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DIVERSITY OF PTERIDOPHYTES IN WESTERN GHATS- A REVIEW

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ABSTRACT

Pteridophytes are vascular cryptogams that dominated the earth 250 million years ago. Currently, there are 13,600 species of pteridophytes around the world, and is the second most dominant plant group. In India, there are 1200 pteridophyte species with 70 families and 192 genera. The pteridophyte hotspots in India are the Himalayas, Western Ghats, Eastern Ghats, Central India, and Andaman and the Nicobar Islands. The Western Ghats occupies only 6% of the Indian landmass and still holds a pteridophyte diversity of 383 species. Fern and fern allies are highly sensitive to changes in their natural habitat, thus habitat destruction, anthropogenic influences, climate change, etc., are causing a fast decline in their population. Epiphytic species are easily destroyed due to the felling of trees and because of this at present 41- 43% of epiphytic pteridophytes in India are reported to be threatened. It necessitates the frequent analysis of the pteridophyte flora of a region to ensure the existence of its species diversity. The potential of in-vitro and ex-situ conservation techniques can be explored for the conservation of threatened pteridophyte species.

Keywords: *Diversity, pteridophytes, Western Ghats, conservation status*

INTRODUCTION

Most of the flora in the present world is comprised of seed-bearing plants known as angiosperms, but around 280- 230 million years ago, seedless vascular plants, pteridophytes dominated our planet surface (Mehra, 1961 and Bir, 1987, 1994). This is one of the most primitive plant groups and is known as the 'vascular cryptogams'. They are also known as 'ferns and fern allies'. It is estimated that pteridophytes originated during the Silurian and Devonian periods, and became the dominant plant group in the carboniferous period. They played a massive role in the establishment of plants on land during these periods. Due to their high reproductive ability and simple genetic makeup, pteridophytes quickly invaded the seashores, riverbanks, and places with very little disturbances (Kenrick and Crane, 1997). In the past, there were large fern trees that showed secondary growth, but at present, the numbers of tree ferns are very few. Currently, pteridophytes constitute the second largest floral group.

Fern and fern-allies can be seen in humid and shady places. The common types of forests that act as habitat for pteridophytes are tropical, subtropical and moist-deciduous forests. Geographically ferns can be seen from sea level to the highest mountains(Dixit, 2000). They are highly sensitive to microclimatic conditions, thus even small disturbances in the climatic and other environmental factors can cause their extinction from the natural habitats, and hence the existence of pteridophytes is largely dependent on the existence of these forests. Pteridophytes can also be seen as epiphytes on trees, lithophytes on the crevices of rocks, and even as hydrophytes completely immersed in water.

India is a subcontinent that hosts a wide variety of habitats. The climatic condition in India varies from the hot and dry Thar Desert in the North- West to the wettest place on the earth, Mawsynram in the North- East. The country is home to the dry deciduous forest in its southern part and also accommodates the Great Himalayas in the North. In this way, eachpart of this subcontinent shows a variety of habitat for pteridophytes and a large portion of these species are endemic. The main hotspots of pteridophyte diversity in India are:

- The Eastern Himalayas
- The Western Himalayas
- The Western Ghats
- The Eastern Ghats
- Central India
- Andaman and Nicobar Islands

According to Moran (2008), there are13,600 species of ferns globally, and of this, approximately 1200 species with 70 families and 192 genera are seen in India (Dixit, 1984;2000;Sukumaran *et al.*, 2009;Dudani *et al.,* 2011; Patil *et al.,*2013;Kavitha *et al.,* 2017; Patil *et al.,* 2016). In the year 1883**,** Beddome published the most authentic work on Indian pteridophytes known as Beddome's "Handbook of the ferns of British India, Ceylon, and the Malay Peninsula" and this formed the foundation for pteridophyte taxonomic studies in India.

The current paper is a review of the studies of pteridophyte diversity undertaken along the Western Ghats of India till 2019. The most recent review of pteridophyte flora of Western Ghats was done in 2011 by Dudani*et al*., and it gave a comprehensive list of 277 species. This review intends to summarize and unify the existing study results

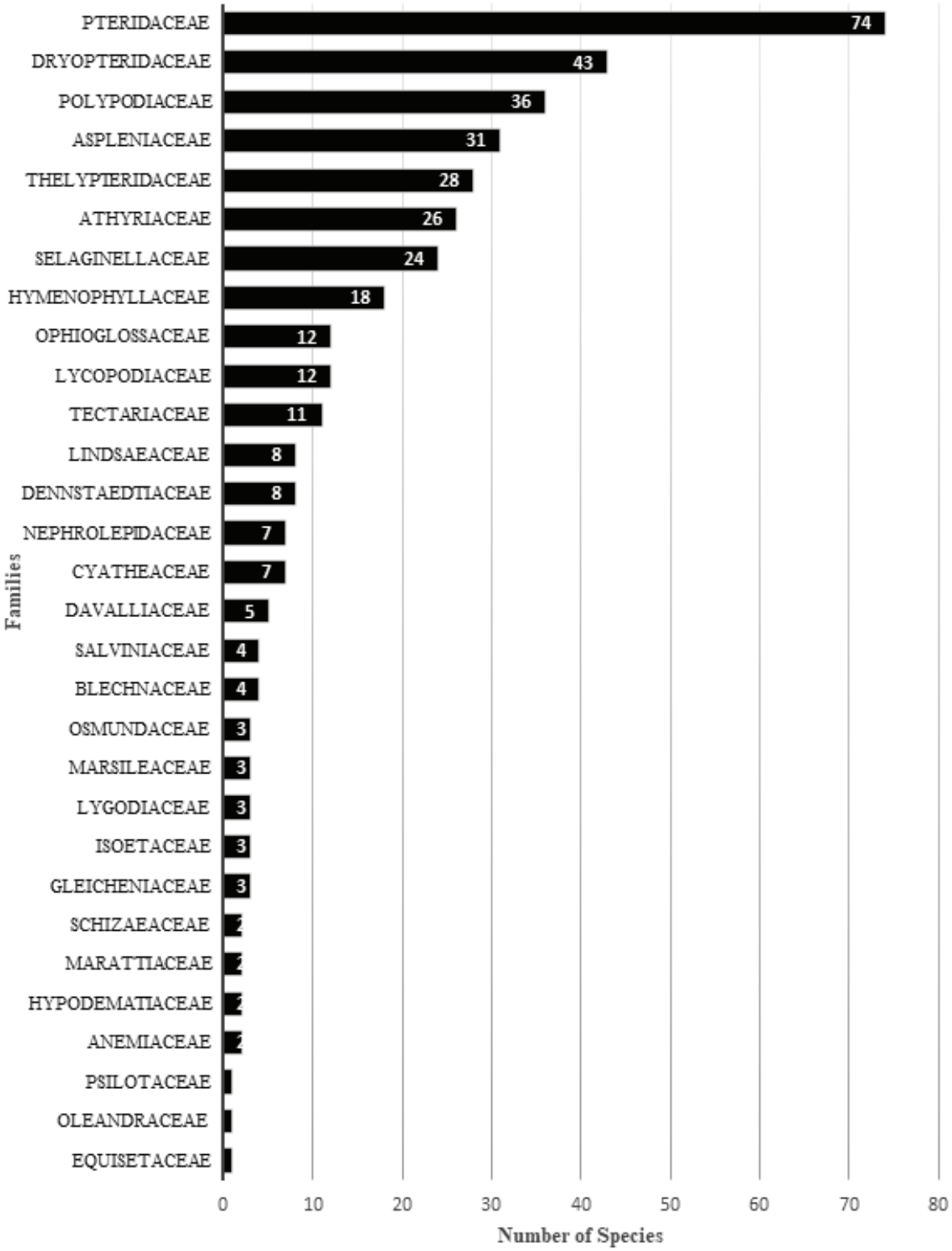

Figure 1: Family wise distribution of pteridophytes in Western Ghats

for a detailed analysis of the pteridophyte flora of the six states along the Western Ghats. The conservation status of the pteridophytes is also analyzed so as to provide a clear picture about the extent of damage the pteridophyte population has suffered until now and to emphasize the necessity of developing immediate action plan to protect the species that are on the verge of extinction.

The Western Ghats

The Western Ghats, one among 34 global biodiversity hotspot centers, is rich in floral and faunal diversity with great endemism throughout the plant and animal kingdom (Daniels, 2003 and Sreekantha *et al.,* 2007). The criteria for a region to be recognized as a "Biodiversity Hotspot" by Conservation International (2005) is the presence of a minimum of 1500 endemic species of vascular plants and the loss of at least 70 percent of its original habitat. Due to the distribution of endemism, Nayar and Geevarghese (1993)compared the ecological niches in the Western Ghats to be similar to that of an Island. The mountain chain has perennial streams, rivers, evergreen forests, and high altitude sholas, thus making a perfect habitat for ferns

Table 1: State wise distribution of pteridophytes in Western Ghats and their conservation status

Sl. no	Name of the species	Distribution in each states ('+' denotes presence)						IUCN status
		Kerala	Tamil Nadu	Karnataka	Maharashtra	Goa	Gujarat	
1	*Abrodictyum obscurum* (Blume) Ebihara & K. Iwats.	+		+				
2	*Acrostichum aureum* L.	+	+			+		LC
3	*Actiniopteris radiata* (J. Koenig ex Sw.) Link	+			+		+	
4	*Actinostachys digitata* (L.) Wall. ex C. F. Reed	+						EN
5	*Adiantum capillus veneris* L.	+	+	+	+	+		LC
6	*Adiantum caudatum* L.		+					
7	*Adiantum concinnum* Humb. & Bonpl. ex Willd.		+	+				
8	*Adiantum hispidulum* Sw.	+	+					
9	*Adiantum incisum* Forssk.		+	+	+		+	
10	*Adiantum incisus* subsp. *indicum* (Ghatak) Fraser-Jenk.	+						
11	*Adiantum latifolium* Lam.	+	+	+				
12	*Adiantum monochlamys* Eaton	+						
13	*Adiantum nagnum*		+					
14	*Adiantum peruvianum* Klotzsch					+		
15	*Adiantum philippense* L.	+			+	+		
16	*Adiantum philippense* subsp. *philippense*	+	+			+		
17	*Adiantum poiretii* Wikstr.	+	+		+			
18	*Adiantum raddianum* C. Persl	+	+	+	+			
19	*Adiantum soboliferum* Wall.	+	+	+	+		+	CR
20	*Adiantum tenerum* Sw.	+						
21	*Adiantum unilateral* var. birii	+	+					
22	*Adiantum venustum* D.Don	+						
23	*Adiantum zollingeri* Mett. ex Kuhn		+					
24	*Aglaomorpha quercifolia* (L.) Hovenkamp & S. Linds.	+		+		+		
25	*Aleuritopteris albomarginata* (C.B. Clarke) Ching				+	+		
26	*Aleuritopteris anceps* (Blanf.) Panigrahi			+	+			
27	*Aleuritopteris bicolor* (Roxb.) Fraser-Jenk.		+	+	+		+	
28	*Aleuritopteris farinosa* (Forsk.) Fée	+	+			+	+	
29	*Aleuritopteris formosana* (Hayata) Tagawa		+					
30	*Aleuritopteris tenuifolia* (Burm. f.) Sw.			+				
31	*Alsophila gigantea* Wall. ex Hook.	+	+	+		+		
32	Alsophila nilgirensis (Holttum) R.M.Tryon	+	+	+				LC
33	*Alsophila nllgirensls var. lobatus*		+					
34	*Alsophila spinulosa* (Wall. ex Hook.) R. M. Tryon	+	+	+		+		
35	*Alsophila walkerae* (Hook.) J. Sm.		+					
36	*Ampelopteris prolifera* (Retz.) Copel			+		+		
37	*Anemia schimperiana* subsp. *wightiana* (Gardner) Fraser-Jenk.		+					EN
38	*Anemia tomentosa* (Sav.) Sw.	+	+					
39	*Angiopteris evecta* (G. Forst.) Hoffm.	+	+			+		
40	*Angiopteris helferiana* C. Presl.	+		+	+			

Table 1: Continued...

41	*Anisocampium cumingianum* C. Persl	+	+					
42	*Anogramma leptophylla* (L.) Link	+			+			EN
43	*Antrophyum plantagineum* (Cav.) Kaulf	+		+				
44	*Antrophyum reticulatum* (G. Forst.) Kaulf.		+					
45	*Arachniodes amabilis* (Blume) Tindale	+						
46	*Arachniodes aristata* (G. Forst.) Tindale	+	+	+				
47	*Arachniodes coniifolia* (T. Moore) Ching		+					
48	*Arachniodes sledgei* Fraser-Jenk.			+				
49	*Arachniodes tripinnata* (Goldm.) Sledge	+		+				
50	*Arthropteris palisotii* (Desv.) Alston		+					CR
51	*Asplenium* aequibasis(C.Chr.) J.P.Roux		+	+				LC
52	*Asplenium aethiopicum* (Burm.f.) Bech.	+		+				VU
53	*Asplenium affine* Sw.		+					EN
54	*Asplenium auritum* Sw.	+	+					CR
55	*Asplenium bipinnatifidum* Baker		+					
56	*Asplenium cheilosorum* Kunze ex Mett.	+	+	+				
57	*Asplenium crinicaule* Hance	+	+	+				
58	*Asplenium decrescens* Kunze	+	+	+	+			
59	*Asplenium ensiforme* Wall.			+				
60	*Asplenium exiguum* Bedd.	+	+					EN
61	*Asplenium fissum* Willd.	+	+					NT
62	*Asplenium formosum* Willd.	+	+	+		+		LC
63	*Asplenium grevillei* Wall.	+						VU
64	*Asplenium hindusthanensis* Bir.		+					
65	*Asplenium inaequilaterale* Bory ex Willd.	+	+	+	+			
66	*Asplenium indicum* Sledge	+						
67	*Asplenium mysorense* Roth	+	+	+				NT
68	*Asplenium nidus* L.	+	+					
69	*Asplenium normale* D. Don		+					
70	*Asplenium phyllitidis* D.Don	+		+				
71	*Asplenium polyodon* G. Forst.	+	+		+			
72	*Asplenium scalare* Rosenst.	+						CR
73	*Asplenium semcula* Fee.	+						
74	*Asplenium tenerum* G. Forst.	+						NT
75	*Asplenium trichomanes* L.	+						LC
76	*Asplenium unilateral* Lam.	+	+			+		
77	*Asplenium yoshinagae* Makino subsp. *indicum* (Sledge) Fraser-Jenk.			+	+			
78	*Asplenium zenkerianum* Kunze	+						
79	*Athyrium anisopterum* Christ		+					
80	*Athyrium dubium* Ching		+					
81	*Athyrium falcatum* Bedd.		+	+	+			
82	*Athyrium filix-femina* (L.) Roth	+						LC
83	*Athyrium ghost*	+						
84	*Athyrium hohenackeranum* (Kunze) T. Moore	+		+	+	+	+	
85	*Athyrium micropterum* Fraser-Jenk.				+			

Table 1: Continued...

86	*Athyrium parasnathense* (C. B. Clarke) Ching ex Mehra & Bir		+		+			
87	*Athyrium pectinatum* (Wall. ex Hope) C. Presl		+		+			
88	*Athyrium praetermissum* Sledge		+					
89	*Athyrium puncticaule*(Blume) Moore		+					
90	*Athyrium schipmeri* Moug.ex Fee.		+					
91	*Athyrium solenopteris* (Kunze) T. Moore		+	+			+	LC
92	*Athyrium tozanense* (Hayata) Hayata	+	+					
93	*Austroblechnum colensoi* (Hook. fil.) Gasper & V. A. O. Dittrich		+					
94	*Azolla microphylla* Kaulf.		+					LC
95	*Azolla pinnata* R.Br.	+	+	+	+		+	LC
96	*Blechnopsis orientalis* (L.) C. Presl	+	+	+	+	+		
97	*Bolbitis* × *terminans* (Wall.) Gandhi & Fraser-Jenk.			+	+	+		
98	*Bolbitis angustipinna* (Hayata) H. Itô.		+		+	+		
99	*Bolbitis appendiculata*(Willd.) Iwatsuki	+	+	+		+		LC
100	*Bolbitis asplenifolia* (Bory) K. Iwats.			+	+	+		DD
101	*Bolbitis prolifera* (Bory) C. Chr. & Tardieu ex Tardieu & C. Chr.		+	-	+			
102	*Bolbitis repanda* (Blume) Schott	+	+	+	+			NT
103	*Bolbitis semicordata* (Moore) Ching	+	+	+	-	+		VU
104	*Bolbitis subcrenata*(Hook & Grev.) Ching	+						LC
105	*Bolbitis thommankunthiana*		+					
106	*Bolbitis virens* (Wall. *ex* Hook. and Grev.) Schott		+		+			
107	*Bosmania membranacea* (D. Don) Testo	+	+	+	+	+		
108	*Ceratopteris thalictroides* (L.) Brongn.	+	+	+	+	+	+	LC
109	*Cheilanthes viridis* (Forsk.) Sw.		+					
110	*Cheilanthes tenuifolia* (Burm. fil.) Sw.	+	+	+	+	+		
111	*Christella meeboldii* (Rosenst.) Holttum					+		
112	*Christella papilio* (C. Hope) Holttum		+			+		
113	*Christella parasitica* (L.) K. Iwats.	+	+	+		+		EN
114	*Christella quadrangularis* (Fée) Holttum		+	+				
115	*Crepidomanes bipunctatum* (Poir.) Copel.		+					
116	*Crepidomanes campanulatum* (Roxb.) Panigrahi & Sarn. Singh	+		+				
117	*Crepidomanes christii* (Copel.) Copel.	+						
118	*Crepidomanes intramarginale* (Hook. & Grev) Copel	+	+	+		+		EN
119	*Crepidomanes latealatum* (Bosch) Copel.				+			
120	*Crepidomanes minutum* (Blume) K. Iwats.	+		+				
121	*Crepidomanes proliferum var.prollferum*		+					
122	*Cyathea crinita* Copel.	+						EN
123	*Cyclosorus ciliatus* (Wall. ex Benth.) Panigrahi		+					LC
124	*Cyclosorus interruptus* (Willd.) H. Itô	+	+	+		+	+	LC
125	*Cyrtomium caryotideum* (Wall. ex Hook. & Grev.) C. Presl		+					
126	*Cyrtomium micropterum* (Kunze) Ching		+					EN
127	*Davallia bullata* Wall.	+	+					
128	*Davallia denticulata* (Burm. fil.) Mett. ex Kuhn	+						VU
129	*Davallia hymenophylloides* (Blume) Kuhn	+	+					EN

Table 1: Continued...

130	*Davallia pulchra* D. Don	+		+	+	+		
131	*Davallia repens* (L. fil.) Kuhn		+					VU
132	*Deparia lancea* (Thunb.) Fraser-Jenk.		+					
133	*Deparia petersenii* (Kunze) M. Kato		+		+			
134	*Dicranopteris linearis* (Burm.f) var. *sebastiana* Panigrahi & Dixit		+					
135	*Dicranopteris linearis* (Burm.f) var. *tenuis* Manickam & Irudayaraj		+					
136	*Dicranopteris linearis* (Burm.f.) Underwood.	+	+	+		+		LC
137	*Didymoglossum bimarginatum* (Bosch) Ebihara & K. Iwats.	+	+					
138	*Didymoglossum exiguum* (Bedd.) Copel.		+					EN
139	*Didymoglossum henzaianum* (Parish ex Hook.) Mazumdar	+						EN
140	*Didymoglossum mindorense* (Christ) K. Iwats.	+						CR
141	*Didymoglossum sublimbatum* (Müll. Berol.) Ebihara & K. Iwats.	+		+				VU
142	*Diphasiastrum wightianum* (Wall. ex Hook. & Grev.) Holub	+	+					
143	*Diplazium beddomei* C. Chr.	+	+					CR
144	*Diplazium brachylobum* (Sledge) Manickam & Irudayaraj			+				
145	*Diplazium dialatulum* Bl.	+						
146	*Diplazium esculentum* (Retz.) Sw.	+	+	+	+	+		LC
147	*Diplazium leptophyllum* Christ	+	+					VU
148	*Diplazium muricatum* (Mett.) Alderw.	+						
149	*Diplazium polypodioides* Blume	+	+	+				
150	*Diplazium sylvaticum* (Bory) Sw.	+						
151	*Diplazium travancoricum* Bedd.	+	+					NT
152	*Doodia dives* Kunze.		+					
153	*Doryopteris concolor* (Langsd. & Fisch.) Kuhn	+	+	+				
154	*Dryopteris atrata* (Wall) Ching	+	+					
155	*Dryopteris austroindica* Fraser-Jenk.			+				EN
156	*Dryopteris cochleata* (D. Don) C. Chr.	+	+	+	+			
157	*Dryopteris deparioides* subsp. *concinna* (Bedd.) C. Chr.		+					CR
158	*Dryopteris hirtipes* (Blume) Kuntze	+		+				
159	*Dryopteris juxtaposita* Christ		+	+				
160	*Dryopteris macrochlamys* (Fée) Fraser-Jenk.		+					
161	*Dryopteris odontoloma* (Moore) C. Chr.	+	+					NT
162	*Dryopteris scabrosa* (Kunze) Kuntze	+	+					VU
163	*Dryopteris sledgei* Fraser-Jenk.		+					EN
164	*Dryopteris sparsa* (D. Don) Kuntze		+	+	+			
165	*Elaphoglossum beddomei* Sledge	+	+					NT
166	*Elaphoglossum commutatum* (Mett. ex Kuhn) Alderw.		+					
167	*Elaphoglossum nilgiricum* Krajina ex Sledge	+	+	+				EN
168	*Elaphoglossum stelligerum*(Wall. ex Baker) T.Moore ex Alston & Bonner		+					LC
169	*Elaphoglossum stigmatolepis* (Fee) Moore		+	+				EN
170	*Equisetum ramosissimum* Desf.	+	+		+		+	LC
171	*Glaphyropteridopsis erubescens* (Wall. ex Hook.) Ching			+				
172	*Haplopteris elongata* (Sw.) E. H. Crane	+	+	+				
173	*Haplopteris ensiformis* (Sw.) E. H. Crane		+			+		VU
174	*Haplopteris flexuosa* (Fée) E. H. Crane		+					

Table 1: Continued...

175	*Haplopteris microlepis* (Hieron.) Mazumdar	+	+			+		EN
176	*Helminthostachys zeylanica* (L.) Hook.	+	+					
177	*Histiopteris incisa* (Thunb.) J. Sm.		+					
178	*Huperzia serrata* (Thunb.) Trevis.	+						
179	*Hymenasplenium hondoense* (N. Murak. & Hatan.) Nakaike	+	+					NT
180	*Hymenasplenium obscurum* (Blume) Tagawa	+	+	+				
181	*Hymenasplenium rivulare* (Fraser-Jenk.) Viane & S. Y. Dong	+	+					NT
182	*Hymenophyllum acanthoides* (Bosch.) Rosenst.	+						CR
183	*Hymenophyllum denticulatum* Sw.			+				
184	*Hymenophyllum exsertum* Wall. ex Hook.	+						
185	*Hymenophyllum gardneri* Van. Den. Bosch.			+				
186	*Hymenophyllum javanicum* Spreng.					+		
187	*Hypodematium crenatum* (Forsk.) Kuhn		+		+			
188	*Hypolepis resistens* (Kunze) Hook.	+						
189	*Isoetes coromandelina* L.f.	+	+	+	+		+	LC
190	*Isoetes panchganiensis* G.K.Srivast., D.D.Pant & P.K.Shukla				+			EN
191	*Isoetes udupiensis* P. K.Shukla, G. K. Srivast., S. K. Shukla & P.K. Rajagopal			+				DD
192	*Japanobotrychum lanuginosum* (Wall. ex Hook. & Grev.) M. Nishida ex Tagawa	+	+	+	+			
193	*Lastreopsis tenera* (R. Br.) Tindale	+	+					VU
194	*Lepisorus amaurolepidus* (Sledge) Bir & Trikha	+	+	+				
195	*Lepisorus nudus* (Hook.) Ching	+	+	+	+	+		
196	*Leptochilus axillaris* (Cav.) Kaulf.	+	+	+				
197	*Leptochilus decurrens* Blume.	+	+	+	+	+		LC
198	*Leucostegia truncata* (D. Don) Fraser-Jenk.		+	+	+			
199	*Lindsaea ensifolia* Sw.	+	+	+	+	+		
200	*Lindsaea heterophylla* Dryand.		+	+	+	+		
201	*Lindsaea malabarica* Baker	+	+					NT
202	*Lindsaea venusta* Kaulf. ex Kuhn	+						EN
203	*Loxogramme chinensis* Ching		+					
204	*Loxogramme cuspidata* (Zenker) M. G. Price		+					
205	*Loxogramme involuta* (D. Don) C. Presl	+		+				
206	*Loxogramme parallela* Copel.	+						
207	*Lycopodiella cernua* (L.)Pic.Serm.	+	+	+		+		LC
208	*Lycopodium clavatum* L.	+	+					LC
209	*Lycopodium japonicum* Thunb.		+			+		
210	*Lygodium flexuosum* (L.) Sw.	+	+	+	+	+	+	
211	*Lygodium longifolium* (Willd.) Sw.	+						NT
212	*Lygodium microphyllum* (Cav.) R. Br.	+	+	+		+		LC
213	*Macrothelypteris ornata* (J. Sm.) Ching		+					
214	*Macrothelypteris torresiana* (Gaudich.) Ching	+		+		+		
215	*Marsilea crenata* C.Presl		+					LC
216	*Marsilea minuta* L.	+	+	+	+		+	LC
217	*Marsilea quadrifolia* L.		+					LC
218	*Metathelypteris flaccida* (Blume) Ching		+					

Table 1: Continued...

219	*Mickelopteris cordata* (Hook. & Grev.) Fraser-Jenk.	+	+	+				
220	*Microlepia majuscula* (E. J. Lowe) Moore	+	+					EN
221	*Microlepia platyphylla* (D. Don) J. Sm.		+					
222	*Microlepia speluncae* (L.) Moore	+	+	+	+			
223	*Microlepia strigosa* (Thunb.) C. Presl	+						
224	*Microsorum linguaforme* (Mett.) Copel	+						
225	*Microsorum pteropus* (Blume) Copel.	+		+	+			LC
226	*Microsorum punctata* (L.) Copel.	+	+	+				
227	*Neolepisorus zippelii* (Blume) Li Wang			+				
228	*Nephrolepis auriculata* (L.) Trimen	+	+	+		+		
229	*Nephrolepis biserrata* (Sw.) Schott	+	+					
230	*Nephrolepis brownii* (Desv.) Hovenkamp & Miyam.	+	+	+		+		
231	*Nephrolepis cordifolia* (L.) C.Presl	+	+	+	+			
232	*Nephrolepis exaltata* (L.) Schott.				+			
233	*Nephrolepis falcata* (Cav.) C.Chr.					+		
234	*Nephrolepis undulata* (Afzel. *ex* Sw.) J.Sm.			+	+			LC
235	*Odontosoria chinensis* (L.) J. Sm.	+	+	+				
236	*Odontosoria chinensis* subsp. *chinensis*			+				
237	*Odontosoria chinensis* subsp. *tenuifolia* (Lam.) Fraser-Jenk. & Kandel			+				
238	*Oeosporangium elegans* (Poir.) Fraser-Jenk. & Pariyar		+					
239	*Oeosporangium elegans* (Poir.) Fraser-Jenk. & Pariyar	+	+					
240	*Oeosporangium thwaitesii* (Mett. ex Kuhn) Fraser-Jenk.		+					
241	*Oleandra musifolia* (Blume.) C. Presl.	+	+	+				
242	*Ophioglossum costatum* R. Br.	+		+	+		+	VU
243	*Ophioglossum gramineum* Willd.	+	+	+	+	+	+	LC
244	*Ophioglossum lusitanicum* L.				+			CR
245	*Ophioglossum nudicaule* L. f.		+	+	+		+	VU
246	*Ophioglossum parvifolium* Hook. & Grev.				+		+	LC
247	*Ophioglossum petiolatum* Hook.		+		+			CR
248	*Ophioglossum polyphyllum* A. Braun		+					DD
249	*Ophioglossum reticulatum* L.	+	+	+	+		+	LC
250	*Ophioglossum vulgatum* L.		+	-	-		+	LC
251	*Oreogrammitis attenuata* (Kunze) Parris	+	+					EN
252	*Oreogrammitis austroindica* (Parris) Parris		+					CR
253	*Oreogrammitis medialis* (Baker) Parris		+	+				
254	*Oreogrammitis pilifera* (Ravi & J. Joseph) Parris.	+						VU
255	*Osmolindsaea odorata* (Roxb.) Lehtonen & Christenh.	+						
256	*Osmunda hilsenbergii* Hook. & Grev.			+				
257	*Osmunda hugeliana* C.Presl	+	+	+	+	+		LC
258	*Osmunda regalis* L.			+				LC
259	*Parathelypteris beddomei* (Baker) Chin	+						CR
260	*Pellaea boivinii* Hook.	+	+					VU
261	*Pellaea falcata* (R. Br.) Fée	+						NT
262	*Pellaea longipilosa* Bonap.	+	+	+				CR
263	*Phlebodium aureum* (L.) J. Sm.		+					

Table 1: Continued...

264	*Phlegmariurus ceylanicus* (Spring)	+						
265	*Phlegmariurus hamiltonii* (Spreng.) Á. Löve & D. Löve	+	+	+	+			
266	*Phlegmariurus niligaricus* (Spring) A. R. Field & Bostock	+	+					VU
267	*Phlegmariurus phlegmaria* (L.) Holub	+	+					
268	*Phlegmariurus phyllanthus* (Hook. & Arn.) R. D. Dixit	+	+	+				
269	*Phlegmariurus squarrosus* (G. Forst.) Á. & D. Löve	+		+				
270	*Phlegmariurus vernicosus* (Hook. & Grev.) Á. & D. Löve	+						CR
271	*Phymatosorus cuspidatus* subsp. *cuspidatus*	+						
272	*Phymatosorus longissimus* (Blume) Pic. Serm.	+						VU
273	*Phymatosorus membranifolium* (R. Br.) S. G. Lu		+					
274	*Phymatosorus membranifolius* (R.Br) Tindale	+	+					
275	*Pityrogramma calomelanos* (Sw.) Link	+	+	+	+	+		
276	*Pityrogramma calomelanos* var. *aureoflava* (Hook.) Weath. ex Bailey			+				
277	*Pneumatopteris truncata* (Poir.) Holttum		+					
278	*Polystichum anomalum* (Hook. et Arn.) J. Sm.	+	+					EN
279	*Polystichum auriculatum* (L.) C. Presl		+					
280	*Polystichum harpophyllum* (Zenker ex Kunze) Sledge	+	+					
281	*Polystichum manickamianum*Benniamin, Fraser-Jenk. & Irudayaraj		+					CR
282	*Polystichum molluccense*		+					
283	*Polystichum mucronifolium* (Blume) B. K. Nayar & Kaur		+					
284	*Polystichum squarrosum* (D. Don) Fée		+					
285	*Polystichum subinerme* (Kunze) Fraser- Jenk.	+	+					
286	*Polystichum subinerme* var. *orbiculata*	+	+					EN
287	*Pronephrium articulatum* (Houlston & Moore) Holttum	+	+	+				
288	*Pronephrium triphyllum* (Sw.) Holttum	+	+					
289	*Prosaptia alata* (Blume) Christ		+					CR
290	*Prosaptia contigua* (G. Forst.) C. Presl	+	+					CR
291	*Prosaptia obliquata* (Blume) Mett.	+	+					EN
292	*Pseudocyclosorus ochthodes* (Kunze) Holttum			+				
293	*Pseudocyclosorus ochthodes* var. *annamalaiensis*		+					
294	*Pseudocyclosorus ochthodes* var. *palniensis*		+					
295	*Pseudocyclosorus tylodes* (Kunze) Ching	+	+	+				
296	*Psilotum nudum* (L) P. Beauv.	+	+					CR
297	*Pteridium aquilinum* subsp. *wightianum* (Wall. ex J. Agardh) W. C. Shieh	+		+	+	+		
298	*Pteridium* pinetorumC.N.Page & R.R.Mill	+	+			+		LC
299	*Pteridrys cnemidaria* (Christ) C. Chr.	+						EN
300	*Pteridrys syrmatica* (Willd.) C. Chr. et Ching	+	+					CR
301	*Pteris argyraea* T. Moore	+	+	+				
302	*Pteris arisanensis* Tagawa			+				
303	*Pteris aspericaulis* Wall. ex J. Agardh		+			+		
304	*Pteris biaurita* L.	+	+		+	+		
305	*Pteris biaurita* L. subsp. *walkeriana* Fraser- Jenk. & Dom. Rajkumar			+				
306	*Pteris blumeana* J. Agardh	+		+	+			
307	*Pteris confusa* T.G.Walker	+	+	+		+		
308	*Pteris cretica* L.		+					LC

Table 1: Continued...

309	*Pteris cretica* subsp. *cretica*		+					
310	*Pteris ensiformis* Burm.		+					
311	*Pteris geminata* Wall.	+	+					EN
312	*Pteris gongalensis* T.GWalker	+	+					
313	*Pteris heteromorpha* Fee.				+	+		
314	*Pteris hookeriana* J. Agardh	+						CR
315	*Pteris longifolia* L.	+	+			+		
316	*Pteris longipes* D.Don	+						
317	*Pteris mertensioides* Willd.	+	+					CR
318	*Pteris multiaurita* J. Agardh		+					
319	*Pteris multifida* Poir.	+						
320	*Pteris otaria* Bedd.	+	+					
321	*Pteris pellucida* C.Presl	+		+	+	+		
322	*Pteris praetermissa* T.GWalker	+	+					
323	*Pteris quadriaurita* Retz.		+	+		+		
324	*Pteris scabripes* Wall.	+	+	+				
325	*Pteris tripartita* Sw.		+					EN
326	*Pteris venusta* Kunze			+	+			
327	*Pteris vittata* L.	+	+	+	+	+	+	LC
328	*Pyrrosia ceylanica* (Giesenh.) Sledge	+						EN
329	*Pyrrosia heterophylla* (L.) M. G. Price	+	+					
330	*Pyrrosia lanceolata* (L.) Farw.	+	+	+	+	+		
331	*Pyrrosia piloselloides* (L.) M. G. Price	+	+					
332	*Pyrrosia porosa* (C.Presl) Hovenkamp	+	+	+				
333	*Salvinia minima* Baker	+						
334	*Salvinia* x *molesta* D.S. Mitch.	+	+	+	+	+	+	
335	*Sceptridium daucifolium* (Wall. ex Hook. & Grev.) Lyon	+		+				
336	*Schizaea dichotoma* (L.) Sm.	+						VU
337	*Selaginella bryopteris* (L.) Baker	+						
338	*Selaginella cataractarum* Alston.	+	+					CR
339	*Selaginella ciliaris* (Retz.) Spring.	+	+	+	+		+	
340	*Selaginella crassipes* Spring.				+			
341	*Selaginella delicatula* (Desv. *ex* Poir.) Alston.	+		+	+	+	+	
342	*Selaginella ganguliana* R.D. Dixit	+						
343	*Selaginella inaequalifolia* (Hook. Gerv) Spring	+	+					
344	*Selaginella intermedia* (Blume) Spring		+			+		
345	*Selaginella involuens* (SW.) Spring	+	+					
346	*Selaginella keralensis* R.D. Dixit	+						
347	*Selaginella kraussiana* (Kunze) A.Braun	+						LC
348	*Selaginella microdendron* Baker		+					
349	*Selaginella miniatospora* (Dalzell) Baker.		+	+	+	+		NT
350	*Selaginella monospora* Spring.			+				
351	*Selaginella plana* (Desv. ex Poir) Hieron.			+				
352	*Selaginella proniflora* (Lam.) Baker			+		+		
353	*Selaginella radicata* (Hook.and grev) Spring		+			+		

Table 1: Continued...

354	*Selaginella repanda* (Desv. *ex* Poir.) Spring.			+	+		+	
355	*Selaginella tamariscina* (P.Beauv.) Spring		+					
356	*Selaginella tenera* (Hook. &Grev.) Spring	+	+		+	+		
357	*Selaginellavaginata* Spring		+					
358	*Selaginella vogelii* Spring		+					
359	*Selaginella wightii* Hieron.		+					
360	*Selaginella willdenowii* (Desv. ex Poir.) Baker	+						
361	*Selliguea hastata* (Thunb.) Fraser-Jenk.			+				
362	*Selliguea lehmannii* (Mett.) X. C. Zhang & L. J. He		+					EN
363	*Selliguea montana* (Sledge) Hovenkamp	+						
364	*Selliguea oxyloba* (Wall. ex. Kunze) Fraser-Jenk.			+				
365	*Sphaerostephanos arbusculus* subsp. *arbusculus*			+				
366	*Sphaerostephanos subtruncatus* (Bory) Holttum		+					
367	*Sphaerostephanos unitus* (L.) Holttum		+					
368	*Stenochlaena palustris* (Burm.fil.) Bedd.	+	+			+		
369	*Tectaria cicutaria* (L.) Copel.					+	+	
370	*Tectaria coadunata* (Wall. *ex* Hook. and Grev.) C. Chr.	+	+	+	+	+	+	
371	*Tectaria fuscipes* (Wall.) C. Chr.			+				
372	*Tectaria paradoxa* (Fee) Sledge	+	+	+	+			
373	*Tectaria polymorpha* (Wall. ex Hook.) Copel.			+				
374	*Tectaria trimenii* (Bedd.) C. Chr.	+						CR
375	*Tectaria wightii* (C. B. Clarke) Ching	+	+	+				
376	*Tectaria zeilanica* (Houtt.) Sledge	+	+					EN
377	*Thelypteris confluens* (Thunb.) C.V.Morton		+					CR
378	Thelypteris dentata (Forssk.) H.St. John	+	+	+		+		LC
379	Thelypteris pozoi(Lag.) C.V.Morton	+						LC
380	Thelypteris tetragona (Sw.) Small			+				LC
381	*Tomophyllum subfalcatum* (Blume) Parris	+	+					
382	*Trigonospora caudipinna* (Ching)Sledge		+	+				
383	*Trigonospora tenera* (Roxb.) Mazumdar	+	+			+		
Total number of species in each state		**227**	**249**	**148**	**82**	**73**	**27**	

and fern-allies.

The Western Ghats covers a distance of 1600 km from Kanyakumari in Tamil Nadu to Tapti valley in Gujarat state with an area of 160000 km^2. It runs parallel to the western coast of India traversing the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamilnadu. The continuous stretch of the Western Ghats is interrupted by a 30 km break-in Kerala. The interrupted part is known as 'Palghat Gap' (Radhakrishnan 2001). Mountain ranges like Nilgiri Hills, Anamallays Hills and Palni Hills are present in the Ghats, and they have various forest types like scrub forests at an elevation of 200-500 m, moist deciduous forests (500-900 m), tropical moist evergreen forests (1200-1500 m) and Shola forest above 1500 m.The Western Ghats gets an annual rainfall of 1000 to 5000 mm.

Based on the studies done by Manickan and Irudayaraj (1992), the Western Ghats harbors 349 pteridophyte species out of 1200 Indian pteridophyte species. According to Manickam and Irudayaraj (1992), a large portion of pteridophyte species in the Western Ghats is endemic. The most diverse genera present here is *Asplenium, Selaginella, Pteris, Athyrium, Diplazium,* etc. Dudani *et al.,* (2011) found that the major families seen in the Western Ghats were Aspleniaceae, Polypodiaceae, Thelypteridaceae, Selaginellaceae, etc. According to Dixit (2000), based on the available literature, Karnataka holds the maximum diversity of pteridophytes in the family Aspleniaceae which is comprised of 27 species. Other major pteridophyte families were Polypodiaceae, Athyriaceae, Thelypteridaceae, Selaginellaceae, Pteridaceae, etc.

Pteridophyte diversity in the six states traversed by the Western Ghats

Kerala is the state that is situated at the south-western corner of India and it has the Western Ghats on the east side and the Arabian Sea on its west side. The geographical area of Kerala is 38,852 km^2 with a forest cover of 20,321 km^2. Kerala has a high level of heterogeneity because of which there are various vegetation patterns. There are scrub forests in the rain shadow regions and plains, tropical deciduous forests, and rainforests up to an elevation of 1,500 m and shola forests in an elevation above 1500 m (Nayar, 2010). All this variety of terrains and an average rainfall of 2,990mmmake Kerala an appropriate habitat for pteridophytes. The Palghat gap is highly diverse and accounts for 239 species of fern and fern- allies(Manickam and Irudayaraj, 1992).

Muktesh (1998)studied the fern flora of Kerala with special reference to the Sylvan Valley of Munnar. He recorded 159 species of ferns and fern allies belonging to 70 genera and 29 families. It was also found that once abundant species of Munnar forest like *Osmunda hugelina, Angiopteris evecta, Cyathea spp., Diplazium spp. Polystichum spp.* etc., have become rare due to deforestation and man-made and natural forest fires.

Kavitha *et al*., studied the diversity of pteridophytes of Ponmudi hills in 2015. The study area is carpeted by thick tropical forest with a diversity of 28 pteridophyte species. The dominant forest types were tropical evergreen and moist deciduous. Joseph and Thomas(2015) collected 15 chasmophytic pteridophyte species from the Urumbikkara hills of Idukki district of Kerala and, the species belonged to 11 families and 11 genera.

. Joseph *et al.,* (2017) studied the pteridophyte flora of Dr. Salim Ali Bird Sanctuary, Thattekad, Ernakulam; and reported the presence of 30 species of ferns and fern-allies belonging to 23 genera. The sanctuary covers an area of 25.16 km^2 and has tropical evergreen forests, semi evergreen forests, tropical moist deciduous forests, and Mahogany plantations. The pteridophyte flora of Akamala forest station, Thrissur district, kerala was documented by Rekha and Athira (2017). The study area was home to 24 species of pteridophytes. Of these, 2 species belonged to the 'endangered' category, 4 species belonged to the 'rare' category and one species belonged to the 'at risk' category.

Tamil Nadu is the southernmost state of India. It has a geographic area of 1,30,060 km^2 and a forest cover of 26,281 km^2 and that is 20.2% of the total area of the state (Ruma, 2018).The state has four major geographical divisions such as the Eastern and coastal plains, central uplands, western Karnataka plateau, and the central Eastern Ghats. There are nine types of forests in the state and among these tropical dry deciduous forest occupies 46.98% of the total forest area. The average rainfall that Tamil Nadu receives is 3000- 5000 mm per year.

Since Tamil Nadu has both the Western Ghats and the Eastern Ghats passing through it, it holds a rich pteridophyte flora and many studies have been conducted to explore this diversity. Sukumaran *et al.,* (2009) recorded the diversity of pteridophytes in miniature sacred forests of the Kanyakumari district in Southern Western Ghats. A total of 24 species were reported from here and out of these 3 were endemic, 3 were endangered and 8 were rare.

In a study conducted by Abraham and Ramachandran (2013), six species were added to the pteridophytic flora of Nilgiris viz. *Asplenium bipinnatum* Roxb. (Aspleniaceae)*, Cheilanthes viridis* Sw. (Pteridaceae), *Huperziaphlegmaria* Rothm. (Lycopodiaceae)*, Selaginella ciliaris* (Retz.) Spring. (Selaginellaceae)*, Selaginella intermedia* (Blume) Spring. (Selaginellaceae) and *Trichomanes bipunctatum* Poir. (Hymenophyllaceae).

Sathish and Vijayakanth (2016) too added six fern species to the recorded fern flora of Kolli hills in Tamilnadu. The six species added were *Adiantum latifolium, Oleandra musifolia, Diplazium cognatum, Bolbitisap pendiculata, Leptochilusthwaitesianus,* and *Phymatosorusmembranifolium.* And in 2017, Vijayakanth *et al.,* added two new ferns to the fern flora of Tamilnadu. These ferns are *Athyriumparasnathense*of family Athyriaceae and *Leptochilusmetallicus*belonging to Polypodiaceae. Kumari and Jeeva (2018) studied the pteridophytes along the Thamiraparani River in Tamilnadu and reported the presence of 65 pteridophytes species along the Thamiraparani River and in this 33% were terrestrial, 12% were aquatic, 11% were lithophytes and 13.8% were epiphytes.

Alagesaboopathi *et al.,* (2018)documented 14 species of pteridophytes from the Kanjamalai Hills of Salem District. A study on thepteridophyte diversity of the Kilavarai freshwater river in Kodaikanal was conducted(Packiaraj and Suresh 2019)and, 36 species belonging to 25 genera distributed among 19 families were reported. The dominant species belonged to Adiantaceae, Polypodiaceae, Pteridaceae, and Cheilanthaceae families.

Karnataka has a major portion of the Central Western Ghats and also hosts a large portion of its endemism.. Most of the pteridophytes species are seen in the central Western Ghats (Rajagopal and Bhat, 1998).The studies on the pteridophyte diversity began with the work by Blatter and D'almeida (1922) and 75 species were recorded in the 'Ferns of Bombay'. Followed by this many studies were conducted, Alston (1945) recorded four species of *Selaginella*; Kammathy *et al.,* (1967) listed 25 species; Holttum (1976) included 10 fern species from the family Thelypteridaceae in 'Flora of Hassan District' and Yoganarasimham *et al.,* (1981) added 12 species in 'Flora of Chikmangalur District'. Matchperson recorded 90 fern species from the North Canara district(Matchperson, 1986).

Again after a significant time gap, more research wasbeing conducted to provide detailed data on the pteridophyte diversity of Karnataka. Deepa *et al.,*(2013) studied the distribution of pteridophytes in the Kigga forest of Central Western Ghats in Karnataka. The species diversity was calculated using Shannon's diversity index and Simpson's

diversity. *Aleuritopteris anceps* (Blanf.) Panigrahi was the most abundant species in the studied area. Deepa *et al.,* (2017) later enumerated 23 pteridophytes in Madhuguni forest of Central Western Ghats in Karnataka. The majority of the pteridophyte species were terrestrial with an exception of two epiphytes, one aquatic and one climbing fern.

The pteridophyte composition of the Banjalaya forest region was documented by Ashwini and Parashurama (2014). 19 pteridophyte species were collected and these belonged to 11 families. *Athyrium hohenackeranum* (Kunze) T. Moore was found to be the most abundant species. The wet evergreen forests of Sakleshpur, which is considered as the 'Hottest hotspot of biodiversity' was surveyed by Dudani *et al.,*(2014) and a total of 45 species of pteridophytes were reported from this region. Parashurama *et al.,* (2016) assessed the pteridophyte diversity in Mudigere taluk, Central Western Ghats, Karnataka, and a total of 26 species of pteridophytes belonging to 17 families were obtained from the study area. Their habitat was also observed and it was recorded that 22 species were terrestrial.

Maharashtra is a state with a geographic area of 3,07,713 km^2(Ruma, 2018). Maharashtra has a forest cover of 21% and has mountain ranges with tropical rain forests. 17% of the state has deciduous forests. There are 3 game reserves, 5 national parks, and 24 bird sanctuaries(Shelar and Madhuri, 2016). 64 fern species have been reported from Maharashtra and most of these are confined to the northern Western Ghats (Manickam and Irudayaraj, 2003). A new addition was done to the flora of Maharashtra by Sachin *et al.,* (2016).

Goa has a geographical area of 3702 km^2 and of this, 2229 km^2 is forest area. 95% of its forest area has 'protected area' status due to the presence of four wildlife sanctuaries. Datar and Laksminarasimham (2010)conducted a study to compile data on the pteridophyte diversity of Goa and concluded that Goa has a pteridophyte flora comprising of 47 pteridophyte species and these belonged to 32 genera under 20 families.

Gujarat has a land area of 1,96,244 km^2 and a forest cover of 14,757 sq km^2(Ruma, 2018). In 1996, the Gujarat Ecological Commission documented 16 pteridophyte species from different parts of Gujarat. Later few studies were done by Patel *et al.,* (2010), Dabgar (2012), and Modi and Dudani (2013).In 2015, Modi published a paper which documented the presence of 16 species in Gujarat. Rajput *et al.,* (2016) assessed the pteridophyte diversity of Gujarat through a field study of three years, in which 23 species were collected. It was also noted that *Equisetum debile* was extinct from the wild and *Isoetes coromandeliana* was on the verge of extinction. Eight species were also recorded for the first time in the state.

Conservation statuses of Western Ghats pteridophytes

The study and recording of endemic pteridophytes of India were first done by Chandra (1982). In his study, 96 species were recorded and in a later study with Kaur(1994), 41 more species were reported. According to Dixit (1984), 214 pteridophyte species are endemic to India. In the year 2008, Fraser- Jenkins removed many endemic species, as these were pseudo- endemics and was mistaken by pteridologists due to their synonyms and lack of species understanding. Currently, a total of 49 pteridophytes are recognized as endemic to India. The majority of the endemic pteridophytes (33 species) are reported from Deccan Peninsula and the Western Ghats. Some of the endemic species in the Western Ghats are *Polystichum manickamii, Cyathea nilgiriensis, Bolbitis semicordata, Selaginella radicata* etc. Endangered species in this region include*Psilotum nudum, Tectaria zeylanica, Lindsaea malabarica, Cheilanthes rufa*, etc.

According to Fraser- Jenkins (2012), out of the total 1100 indigenous pteridophytes of India; 337 species are considered to be threatened or endangered. The conservation statuses of the pteridophytes were determined based on the IUCN (2010) listing. According to this study, 12 species were Extinct (EX), 4 were Extinct in the wild (EW), 95 were critically endangered (CR), 117 were Endangered (EN), 67 were Vulnerable (V) and 43 were near threatened (NT). State wise distribution of pteridophytes along the Western Ghats and their conservation status is given in table 1.

The data reveals that pteridophytes in the Western Ghats belong to 30 families and 103 genera and 384 species. The most common families seen in the Western Ghats are the Pteridaceae with 74 species, Dryopteridaceae with 43 species, and Polypodiaceae with 36 species(Fig 1). The conservation statuses of 129 recorded species were obtained from IUCN (2020) and Fraser- Jenkins' 2012 study. Based on these 24 species were categorized under critically endangered(CR), 30 species belonged to the endangered (EN) category, 13 belonged to near threatened (NT), and 17 species are categorized as vulnerable(VU).

CONCLUSION

India has a total landmass of 3.287 million km^2, and the Western Ghats occupy only 18000 km^2 in it. It consists of different types of forests and many mountain ranges. The Western Ghats currently contains 384 species of ferns and fern allies. Each pteridophyte thrives on a specific temperature, humidity, soil type, etc., thus acting as the indicator of such climatic conditions. Various anthropogenic factors are causing a decline in the fern population causinga threat to their survival. Currently, nearly half of the pteridophytes in India are under the red list category of IUCN(Chandra 2008). Tamil Nadu and Kerala are the states that are situated in the southernpart of Western Ghats and they have the highest pteridophyte diversity. Gujarat is the state that lies in the Northern part of Western Ghats and has the lowest pteridophyte diversity.

Studies on pteridophytes are gaining momentum and this is shedding light on the medicinal and economic importance of these plants. Understanding the flora of a region always helps in understanding the change in the ecosystem and

in-vitro and ex-situ conservation can be widely exploited to bring back the threatened species from the verge of extinction and preserve this plant group for our coming generations.

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