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Reassessment of endemic angiosperm genera in India

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Abstract: This paper reassesses the current status of endemic genera after about a decade. Earlier Irwin and Narasimhan (2011) reported 49 genera as endemic to India. Later, Singh *et al.* (2015) have reported 58 endemic genera for India. We, in this paper, based on extensive scrutiny of literature and online resources, report a total of 46 genera as endemic to the political boundary of India. An analysis of the phytogeographical distribution of these genera confirms our earlier inference, except for minor variations in numbers of endemic genera in Peninsular Indian and Himalayan regions. The life form analysis shows that nearly three fourth of the endemic genera are herbaceous which occur predominantly in wet evergreen and grassland vegetation. In spite of their endemic nature, IUCN assessment at the global level has not yet been done for most of the species of these genera even though this gap was mentioned a decade earlier by Irwin and Narasimhan (2011).

Keywords: Angiosperm, Conservation, Endemism, Threat Status.

Introduction

Endemism reflects the environmental and biological history of a region (Hobohm *et al.,* 2014; Vanderplank, 2014; Veron *et al.,* 2019). Across the globe, 36 regions have been recognized as Biodiversity Hotspots based on the richness of endemism and level of habitat degradation (Noss *et al.,* 2015; CEPF, 2016). Of these, four regions, namely, Indo-Burma, Eastern Himalayas, Western Ghats - Sri Lanka and the Sundaland majorly or partly fall within the boundaries of India (Mittermeier *et al.,* 2011) and posses higher concentrations of endemic genera. Of the total 18,532 species of angiosperms documented in India, the current estimate shows that only 4303 (29%) taxa are endemic (Singh *et al*., 2015; Singh *et al*., 2018). These endemic species show narrow ranges of distribution and are restricted to peninsular regions, mountain tops, islands and unique geographical areas like swamps and mangroves. The present paper is an updated assessment of the endemic genera of angiosperms in India after Irwin and Narasimhan (2011) and Singh *et al*. (2015).

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Materials and Methods

The following literature was consulted to revisit the endemic status of angiosperm genera recorded from India: Cooke (1901–1908); Chatterjee (1939); Bor (1949, 1954, 1958, 1960); Shaw (1952); Clifford (1967); Ansari and Hemadri (1971); Rao (1972, 1979); Mukherjee and Constance (1974); Saldanha (1974); Sohmer (1976); Hong (1980); Chakraborti (1981); Clayton (1981); Nair *et al. (*1982, 1983); Panigrahi and Das (1983); Uniyal and Pal (1983); Chakrabarty and Rao (1984); Pandurangan *et al.* (1984); Bhat (1986); Mukherjee and Constance (1986); Rao and Chakrabarty (1986); Takhtajan (1986); Ahmedullah and Nayar (1987); Sreekumar and Shetty (1987); Deshpande *et al. (*1989); Eriksson (1990); Matthew (1991); Mill (1991); Mathew and Lakshminarasimhan (1994); Kumar (1995); Sarkar (1995); Uniyal (1995); ING (1996); Nayar (1996); Sharma *et al.* (1996); Kumar and Rasmussen (1997); Shivamurthy and Sadanand (1997); Yoganarasimhan

et al. (1997); Rao (1998); Sreekumar and Coomar (1999); Ahmedullah (2000); Janarthanam *et al.* (2000); Singh *et al.* (2001); Yadav and Sardesai (2002); Fonseca and Janarthanam (2003); Sasidharan (2004); Daniel (2005); Govaerts (2005); Govaerts (2006); Nayar *et al.* (2006); Venu (2006); Balakrishnan and Chakrabarty (2007); Mitra and Mukherjee (2007); Rajkumar and Janarthanam (2007); Anderberg and Pandey (2008); Kabeer and Nair (2009); Karthikeyan *et al.* (2009); Govaerts *et al.* (2011); SNMNH (2011); USDA (2011); eFloras (2011); Irwin and Narasimhan (2011); Singh *et al.* (2015); Clayton *et al.* (2016); ILDIS (2018); Mabberley (2018); IPNI (2020); Tropicos (2020); POWO (2020).

Genera that were earlier considered endemic and now show extended distributions and genera that were segregated earlier and merged later with the parent/allied genera based on phylogenetic reassessments have been critically reviewed (Table 2). The current updated list of endemic genera is arranged based on phytogeographical regions (Table 3). Species of each endemic genus are provided with state level distributions and habitats (Table 3). Families of the endemic genera are organized as per APG IV classification (APG IV, 2016). The threat status assessed for the species of these genera is also indicated (Deshpande, 1987a, b, 1988; Mukherjee, 1988; Ahmedullah and Nayar, 1990; Nayar, 1996; IUCN, 2020).

Results

Earlier analysis

There are different estimates of endemic genera by different authors in the last three decades based on the available information on distribution and nomenclatural changes (Table 1).

The present assessment shows that out of the 58 endemic genera documented by Singh *et al.* (2015) and 49 endemic genera listed by Irwin and Narasimhan (2011) only 43 genera have retained their endemic status. Genera that include *Frerea* Dalzell, *Lamprachaenium* Benth., *Meteoromyrtus* Gamble, *Munrochloa* M.Kumar & Remesh, *Nanothamnus* Thomson, *Odisha* S.Misra, *Paracaryopsis* (Riedl) R.R.Mill, *Polyzygus* Dalzell, *Pseudojacobaea* (Hook.f.) R.Mathur and *Seshagiria* Ansari & Hemadri have been merged with their parental genera. The genus *Trilobachne* Schenck ex Henrard and *Willisia* Warm. show extended distribution to Myanmar and Bangladesh. Similarly, *Decalepis* Wight & Arn. has lost its endemic status due to the extended distribution of *Decalepis khasiana* (Kurz) Lonta ex Kambale, to Bangladesh, South China and Myanmar. *Canscorinella* Shahina & Nampy, a genus erected by Shahina and Nampy (2014), is again merged with its parent genus *Canscora* Lam. (POWO 2020, http://www.plantsoftheworldonline.org/).

Table 1: Earlier estimates on the number of Indian endemic genera

No.	Authors	No. of Genera
1	Sarkar (1995)	142
2	Nayar (1996)	147
3	Ahmedullah (2000)	140
4	Mitra and Mukherjee (2007)	121
5	Irwin and Narasimhan (2011)	49
6	Singh *et al.* (2015)	58

Many studies reported that the genus *Hardwickia* Roxb. lost its endemic status due to its distribution in many parts of the world especially in Bangladesh. Discussions with experts from India and Bangladesh as well as a thorough literature survey (Kundu & Schmidt, 2011; Mitra & Mukherjee, 2014) confirm that the genus occurs in other parts of the world only under cultivation.

Current estimates of endemic genera in India

Our analysis shows that the endemic genera in India constitute only 1.5% (46 genera) of the total

Table 2. Status of genera earlier considered endemic in India

S. No.	Genera considered endemic (Irwin & Narasimhan, 2011; Singh *et al*., 2015)	Parent genus with which merged / extended distribution	Source
1	*Canscorinella* Shahina & Nampy (Gentianaceae)	*Canscora* Lam.	POWO, 2020
2	*Frerea* Dalzell (Apocynaceae)	*Boucerosia* Wight & Arn.	Meve & Liede, 2002; POWO, 2020
3	*Lamprachaenium* Benth. (Asteraceae)	*Phyllocephalum* Blume	Roskov *et al.,* 2018
4	*Meteoromyrtus* Gamble (Myrtaceae)	*Eugenia* L.	Wilson & Heslewood, 2016
5	*Munrochloa* M.Kumar & Remesh (Poaceae)	*Pseudoxytenanthera* Soderstr. & R.P.Ellis	Govaerts, 2011; POWO, 2020
6	*Nanothamnus* Thomson (Asteraceae)	*Blumea* DC.	Anderberg & Pandey, 2008; Mabberley, 2018
7	*Odisha* S.Misra (Orchidaceae)	*Habenaria* Willd.	Govaerts, 2011; POWO, 2020
8	*Paracaryopsis* (Riedl) R.R.Mill (Boraginaceae)	*Adelocaryum* Brand.	Mill, 2010; Mabberley, 2018
9	*Polyzygus* Dalzell (Apiaceae)	*Pinda* P.K.Mukh. & Constance	Lekhak & Yadav, 2012
10	*Pseudojacobaea* (Hook.f.) R.Mathur (Asteraceae)	*Senecio* L.	Roskov *et al*., 2018
11	*Seshagiria* Ansari & Hemadri (Apocynaceae)	*Cynanchum* L.	Khanum *et al.,* 2016; Mabberley, 2018
	GENERA WITH EXTENDED DISTRIBUTION		
12	*Decalepis* Wight & Arn. (Apocynaceae)	Bangladesh, South China & Myanmar	Kambale *et al*., 2016; Mabberley, 2018
14	*Trilobachne* Schenck ex Henrard (Poaceae)	Myanmar	Clayton *et al.,* 2006; POWO, 2020
15	*Willisia* Warm. (Podostemaceae)	Bangladesh	POWO, 2020

2991 genera of flowering plants in India. They comprised of 78 taxa (Table 3). 78% of the endemic genera (36 genera) are confined to Peninsular India, 12% to the Himalayan region and about 6% to Andaman and Nicobar Islands. The genus *Bentinckia* Berry ex Roxb. shows disjunct distribution in two major phytogeographical regions namely India (Western Ghats) and Indo-Malesia (Nicobar). Most of the endemic genera occur predominantly in wet evergreen forests and in high altitude grasslands. Genera such as *Deccania* Tirveng., *Helicanthes* Danser and *Nicobariodendron* Vasudeva Rao & Chakrab. are found to occur in dry deciduous forests.

The endemic genera of India are distributed in 25 families. Of these, Poaceae contributes to 56% of the endemic genera, followed by Apiaceae (16%) and Acanthaceae (12%). 16 families are represented by a single taxon. Endemic genera are dominated by herbaceous forms (60 herbs) followed by trees (14) and shrubs (4).

Habit: CS – climbing shrub; H – herb; S – shrub; ST – small tree; T – tree.

Threat status of Indian endemic genera

The majority of taxa of the Indian endemic genera are threatened primarily because of their restricted range of distribution. However, only eight taxa

Table 3. Endemic angiosperm genera of India, with included species, habit, habitat, and distribution

S. No.	Genera / Species (Family)	Habit	Habitat	Distribution
	HIMALAYA			
1	*Brachycaulos* Dikshit & Panigrahi (Rosaceae)			
	B. simplicifolius Dikshit & Panigrahi	H	EF	SK
2	*Ivanjohnstonia* Kazmi (Boraginaceae)			
	I. jaunsariensis Kazmi	H	EF	UK
3	*Kashmiria* D.Y.Hong (Plantaginaceae)			
	K. himalaica (Hook.f.) D.Y.Hong	H	EF	J&K, UK
4	*Parakaempferia* A.S.Rao & D.M.Verma (Zingiberaceae)			
	P. synantha A.S.Rao & D.M.Verma	H	EF	AS
5	*Pseudodanthonia* Bor & C.E. Hubb.(Poaceae)			
	P. himalaica (Hook.f.) Bor & C.E. Hubb.	H	EF	UK
6	*Stapletonia* P.Singh, S.S.Dash & P.Kumari (Poaceae)			
	S. arunachalensis (H.B.Naithani) P.Singh, S.S.Dash & P.Kumari	H	EF	ARP
	S. rigoensis L.B.Singha, P.Niri & R.Devi	H	EF	ARP
	S. seshagiriania (R.B.Majumdar) H.B.Naithani	H	EF	ARP
PENINSULAR INDIA				
7	*Adenoon* Dalzell (Asteraceae)			
	A. indicum Dalzell	H	GL	WG of KA, KL, MH, TN
8	*Aenhenrya* Gopalan (Orchidaceae)			
	A. rotundifolia (Blatt.) C.S.Kumar & F.N.Rasm.	H	EF	WG of KL, TN
9	*Agasthiyamalaia* S.Rajkumar & Janarth. (Clusiaceae)			
	A. pauciflora (Bedd.) S.Rajkumar & Janarth.	T	EF	WG of KL, TN
10	*Anaphyllum* Schott (Araceae)			
	A. beddomei Engl.	H	EF	WG of KL, TN
	A. wightii Schott	H	EF, MDF	WG of KL, TN
11	*Bhidea* Stapf ex Bor (Poaceae)			
	B. borii Deshp., V.Prakash & N.P.Singh	H	GL	WG of KA
	B. burnsiana Bor	H	GL	WG of KA, KL, MH
	B. fischeri Sreek. & B.V.Shetty	H	GL	WG of KL, MH
12	*Blepharistemma* Wall. ex Benth. (Rhizophoraceae)			
	B. membranifolium (Miq.) Ding Hou	ST	MDF	WG of KA, KL

13	*Calacanthus* T.Anderson ex Benth. & Hook.f. (Acanthaceae)			
	C. grandiflorus (Dalzell) Radlk.	S	GL	WG of GA, KA, KL, MH
14	*Chandrasekharania* V.J.Nair, V.S.Ramach. & Sreek. (Poaceae)			
	C. keralensis V.J.Nair, V.S.Ramach. & Sreek.	H	GL	WG of KA, KL
15	*Cynarospermum* Vollesen (Acanthaceae)			
	C. asperrimum (Nees) Vollesen	H	MDF	WG of GA, KA, MH
16	*Danthonidium* C.E.Hubb. (Poaceae)			
	D. gammiei (Bhide) C.E.Hubb.	H	GL	WG of KA, KL, MH
17	*Deccania* Tirveng. (Rubiaceae)			
	D. pubescens (Roth) Tirveng. var. *pubescens*	T	DEF, DDF	AP,TN
	D. pubescens (Roth) Tirveng. var. *candolleana* (Wight & Arn.) Tirveng.	T	DEF, DDF	AP, KA, TN
18	*Erinocarpus* Nimmo ex J.Graham (Malvaceae)	T		WG of MH, KA
	E. nimmonii J.Graham		MDF, DDF	
19	*Glyphochloa* Clayton (Poaceae)			
	G. acuminata (Hack.) Clayton var. *acuminata*	H	GL	WG of KA, KL, MH, TN
	G. acuminata (Hack.) Clayton var. *stocksii* (Hook.f.) Clayton	H	GL	WG of MH
	G. acuminata (Hack.) Clayton var. *woodrowii* (Bor) Clayton	H	GL	WG of MH
	G. bombaiensis (Bor) Gosavi, S.R.Yadav, Praveen Karanth & Survesw.	H	GL	WG of KA
	G. divergens (Hack.) Clayton var. *divergens*	H	GL	WG of KA, KL
	G. divergens (Hack.) Clayton var. *hirsuta* (C.E.C.Fisch.) Clayton	H	GL	WG of KA
	G. forficulata (C.E.C.Fisch.) Clayton	H	GL	WG of KA, KL, MH, TN
	G. goaensis (R.S.Rao & Hemadri) Clayton	H	GL	WG of GA
	G. henryi Janarth., V.C.Joshi & S.Rajkumar	H	GL	WG of GA
	G. maharashtraensis Potdar & S.R.Yadav	H	GL	WG of MH
	G. maharashtraensis var. *hirsuta* Potdar & S.R.Yadav	H	GL	WG of MH
	G. mysorensis (S.K.Jain & Hemadri) Clayton	H	GL	WG of KA
	G. ratnagirica (Kulkarni & Hemadri) Clayton	H	GL	WG of MH
	G. santapaui (S.K.Jain & Deshp.) Clayton	H	GL	WG of MH
	G. talbotii (Hook.f.) Clayton	H	GL	WG of MH
	G. veldkampii M.A.Fonseca & Janarth.	H	GL	WG of GA
20	*Hardwickia* Roxb. (Fabaceae)			
	Hardwickia binata Roxb.	T	DDF	WG & EG

21	*Haplanthodes* Kuntze (Acanthaceae)			
	H. plumosa (T.Anderson) Panigrahi & G.C.Das	H	MDF	WG of MH
	H. tentaculatus (L.) R.B.Majumdar	H	MDF	WG of GJ, MH
	H. tentaculata var. *neilgherryensis* (Wight) J.R.I. Wood	H	MDF	WG of KA, KL
	H. verticillatus (Roxb.) R.B.Majumdar	H	MDF	WG of KA, MH
22	*Haplothismia* Airy Shaw (Burmanniaceae)			
	H. exannulata Airy Shaw	H	EF	WG of KL
23	*Helicanthes* Danser (Loranthaceae)			
	H. elastica (Desr.) Danser	S	EF, MDF / P	WG of KA, MH
24	*Hubbardia* Bor (Poaceae)			
	H. heptaneuron Bor	H	MRL in MDF	WG of MH
	H. diandra Chandore, Gosavi & S.R.Yadav	H	MRL in SEF	WG of KA, MH
25	*Indobanalia* A.N.Henry & B.Roy (Amaranthaceae)			
	I. thyrsiflora (Moq.) A.N.Henry & B.Roy	H	EF	WG of KA, KL, TN
26	*Indopoa* Bor (Poaceae)			
	I. paupercula (Stapf) Bor ex Ramamoorthy	H	R/TT/W	WG of KA, KL, MH
27	*Jerdonia* Wight (Gesneriaceae)			
	J. indica Wight	H	EF	WG of KA, KL, TN
28	*Karnataka* P.K.Mukh. & Constance (Apiaceae)			
	K. benthamii (C.B.Clarke) P.K.Mukh. & Constance	H	EF	WG of KA
29	*Leucoblepharis* Arn. (Asteraceae)			
	L. subsessilis Arn.	S	MDF	WG of KA, MH, MP, TN and EG of AP
30	*Limnopoa* C.E.Hubb. (Poaceae)			
	L. meeboldii (C.E.C.Fisch.) C.E.Hubb.	H	WL	WG of KA, KL
31	*Lophopogon* Hack. (Poaceae)			
	L. ingie Hook.f.	H	DL	BI
	L. tridentatus (Roxb.) Hack.	H	P-LA/ DL	AP, BI, GJ, KA, MP, MH, TN
32	*Nanooravia* Kiran Raj & Sivad.(Poaceae)			
	N. santapaui (M.R.Almeida) Kiran Raj & Sivad.	H	GL	WG of KA, KL
	N. kayyurense Shaju, Rajendraprasad, Rijuraj & Ratheesh Narayanan	H	WL	WG of KL

33	*Otonephelium* Radlk. (Sapindaceae)			
	O. stipulaceum Radlk.	T	EF, MDF	WG of KA, KL, TN
34	*Pinda* P.K.Mukh. & Constance (Apiaceae)			
	P. concanensis (Dalzell) P.K.Mukh. & Constance	H	MDF	WG of MH
35	*Poeciloneuron* Bedd. (Pentaphylacaceae)			
	P. indicum Bedd.	T	EF	WG of KA, KL, TN
36	*Pogonachne* Bor (Poaceae)			
	P. racemosa Bor	H	SGWC	WG of MH
37	*Sanjappa* E.R.Souza & M.V.Krishnaraj (Fabaceae)			
	S. cynometroides (Bedd.) E.R.Souza & M.V.Krishnaraj	S	EF, SEF	WG of KL
38	*Sivadasania* N.Mohanan & Pimenov (Apiaceae)			
	S. josephiana (Wadhwa & H.J.Chowdhery) N.Mohanan & Pimenov	H	EF	WG of KL
39	*Silentvalleya* V.J.Nair, Sreek., Vajr. & Bhargavan (Poaceae)			
	S. nairii V.J.Nair, Sreek., Vajr. & Bhargavan	H	HAG	WG of KL
	S. chandwadensis Gosavi, B.R.Pawar & S.R.Yadav	H	MDF	WG of MH
40	*Smithsonia* C.J.Saldanha (Orchidaceae)			
	S. maculata (Dalzell) C.J.Saldanha	H	MDF	WG of KA, KL, TN
	S. straminea C.J.Saldanha	H	EF	WG of KA, KL
	S. viridiflora (Dalzell) C.J.Saldanha	H	EF	WG of KA, KL, MH
41	*Triplopogon* Bor (Poaceae)			
	T. ramosissimus (Hack.) Bor	H	SPHF	WG of MH
42	*Vanasushava* P.K.Mukh. & Constance (Apiaceae)			
	V. pedata (Wight) P.K.Mukh. & Constance	H	HAG	WG of KA, KL, TN
ANDAMAN AND NICOBAR ISLANDS				
43	*Nicobariodendron* Vasudeva Rao & Chakrab. (Celastraceae)			
	N. sleumeri Vasudeva Rao & Chakrab.	T	MDF, EF	NI
44	*Pseudodiplospora* Deb (Rubiaceae)			
	P. andamanica (N.P.Balakr. & N.G.Nair) Deb	T	EF	AI
45	*Sphyranthera* Hook.f. (Euphorbiaceae)			
	S. airyshawii Chakrab. & Vasudeva Rao	T	MDF, EF	A & NI
	S. lutescens (Kurz) Pax & K.Hoffm.	T	LF	A & NI

PENINSULAR INDIA AND NICOBAR ISLANDS				
46	*Bentinckia* Berry ex Roxb. (Arecaceae)			
	B. condapanna Berry ex Roxb.	T	EF	WG of KL, TN
	B. nicobarica (Kurz) Becc.	T	EF	NI

Habitat: AQ – aquatic; DDF – dry deciduous forests; DDF/SJ – dry deciduous forests/scrub jungle; DEF – dry evergreen forests; DL – dry localities; EF – evergreen forests; GL – grasslands; HAG – high altitude grasslands; LP – lateritic plateaus; DDF – dry deciduous forests; MDF – moist deciduous forests; P – LA/DL – plains to low altitude, RRS – rocks in running streams; R/TT/W – on rocks, tree trunks and on old walls; SGWC – slopes of the Ghats near water courses; SP – HF – stony places in hill forests; WL – wetlands.
Distribution: A & NI – Andaman & Nicobar Islands; AP – Andhra Pradesh; ARP – Arunachal Pradesh; AS – Assam; BI – Bihar; GA – Goa; GJ – Gujarat; J & K – Jammu & Kashmir; KA – Karnataka, KL – Kerala; MP – Madhya Pradesh; MH – Maharashtra; NI – Nicobar Islands; SK – Sikkim; TN – Tamil Nadu; UK – Uttarakhand; WG – Western Ghats; EG – Eastern Ghats.

have been assessed so far based on IUCN threat Categories and Criteria by International Union for Conservation of Nature and Natural Resources (IUCN, 2020). They are: *Agasthiyamalaia pauciflora* (Critically Endangered B1+ 2c), *Glyphochloa santapaui* (Vulnerable (D2), *Hubbardia heptaneuron* (Vulnerable (D2), *Limnopoa meeboldii* (Endangered B2ab(iii)), *Parakaempferia synantha* (Critically Endangered B2ab (iii)), *Sanjappa cynometroides* (Critically Endangered B1b (i, ii) + C1(a)), *Bentinckia condapanna* (Vulnerable A1c) and *B. nicobarica* (Endangered C2a).

The most recently erected genus *Sanjappa* (Critically Endangered B1b (i, ii) + C1(a)) has been assessed based on Souza *et al*., (2016). Some of the species of endemic genera such as *Blepharistemma membranifolium*, *Erinocarpus nimmonii*, *Glyphochloa divergens* and *Glyphochloa talbotii, Haplothismia exannulata, Pinda concanensis*, *Pseudodiplospora andamanica, Sphyranthera airyshawii* and *Vanasushava pedata* have been assessed by Mukherjee (1988), Ahmedullah and Nayar (1990), Nayar (1996) and Deshpande (1987a, b) but based on the earlier version 1.0 – 3.0 of IUCN Red List Categories and Criteria.

Discussion

Life-forms of the endemic genera

Angiosperms are predominantly represented by herbaceous life forms (Nie *et al.,* 2016) and this very well corroborates also with the Indian endemic genera that consist of 76% of herbaceous taxa. Studies on monospecific endemic taxa also confirm the dominance of herbaceous taxa (64%) in Indian flowering plants (Rana & Ranade, 2009). Trees form the next dominant life forms. Only four endemic genera namely *Calacanthus*, *Helicanthes, Leucoblepharis* and *Sanjappa* are shrubby forms that are distributed in peninsular India.

Monospecific genera

Monospecific genera that are restricted to small geographical areas have received more attention in recent years from biogeographers due to their morphological uniqueness. This isolation is an indication of their relict nature and they form key floristic elements of the region (Rana & Ranade, 2009; Vanderplank *et al.,* 2014). Of the total monospecific endemic genera recorded, 64.7% taxa are herbaceous. Five of the endemic genera reported from Indian Himalayas are monospecific. Seventy-two percent of the Peninsular Indian endemics are unispecific and are represented by herbaceous families such as Acanthaceae, Asteraceae Poaceae and Apiaceae. Arborescent monospecific endemic genera are mostly found restricted to Peninsular India. All the four monospecific endemic shrubs namely *Calacanthus*, *Helicanthes*, *Leucoblepharis* and *Sanjappa* occur in Western Ghats. In spite of its rich diversity of understory flora in Western Ghats, endemism among shrubs is very low (Krishnan & Davidar, 2007). Similarly, among the eight monospecific endemic genera, four genera namely *Agasthiyamalaia*, *Blepharistemma*, *Erinocarpus* and *Otonephelium* are reported from the Western Ghats.

Based on the evolutionary age of the families of these monospecific tree genera (Li *et al.,* 2019) and the geological age of the region, the endemic tree genera of the Western Ghats may be considered as paleoendemic relicts. *Nicobariodendron* and *Pseudodiplospora* are the relict endemics reported from the Andaman & Nicobar Islands. Geographically isolated regions like mountain peaks and Islands are known for relict endemic floras (Kruckeberg, 2002; Lopez *et al.,* 2011).

Endemic genera of the Indian Himalaya

The Himalayan phytogeographic region is rich in species diversity and possesses a high degree of endemism in India (Nayar, 1996; Singh *et al*., 2015). Though there are different classifications of the Indian Himalayan region, this paper follows the subdivision of Nandy *et al*. (2006). The present analysis reports six genera as endemic to the Indian Himalaya. These endemic genera are distributed in Trans-Himalayan, Western Himalayan, Central Himalayan and Eastern Himalayan subdivisions. The genus *Kashmiria* is distributed in both Trans-Himalayan and Western Himalayan subdivisions. The western Himalayan endemic genera *Ivanjohnstonia* and *Pseudodanthonia* are reported from Uttarakhand, and the Eastern Himalayan genus *Parakaempferia* is reported from Arunachal Pradesh, Assam and Meghalaya. The eastern Himalayan genus *Brachycaulos* is restricted to Sikkim while the genus *Stapletonia* occurs only in Arunachal Pradesh.

Endemic genera of Peninsular India

Peninsular India, that includes the Western and Eastern Ghats, is rich in species diversity due to its varied rainfall, temperature, latitudinal and altitudinal gradients (Nayar, 1996). The hill tops of the Ghats harbour about 53% of the endemic species of the country (Singh *et al.,* 2015). It is considered that most of the endemic species found in the hills of Peninsular India are paleoendemics (Ahmedullah & Nayar, 1987; Nayar, 1996). Of the 36 endemic genera in Peninsular India, 33 are exclusively distributed in the Western Ghats. In addition, four genera are extending to adjacent areas of the Western Ghats: *Leucoblepharis* is distributed in the moist deciduous forest of the Western and Eastern Ghats, *Deccania* occurs in dry deciduous forests of the Eastern Ghats of Tamil Nadu and Andhra Pradesh, *Hardwickia* is distributed in dry deciduous forests of the Western and Eastern Ghats and *Lophopogon* is distributed in dry localities throughout Peninsular India. Poaceae are the dominant family in the Western Ghats (Arora, 1964; Parthasarathy, 1983; Nair & Daniel, 1986; Venu, 1998) with the highest (11) generic endemism and are mostly concentrated in the states of Karnataka, Kerala and Maharashtra. About 64 of the genera of Poaceae have been reported from grasslands. Two genera (*Limnopoa*, *Pogonachne*) and one species (*Nanooravia kayyurense*) occur in wetland habitats. Highest endemic species (16 taxa) diversity is found in *Glyphochloa* which are restricted to lateritic plateaus of the northern Western Ghats. Six tree genera have been reported from Peninsular India, all of which occur in the Western Ghats. Most of the Peninsular Indian endemics (*Agasthiyamalaia, Blepharistemma, Otonephelium, Poeciloneuron*) are confined to southern and central Western Ghats and whereas, *Erinocarpus* is restricted to the central and northern Western Ghats.

Endemic genera of the Andaman & Nicobar Islands

The present analysis shows that the number of endemic genera remains the same and only three genera are endemic to these islands which occur in moist deciduous to wet evergreen forests (Irwin & Narasimhan, 2011).

Disjunct distribution of *Bentinckia* species

The only endemic palm genus *Bentinckia* has two species and shows disjunct distribution. *Bentinckia condapanna* is distributed in the southern Western Ghats while, *B. nicobarica* is distributed in the Nicobar Islands. This type of distribution is evolved due to vicariance. Stuessy *et al*. (1998) proved in

Juan Fernandez Islands and Chile that two closely related endemic species evolved due to vicariance. However, a clear picture of the two species of *Bentinckia* may emerge only from molecular phylogenetic studies.

Threat status and conservation

The threat status for 70% of the taxa belonging to endemic genera of India is yet to be assessed. Of the 80 taxa belonging to these genera, only 18 taxa have been assessed. Among these, only eight genera namely *Agasthiyamalaia* (1 sp.), *Bentinckia* (2 spp.), *Glyphochloa* (1 sp.), *Hubbardia* (1 sp.), *Lamprachaenium* (1 sp.), *Limnopoa* (1 sp.) and *Sanjappa* (1 sp.) have been assessed based on the IUCN Criteria (version 3.1). Hence, there is a need to assess the status of rest of the taxa. A few taxa, whose status has been assessed using older IUCN versions, need to be reassessed as per the latest version of IUCN's Red List Categories and Criteria (IUCN, 2020). Narrow habitat, limited seed set, lower dispersal rate, overexploitation, specialized niche, and low genetic variability positions most of these endemic species to possibly become threatened (Ashton, 1981; Ahmedullah & Nayar, 1987; Abeli, 2010; Kani, 2011).

Brachycaulos simplicifolius Dikshit & Panigrahi, is known only by its type and has not been recollected since then (Singh & Pusalkar, 2020). Hence, this needs to be considered as presumably extinct.

Isolated habitats such as islands show range-restricted species and therefore, have high levels of endemism (Kiera *et al*., 2009; Veron *et al*., 2019). Species with limited geographic distribution will become more vulnerable when compared to other taxa (Nayar, 1980; Kani, 2011) and anthropogenic stress forces these population to easily get extinct (*e.g*. Rossi *et al*., 2009; Peters *et al.,* 2015).

Conservation of plants is more cost-effective compared to conservation of other organisms such as invertebrates (Gordon *et al*., 2019). Among the estimated vascular plants 13% are known to be threatened (Barik *et al*., 2018). Priority for conservation should be given to threatened and endemic genera/species that are restricted to a particular ecological zone and it is wise to map these species using remote sensing (Raven, 1988; Chiarucci, 2019; Volis, 2019). It is seen that fragmentation of terrestrial biomes is affecting the survival rate of the rare plants. Failure in pollination and seed dispersal of these plants or fragmented populations will adversely affect the endemic species of an area (Lander *et al.,* 2019). The survival rate of isolated fragments is very low when compared to connected fragments especially in the case of narrow endemic species (Matesanz *et al.,* 2017). Continuous monitoring of these fragmented populations is required for better conservation and management (Kani, 2011; Chiarucci, 2019). Research/academic institutions, scientists, government agencies and voluntary organizations have to collaborate together and work to conserve these endemic taxa in India.

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