

RESEARCH ARTICLE

Preliminary studies on the succulent plants diversity in western ghats of Kerala, India

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Abstract: The present study highlights the succulent diversity in the Malabar region of Kerala, a part of Western Ghats. A total of 154 succulent species belonging to 84 genera covering 40 families were recorded. Among them 18 species are endemic. The family Orchidaceae (18) is dominant followed by Amaryllidaceae and Commelinaceae (14 each), Araceae and Zingiberaceae (12 each), Balsaminaceae (11). Among these species 128 were herbs, 15 shrubs and 11 climbers. This study will provide reliable data on the occurrence and distribution for the conservation of endemic, endangered and threatened succulents.

Keywords: Succulent diversity, Conservation, Western Ghats, Kerala

Introduction

Succulence is defined as the presence of thickened tissue in plant organs for which the primary function is water storage and drought avoidance. They have diverse life forms such as geophytes, prostrate, creeping perennials, epiphytes, drought deciduous perennials and annuals. The succulent nature is associated with a broad range of ecophysiological strategies and occurs in plants that have evolved in many different environments. The succulent syndrome is considered to be one of the convergent evolutions across the plant kingdom (Males 2017).

The succulents are native to many regions from Northern Europe to the Far East, although most are concentrated in Southern Arid Eastern Africa. Exploration and trading and natural distribution enabled cacti and succulents to establish themselves in new habitats across the world. It is estimated that there are approximately 12,500 species throughout the tropical and subtropical countries including some of the endemic and fascinating plants. The environmental similarity between the succulent hotspot shows conspicuous difference in climate (Nyffeler and Eggli 2010).

They can occur in any vegetative organ such as leaf and stem which are the most familiar and also occur in roots, bulbs or tubers of geophytes, pseudobulbs of orchids and the parenchymatous rays of pachycaul trees (Eggli and Nyffeler 2009). Succulent growth forms are tremendously diverse, which is ranging from small herbaceous rosettes and cushion plants to woody shrubs and trees. Succulents are distributed in almost all parts of the world, but centers of diversity are easily recognizable. Approximately, one third of the total leaf biomass of wet tropical forests is covered by succulent epiphytes (Griffiths and Males 2017).

Dominant succulent plant families are Euphorbiaceae that consist of more than 2,000 species (Horn *et al.* 2012), Aizoaceae (1,800 succulent species), Cactaceae (1,500 succulent species), and Apocynaceae (1,100 succulent species), Asphodelaceae, 500 succulent species) and Agavaceae (200 succulent species) (Arakaki *et al.* 2011). The astonishing family Orchidaceae, consist of 4,400 succulent species (Nyffeler and Eggli 2010), many of which occur in arid and semi-arid habitats (Grace 2019). Succulents are abundant among epiphytes.

Succulents are highly diverse and adaptations vary in every family. The review of literature clearly indicates that there is no separate

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flora for succulent diversity in Kerala. Hence, the present study is an attempt to study the diversity of succulents in Kerala.

Materials and methods

Intensive field visits were carried out at Malabar region of Kerala during the period 2019–2021 to document floristic diversity of succulent plants. Photographs of plants and habitats were taken using a Nikon D5600 camera. The specimens collected for laboratory studies were worked out and identified using relevant floras (Gamble and Fischer 1936, Manilal and Sivarajan 1982, Ramachandran and Nair 1988, Manilal 1988, Ratheesh Narayanan and Sivadasan 2009), revisions, monographs and pertinent literature. Herbarium studies were also conducted to confirm the identity of species by comparison with the specimens available at Bharathiar University Herbarium and Madras Herbarium (MH). The voucher specimens were poisoned pressed and the herbarium specimens were prepared following the standard instructions (Jain and Rao 1976). The specimens were deposited in the Herbarium of Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu. Botanical names were updated using online databases such as The International Plant Name Index (IPNI) and Tropicos. Endemism were recorded using Ahmedullah and Nair (1986), Sasidharan (2004),

Jyosna *et al.* (2011), Jalal and Jayanthi (2012), Sasidharan (2013), Sharmila *et al.* (2014), Singh *et al.* (2015), Josekutty *et al.* (2017), Pramod and Pradeep (2021).

Study area

The Western Ghats is a hotspot covering the eastern boundary of the Kerala State. Malabar region lies between the Western Ghats and the Arabian Sea. It includes Kasaragod, Kannur, Wayanad, Kozhikode, Malappuram and Palakkad district of Kerala. It covers an area of 17,461km², lies between 74°30'E to 77°E longitude and 10°N to 12°30'N latitude

Results and discussion

During the present study, 154 succulent species belonging to 84 genera and 40 families were recorded from the study area (Table-1). The families are arranged using the APG system of classification (APG IV 2016). The highest number of species was represented by Orchidaceae (18) followed by Amaryllidaceae and Commelinaceae (14 each), Araceae and Zingiberaceae (12 each), Balsaminaceae (11), Asteraceae (5), Asparagaceae, Gesneriaceae and Melastomataceae (4 each), Apocynaceae, Cactaceae, Portulacaceae and Urticaceae (3 each), Aizoaceae, Araliaceae, Begoniaceae, Convolvulaceae, Dioscoreaceae, Musaceae, Piperaceae and Plantaginaceae (2 each) while remaining families have one species (Fig. 4).

Out of 154 succulent taxa herbs are most predominant with 128 species, followed by 15 species of shrubs and 11 species of climbers (Fig. 2). Among these, 134 species were terrestrials, 13 epiphytes, 4 lithophytes, 2 parasites and 1 psammophyte (Fig-3). The epiphytic species are *Acampe ochracea* (Lindl.) Hochr., *Acampe praemorsa* (Roxb.) Blatt. & McCann, *Acampe praemorsa* var. *longepedunculata* (Trimen) Govaerts, *Aerides crispa* Lindl., *Aerides ringens* (Lindl.) C.E.C.Fisch., *Aeschynanthus perrottetii* A.DC., *Cymbidium aloifolium* (L.) Sw., *C. bicolor* Lindl., *Impatiens dendricola* C.E.C.Fisch., *I. stocksii* Hook.f. & Thomson, *Porpax jerdoniana* (Wight) Rolfe, *Rhynchostylis retusa* (L.) Blume, *Sirhookera latifolia* (Wight) Kuntze. The combination of epiphytism and succulence occurs in orchids which provide an important contribution



Figure 1: Maps showing Malabar region of Kerala

Table 1: Succulent Plants in Malabar Region of Kerala

S.no.	Species	Family	Habit	Habitat	Succulent Part	Succulent Type	Distribution	Ornamental utility
1	<i>Acampe ochracea</i> (Lindl.) Hochr.	Orchidaceae	H	Epi	Le	SS	Vilangad	Indoor & outdoor plants
2	<i>Acampe praemorsa</i> (Roxb.) Blatt. & McCann	Orchidaceae	H	Epi	Le	SS	Kuttiady	Indoor & outdoor plants
3	<i>Acampe praemorsa</i> var. <i>longepedunculata</i> (Trimen) Govaerts	Orchidaceae	H	Epi	Le	SS	Vanimel	Indoor & outdoor plants
4	<i>Aerides crispa</i> Lindl.	Orchidaceae	H	Epi	Le	SS	Paithalmala	Indoor & outdoor plants
5	<i>Aerides ringens</i> (Lindl.) C.E.C.Fisch.	Orchidaceae	H	Epi	Le	SS	Taliparamba	Indoor & outdoor plants
6	<i>Aeschynanthus perrottetii</i> A.DC.	Gesneriaceae	Cl	Epi	Le	SS	Ranipuram	Household creepers
7	<i>Agapanthus africanus</i> (L.) Hoffmanns.	Amaryllidaceae	H	Terl	Le	SS	Vilangad	Garden plants
8	<i>Agave americana</i> L.	Asparagaceae	S	Terl	Le	XS	Kuttiady	Garden plants
9	<i>Agave salmiana</i> var. <i>ferox</i> (K.Koch) Gentry	Asparagaceae	S	Terl	Le	XS	Panom	Garden plants
10	<i>Agave sisalana</i> Perrine	Asparagaceae	S	Terl	Le	XS	Thirunelli Tholpetty	Garden plants
11	<i>Alocasia fornicata</i> (Kunth) Schott	Araceae	H	Terl	Pi, Pe, Tu	SS	Ranipuram	-
12	<i>Alocasia macrorrhizos</i> (L.) G.Don	Araceae	H	Terl	Pi, Pe, Tu	SS	kuttiady	-
13	<i>Amaranthus spinosus</i> L.	Amaranthaceae	H	Terl	St	SS	Thikkodi	--
14	<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson	Araceae	H	Terl	Pi Pe Tu	SS	Kuttiady	-
15	<i>Amorphophallus sylvaticus</i> (Roxb.) Kunth	Araceae	H	Terl	Pi, Pe, Tu	SS	Niravilpuzha Purameri	-
16	<i>Argostemma verticillatum</i> Wall.	Rubiaceae	H	Terl	St	SS	Paithalmala	
17	<i>Arisaema leschenaultii</i> Blume	Araceae	H	Terl	Pi, Pe, Tu	SS	Paithalmala Ranipuram	-
18	<i>Arisaema tortuosum</i> (Wall.) Schott	Araceae	H	Terl	Pi, Pe, Tu	SS	Ranipuram	-
19	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Cl	Terl	Tu	SS	Purameri	Household creepers
20	<i>Bacopa monnieri</i> (L.) Wettst.	Plantaginaceae	H	Terl	Le	SS	Anaikatti Kasaragod	-
21	<i>Begonia floccifera</i> Bedd.	Begoniaceae	H	Terl	Pe, Pi	SS	Meppadi	Garden plants
22	<i>Begonia grandis</i> Dryand.	Begoniaceae	H	Terl	Pe, Pi	SS	Niravilpuzha	Garden plants
23	<i>Bulbophyllum acutiflorum</i> A.Rich.	Orchidaceae	H	Terl	Le, Pb	SS	Kodiyura	Garden plants
24	<i>Caladium bicolor</i> (Aiton) Vent.	Araceae	H	Terl	Pi, Pe, Tu	SS	Kainatty Kuttiady	Indoor plants
25	<i>Canna indica</i> L.	Cannaceae	H	Terl	St	SS	Banasura	Bio-Fencing
26	<i>Centella asiatica</i> (L.) Urb.	Apiaceae	Cl	Terl	St	SS	Kuttiady	
27	<i>Cereus pterogonus</i> Lem.	Cactaceae	S	Terl	St	XS	Arakkal	Lawns
28	<i>Chrysothemis pulchella</i> (Donn ex Sims) Decne.	Gesneriaceae	H	Terl	St	SS	Avolam	-
29	<i>Cissus quadrangularis</i> L.	Vitaceae	Cl	Terl	St	SS	Parappupara	Household creepers
30	<i>Coleus amboinicus</i> Lour.	Lamiaceae	H	Terl	Le, St	SS	Kuttiady	-
31	<i>Colocasia affinis</i> Schott	Araceae	H	Terl	Pi, Pe, Tu	SS	Kainatty	-
32	<i>Colocasia esculenta</i> (L.) Schott	Araceae	H	Terl	Pi, Pe, Tu	SS	Kuttiady	-
33	<i>Commelina communis</i> L.	Commelinaceae	H	Terl	St	SS	Vilangad	-
34	<i>Commelina benghalensis</i> L.	Commelinaceae	H	Terl	St	SS	Koranappara	-
35	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Asteraceae	H	Terl	St	SS	Koranappara	-
36	<i>Crepidium acuminatum</i> (D.Don) Szlach.	Orchidaceae	H	Terl / Litho	St	SS	Paithalmala	Garden plants
37	<i>Crepidium purpureum</i> (Lindl.) Szlach.	Orchidaceae	H	Terl / Litho	St	SS	Paithalmala	Garden plants
38	<i>Crinum asiaticum</i> L.	Amaryllidaceae	H	Terl	Le, Pe, Bu	SS	Kaiveli Thalassery	Garden plants
39	<i>Crinum latifolium</i> L.	Amaryllidaceae	H	Terl	Le, Pe, Bu	SS	Vattoli	Garden plants
40	<i>Crinum viviparum</i> (Lam.) R. Ansari & V.J. Nair	Amaryllidaceae	H	Terl	Le, Pe, Bu	SS	Payyoli	Garden plants
41	<i>Curculigo orchidioides</i> Gaertn.	Amaryllidaceae	H	Terl	Tu	SS	Paithalmala	-
42	<i>Curcuma amada</i> Roxb.	Zingiberaceae	H	Terl	Rh, PSt	SS	Kuttiady	-
43	<i>Curcuma amada</i> var. <i>amada</i> Hook. f.	Zingiberaceae	H	Terl	Rh, PSt	SS	Mananthavady Mukkali	-
44	<i>Curcuma angustifolia</i> Roxb.	Zingiberaceae	H	Terl	Rh, PSt	SS	Mangad	-
45	<i>Curcuma aromatica</i> Salisb.	Zingiberaceae	H	Terl	Rh, PSt	SS	Chandanathode	-
46	<i>Curcuma caesia</i> Roxb.	Zingiberaceae	H	Terl	Rh, PSt	SS	Ranipuram	-
47	<i>Curcuma decipiens</i> Dalzell	Zingiberaceae	H	Terl	Rh, PSt	SS	Mukkali	-
48	<i>Curcuma haritha</i> Mangaly & M.Sabu	Zingiberaceae	H	Terl	Rh, PSt	SS	Payyoli	-
49	<i>Curcuma longa</i> L.	Zingiberaceae	H	Terl	Rh, PSt	SS	Kallodi	-
50	<i>Curcuma oligantha</i> Trimen	Zingiberaceae	H	Terl	Rh, PSt	SS	Karthikappally	-
51	<i>Curcuma kannanorensis</i> R.Ansari, V.J.Nair & N.C.Nair	Zingiberaceae	H	Terl	Rh, PSt	SS	Thalassery Kuttiady	-
52	<i>Curcuma xanthorrhiza</i> Roxb.	Zingiberaceae	H	Terl	Rh, PSt	SS	Kallodi	-
53	<i>Cuscuta chinensis</i> Lam.	Convolvulaceae	Cl	Pr	St	SS	Payyoli	-
54	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Cl	Pr	St	SS	Koranappara	-

55	<i>Cyanotis axillaris</i> (L.) D.Don ex Sweet.	Commelinaceae	H	Terl	Le St	SS	Iritty Karimpuzha	-
56	<i>Cyanotis cristata</i> (L.) D.Don	Commelinaceae	H	Terl	Le St	SS	Tholpetty	-
57	<i>Cyanotis obtusa</i> (Trimen) Trimen	Commelinaceae	H	Terl	Le St	SS	Kannoth	-
58	<i>Cyanotis pilosa</i> Schult. & Schult.f.	Commelinaceae	H	Terl	Le St	SS	Chandanathope	-
59	<i>Cyanotis thwaitesii</i> Hassk.	Commelinaceae	H	Terl	Le St	SS	Arakkal	-
60	<i>Cyanotis villosa</i> (Spreng.) Schult. & Schult.f.	Commelinaceae	H	Terl	Le St	SS	Kannoth	-
61	<i>Cymbidium aloifolium</i> (L.) Sw.	Orchidaceae	H	Epi	Le	SS	Banasura Taliparamba	Garden plants
62	<i>Cymbidium bicolor</i> Lindl.	Orchidaceae	H	Epi	Le	SS	Banasura	Garden plants
63	<i>Dendrophthoe falcata</i> (L.f.) Ettingsh.	Loranthaceae	H	Pr	Le	SS	Thalassery	-
64	<i>Dioscorea alata</i> L.	Dioscoreaceae	Cl	Terl	Tu	SS	Poothampara	-
65	<i>Dioscorea wallichii</i> Hook.f.	Dioscoreaceae	Cl	Terl	Tu	SS	Tholpetty	-
66	<i>Dracaena trifasciata</i> (Prain) Mabb.	Asparagaceae	H	Terl	Le	SS	Payod	-
67	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	H	Terl	St	SS	Vallikkad	-
68	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	H	Terl	St	SS	Arakkal Paithalmala	-
69	<i>Ensete superbum</i> (Roxb.) Cheesman	Musaceae	S	Terl	PSt	SS	Paithalmala	-
70	<i>Epipogium roseum</i> (D.Don) Lindl.	Orchidaceae	H	Terl	Pe, Rh	SS	Chandanathode	-
71	<i>Epithema carnosum</i> Benth.	Gesneriaceae	H	Terl	St	SS	Paithalmala	-
72	<i>Euphorbia milli</i> Des Moul.	Euphorbiaceae	H	Terl	St	XS	Poothampara	Outdoor plants
73	<i>Euphorbia neohumbertii</i> Boiteau	Euphorbiaceae	H	Terl	St	XS	Pakramthalam	Outdoor plants
74	<i>Euphorbia tirucalli</i> L.	Euphorbiaceae	S	Terl	St	XS	Koranappara	Outdoor plants
75	<i>Euphorbia tithymaloides</i> L.	Euphorbiaceae	S	Terl	St	XS	Chathangottunada	-
76	<i>Euphorbia tortilis</i> Rotler ex Ainslie	Euphorbiaceae	S	Terl	St	XS	Pakramthalam	-
77	<i>Euphorbia viguieri</i> Denis	Euphorbiaceae	H	Terl	St	XS	Poothampara	-
78	<i>Furcraea foetida</i> (L.) Haw.	Asparagaceae	S	Terl	Le	XS	Vilangad	-
79	<i>Glinus oppositifolius</i> (L.) Aug.DC.	Molluginaceae	H	Terl	St	SS	Payyoli	-
80	<i>Globba sessiliflora</i> Sims	Zingiberaceae	H	Terl	Rt	SS	Paithalmala	Garden Plants
81	<i>Gloriosa superba</i> L.	Colchiaceae	Cl	Terl	Tu	SS	Urithookimala	Household creepers
82	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	H	Terl	St	SS	Balavadi	-
83	<i>Gynura nitida</i> DC.	Asteraceae	H	Terl	St	SS	Paithalmala	-
84	<i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta	Costaceae	H	Terl	Rh, St	SS	Paithalmala	-
85	<i>Hippeastrum puniceum</i> (Lam.) Voss	Amaryllidaceae	H	Terl	Bu, Le, Pe	SS	Koranappara	Bio-Fencing
86	<i>Hippeastrum reginae</i> (L.) Herb.	Amaryllidaceae	H	Terl	Bu, Le, Pe	SS	Payod, Thirunelli	Bio-Fencing
87	<i>Hippeastrum reticulatum</i> (L'Hér.) Herb.	Amaryllidaceae	H	Terl	Bu, Le, Pe	SS	Urithookimala	Bio-Fencing
88	<i>Hydrocotyle javanica</i> Thunb.	Araliaceae	Cl	Terl	St	SS	Banasura Ranipuram	-
89	<i>Hydrocotyle moschata</i> G.Forst.	Araliaceae	Cl	Terl	St	SS	Kudiyan mala	-
90	<i>Hymenocallis littoralis</i> (Jacq.) Salisb.	Amaryllidaceae	H	Terl	Bu, Le, Pe	SS	Mattilayam Taliparamba	Bio-Fencing
91	<i>Impatiens acaulis</i> Arn.	Balsaminaceae	H	Litho	Pe, Pi	SS	Chandanathode	-
92	<i>Impatiens balsamina</i> L.	Balsaminaceae	H	Terl	St	SS	Pulinjal	Garden Plants
93	<i>Impatiens chinensis</i> L.	Balsaminaceae	H	Terl	St	SS	Kannavam Ranipuram	-
94	<i>Impatiens dendricola</i> C.E.C.Fisch.	Balsaminaceae	H	Epi	Pi	SS	Paithalmala	-
95	<i>Impatiens diversifolia</i> Wall. ex Wight & Arn.	Balsaminaceae	H	Terl	St	SS	Kannoth	-
96	<i>Impatiens minor</i> (DC.) Bennet	Balsaminaceae	H	Terl	St	SS	Koranappara Pulinjal	-
97	<i>Impatiens modesta</i> Wight	Balsaminaceae	H	Litho	Pe, Pi	SS	Paithalmala	-
98	<i>Impatiens oppositifolia</i> L.	Balsaminaceae	H	Terl	St	SS	Kudiyanmala Paithalmala	-
99	<i>Impatiens scapiflora</i> B.Heyne ex Wall.	Balsaminaceae	H	Litho	Pe, Pi	SS	Attappadi	-
100	<i>Impatiens stocksii</i> Hook.f. & Thomson	Balsaminaceae	H	Epi	Pe, Pi	SS	Paithalmala	-
101	<i>Impatiens walleriana</i> Hook.f.	Balsaminaceae	H	Terl	St	SS	Pulinjal	Garden Plants

102	<i>Kalanchoe blossfeldiana</i> Poelln.	Crassulaceae	H	Terl	Le, St	Su	Parappupara	-
103	<i>Kalanchoe delagoensis</i> Eckl. & Zeyh.	Crassulaceae	H	Terl	Le, St	Su	Chathangottu nada	-
10	<i>Kalanchoe pinnata</i> (Lam.) Pers.	Crassulaceae	H	Litho, Terl	Le, St	Su	Kudiyannmala	Indoor & outdoor plants
105	<i>Leuenbergeria bleo</i> (Kunth) Lodé	Cactaceae	S	Terl	St	XS	Pazhankavu	Indoor & outdoor plants
106	<i>Limnophila repens</i> (Benth.) Benth.	Plantaginaceae	H	Terl	Le, St	SS	Ayancherry	-
107	<i>Torenia crustacea</i> (L.) Cham. & Schltdl.	Linderniaceae	H	Terl	St	SS	Kalindi	-
108	<i>Malaxis densiflora</i> (A.Rich.) Kuntze.	Orchidaceae	H	Terl	Tu	SS	Paithalmala	Garden Plants
109	<i>Mirabilis jalapa</i> L.	Nyctaginaceae	H	Terl	Tu	SS	Kallodi	Garden Plants
110	<i>Murdannia semiteres</i> (Dalzell) Santapau	Commelinaceae	H	Terl	Le, Pe	SS	Meenmutty Taliparamba	-
111	<i>Murdannia simplex</i> (Vahl) Brenan	Commelinaceae	H	Terl	Tu	SS	Urithookimal a	-
112	<i>Murdannia nudiflora</i> (L.) Brenan	Commelinaceae	H	Terl	St	SS	Kanjirakkada vu	-
113	<i>Musa acuminata</i> Colla	Musaceae	S	Terl	PSt	SS	Ranipuram	-
114	<i>Opuntia cochenillifera</i> (L.) Mill.	Cactaceae	S	Terl	Le/Cd	XS	Pakramthala m	Garden Plants
115	<i>Ophiopogon intermedius</i> D.Don	Asparagaceae	H	Terl	Tu	SS	Paithalmala	Garden Plants
116	<i>Oxalis triangularis</i> A.St.-Hil.	Oxalidaceae	H	Terl	Pe Pi	SS	Pulinjal	Garden Plants
117	<i>Pachystoma pubescens</i> Blume	Orchidaceae	H	Terl	Tu	SS	Ranipuram	Garden Plants
118	<i>Pancratium nairii</i> Sasikala & Reema Kumari	Amaryllidaceae	H	Terl	Bu, Le, Pe	SS	Aralam Jagannath Temple gate	Garden Plants
119	<i>Pancratium triflorum</i> Roxb.	Amaryllidaceae	H	Terl	Bu, Le Pe	SS	Chathangottu nada	Garden Plants
120	<i>Peperomia heynana</i> Miq.	Piperaceae	H	Terl	St	SS	Ranipuram	-
121	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	H	Terl	St	SS	Koranappara	-
122	<i>Pilea microphylla</i> (L.) Liebm.	Urticaceae	H	Terl	Le, St	SS	Kuttiady	-
123	<i>Pilea victoriae</i> V. Suresh & Sojan	Urticaceae	H	Terl	Le St	SS	Palakkad	-
124	<i>Pilea wightii</i> Wedd.	Urticaceae	H	Terl	St	SS	Vilangad	-
125	<i>Plumeria alba</i> L.	Apocynaceae	S	Terl	St	SS	Arakkal Payyoli	Avenue Plants
126	<i>Plumeria pudica</i> Jacq.	Apocynaceae	S	Terl	St	SS	Thikkodi	Avenue Plants
127	<i>Plumeria rubra</i> L.	Apocynaceae	S	Terl	St	SS	Pazhankavu	Avenue Plants
128	<i>Porpax jerdoniana</i> (Wight) Rolfe	Orchidaceae	H	Epi	Le	SS	Ranipuram	-
129	<i>Portulaca grandiflora</i> Hook.	Portulacaceae	H	Terl	Le, St	Su	Kaiveli	Garden Plants
130	<i>Portulaca oleracea</i> L.	Portulacaceae	H	Terl	Le, St	Su	Thalassery	Garden Plants
131	<i>Portulaca pilosa</i> L.	Portulacaceae	H	Terl	Le, St	Su	Kuttiady	-
132	<i>Remusatia vivipara</i> (Roxb.) Schott	Araceae	H	Epi	Pe, Pi, Tu	SS	Paithalmala	-
133	<i>Rhynchosoglossum notonianum</i> (Wall.) B.L. Burtt	Gesneriaceae	H	Terl	St	SS	Ranipuram	-
134	<i>Rhynchostylis retusa</i> (L.) Blume	Orchidaceae	H	Epi	Le	SS	Taliparamba	Indoor & outdoor plants
135	<i>Scadoxus multiflorus</i> (Martyn) Raf.	Amaryllidaceae	H	Terl	Bu, Pe	SS	Ayanikkad Chenamangal am	Garden Plants
136	<i>Sesuvium portulacastrum</i> (L.) L.	Aizoaceae	H	Psam	St	SS	Thalassery	-
137	<i>Sirhookera latifolia</i> (Wight) Kuntze	Orchidaceae	H	Epi	Le	SS	Paithalmala	-
138	<i>Sonerila wallichii</i> Benn.	Melastomatacea e	H	Terl	Pe	SS	Vilangad	Garden Plants
139	<i>Sonerila raghaviana</i> Ratheesh, Sunil, Nandakumar & Shaju	Melastomatacea e	H	Litho	Pe	SS	Paithalmala	Garden Plants
140	<i>Sonerila longipedunculata</i>	Melastomatacea e	H	Terl	Pe	SS	Kuttiady	Garden Plants
141	<i>Sonerila rheedii</i> Wall. ex Wight & Arn.	Melastomatacea e	H	Terl	Pe	SS	Koranappara Chandanathode, Mahe	Garden Plants
142	<i>Talinum portulacifolium</i> (Forssk.) Asch. ex Schweinf.	Talinaceae	H	Terl	St	SS	Thikkodi	-
143	<i>Tradescantia pallida</i> (Rose) D.R.Hunt.	Commelinaceae	H	Terl	St	SS	Pakramthala m	Garden Plants
144	<i>Tradescantia spathacea</i> Sw.	Commelinaceae	H	Terl	St	SS	Parappupara	Garden Plants
145	<i>Tradescantia zebrina</i> Bosse	Commelinaceae	H	Terl	St	SS	Kaiveli	Garden Plants
146	<i>Trianthema portulacastrum</i> L.	Aizoaceae	H	Terl	St	SS	Thalassery Mannarkkad	-
147	<i>Typhonium roxburghii</i> Schott	Araceae	H	Terl	Pe, Pi, Tu	SS	Kelubazar	-
148	<i>Xanthosoma sagittifolium</i> (L.) Schott	Araceae	H	Terl	Pe, Pi, Tu	SS	Kuttiady	-
149	<i>Zephyranthes minuta</i> (Kunth) D.Diet.	Amaryllidaceae	H	Terl	Bu, Pe, Le	SS	Pulinjal	Garden Plants
150	<i>Zephyranthes candida</i> (Lindl.) Herb.	Amaryllidaceae	H	Terl	Bu, Pe, Le	SS	Korom	Garden Plants
151	<i>Zephyranthes robusta</i> (Herb.) Baker	Amaryllidaceae	H	Terl	Bu, Pe, Le	SS	Vattoli	Garden Plants
152	<i>Zeuxine affinis</i> (Lindl.) Benth. ex Hook. f.	Orchidaceae	H	Epi	St, Tu	SS	Kuttiady	-
153	<i>Zeuxine gracilis</i> (Breda) Blume	Orchidaceae	H	Epi	St, Tu	SS	Ranipuram	-
154	<i>Zeuxine longilabris</i> (Lindl.) Trimen	Orchidaceae	H	Epi	St, Tu	SS	Koranappara	-

Foot Note: H- Herb, S- Shrub, Cl- Climber, Epi- Epiphyte, Terl- Terrestrial, Litho- Lithophyte, Pa- Parasitic, Psam- Psammophyte, Le- Leaf, Pi- Petiole, Pe- Peduncle, Tu, Tuber, St- Stem, Pb- Pseudobulb, Bu- Bulb, PSt- Pseudostem, Rh- Rhizome, Cd- Cladode, SS- Semi Succulent, XS- Xerophytic Succulent, Su- Succulen

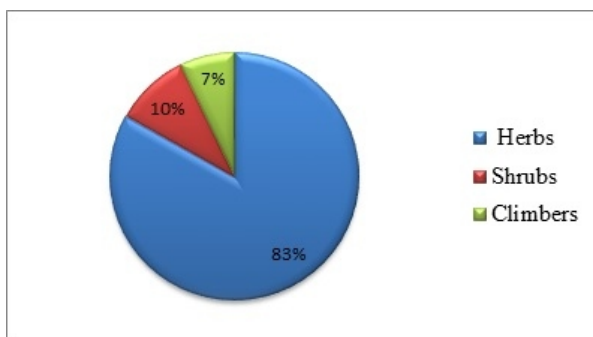


Figure 2: Succulent plant diversity based on Habit

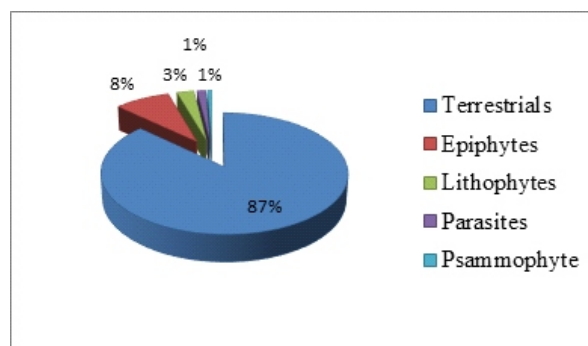


Figure 3: Succulent plant diversity based on Habitat

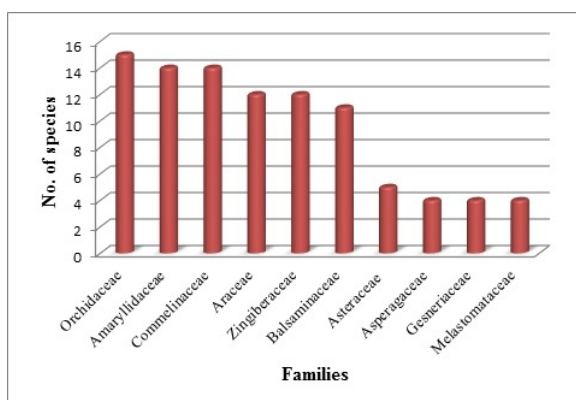


Figure 4: Diversity of dominant succulent families

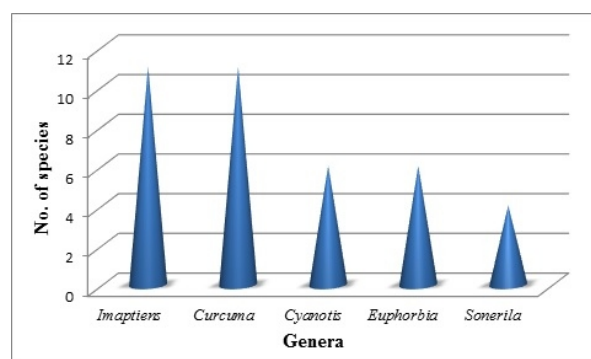


Figure 5: Dominant succulent genera

to the floristic and functional diversity of forests throughout the tropics (Griffiths and Males 2017).

Among the 84 genera, the dominant genera is *Impatiens* and *Curcuma* (11 species each) followed by *Cyanotis* and *Euphorbia* (6 species each), *Sonerila* (4 species), *Acampe*, *Agave*, *Crinum*, *Hippeastrum*, *Kalanchoe*, *Murdannia*, *Pilea*, *Plumeria*, *Portulaca*, *Tradescantia*, *Zephyranthes*, *Zeuxine* (3 species each), *Aerides*, *Alocasia*, *Amorphophallus*, *Arisaema*, *Begonia*, *Colocasia*, *Commelina*, *Crepidium*, *Cuscuta*, *Dioscorea*, *Hydrocotyle*, *Pancratium*, *Peperomia* (2 species each) and remaining genera have one species each (Fig. 5).

Based on water content, succulent plants are classified as semi succulents and xerophytic succulents (Delf 1912). Out of these 154 species, the dominant succulent type is semi succulent with 141 species followed by xerophytic succulent with 13 species. Based on the part of succulent, highest number of species comes under stem succulent (52 species) followed by leaf succulent (22 species), leaf and stem (15 species), peduncle and petiole and

tuber (12 species), bulb and leaf and peduncle (12 species), pseudostem and rhizome (11 species), tuber (10 species), peduncle and petiole (7 species), peduncle (4 species), pseudostem (2), bulb and peduncle (1 species), leaf and peduncle (1 species), leaf and pseudobulb (1 species), peduncle and rhizome (1 species), petiole (1 species), rhizome and stem (1 species), root (1 species), respectively.

The present explorations resulted in the enumeration of 18 endemic species. Among these, nine species are endemic to western ghats, viz. *Aerides crispa* Lindl., *Aeschynanthus perrottetii* A.DC., *Bulbophyllum acutiflorum* A.Rich., *Epithema carnosum* Benth., *Gynura nitida* DC., *Impatiens modesta* Wight, *Porpax jerdoniana* (Wight) Rolfe, *Sonerila raghavia* Ratheesh, Sunil, Nandakumar & Shaju, *Sonerila rheedii* Wall. ex Wight & Arn; four taxa are endemic to Southern Western Ghats, viz. *Arisaema leschenaultii* Blume, *Curcuma haritha* Mangaly & M.Sabu, *Curcuma kannanorensis* R.Ansari, V.J.Nair & N.C.Nair, two taxa are endemic to India, viz. *Curcuma angustifolia* Roxb., *Ophiopogon intermedius* D.Don; two taxa are endemic to



Plate 1: **A.** *Acampe praemorsa* (Roxb.) Blatt. & McCann, **B.** *Arisaema leschenaultii* Blume, **C.** *Murdannia simplex* (Vahl) Brenan, **D.** *Rhynchoglossum notonianum* (Wall.) B.L. Burtt, **E.** *Impatiens minor* (DC.) Bennet, **F.** *Scadoxus multiflorus* (Martyn) Raf.

Peninsular India, viz. *Impatiens minor* (DC.) Bennet, *Murdannia semiteres* (Dalzell) Santapau; two taxa are endemic to India and Sri Lanka, viz. *Crinum viviparum* (Lam.) Ansari and Nair, *Pancratium triflorum* Roxb., respectively. It is assumed that the invasion of African elements to the peninsular Indian region and migration of Indian

endemics to Sri Lanka might have occurred along with the splitting of the Mozambique belt (Mathew 2015).

Succulents have been in high demand because of their specific characteristics as they are drought resistant and can survive even under minimal light making them suitable for indoor use (Bell 2001; Nefzaoui 2007). Due to their



Plate 2: G. *Hippeastrum puniceum* (Lam.) Voss, H. *Cymbidium aloifolium* (L.) Sw., I. *Aerides crispata* Lindl. J. *Peperomia pellucida* (L.) Kunth, K. *Zeuxine longilabris* (Lindl.) Trimen L. *Sonerila rheedii* Wall. ex Wight & Arn.

architectural and sculptural shapes, succulents are a joy to behold and a delight to design with. Many succulents have rosette shapes that resemble flowers. Succulents look the same day in and day out unless they are in bloom (Baldwin 2013). Among the 154 succulent plant species, 63 species were used as ornamental succulents, because of their attractive flower (38 species), habit with parts

(14 species) and attractive leaf (11 species) (Table-1).

Conclusion

Succulent plants represent a unique, large and diverse resource with extraordinary potential to

mitigate the negative consequences of climatic change in regions where interventions will be most needed. Malabar region of Kerala, a part of Western Ghats, which is the home for many endemic species. Plants are becoming endangered or extinct due to climatic changes, deforestation, or encroachment of invasive plant species and anthropogenic activities. Systematic approaches are required to conserve various unique habitats, which support great diversity of existing plant species. The data generated in this study will help in planning for conservation of endemic, threatened and endangered succulent plants. Furthermore, improved knowledge of succulent biology may help us to better understand the ethnobotanical significance of succulents.

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