ESTABLISHMENT OF AN ARBORETUM (BOTANICAL GARDEN) OF WESTERN GHATS AT PILIKULA NISARGADHAMA WITH SPECIAL REFERENCE TO ENDEMIC AND THREATENED PLANTS AS AN EX-SITU CONSERVATION MEASURE

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ABSTRACT

An arboretum is a special type of Botanical Garden meant for conserving arborescent species (= trees and shrubs). Pilikula Arboretum is one such Botanical Garden established in 35 ha of land in Mangaluru, Dakshina Kannada District of Karnataka, India. A total of about 60,000 plants belonging to 250 species of trees & shrubs of the Western Ghats region are conserved in this Arboretum. This list includes 77 endemic species of Western Ghats, 14 threatened, one newly reported, and two rediscovered. This list also includes 4 monotypic genera. Pilikula arboretum is exclusively meant for conserving the plant species of the Western Ghats region of Karnataka state. This is a good example of an example of ex-situ conservation of plants.

KEYWORDS: *The Western Ghats, arboretum, Pilikula Nisarga Dhama, ex-situ conservation, endemic, threatened, monotypic*

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INTRODUCTION

As per the Biological Diversity is concerned, India is one of the richest countries in the world. Based on the overall species richness, India has got a place in the 17 megadiverse countries of the world. Many cultivated plants were originated in this country and thus its richness concerning agro-biodiversity is very impressive. Western Ghats harbour many endemic and threatened species. Endemic species are those with restricted distribution and hence are extinction-prone. The word "endemism" means the confinement of an organism to a particular geographical location or locations; in other words, they survive in only such places where the type of ecosystem prevails. Since the species are distributed in the smaller the area, they are facing greater the threat, particularly if their habitats are disturbed. The Western Ghats which is recognised as one of the 35 globally recognised hotspots, namely India - Sri Lanka hotspot (www.conservation.org). If the organisms are destroyed in their location, they will be eliminated once for all from the earth. Hence hotspots are considered as the area of high conservation priority. That's why the Hotspots play a vital role in conserving the Biological Diversity of the World.

Western Ghats harbour a total of 7,402 vascular plant species (Nayar et al 2014). Singh et al (2015) reported 2116 species of endemic plants in the Western Ghats. About 80 endemic plant genera have a single species (monotypic genera) and some have many species, for example, the genus *Strobilanthes* is having 44 species; nearly 70% of the endemic genera monotypic. Since these genera having single species, if that single species is lost, the entire genus will vanish from the world.

Some of the genera of Western Ghats are represented by large numbers of endemic species. Examples, *Impatiens* - 76 out of 86 species are endemic, *Dipterocarpus* - 12 out of 13 species are endemic, and *Calamus* - 23 of 25 species are endemic. A total of 308 species out of 490 tree species recorded from low- and mid-elevation forests are endemic. Among the 267 species of orchids recorded from the Western Ghats, 130 are endemic to this region. The single gymnosperm tree species, *Podocarpus wallichianus* is also endemic to the Western Ghats.

Western Ghats region is a source of economically important species. It is thus an area with very high priority from the conservation point of view.

Destructive anthropic activities have taken a heavy toll of the forests of Western Ghats. The chief among them is the cultivation of exotic plant species like *Acacia* and *Eucalyptus* species, monoculture forest tree species like teak and plantations of commercial crops like coffee, tea, rubber and cocoa. Spices such as cardamom, clove and cinnamon are also cultivated at the cost of forests. Other activities like mining, river valley projects, fuelwood gathering, overgrazing, and forest fire and timber extraction have also contributed to the loss of forests.

Endemic species are found in a very restricted area and they require a special niche for their survival. If their habitat is disturbed, they may become endangered. Most of the endemic species are extinction prone because of they may have narrow geographical range, they have been having only one or a few populations; small population or little genetic variability; declining population; low reproductive potential or they be overexploited by the people etc.

About one-third of the endemic species of the Western Ghats are endangered and many species are believed to be extinct or on the verge of becoming extinction. Examples, *Buchanania barberi* Gamble (Anacardiaceae); *Hopea jacobi* C.E.C.Fisch (Dipterocarpaceae); *Nothopegia aureo-fulva* Beddome ex Hook.f. (Anacardiaceae); *Cynometra beddomei* Prain (Fabaceae); *Dialium travancoricum* Bourd. (Fabaceae); *Eugenia singampattiana* Beddome (Myrtaceae); *Syzygium bourdillonii* (Gamble) Rathakr. & Nair (Myrtaceae); *Syzygium courtallense* (Gamble) Alston (Myrtaceae); *Syzygium microphyllum* Gamble (Myrtaceae); *Syzygium palghatense* Gamble (Myrtaceae); *Syzygium travancoricum* Gamble (Myrtaceae); *Madhuca insignis* (Radlk.) H.J.Lam (Sapotaceae); *Actinodaphne bourneae* Gamble (Lauraceae), and *Pseudoglochidion anamalayanum* Gamble (Euphorbiaceae).

Ex-situ conservation is the best-suited method to conserve the Biological Diversity in the wild. But due to persisting threats to the flora from various anthropogenic activities, it may not always be practical to conserve the species. Hence ex-situ conservation may sometimes prove to be an effective alternative to in situ conservation. One of the best examples of ex situ plant conservation is the establishment of Botanical Gardens. These gardens play a key role in plant conservation particularly endemic and threatened ones.

ARBORETUM (BOTANICAL GARDEN) AT PILIKULA

With the financial assistance from Indo-Norwegian Environment Program (INEP), an arboretum (Botanical Garden) extending over an area of about 85 acres has been established in Pilikula Nisarga Dhama, Mangaluru, Karnataka during 2000-2004, for conserving plant species of the Western Ghats region of Karnataka. Before planting this area was under *Acacia* and *Casuarina* cultivation.

View of the arboretum in 2003

Present view of the arboretum

A total of 250 species belonging to 60 families have been introduced in the arboretum. Among them 77 species are endemic to the Western Ghats, 14 are threatened, four monotypic genera, one newly reported and three rediscovered species (Appendix 1).

DISCUSSIONS

The threatened endemic trees species introduced in the arboretum are *Calophyllum apetalum* Willd. (Clusiaceae), *Dipterocarpus indicus* Bedd. (Dipterocarpaceae), *Garcinia indica* (Thouars) Choisy (Clusiaceae), *Gymnacranthera canarica* (King) Warb. (Myristicaceae), *Hopea canarensis* Hole (Dipterocarpaceae), *Hydnocarpus pentandrus* (Buch.-Ham.) Oken (Achariaceae), *Kingiodendron pinnatum* (DC.) Harms (Leguminosae), *Myristica magnifica* Bedd. (Myristicaceae), *Myristica malabarica* Lam. (Myristicaceae), *Ochreinauclea missionis* (Wall. ex G. Don) Ridsdale (Rubiaceae), *Saraca asoca* (Roxb.) Willd. (Leguminosae), and *Vateria indica* L. (Dipterocarpaceae). The list also includes rediscovered species like *Madhuca insignis* (Radlkofer) H.J. Lam (rediscovered after 120 years by Krishna Kumar *et al*, 2004); *Syzygium kanarensis* (Talbot) Raizada (rediscovered after 50 years by Shenoy *et al*, 2015); and newly reported species like *Syzygium travancoricum* Gamble (New report to Karnataka by Krishna Kumar and Shenoy 2006).

In addition to this, the following monotypic genera (Uniyal and Mathur 1994) are also introduced in the arboretum. These genera have single species and are endemic to the Western Ghats.

Blepharistemma Wallich ex Benth. (Rhizophoraceae)

B. serratum (Dennst.) Suresh

Otonophelium Radlk. (Beddome) Radlk. (Sapindaceae)

O. stipulaceum (Beddome) Radlk.

The monotypic genus *Moullava* Adans. with single species *spicata* (Dalz.) Nicolson (Fabaceae) earlier considered as endemic to India, but now it has lost its endemic status with extended distribution (Nayar *et al* 2014). And another monotypic genus *Erinocarpus* with single species *nimmonii* is also non-endemic to the Western Ghats.

It is also interesting to note that, the arboretum also has endemic palms and canes like *Arenga wightii* Griffith, *Pinanga dicksonii* (Roxb.) Blume, *Calamus hookerianus* Becc., *C. karnatakensis* Renuka & Lakshmana, *C. lakshmanae* Renuka, *C. nagabettai* Fernandez & Dey, *C. prasinus* Lakshmana & Renuka, *C. travancoricus* Beddome ex Becc. & Hook.

f., *C. vattayila* Renuka.

The endemic climbers like *Combretum razianum* K.G.Bhat, *Kunstleria keralensis* C.N. Mohanan & Nair, *Spatholobus purpureus* Benth. ex Baker and *Ventilago bombaiensis* Dalz. are also introduced in the arboretum.

Many endemic species in the arboretum are economically important in one or more ways. For example, plants yielding timber (*Dipterocarpus indicus* Beddome, *Artocarpus hirsutus* Lam., *Calophyllum apetalum* Willd., *H. parviflora* Beddome, *Kingiodendron pinnatum* (DC.) Harms, *Lagerstroemia microcarpa* Wight, *Poeciloneuron indicum* Beddome, *Polyalthia fragrans* (Dalz.) Beddome, *Syzygium laetum* (Buch.-Ham.) Gandhi, *Syzygium travancoricum* Gamble and *Vateria indica* L.) plants used for weaving baskets, for making furniture and in handicrafts (*Calamus nagabettai* Fernandez & Dey, *Calamus prasinus* Lakshmana & Renuka, *Ochlandra scriptoria* (Dennst.) C. Fischer and *O. travancorica* Benth. ex Gamble); plants yielding gums and resins (*Garcinia gummi-gutta* (L.) N. Robson, *H. ferruginea* Marchand, *H. grahamii* (Wight) Kurz, *H. nigra* Bourd., *Vateria indica* L.); plants yielding paper pulp (*Ochlandra scriptoria* (Dennst.) C. Fischer and *O. travancorica* Benth. ex Gamble); plants yielding edible fruits (*Artocarpus hirsutus* Lam., *Baccaurea courtallensis* Muell.-Arg., *Garcinia indica* (Thouars) Choisy, *Flacourtia montana* Graham and *Syzygium laetum* (Buch.-Ham.) Gandhi) and plants having medicinal importance (*Hydnocarpus pentandrus* (Buch.-Ham.) Oken, *Memecylon malabaricum* (C.B. Clarke) Cogn. etc.).

CONCLUSIONS

Arboreta (Botanical Gardens) play a vital role in the *ex-situ* conservation of endangered and endemic plant species as they serve readymade constituency for conservation. The *ex-situ* conservation of some of the endemic and threatened plants of the Western Ghats of Karnataka in the arboretum will not only help in educating the people, particularly the student community, about the diversity of plants in the Western Ghats and the need to conserve them but can also serve as source material for micro-propagation of rare and threatened plants

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Appendix 1: List of plant species introduced in the Arboretum

Sl. No	Name of the species	Family	Conservation status
1.	<i>Actinodaphne malabarica</i> Balakr.	LAURACEAE	Endemic to W. Ghats
2.	<i>Arenga wightii</i> Griffith	PALMAE	Endemic to W. Ghats
3.	<i>Artocarpus hirsutus</i> Lam.	MORACEAE	Least Concern (IUCN)
4.	<i>Baccaurea courtallensis</i> Muell.-Arg.	EUPHORBIACEAE	Endemic to W. Ghats
5.	<i>Blepharistemma serratum</i> (Dennst.) Suresh	RHIZOPHORACEAE	Endemic, Monotypic
6.	<i>Calamus hookerianus</i> Becc.	PALMAE	Endemic to W. Ghats
7.	<i>Calamus karnatakensis</i> Renuka & Lakshmana	PALMAE	Endemic to W. Ghats
8.	<i>Calamus lakshmanae</i> Renuka	PALMAE	Endemic to W. Ghats
9.	<i>Calamus nagabettai</i> Fernandez & Dey	PALMAE	Endemic to W. Ghats
10.	<i>Calamus prasinus</i> Lakshmana & Renuka	PALMAE	Endemic to W. Ghats
11.	<i>Calamus travancoricus</i> Beddome ex Becc. & Hook. f.	PALMAE	Endemic to W. Ghats
12.	<i>Calamus vattayila</i> Renuka	PALMAE	Endemic to W. Ghats
13.	<i>Calophyllum apetalum</i> Willd.	CLUSIACEAE	Vulnerable (IUCN)
14.	<i>Cinnamomum malabattrum</i> (Burm.f.) Blume	LAURACEAE	Endemic to W. Ghats
15.	<i>Combretum razianum</i> K.G.Bhat	COMBRETACEAE	Endemic to W. Ghats
16.	<i>Croton malabaricus</i> Beddome	EUPHORBIACEAE	Endemic to W. Ghats
17.	<i>Diospyros bourdillonii</i> Brandis	EBENACEAE	Endemic to W. Ghats
18.	<i>Dipterocarpus indicus</i> Beddome	DIPTEROCARPACEAE	Endangered (IUCN)
19.	<i>Dysoxylum malabaricum</i> Beddome ex Hiern	MELIACEAE	Endangered (IUCN)
20.	<i>Ensete superbum</i> (Roxb.) Cheesman	MUSACEAE	Endemic to W. Ghats
21.	<i>Epiprinus mallotiformis</i> (Muell.-Arg.) Croizat	EUPHORBIACEAE	Endemic to W. Ghats
22.	<i>Erinocarpus nimmonii</i> J.Graham	TILIACEAE	Monotypic, Non-endemic
23.	<i>Flacourtia montana</i> Graham	FLACOURTIACEAE	Endemic to W. Ghats
24.	<i>Garcinia gummigutta</i> (L.) N. Robson	CLUSIACEAE	Endemic to W. Ghats
25.	<i>Garcinia indica</i> (Thouars) Choisy	CLUSIACEAE	Vulnerable (IUCN)
26.	<i>Garcinia talbotii</i> Raiz. & Sant.	CLUSIACEAE	Endemic to W. Ghats
27.	<i>Glochidion ellipticum</i> Wight	EUPHORBIACEAE	Endemic to W. Ghats

28.	<i>Glochidion johnstonei</i> Hook. f.	EUPHORBIACEAE	Endemic to W. Ghats
29.	<i>Gordonia obtusa</i> Wallich ex Wight & Arn.	THEACEAE	Endemic to W. Ghats
30.	<i>Grewia heterotricha</i> Masters	TILIACEAE	Endemic to W. Ghats
31.	<i>Gymnacranthera canarica</i> (King) Warb	MYRISTICACEAE	Vulnerable (IUCN)
32.	<i>Holigarna arnottiana</i> Hook. f.	ANACARDIACEAE	Endemic to W. Ghats
33.	<i>Holigarna ferruginea</i> Marchand	ANACARDIACEAE	Endemic to W. Ghats
34.	<i>Holigarna grahamii</i> (Wight) Kurz	ANACARDIACEAE	Endemic to W. Ghats
35.	<i>Holigarna nigra</i> Bourd.	ANACARDIACEAE	Endemic to W. Ghats
36.	<i>Hopea canarensis</i> Hole	DIPTEROCARPACEAE	Endangered (IUCN)
37.	<i>Hopea parviflora</i> Beddome	DIPTEROCARPACEAE	Endemic to W. Ghats
38.	<i>Hopea ponga</i> (Dennst.) Mabb.	DIPTEROCARPACEAE	Endemic to W. Ghats
39.	<i>Hopea racophloeia</i> Dyer	DIPTEROCARPACEAE	Endemic to W. Ghats
40.	<i>Humboldtia brunonis</i> Wallich	CAESALPINIACEAE	Endemic to W. Ghats
41.	<i>Hydnocarpus pentandrus</i> (Buch.-Ham.) Oken	FLACOURTIACEAE	Endangered (IUCN)
42.	<i>Hymenodictyon obovatum</i> Wallich	RUBIACEAE	Endemic to W. Ghats
43.	<i>Ilex malabarica</i> Beddome	AQUIFOLIACEAE	Endemic to W. Ghats
44.	<i>Ixora brachiata</i> Roxb.	RUBIACEAE	Endemic to W. Ghats
45.	<i>Kingiodendron pinnatum</i> (DC.) Harms	CAESALPINIACEAE	Endangered (IUCN)
46.	<i>Knema attenuata</i> (Hook. f. & Thomson) Warb.	MYRISTICACEAE	Lower Risk/least concern (IUCN)
47.	<i>Kunstleria keralensis</i> C.N. Mohanan & Nair	PAPILIONACEAE	Endemic to W. Ghats
48.	<i>Lagerstroemia microcarpa</i> Wight	LYTHRACEAE	Endemic to W. Ghats
49.	<i>Litsea laevigata</i> (Nees) Gamble	LAURACEAE	Endemic to W. Ghats
50.	<i>Madhuca insignis</i> (Radlkofer) H.J. Lam	SAPOTACEAE	Critically Endangered (IUCN)
51.	<i>Mallotus stenanthus</i> Muell.-Arg.	EUPHORBIACEAE	Endemic to W. Ghats
52.	<i>Meiogyne pannosa</i> (Dalz.) Sinclair	ANNONACEAE	Endemic to W. Ghats
53.	<i>Memecylon malabaricum</i> (C.B. Clarke) Cogn.	MELASTOMATACEAE	Endemic to W. Ghats
54.	<i>Memecylon talbotianum</i> Brandis	MELASTOMATACEAE	Endemic to W. Ghats
55.	<i>Moullava spicata</i> (Dalz.) Nicolson	CAESALPINIACEAE	Monotypic, Non-endemic
56.	<i>Myristica magnifica</i> Bedd.	MYRISTICACEAE	Endangered (IUCN)
57.	<i>Myristica malabarica</i> Lam.	MYRISTICACEAE	Vulnerable (IUCN)
58.	<i>Nothopegia racemosa</i> (Dalz.) Ramam.	ANACARDIACEAE	Endemic to W. Ghats
59.	<i>Ochlandra scriptoria</i> (Dennst.) C. Fischer	GRAMINEAE	Endemic to W. Ghats
60.	<i>Ochlandra travancorica</i> Benth. ex Gamble	GRAMINEAE	Endemic to W. Ghats
61.	<i>Ochreinauclea missionis</i> (Wallich ex G. Don) Ridsd.	RUBIACEAE	Vulnerable (IUCN)
62.	<i>Otonophelium stipulaceum</i> (Beddome) Radlk.	SAPINDACEAE	Endemic, Monotypic
63.	<i>Pandanus unipapillatus</i> Dennst.	PANDANACEAE	Endemic to W. Ghats
64.	<i>Pinanga dicksonii</i> (Roxb.) Blume	PALMAE	Endemic to W. Ghats
65.	<i>Pittosporum dasycaulon</i> Miq.	PITTOSPORACEAE	Endemic to W. Ghats
66.	<i>Poeciloneuron indicum</i> Beddome	GUTTIFERAE	Endemic to W. Ghats
67.	<i>Polyalthia fragrans</i> (Dalz.) Beddome	ANNONACEAE	Endemic to W. Ghats
68.	<i>Psychotria dalzellii</i> Hook. f.	RUBIACEAE	Endemic to W. Ghats
69.	<i>Psychotria flavida</i> Talbot	RUBIACEAE	Endemic to W. Ghats
70.	<i>Pterospermum reticulatum</i> Wight & Arn.	STERCULIACEAE	Endemic to W. Ghats
71.	<i>Spatholobus purpureus</i> Benth. ex Baker	PAPILIONACEAE	Endemic to W. Ghats
72.	<i>Syzygium kanarense</i> (Talbot) Raizada	MYRTACEAE	Endemic to W. Ghats
73.	<i>Syzygium laetum</i> (Buch.-Ham.) Gandhi	MYRTACEAE	Endemic to W. Ghats
74.	<i>Syzygium travancoricum</i> Gamble	MYRTACEAE	Critically Endangered (IUCN)
75.	<i>Tabernaemontana heyneana</i> Wallich	APOCYNACEAE	Endemic to W. Ghats
76.	<i>Trewia polycarpa</i> Benth.	EUPHORBIACEAE	Endemic to W. Ghats
77.	<i>Vateria indica</i> L.	DIPTEROCARPACEAE	Vulnerable (IUCN)
78.	<i>Ventilago bombaiensis</i> Dalz.	RHAMNACEAE	Endemic to W. Ghats
79.	<i>Vepris bilocularis</i> (Wight & Arn.) Engl.	RUTACEAE	Endemic to W. Ghats

Plate 1: Photographs of some of the endemic plants introduced in the arboretum

- A. *Syzygium laetum* (Buch.-Ham.)(Image © Ramakrishna Marati)
- B. *Garcinia gummigutta* (L.) N. Robson (Image © Ramakrishna Marati)
- C. *Erinocarpus nimmonii* J.Graham (Image © Ramakrishna Marati)
- D. *Madhuca insignis* (Radlkofer) H.J. Lam.(Image © Ramakrishna Marati)
- E. *Hydnocarpus pentandrus* (Buch.-Ham.) Oken (Image © Ramakrishna Marati)
- F. *Myristica malabarica* Lam.(Image © Ramakrishna Marati)

Plate 1: Photographs of some of the endemic plants introduced in the arboretum (Contd.)

- A. *Myristica fatua* Houtt. var. *magnifica* (Beddome) Sinclair (Image © Ramakrishna Marati)
- B. *Baccaurea courtallensis* Muell.-Arg. (Image © Ramakrishna Marati)
- C. *Artocarpus hirsutus* Lam. (Image © Ramakrishna Marati)
- D. *Gymnacranthera canarica* (King) Warb (Image © Ramakrishna Marati)
- E. *Syzygium kanarense* (Talbot) Raizada (Image © Ramakrishna Marati)
- F. *Garcinia indica* (Thouars) Choisy (Image © Ramakrishna Marati)