

# Distribution and Density of Pteridophytic flora in Galikonda Hills, Eastern Ghats of India, Andhra Pradesh

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**Abstract:** In the present paper, the distribution and density of pteridophytes in Galikonda, Visakhapatnam district is presented. Study on Pteridophytes is carried out with Quadrats of size 0.5X0.5 M. Ten quadrat samples are taken in different seasons during November 2019 – October 2020. A total number of 19 species belonging to 14 genera, 12 families were recorded. Maximum relative density is observed for *Asplenium trichomanes*, *Onychium japonicum kunze*, *Adiantum raddianum* and *Adiantum capillus-veneris*. Minimum relative density is observed for *Cystopteris protrusa*, *Phlebodium aureum* and *Osmunda claytoniana*. The population of Pteridophytes in this region is found to be heterogeneous.

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## I. Introduction

The seedless vascular plants of Pteridophytes had a very flourishing past in dominating the vegetation on the Earth, 280 – 230 million years ago. The term Pteridophyta has a Greek origin Ptera means “a feather”. They occupy a position between the lower non-seed bearing and higher seed bearing plants. They grow in tropical and temperate zones at higher altitudes; Majority of the pteridophytes are terrestrial and grow in moist and shady places. They exist in different eco-geographically endangered regions from sea level to the highest mountains<sup>1</sup>. In the present study, an attempt is made to study the distribution and species density of Pteridophytic flora in Galikonda, Visakhapatnam district of Andhra Pradesh. Several authors studied the distribution of pteridophytes in India.

Kavitha<sup>2</sup> et al. conducted surveys in three seasons (rainy, winter and summer) to identify fern species present on Sitheri Hills of Eastern Ghats, Tamil Nadu and reported that *Psilotum nudum*, *Huperzia* spp., *Actinopteris radiata* were significant in the study area. Narasimha Rao<sup>3</sup> studied the distribution of Pteridophytes in agricultural fields of Razole, East Godavari district of Andhra Pradesh and reported that *Marselia*, *Salvinia*, *Azolla* and *Pteris* were found to be dominant in that region. Patil and Dongare<sup>4</sup> reported that the species of *Pteridaceae*, *Ophioglossaceae*, *Adiantaceae*, *Lomariopsidaceae*, and *Woodsiaceae* exhibit maximum diversity in Satara District, Maharashtra, India. Prayaga Murty<sup>5</sup> et al. carried out quadrat studies to evaluate diversity and distribution of Pteridophytes at Punyagiri hills in Visakhapatnam district, Andhra Pradesh. He reported that maximum relative density is observed for *Selaginella* and *Pteris Vittata*. Sonia and Ramachandran<sup>6</sup> reported that Terrestrial or Lithophytic species were reported to grow gregariously along roadsides of Nilgiri hills. Subhadra<sup>7</sup> et al. reported presence of Pteridophytes belonging to 6 families (*Salviniaceae*, *Pteridaceae*, *Azollaceae*, *Marsileaceae*, *Thelypteridaceae*, *Parkeriaceae*) and 6 genera in wetlands of Bhubaneswar and its adjoining areas of Khurda district. Tulasi Rao<sup>8</sup> et al. studied Pteridophytes in Nallamala forests and reported that *Marsilea*, *Aspidium*, *Tectaria*, *Lycopodium*, *Osmunda*, *Davalia*, *Adiantum*, *Athyrium* and *Blechnum* found have medicinal usage. Narasimha Rao and Lohitasyudu<sup>9</sup>, Narasimha Rao and Subba Rangaiah<sup>10</sup> studied the distribution of pteridophytes in Eastern Ghats of India.

## II. Materials and Methods

Galikonda is located in Ananthagiri mandal of Visakhapatnam district, at 97km distance from Visakhapatnam. Galikonda is located at 18° 13' 57" N latitude and 82° 55' 56" E longitude. The hill is inhabited by the abundant growth of Pteridophytes, Bryophytes along with Angiospermic Flora and several perennial streams are observed supporting the flora of the region. High humidity and low temperature prevalent on the hill favored the luxurious growth of Pteridophytes. Environmental parameters, namely Temperature and Humidity are recorded by thermometer and hygrometer respectively. Data of rainfall during the study period is collected from Meteorological Department of Andhra University, Visakhapatnam. Random sampling of Pteridophytes is done by quadrats of size 0.5 x 0.5M. The number of species present in each quadrat is recorded. Field visit is carried out every month and 10 quadrat samples are taken from the study area during each visit.

### III. Phyto-Sociological Studies

Abundance, Density and Frequency and their relative values are calculated as detailed below.

$$\text{Frequency}(\%): \frac{\text{Total number of quadrates in which a species occur}}{\text{Total number of quadrates studied}} \times 100$$

$$\text{Density:} \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates studied}}$$

$$\text{Abundance:} \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number quadrates in which the species occurred}}$$

$$\text{Relative Frequency:} \frac{\text{Frequency of individuals of a species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative Density:} \frac{\text{Density of individuals of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Abundance:} \frac{\text{Abundance of individuals of a species}}{\text{Total abundance of all species}} \times 100$$

Based on the value of frequency, classes of pteridophytes were determined. There are 5 frequency classes i.e. 'A' class with the species of frequency ranging from 1- 20%; 'B' class 21-40%; 'C' class 41-60%; 'D' class 61-80%; 'E' class 81-100%. Further, the pteridophytes frequency patterns were compared with the normal frequency pattern of Raunkiaer (A>B>C>=D<E). Based on frequency pattern of the community, the homogeneity and heterogeneity of the vegetation is ascertained. If the values are high with respect to B, C and D, then the community is said to be heterogeneous whereas higher values of E indicates the homogeneous nature.

### IV. Results and Discussion

Collected data on Environmental Parameters such as Temperature, Humidity and Rainfall at the study locations during November 2019 – October 2020 is presented in Table 1. It is observed that maximum humidity is recorded in August 2020 and minimum temperature is observed in January 2020 at the study area. The pteridophyte species observed at the study area along with their family are presented in Table 2. The density and distribution of pteridophytic flora at the study area are determined and presented in Table 3. The Frequency distribution and Relative density of various species at the study area are shown in Fig.1 and Fig.2.

From Table 3, it is observed that *Asplenium trichomanes* (18.5%) has maximum relative density followed by *Onychium japonicum kunze* (15.6%), *Adiantum raddianum* (14.8%) and *Adiantum capillus-veneris* (13.9%). Minimum relative density is observed for *Cystopteris Protrusa* (0.4%), *Osmunda claytoniana* (1.1%) and *Phlebodium aureum* (1.2%).

From the Fig.1, most of the Pteridophyte species present in Galikonda region study location are in frequency category 'A'. As Raunkiaer's normal frequency pattern A>B>C=D<E is not satisfied, Pteridophyte community at Galikonda hills is classified as heterogeneous. *Asplenium Trichomanes*, *Onychium japonicum kunze*, *Adiantum capillus-veneris*, *Adiantum raddianum*, *Adiantum pedatum* and *Selaginella* are found to be dominating species along the hill slope region at Galikonda study area.

**Table no 1:** Environmental features at Galikonda hills during November 2019-October 2020

Month and Year	Temperature ( <sup>0</sup> C)	Rainfall (mm)	Humidity
November 2019	25.02	0	68.72
December 2019	22.71	0.5	66.90
January 2020	22.48	3.8	67.05
February	23.97	3.5	63.66
March	26.12	11.4	61.98
April	28.54	23.4	56.88
May	30.39	16.1	59.19
June	28.74	62.2	72.70
July	26.31	72.8	89.90
August	25.84	144.3	90.60
September	26.01	83.9	90.21
October 2020	25.54	58.8	86.23

**Table no 2:** Composition of Pteridophytic flora at Galikonda hills study area

S. No.	Name of the plant	Family
1	<i>Asplenium trichomanes</i>	<i>Aspleniaceae</i>
2	<i>Osmunda claytoniana</i>	<i>Osmundaceae</i>
3	<i>Onychium japonicum kunze</i>	<i>Pteridaceae</i>
4	<i>Dryopteris Marginallis</i>	<i>Dryopteridaceae</i>
5	<i>Phlebodium aureum</i>	<i>Polypodiaceae</i>
6	<i>Polypodium virginianum</i>	<i>Polypodiaceae</i>
7	<i>Pteridium aquilinum</i>	<i>Demnstaedtiaceae</i>
8	<i>Cystopteris protrusa</i>	<i>Cystopteridaceae</i>
9	<i>Phegopteris connectilis</i>	<i>Thelypteridaceae</i>
10	<i>Adiantum pedatum</i>	<i>Pteridaceae</i>
11	<i>Adiantum radianum</i>	<i>Pteridaceae</i>
12	<i>Dryopteris filix- mas</i>	<i>Dryopteridaceae</i>
13	<i>Adiantum capillus veneris</i>	<i>Pteridaceae</i>
14	<i>Polypodium vulgare</i>	<i>Polypodiaceae</i>
15	<i>Botrychium dissectum</i>	<i>Ophioglossaceae</i>
16	<i>Dryopteris concolor</i>	<i>Pteridaceae</i>
17	<i>Matteuccia struthiopteris</i>	<i>Onocleaceae</i>
18	<i>Selaginella tamariscina</i>	<i>Selaginellaceae</i>
19	<i>Nephrolepis biserrata</i>	<i>Nephrolepidaceae</i>

**Table no 3:** Frequency, density and abundance of pteridophytic flora at Galikonda hills, Visakhapatnam district during November 2019- October 2020

Plant	TNO	TNI	F(%)	FC	D	A	R.F	R.D	R.A
<i>Asplenium trichomanes</i>	21	433	17.5	A	3.61	20.6	6.9	18.5	16.6
<i>Osmunda claytoniana</i>	13	26	10.8	A	0.22	2.0	4.3	1.1	1.6
<i>Onychium japonicum Kunze</i>	19	365	15.8	A	3.04	19.2	6.2	15.6	15.5
<i>Dryopteris marginallis</i>	15	41	12.5	A	0.34	2.7	4.9	1.8	2.2
<i>Phlebodium aureum</i>	11	28	9.2	A	0.23	2.5	3.6	1.2	2.0
<i>Polypodium virginianum</i>	15	35	12.5	A	0.29	2.3	4.9	1.5	1.9
<i>Pteridium aquilinum</i>	10	49	8.3	A	0.41	4.9	3.3	2.1	3.9
<i>Cystopteris protrusa</i>	5	9	4.2	A	0.08	1.8	1.6	0.4	1.4
<i>Phegopteris connectilis</i>	17	50	14.2	A	0.42	2.9	5.6	2.1	2.4
<i>Adiantum pedatum</i>	19	247	15.8	A	2.06	13.0	6.2	10.6	10.5
<i>Adiantum radianum</i>	29	345	24.2	B	2.88	11.9	9.5	14.8	9.6
<i>Dryopteris Filix- mas</i>	15	29	12.5	A	0.24	1.9	4.9	1.2	1.6
<i>Adiantum capillus veneris</i>	23	326	19.2	A	2.72	14.2	7.5	13.9	11.4
<i>Polypodium vulgare</i>	16	39	13.3	A	0.33	2.4	5.2	1.7	2.0
<i>Botrychium dissectum</i>	17	56	14.2	A	0.47	3.3	5.6	2.4	2.7

<i>Dryopteris concolor</i>	15	55	12.5	A	0.46	3.7	4.9	2.4	3.0
<i>Matteuccia struthiopteris</i>	17	54	14.2	A	0.45	3.2	5.6	2.3	2.6
<i>Selaginella tamariscina</i>	12	104	10.0	A	0.87	8.7	3.9	4.4	7.0
<i>Nephrolepis biserrata</i>	16	47	13.3	A	0.39	2.9	5.2	2.0	2.4
			254.2		19.48	124.3	100.0	100.0	100.0

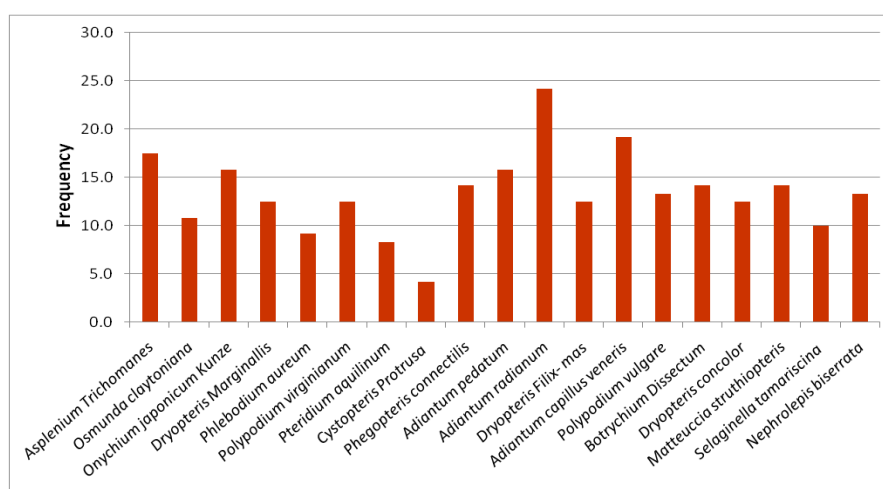


Fig.1. Frequency of Pteridophytic flora at Galikonda hills of Visakhapatnam District during Nov' 2019- Oct'2020

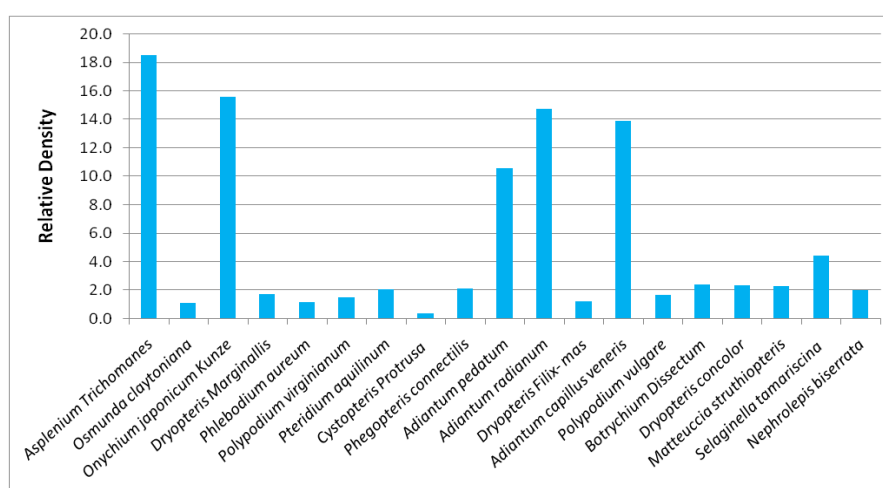


Fig.2. Relative Density of Pteridophytic flora at Galikonda hills of Visakhapatnam District during Nov' 2019- Oct'2020

### Species identified in Galikonda hills:

The species identified in Galikonda are described below.

*Asplenium trichomanes*, is a maiden hair small fern of 10 to 30 cm tall growing across the world in rocky habitats in all seasons. The fronds are long and tapering towards the tip. It is widespread in temperate and subarctic areas and also occurs in mountainous regions in the tropics. The fronds are pale to dark green and contain roundish pinnae. It widely occurs in Europe, Asia, Turkey, Iran and the Himalayas.

*Osmunda claytoniana* is a deciduous fern 2-5ft tall which grows in shady regions, wet lands and moist forests. It is also known as interrupted fern since its leaves consists of interruptions in fronds. Among 12-14 species of *Osmundaceae* family, four species *Osmunda claytoniana*, *Osmunda regalis*, *Osmunda cinnamomea* and *Osmunda Japonica* grow in India. It is a short, upright usually subterranean covered by persistent leaf bases. It consists of pale green fronds surrounded by central fertile fronds. Brown leaflets interrupt the fertile fronds which fall off in summer.

*Onychium japonicum kunze* also known as carrot fern is a deciduous fern growing in forests in bright light. The leaves are tripinnate and arranged opposite to one another. The fronds are finely cut and can grow upto 60cm high emerging from below ground.

*Dryopteris marginalis* is an evergreen non spreading fern growing up to heights of 30-60cm. The fronds are dark green and leathery but turn golden brown in spring. The leaflets are arranged opposite to each other on the rachis and curved towards the tip. It grows abundantly in moist shaded regions.

*Phlebodium aureum* commonly known as golden polypody is an epiphytic or terrestrial fern with large fronds found in tropical rain forests. It is evergreen when rainfall is available throughout the year. The fronds are 30-130cm long and 10-50cm wide with dark green in colour. It spreads through golden brown coloured creeping rhizomes. It becomes dormant in high temperatures. It can be used for medical purposes.

*Polypodium virginianum*, commonly known as rock polypody, is an evergreen species of fern growing on rocks, rocky cliffs, boulders and talus. It occurs as dense colonies and spreads by creeping through rhizomes. The fronds are 3-15in. long and 1-2 in. wide. It was used as a medicinal herb by Native Americans.

*Pteridium aquilinum* also known as bracken fern is a deciduous fern found across the world in temperate to tropical zones. It forms large colonies through creeping rhizome or wind blown spores. It can grow up to heights of 3-4ft and 4-5ft wide.

*Cystopteris protrusa* commonly known as the lowland bladder fern, lowland brittle fern or lowland fragile fern has its origin from North America. It grows mostly in spring season and requires wet/ moist environment. It occurs along slopes, valleys and streams.

*Phegopteris connectilis* also known long beech fern is a deciduous fern growing in part to full shade conditions on the surface of rocks in moist environment. They become dormant in hot and dry climates. The fronds are green and triangular shaped. It can grow upto heights of 45cm and spread slowly from upright rhizome.

*Adiantum pedatum*, also known as northern maidenhair fern or five fingered fern is a deciduous fern of height 30-75cm growing in moist forests on rocky habitats. The fronds are green dissected into two blades with pinnae arranged in a semi circular shape. It spreads slowly by creeping through rhizomes to form dense colonies.

*Adiantum raddianum*, also known as Delta maidenhair fern is an evergreen delicate short creeping fern of about 1-2 ft high found in partial to fully shaded moist areas on rocks or terrestrial ground. The fronds are light to dark green, arched and divided into segments. High humidity, shaded areas with a fair constant temperature favours abundant growth of *Adiantum raddianum*.

*Dryopteris filix-mas*, is a semi-evergreen male fern occurring in shaded regions in moist forests, along mountain slopes and rocky habitats. Fronds are green, bipinnate, long (20-80cm) and taper at both ends. It is native to Europe, Asia and North America. It consists of round sori and rhizomatous reproduction.

*Adiantum capillus-veneris*, is a maiden hair and venus fern found in temperate to warm temperate tropical climates. It grows in rocky habitats with regular water access, shady areas, moist cliffs etc. The fronds are light green and fan shaped. It is about 35 cm tall with a creeping rhizome. The fronds of *Adiantum capillus veneris* found its application in medicine for curing different diseases.

*Polypodium vulgare*, is an evergreen fern consisting of leathery bright green fronds of 10-50 cm long with triangular leaflets arranged alternatively. It forms into dense colonies through creeping and grows to a height of about 30cm. The fronds are tapering towards the tip of the plant. It is found to have applications in food and traditional medicine.

*Botrychium Dissectum* is a 6-18 inches tall evergreen fern consisting of finely cut leaves/ dissected leaves. They grow in moist forests, valleys and along swamps. The fronds are green during winter and changes to brown during summer. It is also called as Cut leaf gape fern.

*Dryopteris concolor* is an evergreen terrestrial fern grows in rainforests up to heights of 30cm. The leaves are leathery, dark green, uniform in colour and are in the shape of hand. It is a bipinnate fern with sori are present on the edges of the leaf.

*Mettasuca struthopterus* also known as Ostrich fern is a deciduous fern with fine cut frond. It forms large and dense colonies reaching heights upto 1.5m. It is a terrestrial fern growing in moist soils under part shade to full shade conditions.

*Selaginella* is an evergreen creeping or ascendant plant with scale like leaves growing in shady areas and moist forests. It is the largest and only genus of *Selaginellaceae* family. It spreads along the rock habitats and rise upright upto 3 inches. It is a vascular plant consisting of megaspores and microspores. *Selaginella* is widely distributed across the world particularly in tropical regions.

*Nephrolepis biserrata* also known as giant sword fern is an evergreen terrestrial fern growing in tropical zones up to heights of 8ft. The fronds are pale to dark green and large growing up to 1m long and 30-40cm wide. It forms into large and dense clusters spreads through stolons. It requires moist and partial shade conditions.

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