MATERIALS
AND METHODS
LITERATURE SURVEY

A critical examination of the related literature has been made for the taxa under the investigation. The detailed information of the pteridophytes like occurrence, status, distribution and diagnostic characters were gathered from various authentic sources, viz. national and regional floras, books, journals, periodicals and research publications. Maximum data have been gathered through electronic media, i.e. internet. Many authentic literatures were collected from literature retrieval systems of Biodiversity Heritage library (BHL), Botanicus of the Missouri Botanical Garden Library, JSTOR, KEW, Elsevier and Springer.

FIELD WORK

The field work was carried out within 30 months from June 2010 to December 2012. In the first year (June 2010 – June 2011) survey for locating the sites of pteridophytes were carried. Then in the next one and a half years (June 2011 – December 2012) pteridophytes were collected, processed, preserved and identified.

PLANT COLLECTION, PROCESSING AND IDENTIFICATION

Extensive and exhaustive floristic assessment was carried out during the study period (June 2010 – December 2012). The specimens of the pteridophytes were collected from the study area and processed in the laboratory. The collected specimens were poisoned by dipping into 4% formalin for a day. They were dried and affixed on the herbarium sheets by using fevicol glue. The plant specimens were identified by using exhaustive literature as (Beddome, 1883; Blatter and Almedia, 1922; Dixit, 1984; Naiknaware, 1983; Manickam and Irudayaraj, 1992; Chandra, 2000; Pullaiah et. al., 2003; Ghosh et. al., 2004; Smith et. al., 2006; Frazer-Jenkins, 2008) and also personal consulting the experts like Frazer-Jenkins.

NOMENCLATURE, CITATION AND DESCRIPTION OF TAXA:

The nomenclature of pteridophyte species was updated using the online
database, viz. The Plant List Version 1.1 (http://www.theplantlist.org/), Tropicos (http://www.tropicos.org) and International Plant Names Index (http://www.ipni.org) and referring to the authentic taxonomic literature. In the present research work, the classification given by Fraser Jenkins (2009) has been followed. The classification is based on combination of taxonomy and molecular biology. In this classification he has followed the scheme largely based on Pichi Sermolli (1973), Kramer and Green (1990), with certain modifications including from Smith et al. (2006) and some other modifications of his own, recognizing 34 families and 135 genera. For each species correct botanical name was given followed by synonyms wherever it was necessary, by connecting the name with "The Ferns of British India", "The ferns of Bombay", "Pteridophytic flora of Western Ghats – South India", "The Pteridophytic flora of Eastern India" and Taxonomic Revision of three Hundred Indian Subcontinental Pteridophytes". The citations were obtained from the above online databases. The citation was followed by diagnostic description. Information on distribution, ecology, and specimen examined and exsiccate are provided for all species.

ASSESSMENT OF POTENTIAL PTERIDOPHYTES

Based on field observation and literature survey, a list of potential (medicinal, ornamental etc.) species was prepared.

HERBARIUM CONSULTATION

The identity of certain pteridophytes was confirmed with the help of authentic specimens available in different herbaria, viz. CAL, MH, BSI, BLAT and SUK.

DISTRIBUTION

The study of the spatial distributions of plants or vegetation along the environmental gradients, viz. altitude, temperature, rainfall, atmospheric humidity, forest type, habit and habitat were carried out. The altitude range was measured by
using GPS (Garmin GPSmap 60CSx). The classification of pteridophytes based of forest type was created on the data available in gazetteer (2005). However, the categorization of pteridophytes based on rainfall, temperature and humidity is constructed on the data available in meteorological center (Table 1.).

Table 1. Tehsilwise average Meteorological data of Satara District (2008 – 2013)

<table>
<thead>
<tr>
<th>Name of tehsils/Parameters</th>
<th>Temperature (°C)</th>
<th>Rainfall (mm)</th>
<th>Relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahabaleshwar</td>
<td>13 – 34</td>
<td>3000 – 4500</td>
<td>50 - 95</td>
</tr>
<tr>
<td>Jaoli</td>
<td>15 – 35</td>
<td>2500 – 4000</td>
<td>45 – 90</td>
</tr>
<tr>
<td>Patan</td>
<td>12 – 34</td>
<td>3000 – 4500</td>
<td>55 – 95</td>
</tr>
<tr>
<td>Wai</td>
<td>15 – 35</td>
<td>2000 – 3000</td>
<td>45 – 85</td>
</tr>
<tr>
<td>Khandala</td>
<td>15 – 38</td>
<td>1500 – 2000</td>
<td>40 – 75</td>
</tr>
<tr>
<td>Satara</td>
<td>14 – 38</td>
<td>1500 – 3000</td>
<td>45 – 80</td>
</tr>
<tr>
<td>Karad</td>
<td>16 – 38</td>
<td>1000 – 2000</td>
<td>40 – 70</td>
</tr>
<tr>
<td>Phaltan</td>
<td>18 – 40</td>
<td>1000 – 1200</td>
<td>25 – 60</td>
</tr>
<tr>
<td>Khatav</td>
<td>18 – 40</td>
<td>0600 – 0800</td>
<td>20 – 55</td>
</tr>
<tr>
<td>Man</td>
<td>18 – 42</td>
<td>0400 – 0600</td>
<td>10 – 50</td>
</tr>
</tbody>
</table>

Source: Indian Meteorological Department Pune

IUCN STATUS

The status of species was assessed by using “IUCN Red List of Threatened Species, Version 2013.2.” All the taxa assigned IUCN status tentatively based on field observations.

LIFE FORM SPECTRUM

The classification of plant species based on life forms have been outlined by Raunkiaer (1934), Mishra (1968), Muller and Ellenberg (1974). The Raunkiaer method is modified to determine the life form spectrum of pteridophytes in the studied area is as follows.

<table>
<thead>
<tr>
<th>Life Form</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Megacryptophytes:</td>
<td>&gt; 4 ft. high</td>
</tr>
<tr>
<td>Mesocryptophytes:</td>
<td>2 – 4 ft. high</td>
</tr>
<tr>
<td>Microcryptophytes:</td>
<td>up to 2 ft. height</td>
</tr>
<tr>
<td>Lianas / Climbers</td>
<td>Mechanically dependent plant</td>
</tr>
<tr>
<td>Epiphytes</td>
<td>Plant growing on other plants</td>
</tr>
</tbody>
</table>
QUANTIFICATION OF PHYTO-SOCIOLOGICAL ATTRIBUTES

A plant community is an association of plant species in a given place. Community structure is inclusive of all plants that occur in the tree, sapling and shrub, and ground cover (vine/liana and herbs) vegetative layers. The community analysis involves the systematic collection, organization, and analysis of information about plant diversity, status and their associates. The sympathetic study of plant communities and their energetic is an essential to carry out management intended at minimizing degradation, promoting restoration or sustaining productivity of the world's rangelands. The spatial association and temporal dynamics of communities are influenced by resource availability, stress and disturbances as this affects the species plant performance, i.e. they produce spatial or temporal changes in behaviors of plant communities and may induce fluctuation or directional changes in community composition. In the field of conservation, biodiversity is often thoughtfulness within an area, being able to enumerate what is being conserved is essential for better planning and management. The important phyto-sociological attributes of community ecology are as frequency, abundance, density, IVI etc. These can be determined by quadrat method. The population of each species was counted by quadrat method during the year 2010 - 2012. At every site 5 quadrats of 5m X 5m size were randomly placed to quantify the fern species. Following phyto-sociological attributes were considered,

**Frequency:** It is the number of times a plant species is present in a given number of quadrats of a particular size. It was studied by sampling the study area at several places at random and recorded the name of species that occurred in each quadrates. It is calculated by the formula given below and is expressed in percentage (%)

\[
Frequency (F) = \frac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrats studied}} \times 100
\]

(Mishra, 1968 and Sharma, 2007).
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Abundance: It is the study of a number of individuals of different species in the community per unit area. It is measured by following equation and expressed in individuals/m² (Mishra, 1968; Sharma, 2007).

\[
\text{Abundance (A)} = \frac{\text{Total number of individuals of species in all quadrats}}{\text{Total number of quadrates in which the species occurred}}
\]

Density: It is an expression of the numerical strength of a species where the total number of each species in all the quadrats is divided by the total number of quadrates studied. Density is calculated by using the following formula and is presented as plant/m² (Mishra, 1968; Sharma, 2007).

\[
\text{Density (D)} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats studied}}
\]

Importance Value Index (IVI): Frequency, density and abundance provide data on an importance of a particular species in a community. But at the time a species with 100% frequency with wide distribution may contribute very less to the ecosystem or if the plants are of small sized and their number on one side is low or if the species with high density may be restricted to a particular area and its frequency is very low. In order to remove these discrepancies and to arrive at a single numerical value, Curtis (1959) developed an Importance Value Index which can be used to denote the ecological success of a species. The IVI of pteridophytes was carried out using the method given by Murty et al. (2011).

(a) Relative density: Relative density is the study of the numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

\[
\text{Relative density (R_d)} = \frac{\text{Number of individuals of the species}}{\text{Number of individual of all the species}} \times 100
\]
(b) **Relative frequency**: The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

Relative frequency ($R_d$) = \[
\frac{\text{Number of occurrences of the species}}{\text{Number of occurrences of all the species}} \times 100
\]

(c) **Relative abundance**: It is the study of the number of individuals of different species in the community per unit area. By quadrat method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

Relative abundance ($R_a$) = \[
\frac{\text{Total number of individuals of species in all quadrats}}{\text{Total number of quadrats in which the species occurred}} \times 100
\]

**Importance Value Index** = Relative density + Relative frequency + Relative Abundance

**Species Diversity Indices**: A diversity index is a statistic which is designed to determine the local components of a set consisting of various types of things. Diversity indices can be used in various turfs to assess the diversity of any population in which each component belongs to a unique group, type or species. The following diversity indices were considered in the present investigation.

**Shannon Index**

The Shannon index is also referred as the Shannon-Wiener Index or the Shannon-Weaver Index. It is used to measure diversity in Categorical data. The advantage of this index is that it takes into account the number of species and the evenness of the species. It was calculated by using statistical software “Biodiversity Pro”.

**Simpson's Diversity Index**

Simpson's Diversity Index ($D$) is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each
species. As species richness and evenness increase, diversity increases. The value ranges between 0 and 1, with this index, 1 represents an infinite diversity and 0, no diversity. It was calculated by using statistical software "Biodiversity Professional Version 2."

**Similarity Index:** Communities differ in number of ways, i.e. they can differ in species composition, species richness and species evenness. Hence, it is a comparison between different communities growing in different ecological sites. It is also known as Sorensen index or Sorensen's similarity coefficient. It is used for comparing the similarity in between two ecological sites. The Similarity Index was studied by using "Biodiversity Professional Version 2".

**MAPPING AND DOCUMENTATION**

The mapping and documentation of common, endemic, rare and threatened pteridophytes of the Satara district, classifying them into different categories, has been made based on our own field observations, data from herbarium collections and published literature. Also their geographic locations were demarcated using GPS (Garmin GPS-map 60CSx, USA) and the map was prepared manually.

**PHENOLOGY**

The phenology of pteridophytes were studied by observing the different life phases such as development of gametophyte and sporophyte in natural and records were kept for further discussion.