub-divided into two sub-groups viz. B1 (including Fresh water aquatic and amphibious habitats) and B2 (including remaining 5 habitats). Group B1 is mostly represented by those species which need extremely watery or marshy habitats and include some of the rare hydrophytic species such as

*Isoetes sahyadriensis* and *I. sampathkumarani* which deserve greater attention from conservationists. Two of the aquatic ferns namely *Marsilea minuta* and *Azolla pinnata* falling in this group are found widely distributed in ponds, paddy fields and other fresh water wetlands in the plains and hills of the State. In stark contrast is *Salvinia molesta*, an exotic free-floating fern, has become a serious weed choking many water bodies. It is a fast growing plant usually found in ponds, lakes, paddy fields, etc. significantly affecting the aquatic flora and fauna. Group B2 is further sub-divided into three clusters – B2a (including stream banks and moist forests), B2b (including roadsides and rock crevices) and an intermediate cluster B2c (which includes the high altitude sholas and meadows). These habitats shelter most of the members of fern group – Filicales.

The fern group – Filicales is the largest group present on the earth today represented by almost 6000 species of ferns, most of which are mesothermal hygrophytes; that is, they flourish under moist conditions with moderate temperature, and the majority of them are shade loving plants. Of the perennial fern species preferring swampy/moist habitats for their growth include tree fern species *Cyathea gigantea, Angiopteris indica* and *A. helferiana*. Similarly, another endemic fern *Osmunda huegeliana* prefers the moist and humid banks of free flowing perennial streams and rivers. The filmy ferns belonging to family Hymenophyllaceae are strongly hygrophilous and their growth is restricted to wet and moist places, dense and dark forests with a relative constant high degree of humidity being their preferred habitats. Their delicate frond morphology has enabled them to grow as epiphytes in very humid regions (Dubuisson et al. 2003). It is probable that the absorption of water is mostly performed in them by diffusion through the filmy lamina (as in bryophytes; Hébant, 1977), less often by rootless stems and sometimes by specialized root-like shoots (Schneider, 2000). The hygrophilous habitat is prevalent in many ferns, so much so in some of them occur even in association with swamps. The endemic and threatened tree fern *Cyathea nilgi*rensis has its habitat confined to the relic evergreen forests with rare kind of swamps and perennial streams. We found it in the Myristica swamps of Kathalekan (……), its northernmost limit of distribution in the Western Ghats. It occurred there along with rare trees such as *Syzygium travancoricum* (Critically Endangered), *Dipterocarpus indicus* and *Myristica magnifica* (both Endangered), *Gymnacranthera canarica* (vulnerable) and *Semecarpus kathalekanensis* (newly discovered rare tree)- all of them of hygrophilic nature in the latitude of Uttara Kannada, where the rainfall barely lasts six months. List of notable pteridophytes of central Western Ghats in relation to the eight different habitats related to various hydrological conditions is given in Table 2.

**1.3 THREATS AND CONSERVATION**

The pteridophytes in general are moisture and shade loving plants. Where humid and damp conditions prevail on the land we find greater congregations of them. As humid places and water bodies are prioritized by humans for settlements, farming, power generation, setting up of industries etc. most sensitive pteridophytes tend to vanish from such regions. The conversion of humid forests in large scale into monoculture plantations of teak, acacia, eucalypts, rubber etc. has caused massive eliminations of hygrophilous pteridophytes. Factors like climate change, increasing urbanization, encroachment of forest lands, unplanned developmental activities etc. pose major threats to especially humidity and shade loving ferns. Due to felling of trees in the forests the members of epiphytic pteridophytes belonging to the families Polypodiaceae, Davalliaceae, Aspleniaceae, Vittariaceae etc. were reported to be reduced substantially by Dixit, (2000). Large scale collection of ferns from the

forests by the visitors and local people for ornamental purpose, medicinal purpose and during excursions also increases the pressure on these plants. For saving hygrophilous ferns from *en-mass* destruction, their habitat conservation is of paramount importance. By declaring primary forest relics of Western Ghats, the Myristica swamps and dipterocarp forests, for instance, as 'Heritage Sites' or Conservation Reserves, bulk of the germplasm of most humid tropical ferns of Western Ghats can be preserved. The conservation of the humid and shaded habitats along with their gamut of flowering plants is an outstanding necessity for conservation of non-hydrophytic, perennial pteridophytes, more so with increasing northern latitudes in Western Ghats with progressive decline in rainy months. As knowledge on pteridophytes as such is sorely lacking among the public in general, their conservation is difficult, necessitating need for awareness programmes for holistic habitat conservation, which is a more sensible exercise to do in this regard.

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**Figure 1: Similarity of different habitats of pteridophytes based on species occurrence in central Western Ghats**

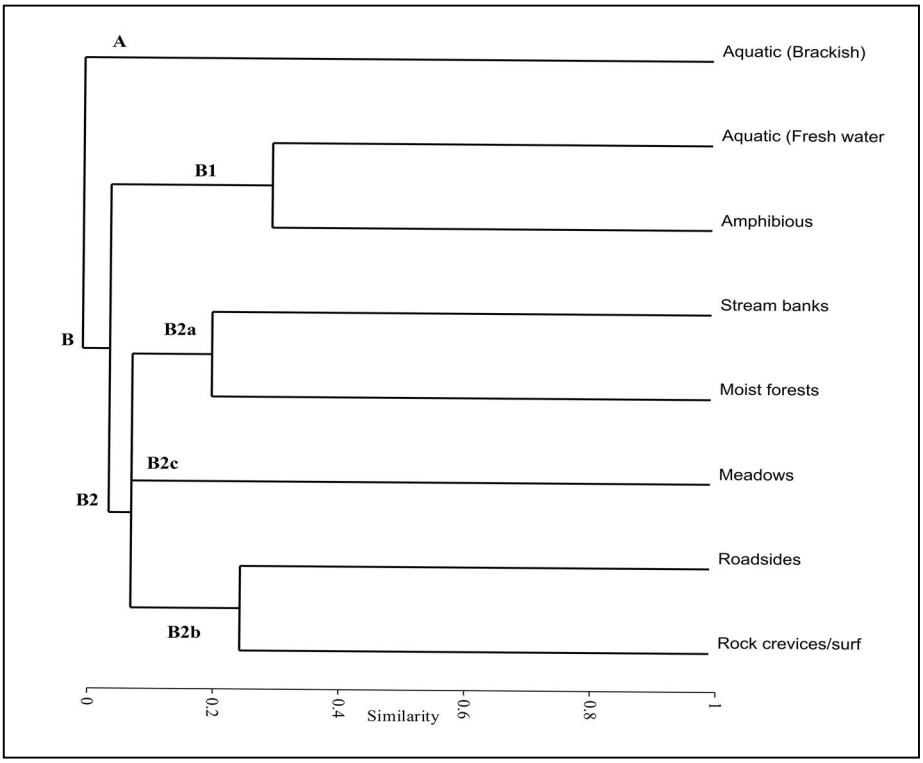


**Table 1: Pteridophyte species distribution in relation to rainy months in Western Ghats**

| | SOUTHERN WESTERN GHATS | CENTRAL WESTERN GHATS | NORTHERN WESTERN GHATS |
|---|---|---|---|
| **Number of rainy months** | 8-10 | 6-8 | 3-5 |
| **Number of pteridophytes** | 232 | 174 | 64 |

**Table 2: Notable pteridophytes in relation to different habitats in central Western Ghats**

| HABITATS | PTERIDOPHYTE SPECIES | STATUS |
|---|---|---|
| Aquatic (Brackish Water) | *Acrostichum aureum* | None |
| Aquatic (Fresh water) and Amphibious | *Marsilea minuta* L. | None |
| | *Azolla pinnata* R. Br. | None |
| | *Salvinia molesta* Mitchell | None |
| | *Ceratopteris thalictroides* (L.) Brongn. | Least Concern |
| | *Isoetes coromandelina* L.f. subsp. *coromandelina* | Least Concern |
| | *Isoetes sahyadriensis* Mahabale | Rare |
| | *Isoetes sampathkumarani* Rao | Rare |
| Stream banks and Moist forests | *Osmunda huegeliana* Presl. | Near-Threatened |
| | *Angiopteris indica* Desv. | None |
| | *Cyathea gigantea* (Wall. *ex* Hook.) Holttum | None |
| | *Cyathea nilgirensis* Holttum | Near-Threatened |
| | *Trichomanes intramarginale* Hook. & Grev. | Rare |
| | *Diplazium esculentum* (Retz.) Sw. | None |
| | *Diplazium polypodioides* Blume | None |
| | *Bolbitis appendiculata* (Willd.) K. Iwatz | None |
| | *Bolbitis semicordata* (Bak.) Ching | Rare |
| | *Pteris aspericaulis* Wallich ex Agardh | Rare |
| | *Pteris argyraea* T. Moore | Rare |
| | *Asplenium normale* D. Don | Rare |
| | *Asplenium crinicaule* Hance | Rare |
| Meadows | *Ophioglossum reticulatum* L. | None |
| | *Pteridium aquilinum* (L.) Kuhn | None |
| | *Loxogramme parallela* Copel. | Rare |
| Roadsides and Rock crevices | *Selaginella wightii* Hieron. | None |
| | *Selaginella delicatula* (Desv. ex Poiret) Alston | None |
| | *Pteris vittata* L. subsp. *vittata* | None |
| | *Actiniopteris radiata* (Sw.) Link | None |
| | *Cheilanthes farinosa* (Forssk.) Kaulf. | None |
| | *Adiantum incisum* Forssk. | None |
| | *Adiantum philippense* subsp. *philippense* | None |
| | *Athyrium hohenackerianum* (Kuntze) T. Moore | None |
| | *Blechnum orientale* L. | None |