

Ecology and distribution of *Huperzia* species in KMTR region, Western Ghats, Tamil Nadu

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Abstract

The aim of this study is the ecology and distribution of *Huperzia* species in KMTR region, Western Ghats region, Tirunelveli District, Tamil Nadu. The field work was carried out from April 1999 until December 2015 in various localities in KMTR region, Tirunelveli District, Tamil Nadu. The complete observation of the KMTR region of Western Ghats identified in *Huperzia* species viz., *Huperzia phlegmaria* Roth, *H. phyllantha* (Hook. And Arnott.) Holub., *H. suarrosa* (Forst) Trev. *H. hamiltonii* (Spreng) Trev., and *H. hiliانا* (Nessel) Holub. The recommendation of the present study, *Huperzia* species were easily conserved by through the vegetative method.

Key words: Conservation, *in situ*, *ex situ*, *Huperzia* sp, KMTR, Western Ghats

Introduction

Fern allies are a diverse group of seedless vascular plants that are not true ferns. The history of ferns and their allies were the dominant form of vascular plant until the Mesozoic Era (the age of the Dinosaurs) when seed bearing plants came into prominence. There is fossil evidence of ferns in the Devonian Era (345-395 million years ago) and they evolved from the first vascular plants that had evolved in the Silurian Era (395-435 million years ago). Ferns have been with us for more than 300 million years and in that time the diversification of their form has been phenomenal. Ferns grow in many different habitats around the world. The ferns were at their height during the Carboniferous Period (the age of ferns) as they were the dominant part of the vegetation at that time. During this era some fern like groups actually evolved seeds (the seed ferns) making up, perhaps half of the fern like foliage in Carboniferous forests and much later giving rise to the flowering plants. Most of the ferns of the Carboniferous became extinct, but some later evolved into our modern ferns. There are thousands of species in the world today. Chapman (2009) estimates that there are ca. 12,000 species of ferns and fern allies. These plants were previously grouped together as Pteridophyta but are now classified as monilophytes and lycophytes respectively. They are both ancient plant groups with long fossil records previously reported (Pryer *et al.*, 2004, 2009; Christenhusz *et al.*, 2011).

The Clubmoss group is an ancient group of plants that has an evolutionary line stretching back to the Devonian period. Researchers suggest that the last common ancestor of extant monilophytes and lycophytes existed about 400 million years ago in the early-mid Devonian (Becker *et al.*, 2002; Pryer *et al.*, 2004). Ferns were dominant from about 380 million to 290 million years ago in a tropical and subtropical environment, but many of the current families and species did not appear until roughly 145 million years ago in the early Cretaceous. Tree-like forms of lycophytes were the dominant plants of the coal forming forests during the Carboniferous period. Lycopodiaceae itself consists of 10-15 genera with approximately 1000 living species (Raven *et al.*, 2004) and their distribution extends from the Arctic to the Tropics. The family Lycopodiaceae are an ancient fern allies (Correll, 1956) and probably monophyletic family without close living relatives and have a virtually cosmopolitan distribution (Øllgaard, 1992). Wikström (2001) who reported that approximately 300 to more than 400 species around the world. It consists of three genera viz. *Huperzia*, *Lycopodium* and *Lycopodiella*. Worldwide the estimated number of species for both *Lycopodium* and *Lycopodiella* is about 40 (Wikström and Kenrick 2000b) and the estimated number of species of *Huperzia* is 300 (Wikström and Kenrick, 2000a). During last decades, many reports indicate a decline in the fern population, may be linked to the vulnerability of their habitats. Their sexual reproductive system, strictly tied to water, gives them greater sensitivity to environmental changes. Many species are today under some level of threat, mainly by the disappearance of natural habitats or climate change. The Red List of Threatened Species (IUCN, 2012) includes 167 species of fern and fern allies in the threatened category (critically [CR] +endangered [EN [+vulnerable [VU]], 2 extinct (EX) and 19 near-threatened (NT), but there is insufficient coverage of the group, as only 3% of describing species are evaluated (Ibars and Estrelles, 2012).

The family, *Huperziaceae* was consisted of two genera, *Huperzia* and *Phlegmariurus*, with a total of about 150 species to be found in worldwide (Rothmaler, 1944; Ma *et al.*, 2005). The *Huperzia* species were growing very slowly, normally requiring fifteen to twenty years of growth from spore germination to maturity stage (Ma *et al.*, 2004; 2006). Number of studies have investigated in the natural products in *Huperzia* species to be found in active compounds



such as lycopodium alkaloids, triterpenes, flavones and phenolic acids (Towers and Maas, 1965; Voirin and Jay, 1978; Tong *et al.*, 2003; Shi *et al.*, 2005). Among these compounds, the lycopodium alkaloids, especially huperzine A (Hup A), was originally isolated from *Huperzia serrata* and have been investigated extensively and intensively (Ma *et al.*, 2004; 2005; 2006; Tong *et al.*, 2003). Recently, various media such as television as well as newspapers and magazines have reported that some species in Malaysia are widely collected and sold by local people as a source of income. Information about ecology and distribution of Lycopodiaceae can help to safeguard this family. Some researcher have been reported in the in vitro culture of *Huperzia* species through bulbils (Szypuła *et al.*, 2005; 2006; Maridass *et al.*, 2011). In this paper we examine ecology study and distribution of *Huperzia* species in the KMTR region, Western Ghats, Tamil Nadu.

Materials and Methods

The methodology of data on ecology and distribution was mostly derived from herbaria sheet information or collection notes and also based on observation during field work. This field work was carried out from April 1999 until December 2015 in various localities in KMTR region, Tirunelveli District, Tamil Nadu. Collected the all specimens were identified and match with Centre for Plant Biodiversity and Biotechnology (CBB), St. Xavier' College, Tirunelveli, Tamil Nadu.

Results and Discussion

In the present study filed trips of KMTR region of Western Ghats from April 1999 until December 2015. The complete observation of KMTR region of Westerns Ghats identified in *Huperzia* species. We are collected and identified as *Huperzia* species such as *H. phlegmaria* Roth., *H. phyllantha* (Hook. And Arnott.), *H. suarrosa* (Forst) Trev., *H. hamiltonii* (Spreng) Trev., and *H. hiliiana* (Nessel) Holub by the matching of voucher herbarium (Centre for Biodiversity and Biotechnology, St. Xavier's College (Autonomous), Palayamkottai-627002), Tamil Nadu, South India). Herbarium of voucher specimens of *Huperzia* species was prepared (Photo-1).

The distribution of *Huperzia* species were recorded in 10 km² for each species and total number of 10 km² grid square per species represented in the table-1. Previously, Rawat *et al.*, (2014) briefly described in the *Huperzia* species are reported. The present study, *Huperzia* species are epiphytic or lithophytic nature to be found in KMTR region. The rooting of *Huperzia* species are present only at the base and the stem is generally erected to sub-erect or sometimes pendulous also. Branching is isodichotomous type; the branches are usually ascending, symmetrical, and rarely simple. The leaves and sporophylls are isomorphous or heteromorphous type. The strobilus or cones are not formed at all in this genus. Occasional vegetative reproduction by bulbils in *Huperzia hiliiana*, and *H. phlegmaria* (Photo-5 &6).

Table 1. Distribution of *Huperzia* species in KMTR

Huperzia Species	Range (10km ²)	Record 10km ²)	Locality			
			Kodaiyar	Muthukulivayal	Upper Dam	Kakkachi stream
<i>H. phyllantha</i>	Upper Kothaiyar	21	4	7	7	3
<i>H. phlegmaria</i>	Upper Kothaiyar Dam	15	6	8	12	1
<i>H. suarrosa</i>	Upper Kothaiyar Muthukuzhivayal Kakachi	26	6	12	5	3
<i>H. hamiltonii</i>	Upper Kothaiyar Dam	14	2	5	6	1
<i>H. hiliiana</i>	Upper Kothaiyar	22	3	7	3	9

Earlier studies on Muktesh Kumar (1998) reported that the current status of *Huperzia* species was described in Western ghats regions. The most of the *Huperzia* species were depend on symbiotic associations with mycorrhizal fungi (Mehltreter *et al.*, 2010). Moreover, many fern species thrive within delimited pH ranges; as one example, ferns within the genus *Lygodium* of eastern North America succeed chiefly in moist, intensely acidic soils. Epiphytic nature of

Lycopodiaceae family are pendulous with dichotomous branching and grow at heights of about 1m up to 10m from the ground. The epiphytic habit is most common in the genus of *Huperzia* species. The results indicated that plant height, width of branchlets, density of leaves, leaf shape and size, phyllotaxy, leaf margin are the most important character in delimiting taxa in this family. Some mircromorphological characters (eg. leaf epidermal cells, stomata, etc.) are too



useful in segregating problematic taxa. The size of sporangium, its outline and depression at the point of attachment varies between species. Sporangia are either reniform or circular in outline with varying degree of grooves. Species of *Lycopodium* have comparatively thinner sporangial walls than *Huperzia*. Gemmae are a common feature of terrestrial species of *Huperzia* and almost absent in epiphytic forms. The diversity of *Huperzia* species is the highest among the terrestrial as well as epiphytic species of *Huperzia*.

conserving biodiversity. The present study, *Ex-situ* conservation of the *Huperzia* species was conserved by vegetative propagation method. The preservation of spores of *Huperzia* species were collected from natural habitats of KMTR region (Photo-3). It is generally preferred to conserve threatened species in situ, because evolutionary processes are more likely to remain dynamic in natural habitats (Brutting *et al.*, 2013, Melfi, 2012). However, considering the rate of habitat loss worldwide, *ex situ* cultivation is becoming increasingly important (Brutting *et al.*, 2013; Yumkham and Singh, 2011).

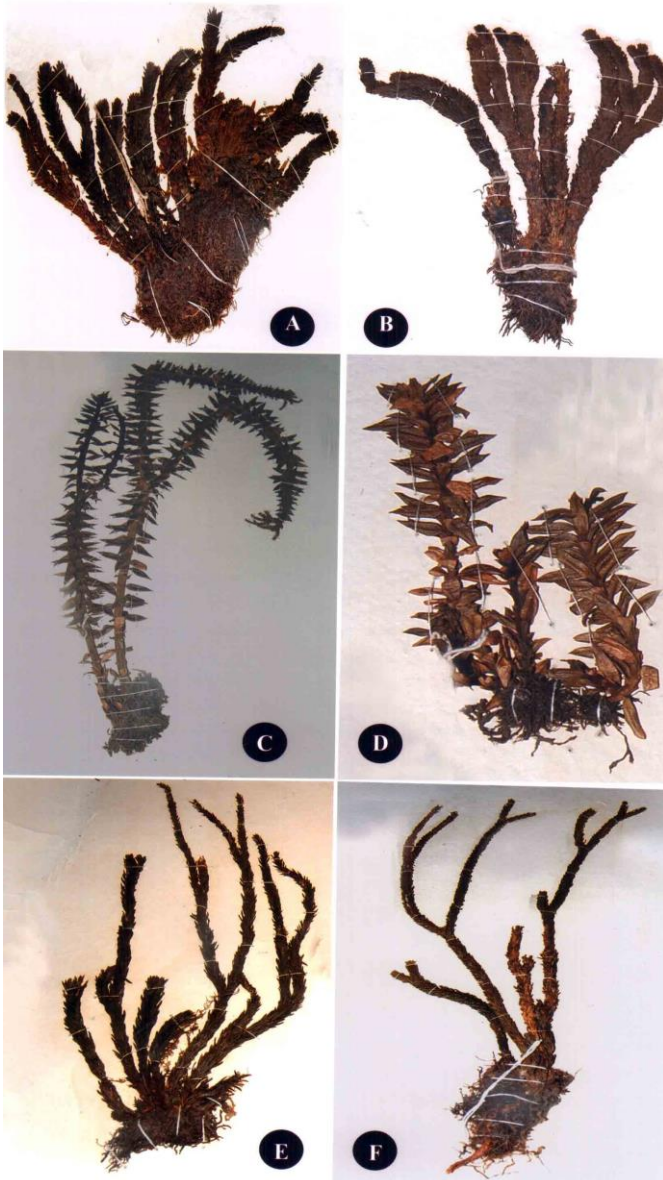


Photo-1: Herbarium of *Huperzia* species



Photo -2: Vegetative regeneration of *H. phyllantha* from Muthukulivayal



Photo -3: Habit of *H. suarrosa* from Muthukulivayal

In-situ conservation, the conservation of species in their natural habitats, is considered the most appropriate way of

The life cycle of *Huperzia* species have two-stage of life cycle (diplohaplontic) with the sporophyte being the most dominant and obvious life form. Upon germination, the spores of *Huperzia* species give rise to bisexual gametophytes which can be rather small (~9mm) size, green color and irregularly shaped. The development and maturation of archegonia and antheridia in gametophytes of *Huperzia* species was formed up to 15 years. Water is a requirement for fertilization. The sporangia, which contain the spores, are borne either singly, in leaf axils or packed together in a strobilus or cone (Raven *et al.*, 2004).



Photo-4: Field observation of *Huperzia* species from Upper Kodaiyar Dam

Natural soil spore banks

Pteridophytes spore banks are a promising *ex situ* conservation tool used to increase the chances of survival of ferns, in fact that large quantities of germplasm with high genetic variation can be conserved in a small space with low economic and technical costs (Sara Magrinia and Anna

Scoppolab, 2012). To complete this survey of different options for the conservation of ferns, we must consider the existence of banks of spores in the soil. Soil spore banks have a potential role in the conservation of endangered fern species (Dyer and Lindsay, 1992; 1994; Dyer, 1994). Ramirez-Trejo *et al.*, (2004) emphasized the spore bank in the soil as a potential source for *in situ* regeneration. Ranal (2004) has also proposed tree bark as another kind of *in situ* spore bank that could contribute to fern conservation. Soil spore banks can be very useful for population reinforcements and to increase the genetic diversity, especially in threatened species with very small populations, and it is the first option for the recovery of spores for the reintroduction of species in places in which the disappearance of populations is observed.

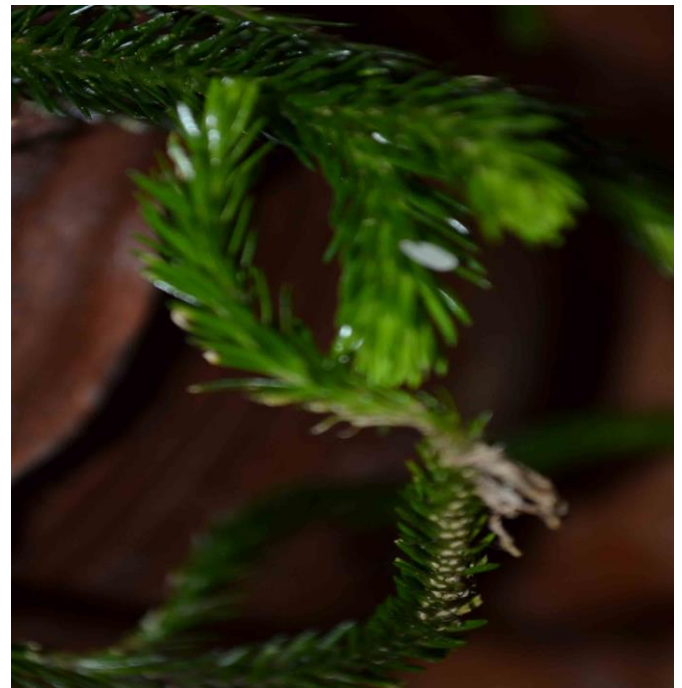


Photo -5: Regeneration of *H. hiliiana* from Upper Kodaiyar Dam



Fig.6: Regeneration of *H. phyllantha*



Photo -7: Habit of *H. hamiltonii* from Kakachi streamFig.8: Natural view of spore bank of *H. phyllantha*Fig.9: Preservation of spore bank of *H. phyllantha*

Conclusions

The conclusion of the present study observed that ecology and distribution of *Huperzia* species are most diverse in lower Upper Kodaiyar region, KMTR, Western Ghats, South India. The *Huperzia* species were well growth and fern house in Upper Kodaiyar region, KMTR, Western Ghats, Tirunelveli District, Tamil Nadu. The recommendation of *Huperzia* species will be conservation through vegetative propagation method and rich resource of *Huperzia* species to be found in the KMTR region, Western Ghats.

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