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FERN AND FERN ALLIES FROM SATARA DISTRICT (MAHARASHTRA)

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ABSTRACT

The present comprehensive survey of fern and fern allies from Satara district records 87 species belonging to 41 genera spread over 24 families of 16 orders. Amongst this a total of 10% species are endemic, whereas 55 % species were listed as Least Concerned (LC), 5% species were Critically Endangered (CE), 14 % species are Rare (R) and 6 % species were Near Threatened (TH). A total 96 % of pteridophytes fall in natural habitats while 4 % pteridophytes were in gardens.

Key Words : Rare, Threatened, Western Ghats, Pteridales

INTRODUCTION

The Pteridophytes are the paraphyletic group of plants consisting of four extant classes viz. Psilopsida, Lycopsida, Equisetopsida and Pteropsida (Pichi Sermolli,1958; Kramer & Tryon,1990). During the last six decades the conception of studies on pteridophytes has undergone incredible innovation in comparison to any other group of plants. Many new species and records have been reported during the last few decades from worldwide. In India there have been few comprehensive taxonomic works on pteridophytes, for example, A Handbook to the Ferns of British India, Ceylon and Malay Peninsula (Beddome, 1883), The ferns of north-western India (Hope 1899 – 1904), The Ferns of Bombay (Blatter and d'Almedia, 1922), A Census of The Indian Pteridophytes (Dixit, 1984), Pteridophyte flora of the Western Ghats – South India (Manickam and Irudayaraj, 1992), Companion to a Census of Indian Pteridophytes (Chandra, 2000), An Illustrated Fern Flora of West Himalaya (Khullar, 2000), Taxonomic Revision of Three Hundred Indian Subcontinental Pteridophytes (Fraser Jenkins, 2008), Field Guide of Fern and Fern allies from Northern Western Ghats of India (Patil, *et al.*, 2017), Annotated Checklist of Indian Pteridophytes Part I, II and III (Fraser-Jenkins *et al.*, 2017, 2019, 2020).

The floristic account of pteridophytes of the Northern Western Ghats has been given by Graham (1839). This formed the first systematic account of the pteridophytes of Bombay. It included 24 species of ferns and 6 species of lycopods. Dalzell (1852) added 4 new species of *Lycopodium* L., from the same region. Dalzell and Gibson (1861) have studied the flora of Bombay. Birdwood (1986 and 1987) studied the pteridophytes of Matheran and Mahabaleshwar. The pteridophyte of Northern Western Ghats was also studied by Blatter

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and d'Almeida (1922). They published a Fern Flora of Bombay. Mahabale (1938) had described a new species *Isoetes sahyadriensis* Mahable from Panchgani plateau. Later on Shende (1945) described another *Isoetes L.,* species viz., *Isoetes dixitii* Shende from same plateau. Parandekar (1966) has studied the Pteridophytes of Kolhapur region. Bole and Almeida (1977) discovered four new species of pteridophytes from Bombay presidency. Naiknaware (1983) has carried out the work on the fern flora of the Western Ghats. He listed 46 genera and 105 species of ferns belonging to 26 families. Almeida and Almeida (1985) have given a note on ferns on Maharashtra. Since last decade Patil and Dongare (2014), Patil *et al.*, (2013 - 2022) have been carrying out research work on various aspects of pteridophytes of Western Ghats. However, so far nobody has attempted the floristic composition of pteridophytes from Satara district. This emphasizes the necessity of the inventorization by continuous searching and re-examination of the pteridophytes of Satara district. Therefore, a study was undertaken to explore and record the diversity of pteridophytes from district Satara.

MATERIALS AND METHODS

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) specimens were collected, processed, preserved and identified.

Plant collection, processing and identification : Extensive floristic assessment was carried out during the study period (June 2010–December 2018). 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. Also each species were introduced in fernery of Department of Botany, Shivaji University, Kolhapur (Maharashtra). 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.

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), Misra (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,

Life Form	Description
Megacryptophytes:	> 4 ft. high
Mesocryptophytes:	2 – 4 ft. high
Microcryptophytes:	up to 2 ft. height
Lianas / Climbers	Mechanically dependent plant
Epiphytes	Plant growing on other plants

RESULTS AND DISCUSSION

The present comprehensive survey of Satara district records 87 species belonging to 41 genera of pteridophytes. These 41 genera are spread over 24 families of 16 orders **(Fig. 1 & Table 1)**. Four genera and 11 species were belongs to the group fern allies.

TABLE 1 : List of Pteridophytes from Satara district

Sr.No.	Name of Species
	Lycopodiaceae
1.	*Huperzia hamiltonii* (Spreng. ex Grev. and Hook.) Trevis.
	Selaginellaceae
2.	*Selaginella ciliaris* (Ritz.) Spring,
3.	*Selaginella crassipes* Spring.
4.	*Selaginella delicatula* (Desv. ex Poir.) Alston.
5.	*Selaginella repanda* (Desv. ex Poir.) Spring.
6.	*Selaginella tenera* (Hook and Grev.) Spring.
	Isoetaceae
7.	*Isoetes coromandelina* L. f.
8.	*Isoetes dixitii* Shende
9.	*Isoetes panchganiensis* Srivastava and Pant.
10.	*Isoetes sahyadrensis* Mahabale
	Equisetaceae
11.	*Equisetum ramosissimum* Desf.
	Ophioglossaceae
12.	*Botrychium lanuginosum* Wallich ex Hooker and Greville
13.	*Ophioglossum costatum* R. Br.
14.	*Ophioglossum gramineum* Willd.
15.	*Ophioglossum lusitanicum* L.
16.	*Ophioglossum nudicaule* L.
17.	*Ophioglossum parvifolium* Grev. and Hook

18.	*Ophioglossum petiolatum* Hook.
19.	*Ophioglossum reticulatum* L.
	Marattiaceae
20.	*Angiopteris helferiana* C. Presl.
	Osmundaceae
21.	*Osmunda huegeliana* C. Presl.
	Lygodaceae
22.	*Lygodium flexuosum* (Linn.) Sw.
	Marsileaceae
23.	*Marsilea minuta* L.
	Azollaceae
24.	*Azolla pinnata* subsp. *asiatica* R.M.K. Saunders and K. Fowler.
	Salveniaceae
25.	*Salvinia molesta* D. Mitch.
	Polypodiaceae
26.	*Lepisorus nudus* (Hook) Ching.
27.	*Leptochilus decurrens* Blume.
28.	*Microsorum membranaceum* (D. Don) Ching.
29.	*Microsorum punctata* (L.) Copel.
30.	*Pyrrosia lanceolata* (Wall.) Farw
	Pteridaceae
31.	*Actiniopteris radiata* (Sw.) Link.
32.	*Anogramma leptophylla* (L.) Link.
33.	*Ceratopteris thalictroides* (L.) Brongn
34.	*Cheilanthes albomarginata* C.B.Clarke
35.	*Cheilanthes anceps* Blanf.,
36.	*Cheilanthes bicolor* (Roxb.) Fraser-Jenk.
37.	*Cheilanthes rufa* D. Don
38.	*Cheilanthes tenuifolia* (Burm. f.) Sw.
39.	*Pityrogramma calomelanos* (L.) Link
40.	*Pteris biaurita* L.
41.	*Pteris blumeana* J. Agardh

42.	*Pteris heteromorpha* Fee
43.	*Pteris liniaris* Poir.
44.	*Pteris pellucida* C. Presl.
45.	*Pteris venusta* Kunze
46.	*Pteris vittata* L.
Adiantaceae	
47.	*Adiantum capillus-veneris* L.
48.	*Adiantum caudatum* L.
49.	*Adiantum incisum* Forssk.
50.	*Adiantum philippense* L.
51.	*Adiantum poiretii* Wikstr.
52.	*Adiantum raddianum* C. Presl.
Hymenophyllaceae	
53.	*Crepidomanes latealatum* (Bosch) Copel
Dennstaedtiaceae	
54.	*Microlepia speluncae* (L.) T. Moore
55.	*Pteridium revolutum* (Blume) Nakai
Lindsaeaceae	
56.	*Lindsaea ensifolia* Sw.
57.	*Lindsaea heterophylla* Dryand.
Thelypteridaceae	
58.	*Thelypteris dentata* (Forssk.) E. P. St. John
59.	*Thelypteris parasitica* (L.) Tardieu
Aspleniaceae	
60.	*Asplenium decrescens* Kunze
61.	*Asplenium inaequilaterale.* Willd.
62.	*Asplenium polyodon* G. Forst.
63.	*Asplenium yoshinagae* Makino
Woodsiaceae	
64.	*Athyrium falcatum* Bedd.
65.	*Athyrium hohenackerianum* (Kunze) T. Moore
66.	*Athyrium micropterum* Bedd.

67.	*Athyrium parasnathense* (Kunze) T. Moore
68.	*Athyrium pectinatum* (Wall. ex Mett.) T. Moore
69.	*Deparia petersenii* (Kunze) M. Kato
70.	*Diplazium esculentum* (Retz.) Sw.
71.	*Hypodematium crenatum* (Forssk.) Kuhn. subsp. *crenatum*
	Dryopteridaceae
72.	*Dryopteris cochleata* (Buch. Ham. ex D. Don) C. Chr.
73.	*Dryopteris sparsa* (Buch. Ham. ex D. Don) Kuntze
74.	*Tectaria paradoxa* (Fee) Sledge
75.	*Tectaria coadunata* (Wall. ex Hook. and Grev.) C. Chr.
	Lomariopsidaceae
76.	*Bolbitis appendiculata* var. *asplenifolia* (Bory) Sledge
77.	*Bolbitis angustipinna* (Hayata) H. Ito
78.	*Bolbitis presliana* (Fee) Ching
79.	*Bolbitis virens* (Wall. ex Hook. and Grev.) Schott
80.	*Bolbitis subcrenatoides* Frazer Jenkins
81.	*Bolbitis* X *prolifera* (Bory) C. chr. and Tardieu-Blot
	Davalliaceae
82.	*Araiostegia pulchra* (D. Don) Copel
83.	*Leucostegia truncata* Frazer Jenkins
	Olendraceae
84.	*Nephrolepis cordifolia* (L.) Presl.
85.	*Nephrolepis exaltata* (L.) Schott.
86.	*Nephrolepis undulata* (Afzel.) J.Sm.
	Blechnaceae
87.	*Blechnum orientale* L.

Amongst the order Pteridales and Aspidiales had maximum number of genera. It was also the most speciose order **(Fig. 2).**

Families with the largest genera were Pteridaceae and Polypodiaceae (**Fig. 3)**. Similarly, most speciose families found in Satara district were Pteridaceae, Polypodiaceae and Woodsiaceae. Pteridaceae is the dominant family in the Satara district, followed by Polypodiaceae, Woodsiaceae, Dryopteridaceae, and Davalliaceae,

Maximum pteridophytes were collected from Mahabaleshwar, Panchagani, Kas

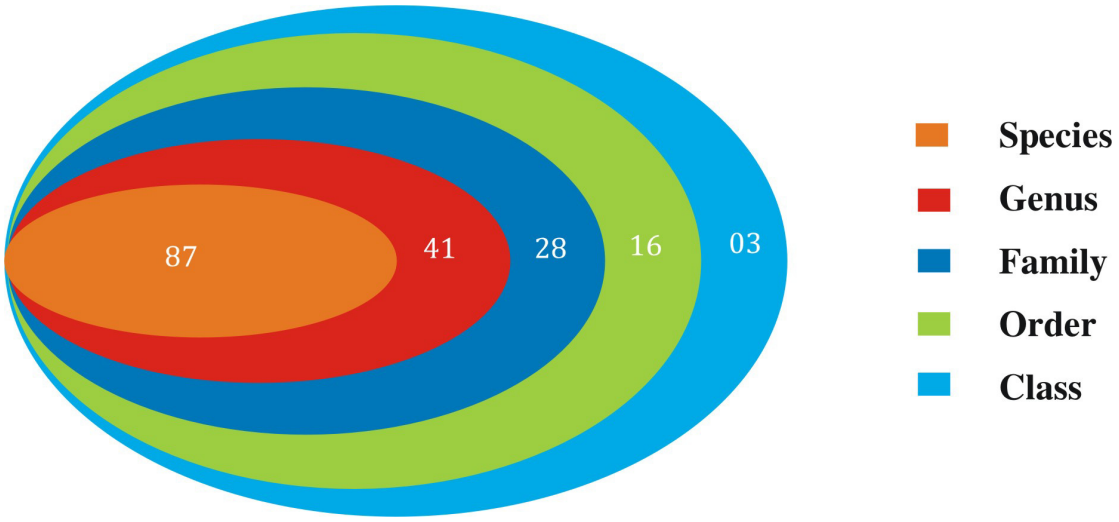

Fig. 1. Diversity of Pteridophytes in Satara district (Maharashtra)

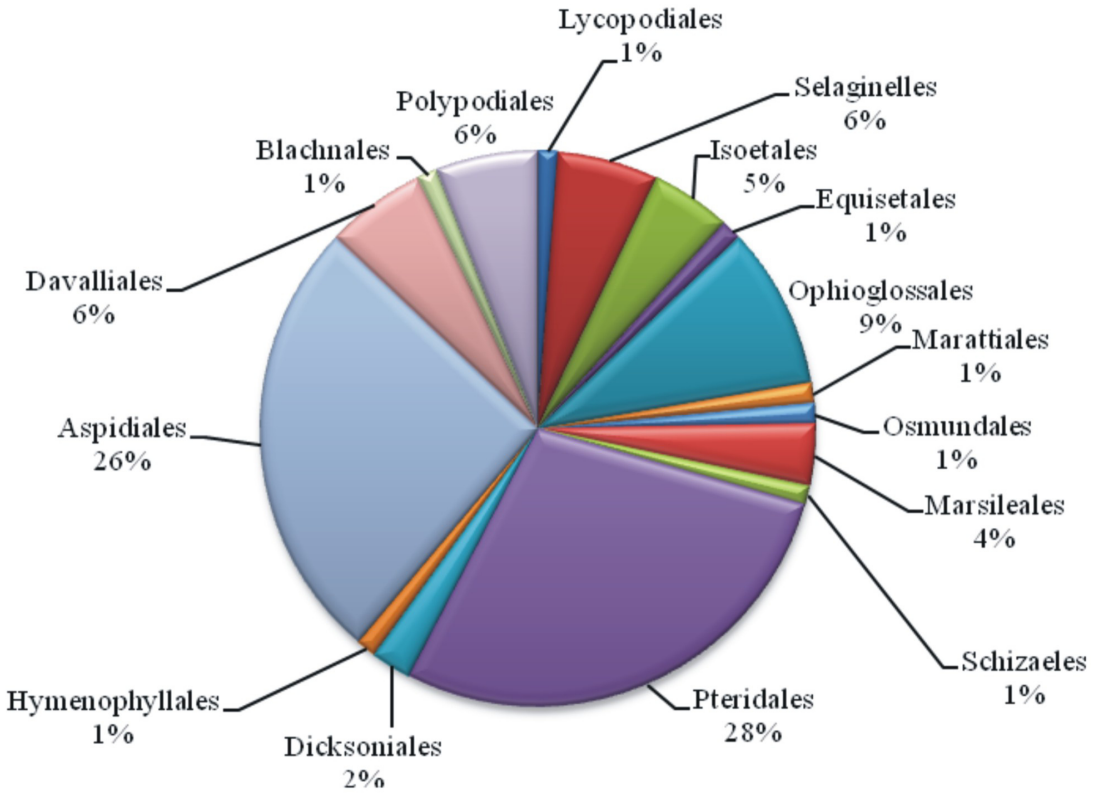

Fig. 2. Pie chart showing number (in %) of species in various orders of Pteridophytes

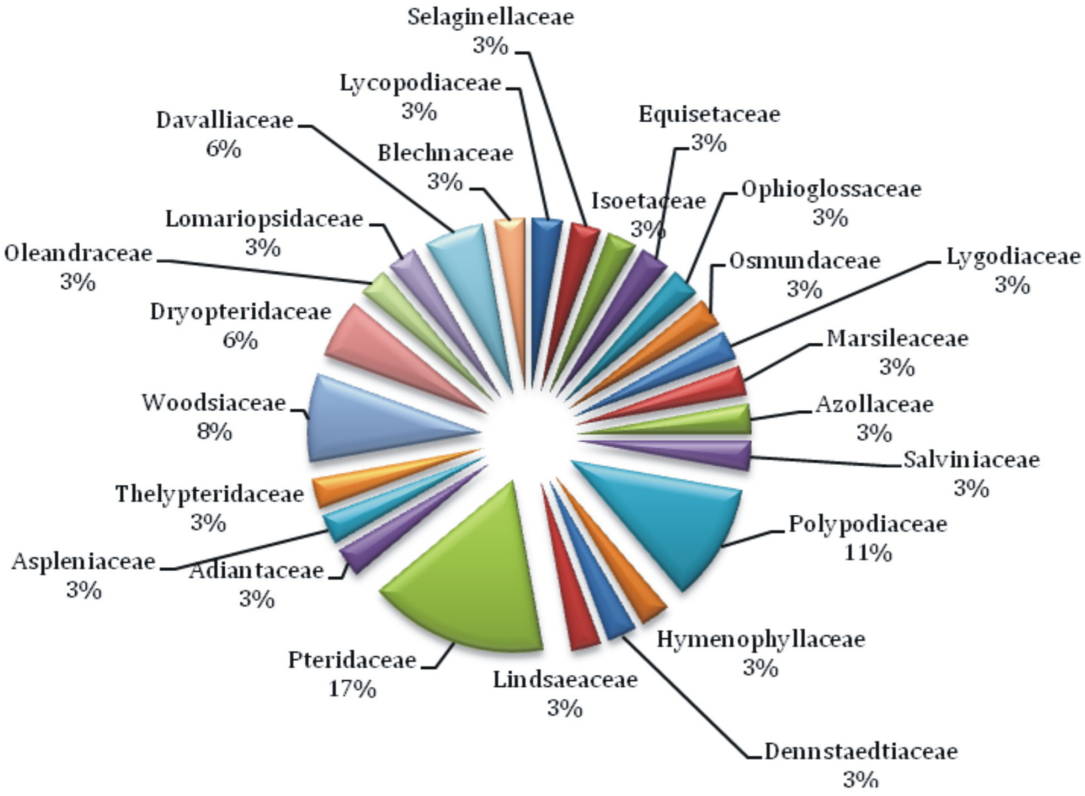

Fig. 3. Species diversity (in %) in various families of Pteridophytes

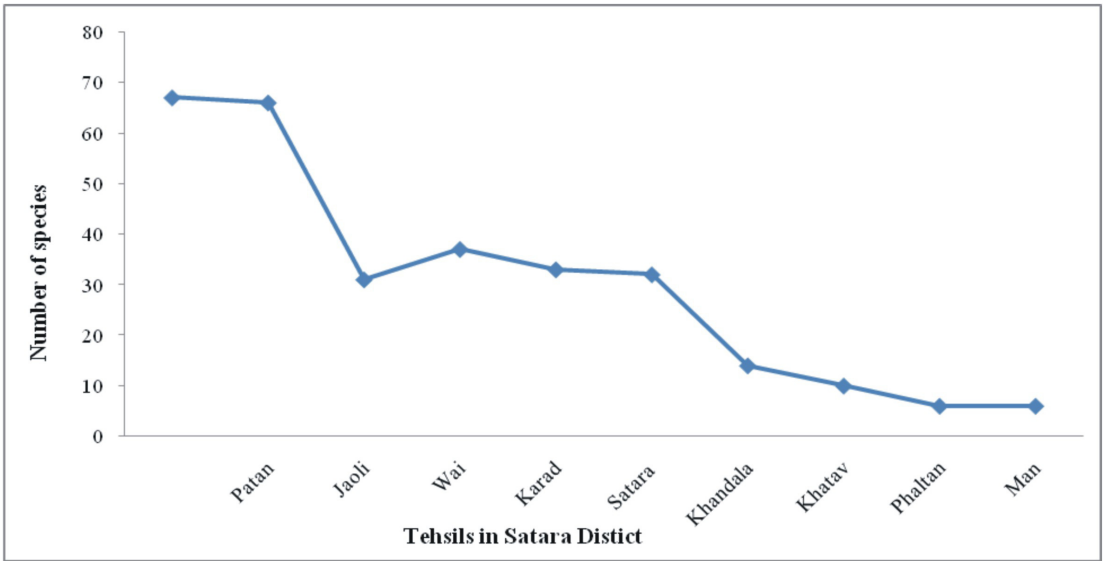

Fig. 4. Distribution of the taxa in different Tehsils of Satara district (Maharashtra)

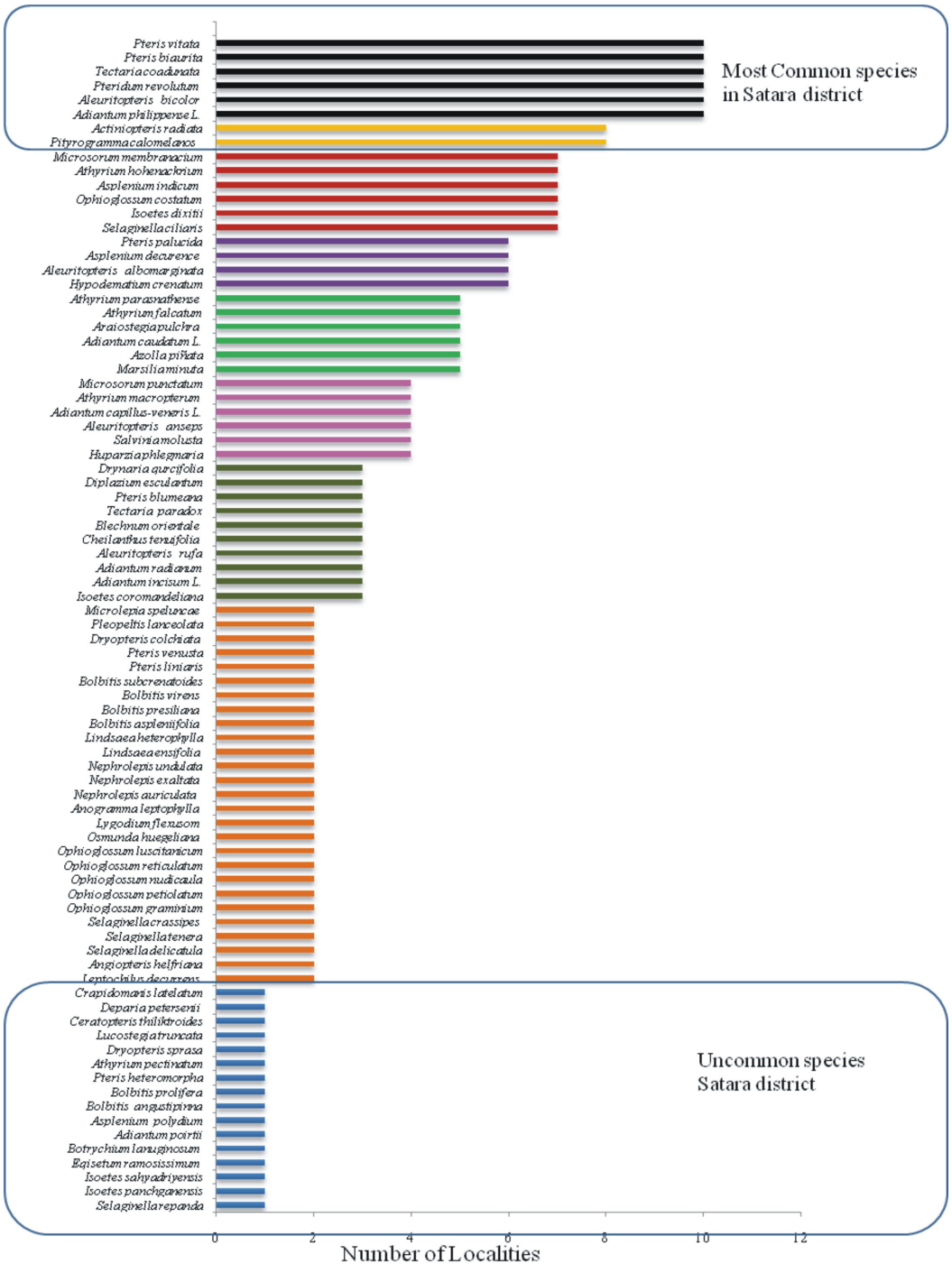

Fig. 5. Species richness of the pteridophyte taxa in Satara district (Maharashtra)

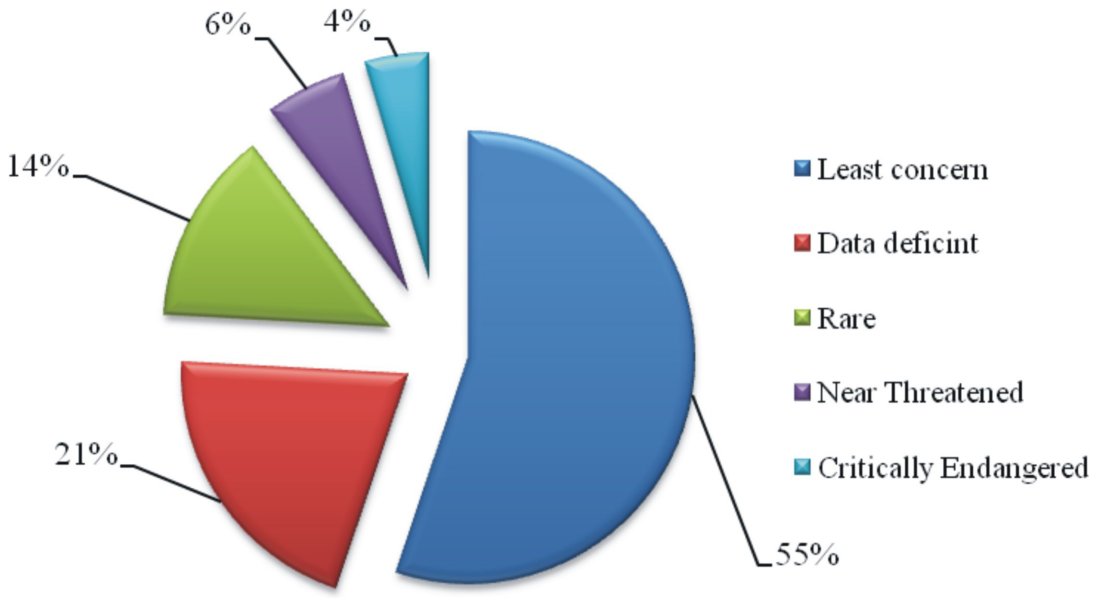

Fig. 6. Status of taxa (in %) in Satara district

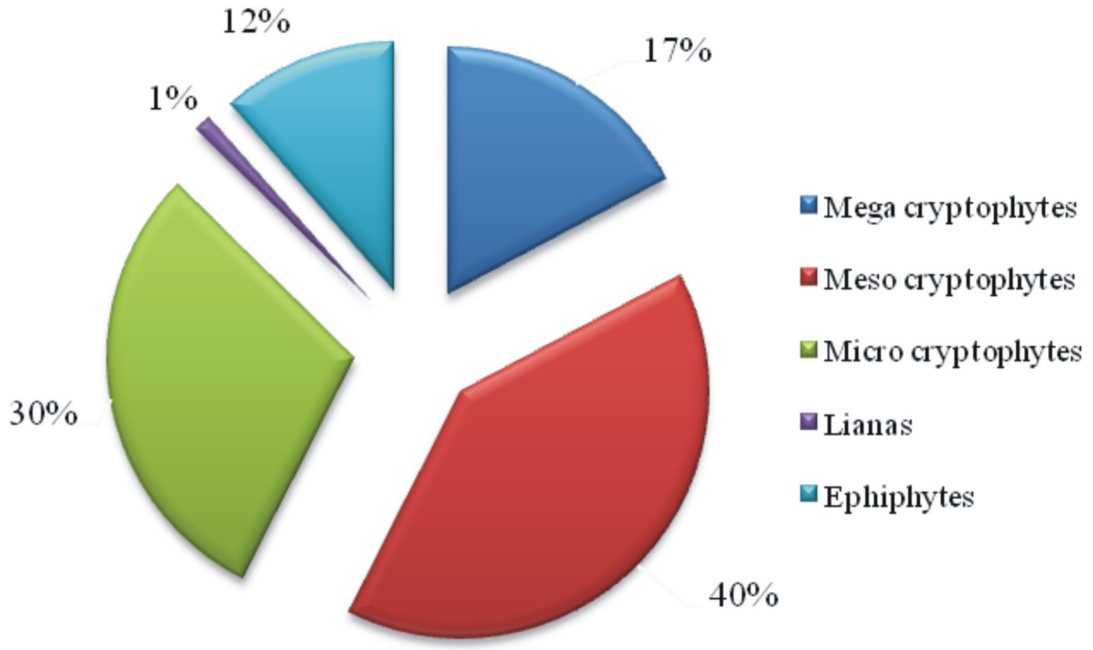

Fig. 7. Spectrum of life forms of pteridophytes in the study area

and Patan where luxuriant growth of pteridophytes occurs because of high rainfall, while the minimum from eastern region of the taluks like Khandala, Man, Khatav and Phaltan (**Figure 4**).

The species viz., *Adiantum philippense, Actiniopteris radiata, Aleuritopteris bicolor, Pteridium revolutum, Pityrogramma calomelanos, Pteris biaurita, P. vitata,* and *Tectaria coadunata* were collected from throughout the district and were supposed to be abundant in the district while some species viz., *Adiantum poiretii, Asplenium polyodon, Athyrium pectinatum, Bolbitis angustipinna, Bolbitis* x *prolifera, Botrychium lanuginosum, Crepidomanes latealatum, Ceratopteris thalictroides, Deparia petersenii, Dryopteris sparsa, Equisetum ramosissimum, Isoetes sahyadriensis, I. panchganensis, Leucostegia truncate, Pteris heteromorpha,* and *Selaginella repanda* were collected from a single locality and they are presumably rare in the district **(Fig 5).** The earlier reported 9 species, viz. *Adiantum hispidulum, Asplenium trichomanes, Ctenopteris subfalcata, Isoetes panchananii, Lycopodium japonicum, Pteris ensiformis, Selaginella brachystachya, S. involvens and S. panchghaniana,* were not collected during present investigation.

ENDEMIC TAXA

Among the species reported from Satara district eight species, viz. *Athyrium parasnathense, Bolbitis presliana, B. subcrenatoides, Isoetes dixitii, I. panchganensis, I. sahyadriensis, Selaginella tenera,* and *Tectaria paradoxa* were found to be endemic to the southern India. Recently, Fraser – Jenkins (2008) had given the list of endemics and pseudo-endemics pteridophytes of India. According to him only 47 Indian pteridophyte species are endemic, less than 10% of those reported previously. He further stated that, remaining several species are rather doubtfully endemic, mainly due to unresolved taxonomic status, Any disturbance or imbalance in their narrowly confined ecosystems is liable to lead to their extinction (Fraser – Jenkins, 2008). With the increase in the population, the demand of land and natural resources increases, that creates pressure on the plant species present in that area. Increasing exploitation of land and natural resources makes many species rare, endangered and may finallycause extinction of some taxa. Based on IUCN Red List Category and Criteria Version 2013.2 (IUCN, 2013), out of total number of taxa recorded during present study a total of 55 % species were listed as Least Concerned (LC), 5% Critically Endangered (CE), 14 % Rare (R) and 6 % species Near Threatened (TH) **(Fig. 6).** However, the total of 21 % species are not evaluated (NE).

LIFE FORMS

The study of life forms reveal that 40% recorded species were of mesocryptophytes, followed by microcryptophytes (30%), megacryptophytes (17%), epiphytes (12%) and lianas (1%) as shown in **Fig. 7**.

THREATS IN THE STUDY AREA

Natural as well as anthropogenic pressure on the wealth of pteridophytes may lead to decline in their diversity and species may become rare, endangered and threatened (RET).

Biological threats : During the present investigation it was found that an insect larva was vigorously growing on majority of ferns. This larva is feeding on fronds of ferns and creates injury to frond.

Forest fragmentation : Fragmentation is a dynamic process in which the habitat is gradually abridged into smaller patches that turn out to be more isolated and progressively more affected by edge effects (Forman & Godron, 1986; Reed *et al.*, 1996; Franklin, 1998 and McGarigal, 2000). Habitat fragmentation is anticipated as one of the main threats to biological diversity. However, the ecological magnitudes of forest fragmentation may depend on the spatial conûguration of the fragments within the landscape and how the conûguration changes both temporally and spatially (Drinnan, 2005). It is the process of breaking up large patches of forest into smaller pieces. This can be caused by many things, from clearing forest for roads or developmental activities, viz. Construction of buildings, colleges, hotels and restaurants.

Above activities are common in Wai, Kas, Thoseghar, Sajjangadh, Panchgani and Mahabaleshwar. If this process continues, the ability of the remnant forests to maintain their original diversity of pteridophytes and ecological processes will be significantly reduced.

Windmill Installation : It is one of the most common cause of forest fragmentation in Satara district. It is common on lateritic plateaus and hilltops regions. Major area of western part of Satara district is covered by windmills. Approximately more than 15% area of Western Ghats of Satara district is occupied by windmills. An RTI application filed by Karad based non-profit Creative Nature Friends in March, 2013 revealed that 1,240 windmills in Satara lie inside the sanctuary precincts. This will affect the diversity of pteridophytes growing on plateaus or along the seasonal streams on plateaus and hilltops regions.

Tourisms : Similarly, large number of tourists visiting to Kas and Panchagani plateaus every year. Hence, there is tremendous anthropogenic pressure on pteridophytes growing on plateaus like *Isoetes dixitii, I, coromandeliana, I. sahyadriensis, I. panchganensis, Ophioglossum costatum, O. lusitanicum, O. parvifolium, O. nudicaule, O. gramineum, O. petiolatum* and *O. reticulatum*. Tableland plateau, Panchgani alone serves 3 – endemic *Isoetes species*. If the activity is continued, all these three species of *Isoetes*, viz. *I. panchganensis, I. dixitii* and *I. sahyadriensis* will become extinct.

Land slides : Another major big issue is land slides. Especially diversity of pteridophytes is more along the road sides in ghat sections. Due to heavy rainfall or road enlargement the hill edge sliding has occurred frequently. This has leads to decrease in the diversity of pteridophytes.

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