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Distribution profile of angiosperms across elevation discontinuity of Palghat Gap in Southern Western Ghats

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Abstract

Floristic documentation in two forest areas on the north and south of the 32km wide elevation discontinuity of the Southern western Ghats, the Palghat Gap has been undertaken to assess the distribution continuity across the topographic discontinuity. The Kollengode forest range is situated on the South of Palghat Gap and is home to 955 species of angiosperms belonging to 135 families and the Olavakkode range has 655 species of angiosperms coming under 105 families. Of the taxa analysed, 103 families and 302 species are common in both the ranges and the average taxonomic singularity is 0.821 in Kollengode forests while it is 0.845 in Olavakkode range. The endemic taxa recorded in Kollengode forests are 216, while it is 93 in Olavakkode range. It is observed that 8 taxa of Olavakkode range has an exclusive Northward distribution and in contrast, 18 species found in Kollengode range has an exclusive southward distribution. *Strobilanthes lanatus* Nees, *Meteoromyrtus wynaadensis* (Bedd.) Gamble and *Justicia glauca* Rottler from north of Palghat Gap and *Ceropegia thwaitesii* Hook., G*ivotia moluccana* (L.) Sreem. and *Diospyros ebenum* J. Koenig from South of the Gap have successfully crossed the dispersal barrier of the mountain pass. The instances of taxa showing habitat sharing on either sides are very less and hence point to the Palghat Gap acting as a barrier in the continuous distribution of taxa.

Key words: Palghat Gap, distribution, dispersal barrier

Introduction

Distribution of vegetation patterns are limited by contrasting climatic regimes. Oceanic foothills in the north and strongly continental inter mountain basins in the south of Siberian mountains revealed that winter and summer temperatures and precipitation exerted a dominant influence on species composition[1]. The study also revealed that on a more local scale, the main source of variation in species composition was topography, producing landscape patterns of contrasting plant communities on slopes of different aspects and valley bottoms. More over the inquiry on the abundance of alien species was found to be declining with the altitude and in contrast, species richness among comparable native taxa appeared to be nearly independent of altitude over the same range[2] .

Palghat Gap in Southern Western Ghats is a natural discontinuity which forms a 32km wide corridor between the political boundary between Kerala and Tamilnadu. The Palghat Gap forms an elevation and topographic discontinuity and whether the distribution of plants across the Gap points to the Gap acting as a barrier for dispersal of plants is debatable. In this backdrop, the floristic analysis of two forest ranges, viz. Olavakkode range in north of Palghat Gap and Kollengode range in south of Palghat Gap have been carried out to understand the distributional continuity of angiosperms

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across the Gap. Special focus has been given to the distribution of threatened and endemic taxa.

Materials and methods

Explorations and collection of angiosperm taxa in the forests of Olavakkode range lying between 10° 45' and 10° 55' North latitude and 76° 50' and 76° 10' East longitude and Kollengode range lying between 10° 25'and 10° 55' North latitude and 76° 35' and 76° 55' East longitude have been done between 2015 and 2018, along with collection of information on distribution of taxa in southern Western Ghats emphasizing Palghat gap. Identification was ascertained with the help of Flora[3,4,5,6]. The updation of nomenclature was done with and IPNI[7], Plant list[8], Tropicos[9]. Threat status was resolved as per IUCN version 13[10] and alien invasive plants were identified from the latest literature[11].

Results

Species diversity

The explorations revealed the presence of 1610 species of angiosperms in the forests of the two ranges. The forests in Kollengode range has 955 species belonging to 135 families and the forests in Olavakkode range has 655 species belonging to 105 families.

Distributional discontinuities across the gap

In Kollengode forest range, out of the 955 species, 77 are new distributional record to the district of Palakkad district (Table 1). Of these, 31 species are reported to be present in regions south and north of Palghat Gap, while 23 have been reported only in regions south of Palghat Gap. Three species that were earlier reported only in regions north of Palghat Gap are *Strobilanthes lanatus* Nees, *Meteoromyrtus wynaadensis* (Bedd.) Gamble and *Justicia glauca* Rottler . In Olavakkode forest range out of the 655 species 18 are new distributional record for the district of Palakkad. In the Olavakkode range 16 species are seen that are having exclusively southward distribution and are examples of range expansion from south of the Palghat Gap to the North. There are 6 species present in Olavakkode range that have a continuous distribution in the northward regions of Palghat Gap and hence have been unable to expand across the discontinuity. The species known to be growing in both these ranges number 302 and are examples of continuous distribution of taxa across the Palghat Gap.

New discoveries

Floristic exploration during this study in Kollengode range has brought to light the presence of taxa hitherto not known to science. *Sonerila nairii* Soumya & Maya[12], *Sonerila victoriae* Soumya & Maya[13], *Oldenlandia vasudevanii* Soumya & Maya[14], *Impatiens sasidharanii* var. *sasidharanii*[15a]), *Impatiens sasidharanii* var. *hirsuta*[15b] are new discoveries from Kollengode range. Olavakkode forest range is the type location for three new species, *Chlorophytum palghatense*[16], *Zingiber sabuanum*[17] and *Justicia gambleana*[18] and an earlier exploration has helped to rediscover *Impatiens concinna*[19] from forests of Olavakkode range

Distribution of taxa with adaptive traits

The insectivorous genera *Drosera* is represented by three species namely, *D. indica* L., *D. burmanii* Vahl. and *D. peltata* Thunb. of which only the former is showing continuous distribution across the Gap. Another insectivorous genera *Utricularia* is represented in the forests of both ranges, with two species, *U. lazulina* P.Taylor and *U. graminifolia* Vahl. showing continuous distribution across the Gap. *U. aurea* Lour. and *U. praeterita* P.Taylor are present in Kollengode range , but not yet recorded in Olavakkode range, while *U. albocaerulea* Dalzell is present in the Olavakkode range, but not in Kollengode range. The Orchid flora of Kollengode range is very diverse consisting of 27 species under 16 genera. Olavakkode range harbors much less species of Orchids with 8 species under 8 genera and the two ranges have very unique orchid flora since none of the species is common to both the ranges.

Table 1. Taxa new distributional record to Palakkad from Kollengode range

Sl. No	Binomial	Family
1.	*Alseodaphne semecarpifolia Nees var. malabarica* Robi & Udayan	Lauraceae
2.	*Andrographis atropurpurea* (Dennst.) Alston	Acanthaceae
3.	*Andrographis elongata* (Vahl) T.Anderson	Acanthaceae
4.	*Asystasia crispata* Benth.	Acanthaceae
5.	*Biophytum intermedium* Wight	Oxalidaceae
6.	*Blumea laevis* (Lour.) Merr.	Asteraceae
7.	*Blumea oxyodonta* DC.	Asteraceae
8.	*Cajanus rugosus* (Wight &Arn.) Maesen	Fabaceae
9.	*Cardamine africana* L.	Brassicaceae
10.	*Cassytha filiformis* L	Lauraceae
11.	*Centranthera tranquebarica* (Spreng.) Merr.	Orobanchiaceae
12.	*Ceropegia maculata* Bedd.	Apocynaceae
13.	*Cestrum aurantiacum* Lindl.	Solanaceae
14.	*Cestrum nocturnum* L.	Solanaceae
15.	*Cheirostylis parvifolia* Lindl	Orchidaceae
16.	*Cladopus hookeriana* (Tul.) C.Cusset	Podostemaceae
17.	*Commelina clavata* C.B. Clarke	Commelinaceae
18.	*Crinum asiaticum* L.	Amaryllidaceae
19.	*Crotalaria grahamiana* Wight &Arn.	Fabaceae
20.	*Cryptocarya stocksii* Meisn.	Lauraceae
21.	*Cyanotis burmanniana* Wight	Commelinaceae
22.	*Cyathula tomentosa* (Roth) Moq.	Amaranthaceae
23.	*Cyperus digitatus*Roxb.	Cyperaceae
24.	*Diodella teres* (Walter) Small	Rubiaceae
25.	*Diospyros ebenum* J.Koenig ex Retz.	Ebenaceae
26.	*Dodonaea viscosa* subsp. *angustifolia* (L.f.) J.G.West	Sapindaceae
27.	*Drimia indica* (Roxb.) Jessop	Asparagaceae
28.	*Echinochloa frumentacea* Link	Poaceae
29.	*Eriocaulon nepalense* Bong. var. *luzulifolium* (Mart.) Praj. &J.Parn	Eriocaulaceae
30.	*Gymnema decaisneanum* Wight	Apocynaceae
31.	*Hardwickia binata* Roxb.	Fabaceae
32.	*Impatiens sasidharanii* var. *hirsute* Prabhukumar*et al.*	Balsaminaceae
33.	*Impatiens sasidharanii* var. *sasidharanii* Prabhukumar*et al.*	Balsaminaceae
34.	*Ipomoea indica* (Burm.) Merr.	Convolvulaceae
35.	*Isodon lophanthoides* (Buch.-Ham. ex D.Don) H.Hara	Lamiaceae
36.	*Justicia glauca* Rottler	Acanthaceae
37.	*Lagerstroemia parviflora* Roxb.	Lythraceae

38.	*Limnophila aromatica* (Lam.) Merr.	Plantaginaceae
39.	*Linum mysurense* B.Heyne ex Benth.	Linaceae
40.	*Luisia tenuifolia*Hook.f	Orchidaceae
41.	*Memecylon bremeri* M.B.Viswan.	Melastomataceae
42.	*Meteoromyrtus wynaadensis* (Bedd.) Gamble	Myrtaceae
43.	*Mollugo nudicaulis* Lam.	Molluginaceae
44.	*Murdannia gigantea* (Vahl) G. Brückn.	Commelinaceae
45.	*Murdannia crocea* subsp. *ochracea* (Dalzell) Faden	Commelinaceae
46.	*Neanotis indica* (DC.) W.H.Lewis	Rubiaceae
47.	*Oldenlandia vasudevanii* Soumya & Maya	Rubiaceae
48.	*Osbeckia gracilis* Bedd.	Melastomataceae
49.	*Pandanus kaida L.*	Pandanaceae
50.	*Phyllocephalum courtallense* (Wight) Narayana	Asteraceae
51.	*Pinalia mysorensis* (Lindl.) Kuntze	Orchidaceae
52.	*Piper hapnium* Buch.-Ham.	Piperaceae
53.	*Premna paucinervis* (C.B.Clarke) Gamble	Lamiaceae
54.	*Pupalia lappacea* var. *orbiculata* (Heyne ex Wall.) Juss.	Amaranthaceae
55.	*Scutellaria wightiana* Benth.	Lamiaceae
56.	*Sesamum indicum* L.	Pedaliaceae
57.	*Smithia gracilis* Benth.	Fabaceae
58.	*Solanum viarum* Dunal	Solanaceae
59.	*Solanum aculeatissimum* Jacq.	Solanaceae
60.	*Sonerila nairii* Soumya&Maya	Melastomataceae
61.	*Sonerila veldkampiana* Ratheesh, Mini &Sivadasan	Melastomataceae
62.	*Sonerila victoriae* Soumya & Maya	Melastomataceae
63.	*Spermacoce hispida* L.	Rubiaceae
64.	*Sporobolus tenuissimus* (Schrank.) Kuntze	Poaceae
65.	*Sterculia balanghas* L.	Malvaceae
66.	*Sterculia foetida* L.	Malvaceae
67.	*Strobilanthes consanguineus* Clarke	Acanthaceae
68.	*Strobilanthes lanatus* Nees	Acanthaceae
69.	*Stylosanthes hamata* (L.) Taub.	Fabaceae
70.	*Taxillus recurvus* Tiegh.	Loranthaceae
71.	*Tephrosia maxima* (L.) Pers	Fabaceae
72.	*Tephrosia pumila* (Lam.) Pers.	Fabaceae
73.	*Thunbergia tomentosa* Wall. ex Nees	Acanthaceae
74.	*Tiliacora racemosa* Colebr.	Menispermaceae
75.	*Trichosanthes tricuspidata* Lour var. *tomentosa*	Cucurbitaceae
76.	*Tylophora ovata* (Lindl.) Hook. exSteud.	Apocynaceae
77.	*Zingiber wightianum*Thwaites	Zingiberaceae

Table 2. New distributional record to Palakkad from Olavakkode range

Sl. No.	Binomial	Family
1	*Thottea sivarajanii* E.S.S.Kumar, A.E.S.Khan&Binu	Aristolochiaceae
2	*Miliusa gokhalaei*	Annonaceae
3	*Dioscorea belophylla* (Prain) Voigt ex Haines	Dioscoreaeae
4	*Dioscorea hamiltonii* Hook.f.	Dioscoreaeae
5	*Dioscorea wightii* Hook.f.	Dioscoreaeae
6	*Phrynium pubinerve* Blume	Marantaceae
7	*Amomum ghaticum* K.G.Bhat	Zingiberaceae
8	*Eriocaulon conicum (*Fyson) C.E.C.Fisch.	Eriocaulaceae
9	*Cymbopogon citratus* (DC.)Stapf	Poaceae
10	*Ischaemum barbatum* Retz.	Poaceae
11	*Elatostema cuneatum* Wight	Urticaceae
12	*Memecylon randerianum* S.M.Almeida&M.R.Almeida	Melastomataceae
13	*Allophyllus serratus*	Sapindaceae
14	*Cyathula tomentosa*	Amaranthaceae
15	*Diospyros ebenum* J.Koenig ex Retz.	Ebenaceae
16	*Justicia japonica* Thunb.	Acanthaceae
17	*Andrographis elongata* (Vahl) T.Anderson	Acanthaceae
18	*Utricularia albocaerulea* Dalzell	Lentibulariaceae

Discussion and conclusion

The Kollengode and Olavakkode forest ranges are located respectively at the southern and northern boundaries of the Palghat Gap, a 32km wide natural discontinuity of the Southern Western Ghats in the district of Palakkad of Kerala state. The elevation of Palghat Gap is 210m.a.s.l., while the Western Ghats continue to a height of 2637m.a.s.l.at Doddapeta in the Nilgiris in the Northern side of Palghat Gap and to the height of 2533m.a.s.l. in the Palani hills lying South of the Palghat Gap. The discontinuity of Palghat Gap therefore could be a dispersal barrier effecting the continuous distribution of plants along the stretch of the Western Ghats.

The exploration of forests of Kollengode forest range has revealed presence of 77 taxa so far not been recorded in the district of Palakkad. Three of these species are so far reported exclusively from the northern part of the Gap. *Strobilanthes lanatus* Nees, *Meteoromyrtus wynaadensis* (Bedd.) Gamble, and *Justicia glauca* Rottler and their presence in the Kollengode range across the Gap cannot be attributed to any common adaptive feature.

Of the 77 new distributional reports from Kollengode, 23 are known to exist only in regions south of Palghat Gap, but the presence of these taxa in the locality can easily be understood as the range expansion of these species along the continuous elevated topography of the Western Ghats. Out of the 77 new distributional reports 34 taxa are reported from both the north and the south of Palghat Gap and can be considered as successful examples of range expansion.

The exploration of forests of Olavakkode forest range has revealed 18 species to be new distributional reports to the district of Palakkad out of which 5 are previously reported only from regions south of Palghat Gap. Clearly the taxa have successfully dispersed themselves across the barrier of the Gap. Three species among the 18 are previously reported only from regions north of gap, while one taxon is reported only from the district of Palakkad, while the rest of the species are seen both to the north and south of the Gap.

Table 3. Taxa showing range expansion across Palghat Gap

Sl. No.	Distribution pattern	Taxa
1	Plants located North of Palghat Gap and in Kollengode & Olavakkode range of Palakkad district	*1.Utricularia lazulina* P. Taylor *2.Colebrookea oppositifolia* Smith *3.Bauhinia racemosa* Lam.
2	Plants located North of Palghat Gap and new distribution report from Kollengode	*1. Strobilanthes lanatus* Nees *2. Meteoromyrtus wynaadensis (*Bedd.) Gamble *1. Justicia glauca* Rottler
3	Plants of Olavakkode range with only Northward distribution	*1. Thottea sivarajanii* E.S.S.Kumar, A.E.S.Khan&Binu *2. Miliusa gokhalaei* Narayanan *Actinodaphne lawsonii* Gamble *3. Cinnamomum palghatensis* M.Gangop. *4. Dioscorea belophylla* (Prain) Voigt ex Haines *Utricularia albocaerulea* Dalzell
4	Plants located South of Palghat Gap and in Kollengode & Olavakkode range of Palakkad district	*1. Calamus rotang* L. *2. Cyanotis papilionacea* (Burm.f.) Schult. &Schult.f. *3. Chrysopogon nodulibarbis* (Hochst. ex Steud.) Henrard *4. Givotia moluccana* (L.) Sreem.
5	Plants of Olavakkode range with only Southward distribution	*1. Amomum ghaticum* K.G.Bhat *2. Crotalaria mysorensis* Roth *3. Dalbergia sissoo* DC. *4. Trifolium repens* L. *5. Givotia moluccana* (L.)Sreem. *6. Hopea utilis* (Bedd.) Bole *7. Cyathula tomentosa* (Roth) Moq. *8. Diospyros ebenum* J.Koenig ex Retz. *9. Ceropegia thwaitesii* Hook. *10. Toxocarpus kleinii* Wight &Arn. *11. Jasminum flexile var. ovatum* Wall.ex C.B.Clarke *12. Andrographis elongata* (Vahl) T.Anderson *13. Calamus rotang* L. *14. Cyanotis papilionacea* (Burm.f.)Schult.&Schult.f.) *15. Chrysopogon nodulibarbis* (Hochst. ex Steud.)Henrard *16. Bauhinia racemosa* Lam.

The range expansion that has been possible for the 95 species shows that 78% of the range expansion has been along the elevation continuity of the Western Ghats while only 23% of the species has been able to expand across the Gap.

Discussing the relationship between tropical climatic uniformity at a given site and the effectiveness of topographical barriers adjacent to the site in preventing movements of plants, Janzen says that 'topographic barriers may be more effective in tropics'. It is the temperature gradient across a mountain range , which determines its effectiveness as a barrier, rather than the absolute height[20]. The district of Palakkad which lies in the Gap region records the highest average temperature in the state,

and could be a factor that influences the range expansion of taxa across the Palghat gap of the Western Ghats.

Examination of the disjunct species distribution patterns in the northern Peruvian seasonally dry tropical forests (SDTFs) suggest that either species migration between the Marañon drainage and the Pacific region over the Andes has recently occurred via the Porculla Gap, or these areas were once continuous before the uplift of the Andes. The Huancabamba Depression in which the Abra de Porculla pass is located separates the northern and southern Andes and serves as a biogeographic barrier to species movement. The RioMaran˜on valley, is located east of the northwestern Peruvian coastal SDF and connected to them by the lowest mountain pass of the whole Andean chain, the Porculla Pass(2,165 m.a.s.l.). It has been suggested, that this pass has favoured the immigration and exchange of SDF biota, which evolved either in the Maran˜on valley or the coastal SDF[21].Phytogeographical conclusions are often derived from the data obtained on the distribution of plant groups in topographically isolated sites. The plant groups typical of the AmotapeHuancabamba Zone in Ecuador – Peru region (*Nasa triphylla* group, *N*. ser. *Alatae, Ribes andicola* group, *Nasa picta* subsp. *picta*) find their southeastern distribution limit in the northern part of the province Pataz, and are replaced by their southern counterparts (*N. poissoniana* group, *Ribes viscosum*) immediately south of this pass height of Abra de Porculla[22]. Elevation and geographic location were the dominant environmental gradients underlying the variations in species composition in Alpine ecosystems of the Hengduan Mountains, northwest Yunnan, China[23].

Evidently elevation continuity is indeed a favourable element in the successful range expansion of species. The declining abundance of alien species with altitude certainly promotes migration and range expansion of native species. The mountain pass therefore is a barrier to the successful range expansion of taxa as is evident from the fact that 77% of the plants that has succeeded in expanding their habitat range has been unable to do it across the Palghat Gap region.

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