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Prioritisation of endemic plants of Eastern Ghats for Biological conservation

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Abstract

There is an international effort to identify species that face extinction in order to make conservation efforts more efficient. Availability of the updated data on the list of threatened plants is important for framing conservation strategies. It has been shown that about 10% of all plant taxa are threatened globally. The Red Data Book of Indian plants is a reference manual that lists threatened plants. The objective of present study was to test whether the Red Data Book provides a comprehensive list of the threatened endemic plants of Eastern Ghats and to suggest a list of potential plants for conservation ranking to include under Red Data Book (RDB). In order to accomplish this task, we listed a total of 145 species of endemic plants, including 44 RDB plant species, compared the data on species distribution based on herbaria, literature and current field surveys and cross checked the listings in the Red Data Book with individual species. The present paper highlights the current status of the endemic plants of Eastern Ghats.

Introduction

India's forests are under severe pressure for meeting growing demands for fuel, fodder, grazing, timber and non-timber forest products from an ever increasing human and livestock population, and industrial demands. It is very difficult to explore beneath the static descriptions of any ecosystem and assess its long-term 'health'. Biodiversity conservation is important to ensure that the fundamental components of living resources are maintained. The Red Data Book (RDB) of Indian Plants (Nayar & Sastry, 1987, 1988, 1990) focuses exclusively on the Indian flora and more precisely on threatened angiosperms, gymnosperms and Pteridophytes. Researchers studying rarity, use it is an analytical tool and the accuracy of their results depend on the RDB. Customs Agencies need the RDB to guide them in controlling the illegal trade of biological material under CITES. Finally the RDB has reached the status of a reference guide with important implications of research, conservation and for the economy. The most recent edition of the RDB is based on the criteria of Leucas & Synge (1978). Since, its creation, IUCN has attempted to list species that are threatened with extinction globally. It has been shown that about 10% of all plant taxa are threatened globally (IUCN, 1994). The criteria used to define the categories of threatened species are accordingly upgraded (IUCN, 2001).The RDB, however contains only 814 species (4.7%) of the known 17000 species in India. It reveals the presence of relatively small proportion of threatened plant species in the RDB. Data on plant species and their distribution in the Eastern Ghats permits us to cross-check the listings in the RDB for a particular flora. The data contains information on the number of records of endemic species in herbaria, in literature and field surveys (C.S. Reddy, 2001; C.S. Reddy *et al*. 2006; C.S. Reddy *et al*. 2008a). The objective of this study was to test whether the RDB provides a comprehensive list of the threatened endemic plants of Eastern Ghats and to suggest a list of potential plants for conservation ranking to include under RDB.

Study Area

The Eastern Ghats along the Peninsular India extending over 2000 km with average width of about 100 km and covering the area under 11 30' to 21 0' N Lat. and 77 22' to 85 20' E long. The wide range of topography and other physical features of the Eastern Ghats, provided by the hills raising from almost sea level to about 1572 m altitude, shaped the land to harbour rich and varied flora. They are not formed of one particular geological formation but consists of rocks varying in origin and structure according to the location (Meher-Homji, 2001). Several large rivers like Mahanadi, Godavari, Krishna, cut the range into discontinuous blocks of hills along the east coast.

Based on geological and tectonic considerations, the Eastern Ghats are formed of four sections:

(1) the portion north of the Mahanadi river covering Mayurbhanj (Similipal) and the adjoining territory;
(2) the portion between the Mahanadi and the Godavari where the mountainous character of the Eastern Ghats is most clearly marked, with the Deomali peak (1672m), Palamkini (1516m), Nimagiri (1516m), Mahendragiri (1501m), Sambarikonda (1512). Araku, Charnokites and Khondalites compose this montane tract;
(3) the third section lies between the Krishna river and the Chennai city along the arcuate eastern margin of the Cuddapah basin. This section includes the Nallamalais, Veligonda, Palakonda, Seshachalam hills whose average elevation is 750m. Quartzite and slate formations predominate.
(4) the last section comprises the tract between Chennai and the Nilgiri hills where they join the Western Ghats. Prominent features are the Javadi hills of North Arcot, the Gingee and Kalrayan hills of South

Arcot, Pachamalai hills of Tiruchirapalli, Shevaroys and Kolli hills of Salem and Biligirirangan hills in Chamrajnagar, Sandoor hills in Bellary and Kolar.

The knowledge of the floral wealth of Eastern Ghats is not fully known and in our estimation based on literature, the number of flowering plant taxa occurring in the Eastern Ghats is about 3200. Eastern Ghats have 'ecological islands' that harbour endemic plants. These areas are Simlipal, Ganjam-Koraput range of Orissa, Visakhapatnam hills, Upper Godavari, Nallamala-Cuddapah-Seshachalam hill ranges of Andhra Pradesh and Shevaroys, North and South Arcot districts of Tamil Nadu. In most of these areas only vestiges of the once luxuriant and verdant forests remain. They are under commercial exploitation of land by way of quarrying and mining (Koraput, Araku, RV Nagar, Gudem, Papi hills), dam building (Srisailam, Nagarjunasagar, Polavaram), monocultures and forest plantations (Koraput, Gudem, Tirumala, Shevaroy), hydrothermal projects (Machkund, Sileru, Kondapalli) and shifting cultivation (Visakhapatnam, East Godavari, Khammam, Koraput, Malkangiri, Nabarangapur, Ganjam, Gajapathi, Phulbani). Most of the native species are under threat due to loss of habitat, anthropogenic pressure, exploitation for medicine and invasion of alien species (C.S. Reddy *et al*. 2008b).

There are many species (96) of wild relatives of cultivated plants are occurring in Eastern Ghats. *Oryza meyeriana* (More & Steud.) Baill., 'the mountain rice' appearing like seedlings of bamboo in northern Eastern Ghats, *Oryza jeyporensis* Govind. & Krishn. is an endemic rice of wetlands in northern Eastern Ghats, *Oryza officinalis* Wall. ex Watt ssp. *malampuzhaensis* (Krishn. & Chandr.) Tateoka is a 'wild rice' in drier tracts of Nallamalais (Middle Eastern Ghats).

Material and Methods

In order to accomplish the task of prioritisation, three sources of data were utilized for compiling the information of endemic species: herbaria (specimens checked in the national and regional herbaria), literature and field surveys since 1996. In the present study (a) listed endemic taxa of the Eastern Ghats, (b) Compared the data on species distribution based on herbaria, literature and current field surveys and (c) Compared the RDB categories with individual species.

Results and Discussion

The species were ranked according to the number of records. We listed a total of 145 species of endemic plants, including the RDB plants. Of these 47 taxa are known from type collections, 21 species are known from type locality and 41 species were least known in herbaria. (table 1). Of the 41 species of least known herbaria species 21 were found the place in RDB. Of the 36 species of discontinuous range, 17 were reported in RDB (table 2). All the rare species were changed to *'vulnerable'* (table 3) to follow the nomenclatural recommendations of IUCN (1994). Habit-wise analysis shows that herbs represent 77 species followed by trees (32), shrubs (24) and climbers (12) (table 4).

RDB covers 44 species of the 145 species of endemics. It means that <2% of species were recorded in the red list categories (RDB) of 3000 species of flowering plants. The number of threatened species increased with decreased number of records. Consequently, the figure of 145 species underestimates the number of indigenous plants under stress. But even the particular assemblage studied here, consisting exclusively of endemic species, contains a relatively higher proportion of threatened species than does the wide spread flora of the Eastern Ghats. A priori, rare species usually have smaller ranges of distribution than abundant species. Herbaria records, field inventories and published literature in combination shows significant correlation to infer species abundances. These findings indicate that number of herbaria records and field records are good indicator of threat. Actually, the species least recorded in herbaria (41 species) have been observed to be very rare and localized. Of these only 3 species appear in the RDB.

In Conservation Assessment and Management Planning (C.A.M.P.) workshop for medicinal plants of Andhra Pradesh (2001) some of the endemic species were assessed under different threat categories (globally) namely: *Cycas beddomei* (Critically Endangered), *Decalepis hamiltonii* (Endangered), *Hildegardia populifolia* (Vulnerable), *Phyllanthus indofischeri* (Vulnerable), *Pimpinella tirupatiensis* (Endangered), *Pterocarpus santalinus* (Endangered), *Shorea tumbaggaia* (Endangered), *Syzygium alternifolium* (Endangered), *Terminalia pallida* (Endangered) and *Urginea nagarjunae* (Endangered) (Jadhav *et al*. 2001).

An urgent re-assessment of the threat categories of the least recorded endemic species is highly desirable. The paper proposes to include all the endemic plants of Eastern Ghats which were known from type collection and type locality on a priority basis in the RDB. It is suggested that the status of several endemic plant species should be examined on a priority basis using qualitative and quantitative methodologies. Table 1 can be used to prioritize a revision.

Justification to consider endemics of Eastern Ghats for conservation prioritization

- The major parts of Eastern Ghats are under explored; floristic wealth of the region is not fully known.

- The Eastern Ghats are '*tors*' of geological antiquity and older than Himalayas and Western Ghats.
- The Eastern Ghats are isolated hill ranges in Peninsular India, harbour primarily Tropical Deciduous vegetation, which represents species of high economic/timber/medicinal potential.
- The Eastern Ghats are homeland for 96 species of wild relatives of crops (eg: *wild rice, wild pepper, wild banana, wild turmeric, wild pigeon-pea*).
- The endemic plants of Eastern Ghats are palaeoendemics,which are under the gradual process of extinction.
- All the endemic plants are shows narrow range of distribution and are localized (in the case of Western Ghats, many endemic species are widely distributed throughout the Ghats and are common).
- The Eastern Ghats are one of the best resource areas for Bauxite deposits in the world, which are of immense economic potential.
- Nearly, 54 tribal communities inhabit Eastern Ghats region.
- Eastern Ghats has the pride of representing one of the costliest and scented woods of the world - *Santalum album* (Sandal wood).
- The Eastern Ghats are cut across by the major rivers like Mahanadi, Godavari, Krishna, Pennar, and Kauveri.
- Species rich zones are isolated in Eastern Ghats in comparison to Western Ghats, where there is a continuity of mountain system and almost same humid climate.

Conclusion

It is now for the botanists to critically examine the entries in Red List category and prepare threatened plants list, more scientific than before for their own regions. This will draw attention of to programmes of conservation and will help planners and administrators to understand the urgency and importance of conservation of threatened species. We need to raise the levels of our perception and evaluation.

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Table 1. Endemic Plant species of Eastern Ghats.

S.No.	Taxon	Habit	RDB category	Uniqueness	Hill ranges	District-wise distribution
	GYMNOSPERMAE = CYCADOPHYTA Cycadaceae					
1	*Cycas beddomei* Dyer	Shrub	Vulnerable	Type locality	Seshachalam	Chittoor, Cuddapah
2	*Cycas sphaerica* Roxb.	Shrub		Scattered	South and Central Eastern Orissa	Gajapathi, Phulbani, Angul, Khurda, Cuttack, Dhenkanal, Nayagarh
	ANGIOSPERMAE = MAGNOLIOPHYTA DICOTYLEDONAE = MAGNOLIOPSIDA Acanthaceae					
3	*Andrographis beddomei* Clarke	Under shrub		Type locality	Nallamalais	Kurnool
4	*Andrographis nallamalayana* Ellis	Procumbent herb		Type locality	Nallamalais	Kurnool, Cuddapah
5	*Barleria morrisiana* Bor ex Fischer	Under shrub		Least Known	Cherukonda & Biligirirangan	VisakhapatnamChamrajnagar
6	*Dicliptera beddomei* Clarke	Erect herb		Type collection	Nallamalais	Kurnool
7	*Justicia gingiana* Sebastine & Ramamurthy	Shrub		Type collection	Gingee hills	Villupuram
8	*Rostellualria vahlii* (Roth) Nees var. *rupicola* Ellis	Prostrate herb		Type collection	Nallamalais	Kurnool
9	*Phlebophyllum jeyporensis* (Bedd.) Bremek.	Shrub	Endangered	Scattered	Upper Godavari, Visakhapatnam, MahEndangeredragiri	East Godavari, VisakhapatnamGajapati
10	*Nilgirianthus circarensis* (Gamble) Bremek.	Erect herb		Scattered	Visakhapatnam & Karlapat	VisakhapatnamKalahandi
11	*Neuracanthus neesianus* Clarke	Erect herb	Endangered	Type collection	Arcot hills	Arcot
12	*Santapaua madurensis* Balakr. & Subram.	Erect herb	Endangered	Least Known	Alagar hills, Tanjore	Madurai (Alagar hills), Tanjore
13	*Thunbergia fragrans* Roxb. var. *hispida* Gamble	Climber		Least Known	Mahendragiri & Deomali	Gajapati, Koraput
	Anacardiaceae					
14	*Nothopegia heyneana* (Hook.f.) Gamble	Small tree	Vulnerable	Scattered	Dharakonda, Kolli hills	Visakhapatnam Salem
	Annonaceae					
15	*Alphonsea madraspatana* Bedd.	Small tree		Scattered		Cuddapah, VisakhapatnamNorth Arcot, Khurda
16	*Uvaria eucinata* Bedd.ex Dunn	Scandent shrub	Endangered	Least Known	Russelkonda, Karachuli	Ganjam
	Apiaceae					
17	*Bupleurum andhricum* Nayar & Banerji	Erect herb		Least Known		Srikakulam, Visakhapatnam
18	**Pimpinella tirupatiensis* Balakr. & Subram.	Erect herb	Endangered	Type locality	Seshachalam	Chittoor

	Asclepiadaceae					
19	*Brachystelma ciliatum* Arekal & Ramakrishna	Erect herb		Type collection	Kolar	Kolar
20	*Brachystelma glabrum* Hook.f.	Erect herb		Type collection	Palakonda	Cuddapah
21	*Brachystelma kolarensis* Arekal & Ramakrishna	Erect herb		Type collection	Kolar	Kolar
22	*Brachystelma volubile* Hook.f.	Twining herb		Least Known	Palakonda	Cuddapah
23	*Caralluma indica* N.E.Br.	Fleshy herb		Scattered		Nellore, Visakhapatnam, Chengalpattu, Villupuram
24	*Caralluma lasiantha* N.E. Br.	Fleshy herb		Scattered		Anantapur, Chittoor
25	*Ceropegia spiralis* Wight.	Tuberous climber	Vulnerable	Scattered		Cuddapah, Chittoor
26	**Decalepis hamiltonii* Wight. & Arn.	Tuberous climber		Scattered		Rayalaseema
27	*Heterostemma deccanense* (Talb.) Swarup & Mangaly	Wiry Climber	Endangered	Least Known	Maredumilli, Upper Sileru	East Godavari Khammam
28	*Oianthus disciflorus* Hook.f.	Climber		Least Known	Nallamalais	Kurnool
29	*Toxocarpus roxburghii* Wight & Arn.	Climbing shrub	Endangered	Least Known	Maredumilli, Sapparlu	East Godavari, Visakhapatnam
	Asteraceae					
30	*Cyathocline manilaliana* C.Raju & R. Raju	Erect herb		Type locality		Adilabad
31	*Notonia shevaroyensis* Fyson	Scapigerous herb		Type locality	Shevaroys	Salem
32	*Pentanema indicum* (L.) Ling var. *sivarajanianum* C. Raju & R. Raju	Erect herb		Type locality	Nallamalais (Upper Ahobilam)	Kurnool
33	*Vernonia shevaroyensis* Gamble	Shrub		Type locality	Shevaroys	Salem
	Burseraceae					
34	**Boswellia ovalifoliolata* Balakr. & Henry	Large tree		Type locality	Nallamalais, Seshachalam	Kurnool, Chittoor, Cuddapah
	Caryophyllaceae					
35	*Polycarpaea corymbosa* var. *longipetala* Srinivas. & Narasimh.	Erect herb		Type locality	Seshachalam	Chittoor
	Celastraceae					
36	*Maytenus bailadilliana* (Narayan & Mooney) D.C.S. Raju & Babu	Shrub		Scattered		Visakhapatnam, Kalahandi, Koraput, Bastar
	Cleomaceae					
37	*Cleome chelidonii* L.f. var. *pallai* C.S. Reddy & V.S. Raju	Erect herb		Type locality	Pakhal	Warangal
38	*Cleome viscosa* L. var. *nagarjunakondensis* Sund.-Ragh.	Erect herb		Type collection	Nagarjunakonda	Nalgonda
	Combretaceae					
39	*Combretum albidum* G.Don var. *cooperi* (Haines) Saxena & Brahmam	Climber		Type collection		Koraput

40	**Terminalia pallida* Brandis	Large tree		Type locality	Seshachalam	Kurnool, Chittoor, Cuddapah
	Convolvulaceae					
41	*Argyreia arakuensis* Balakr.	Climbing shrub		Type collection	Araku	Visakhapatnam
	Crassulaceae					
42	*Kalanchoe cherukondensis* Subbarao & Kumari	Fleshy herb		Type collection	Cherukonda	Visakhapatnam
	Cordiaceae					
43	*Cordia domestica* Roth	Small tree		Scattered	Palakonda, Chengalpattu	Cuddapah, Chengalpattu
	Cucurbitaceae					
44	*Trichosanthes anaimalaiensis* Bedd.	Climber	CR	Least Known	Nallamalais	Mahabubnagar
	Dipterocarpaceae					
45	**Shorea tumbuggaia* Roxb.	Lofty tree		Scattered		Chittoor, Cuddapah, Nellore, Chengalpattu
	Ebenaceae					
46	*Diospyros ebenum* Koenig ex Retz var. *acuminata* Haines	Large Tree		Least Known	Champagarh, Kuntagaon Khol	Nayagadh, Angul
	Euphorbiaceae					
47	*Bridelia cinerascens* Gehrm.	Small tree		Scattered		Cuddapah, Nellore, Chengalpattu
48	*Chamaesyce linearifolia* Sojak var. *nallamalayana* (Ellis) V.S. Raju & P.N. Rao	Erect herb		Type locality	Nallamalais	Kurnool
49	*Chamaesyce senguptae* (Balakr. & Subr.) V.S. Raju & P.N. Rao	Erect herb		Least Known	Nallamalais, Chengalpattu	Cuddapah, Kurnool, Chengalpattu
50	*Croton scabiosus* Bedd.	Small tree		Least Known	Nallamalais	Cuddapah, Kurnool
51	*Dimorphocalyx kurnoolensis* R. Raju & Pullaiah	Small tree		Type locality	Erramalais	Kurnool
52	*Glochidion tomentosum* Dalz.	Small tree	Vulnerable	Scattered		Visakhapatnam, East Godavari, Ganjam
53	*Homonoia intermedia* Haines	Small tree		Least Known	Linkarpara	Angul
54	**Phyllanthus indofischeri* Bennet	Erect herb		Scattered		Chittoor, Cuddapah, Kurnool
55	*Phyllanthus narayanaswamii* Gamble	Erect herb	Endangered	Least Known		East Godavari, Visakhapatnam
56	*Lasiococca comberi* Haines (*Homonoia comberi* (Haines) Merr.)	Small tree		Least Known	Upper Sileru, Mahendragiri	Visakhapatnam, Gajapati
	Flacourtiaceae					
57	*Flacourtia indica* (Burm.f.) Merr. var. *innocua* (Haines) Sax. & Brahm.	Shrub		Type collection	Khandagiri	Khurda
	Hypericaceae					
58	*Hypericum gaitii* Haines	Shrub		Least Known	Simlipal	Mayurbhanj

	Lamiaceae					
59	*Leucas diffusa* Benth.	Diffuse herb		Least Known		East Godavari, Salem
60	*Leucas indica* (L.) R. Br. var. *nagalapuramiana* (Chandr. & Sriniv.) Moulali & Pullaiah	Erect herb		Type collection	Nagalapuram hills	Chittoor
61	*Leucas mollissima* Wall. var. *mukherjiana* Subbarao & Kumari	Erect herb		Type collection	Cherukonda	Visakhapatnam
62	*Leucas mollissima* Wall. var. *sebastiana* Subbarao & Kumari	Erect herb		Type collection	Araku	Visakhapatnam
63	*Leucas mollissima* Wall. var. *silvestriana* Subbarao & Kumari	Erect herb		Type collection	Visakhapatnam	Visakhapatnam
64	*Leucas mukherjiana* Subbarao & Kumari	Villous herb	Endangered	Type collection	Visakhapatnam	Visakhapatnam
	Malvaceae					
65	*Decaschistia cuddapahensis* Paul & Nayar	Shrub		Type locality	Seshachalam	Chittoor, Cuddapah
66	*Decaschistia rufa* Craib	Shrub	Endangered	Scattered	Seshachalam, Chengalpattu	Cuddapah, Chittoor , Chengalpattu
	Malpighiaceae					
67	*Aspidopteris hutchinsonii* Haines	Climber	Vulnerable	Least Known	Russelkonda, Similipal	Ganjam, Mayurbhanj
	Mimosaceae					
68	*Acacia campbelli* Arn.	Small tree	Vulnerable	Scattered		East Godavari, Krishna, Nellore
69	*Acacia donaldii* Haines	Small tree		Scattered	Bamra	Sambalpur
70	*Albizia orissensis* Sahni & Bennet	Small tree		Type collection		Ganjam
71	*Albizia sikharamensis* Sahni & Bennet (awaits a final decision, could be *Acacia caesia* (L.) Willd.)	Small tree		Type collection	Nallamalais (Srisailam, way to Sikharam)	Kurnool
72	*Albizia thompsonii* Brandis	Large tree	Vulnerable	Scattered		Anantapur, Cuddapah, Mahabubnagar, Angul, Dhenkenal
73	*Mimosa barberi* Gamble	Shrub		Type collection	Tummaluru	East Godavari
	Melastomataceae					
74	*Memecylon jadhavii* K.N. Reddy, C.S. Reddy & V.S. Raju	Shrub		Type locality	Sapparla hills	Visakhapatnam
75	*Memecylon madgolense* Gamble	Shrub		Type collection	Madgula hills	Visakhapatnam
	Meliaceae					
76	*Aglaia haslettiana* Haines	Small tree		Type collection		Angul
77	*Toona ciliata* Roem. var. *brevipetiolulata* (Haines) Mishra & Panigr.	Small tree		Type collection		Angul
78	*Toona ciliata* Roem. var. *hainesii* (C.DC.) Mishra & Panigr.	Small tree		Type collection		Angul
	Myrtaceae					

79	**Syzygium alternifolium* (Wight) Walp.	Large tree		Scattered	NallamalaisSeshachalam	Kurnool, Chittoor, Cuddapah
	Papilionaceae					
80	*Alysicarpus mahabubnagarensis* Raghavarao et al.	Erect herb		Type collection	Shadnagar	Mahabubnagar
81	*Alysicarpus monilifer* (L.) DC. var. *cuddapahensis* Almeida & Almeida	Erect herb		Type collection		Cuddapah
82	*Atylosia cajanifolia* Haines	Under shrub	Vulnerable	Scattered		East Godavari, Srikakulam, VisakhapatnamGanjam, Kalahandi, Bastar
83	*Crotalaria clarkei* Gamble	Erect herb		Least Known	Araku, Pottangi	VisakhapatnamKoraput
84	*Crotalaria clavata* Wight & Arn.	Erect herb	Endangered	Least Known	Salem	Salem
85	*Crotalaria filipes* Benth.	Erect herb	Endangered	Least Known	Sanigaram	Karimnagar
86	*Crotalaria longipes* Wight & Arn.	Under shrub	Endangered	Least Known	Palakonda, Shevaroys	Cuddapah, Salem
87	*Crotalaria madurensis* Wight var. *kurnoolica* Ellis & Swamin.	Erect herb		Type locality	Nallamalais	Kurnool
88	*Crotalaria paniculata* Willd. var. *nagarjunakondensis* Thoth.	Erect herb		Type locality	Nagarjunakonda	Nalgonda
89	*Crotalaria rigida* Heyne ex Roth	Erect herb	Vulnerable	Least Known		Nellore, Krishna
90	*Crotalaria sandoorensis* Bedd. ex Gamble	Under shrub	Endangered	Least Known		Bellary (Sandoor hills), Dharmapuri, Salem
91	*Indigofera barberi* Gamble	Under shrub	Vulnerable	Scattered		Chittoor, Cuddapah, Kurnool, Salem, S. Arcot
92	*Mucuna minima* Haines	Climber		Type collection	Bamra	Sambalpur
93	**Pterocarpus santalinus* L.f.	Large tree		Scattered	South Eastern Ghats	Rayalaseema, Chengalpattu, Salem, Dharmapuri
94	*Rhynchosia beddomei* Baker	Under shrub	Vulnerable	Scattered		Cuddapah, Chittoor, Anantapur
95	*Rhynchosia hainesiana* Thoth.	Under shrub		Type collection		Angul
96	*Tephrosia purpurea* (L.) Pers. var. *maritima* Haines	Erect herb		Type locality		Balasore
	Rubiaceae					
97	*Gardenia gummifera* var. *gummiferoides* Haines	Shrub		Type collection	Bamra	Sambalpur
98	*Ophiorrhiza chandrasekharanii* Subbarao & Kumari	Erect herb		Type collection	Vankachinta	Visakhapatnam
99	*Lasianthus truncatus* Bedd.	Shrub		Least Known		Visakhapatnam, Gajapathi

100	*Pavetta madrassica* Bremek.	Shrub		Scattered		Krishna, Nellore, Visakhapatnam, Koraput, Chengalpattu
101	*Wendlandia angustifolia* Wight & Arn.	Small tree	Extinct	Least Known	Seshachalam	Cuddapah (ex Beddome)
102	*Wendlandia gamblei* Cowan	Small tree		Scattered		East Godavari, Visakhapatnam
	Rutaceae					
103	*Triphasia reticulata* Smith var. *parviflora* Santapau	Spiny shrub		Type locality	Seshachalam	Cuddapah
	Sapotaceae					
104	*Isonandra villosa* Wight	Small tree	Vulnerable	Scattered	Veligonda hills	Nellore
	Sterculiaceae					
105	*Eriolaena lushingtonii* Dunn	Small tree	Vulnerable	Type locality	Nallamalais	Kurnool
106	*Eriolaena hookeriana* Wight & Arn. var. *viridis* Haines	Small tree		Type collection		Angul
107	*Hildegardia populifolia* (Roxb.) Schott. & Endl.	Small tree	Endangered	Scattered		Anantapur, Chittoor, Cuddapah, Salem, Villupuram
108	*Heritiera kanikensis* Majumdar & Banerjee (awaits a final decision, could be *H. fomes)*	Small tree		Type collection		Kendrapada (Bhitarkanika)
	Verbenaceae					
109	*Premna calycina* Haines	Small tree		Least Known		Mayurbhanj, Angul, Nayagadh
110	*Premna latifolia* Roxb. var. *mucronata* (Roxb.) Clarke	Small tree		Least Known		Mayurbhanj
	Violaceae					
111	*Hybanthus vatsavayii* C.S. Reddy	Erect herb		Scattered		Khammam, Nalgonda, Warangal
	MONOCOTYLEDONAE = LILIOPSIDA					
	Commelinaceae					
112	*Commelina hirsuta* Clarke	Erect herb	Vulnerable	Least Known	Shanigaram hills	Karimnagar
113	*Murdannia juncoides* (Wight) Rolla Rao & Kammathy	Erect herb	Vulnerable	Scattered	Nallamalais	Cuddapah, Kurnool
	Cyperaceae					
114	*Lipocarpha reddyi* Hooper	Erect sedge		Least Known		Nalgonda, Khammam
	Eriocaulaceae					
115	*Eriocaulon echinulatum* Mart.	Erech herb		Type collection	Motijharan	Sambalpur
	Hydrocharitaceae					
116	*Halophila ovalis* (R.Br.) Hook.f. ssp. *ramamurthiana* Ravi & Ganesan	Submerged herb		Least Known	Theetapuram	Nellore
	Liliaceae					
117	**Urginea nagarjunae* Hemadri & Swahari	Bulbous herb		Type collection	Veligonda hillls, Bhata village	Nellore

	Orchidaceae					
118	*Aphyllorchis montana* (Thw.) Reichb.f.	Epiphyte	Vulnerable	Least Known	Seshachalam	Chittoor
119	*Bulbophyllum kaitiense* (Wight) Reichb.f.	Epiphyte	Vulnerable	Least Known		Chittoor, Salem
120	*Bulbophyllum panigrahianum* Misra	Epiphyte		Type collection	Simplipal	Mayurbhanj
121	*Corymborkis veratrifolia* (Reinw.) Bl.	Epiphyte	Vulnerable	Scattered	Seshachalam	Cuddapah
122	*Dendrobium ovatum* (Willd.) Kranz	Epiphyte	Vulnerable	Scattered	Seshachalam	Chittoor
123	*Eria meghasaniensis* (Misra) Misra	Epiphyte		Type collection	Simlipal	Mayurbhanj
124	*Habenaria panigrahiana* Misra	Tuberous herb		Type collection	Mohana hills	Ganjam
125	*Habenaria panigrahiana* Misra var. *parviloba* Misra	Tuberous herb		Type collection	Bhanjanagar	Ganjam
126	*Habenaria ramayyana* Ramachandrachary & Wood	Tuberous herb		Type collection	Nallamalais (Amrabad)	Mahabubnagar
127	*Liparis vestita* ssp. *seidenfadenii* Misra	Tuberous herb		Type collection	Mahendragiri	Gajapati
128	*Vanilla wightiana* Lindl.	Leafless epiphyte	Vulnerable	Scattered		Chittoor, East Godavari, Salem
	Poaceae					
129	*Arthraxon depressus* Stapf ex Fischer	Erect grass	Vulnerable	Least Known		Khammam
130	*Arthraxon lanceolatus* (Roxb.) Hochst. var. *echinatus* (Nees) Hack.	Erect grass		Scattered		Mahabubnagar, Rayalaseema
131	*Arundinella setosa* Trin. var. *lanifera* Fischer	Erect grass	Vulnerable	Type collection	Mogilikuppa	Cuddapah
132	*Chrysopogon velutinus* (Hook.f.) Bor	Erect grass		Type collection		Cuddapah
133	*Iseilema venkateshwarluii* Satyavathi	Prostrate grass		Type collection		Guntur
134	*Dimeria mahendragiriensis* Ravi, Saxena & Brahm.	Erect grass		Type collection		Gajapathi
135	*Dimeria mooneyi* Raizada ex Mooney	Erect grass		Least Known	Raissili, Sonabera	Koraput
136	*Dimeria orissae* Bor	Erect grass		Least Known		Salem, Koraput
137	*Oropetium roxburghianum* (Steud.) S.M.Phillips	Erect grass	Vulnerable	Least Known		Nellore
138	*Oryza jeyporensis* Govind. & Krish.	Erect grass		Least Known	Biorgumma, Boipariguda	Koraput
139	*Panicum fischeri* Bor	Erect grass	Vulnerable	Least Known	Seshachalam	Chittoor, Cuddapah
140	*Paraphyparrhenia bellariensis* (Hack.) Clayton	Erect grass	Vulnerable	Least Known	Gooty, Bellary	Anantapur, Bellary
141	*Pineria kollimalayana* Mohanan & Rao	Erect grass		Type collection	Kolli hills	Salem
142	*Themeda mooneyi* Bor	Erect grass		Type collection	Raissili	Koraput
143	*Themeda saxicola* Bor	Erect grass		Type collection		Koraput
144	*Tripogon jacquemontii* Stapf	Erect grass	Vulnerable	Scattered		Chittoor, Mahabubnagar
145	*Tripogon wightii* Hook.f.	Erect grass	Vulnerable	Least Known	Seshachalam	Chittoor

(Type collection: Known from Type Collection only; Type locality: Known from Type Locality; Least Known: Least known in herbaria and field; Scattered: Species with discontinuous range of distribution)
* Species marked with asterisk are prioritised for conservation, C.A.M.P., 2001 (Andhra Pradesh)

Table 2. Analysis of endemic species based on their unique distribution record

S. No.	Category	No.of species	No.of redlisted species
1	Species known from type collection	47	3
2	Species known from type locality	21	3
3	Species least known in herbaria and field (less than 5 records)	41	21
4	Species with discontinuous scattered distribution	36	17
	Grand total	**145**	**44**

Table 3. Analysis of Red listed endemic species as per threat category

S.No.	Category	No. of species	% of species
1	Extinct	1	2.3
2	Critically Endangered	1	2.3
3	Endangered	15	34.1
4	Vulnerable	27	61.4
	Total	**44**	**100**

Table 4. Analysis of endemic species as per habit

S. No	Habit	No. of species	% of species
1	Trees	32	22.1
2	Climbers	12	8.3
3	Shrubs	24	16.6
4	Herbs	77	53.1
	Total	**145**	**100**

Table 5. Analysis of endemic species as per vegetation type distribution

S.No.	Habit	No. of species	% of species
1	Semievergreen	22	15.2
2	Moist Deciduous	67	46.2
3	Dry Deciduous	49	33.8
4	Scrub	4	2.8
5	Coastal	3	2.1
	Total	**145**	**100**

Quantitative assessment of plant diversity, bioresource values and conservation of tropical forests of Southern Eastern Ghats, India

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Abstract

This abstract is concerned with large-scale inventory of plant diversity and their bioresource potentials, which is an outcome of a part of on-going major DBT-funded Project titled "Quantitative assessment and mapping of plant resources of Eastern Ghats". The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity countries in the world. The Eastern Ghats, the Western Ghats, Himalayas and the north-eastern hills constitute important biodiversity areas of India. Primary forests of Asia, particularly those of Western Ghats and Eastern Ghats of peninsular India are disappearing at an alarming rate due to the anthropogenic activities and are replaced by forests comprising inferior species or their land use pattern changed. The main objective of this study is to determine species diversity and distributional patterns of plant resources of Eastern Ghats and map them. The southern Eastern Ghats in the five major hill complexes inventoried (Chitteris, Kolli hills, Pachamalais, Shervarayans & Kalrayans) harbor five distinct forest types - tropical evergreen, semi-evergreen, mixed deciduous, dry deciduous and thorn forests. The entire stretch of southern Eastern Ghats (10^0 93' – 12^0 18' N) was divided into 6.25 km x 6.25 km grids and within each grid a 0.5 ha transect (5 m x 1 km) was established. Trees (>=10 cm gbh) and lianas (>=5 cm gbh) were inventoried in the whole transect. At the beginning and end of each transect shrubs (in 5m x 5m quadrat) and herbs (in 1m x 1m quadrat) were sampled. A total of 644 species from 112 families were recorded in a total of 116 grids completed. Contribution of trees to the total species was high - 257 species (40 %), followed by herbs 209 species (32 %), lianas 160 species (25 %) and shrubs 18 species (3%). Out of the total 112 families, the most speciose family was Euphorbiaceae with 44 species, followed by Papilionaceae (30 species), Poaceae (30 species), Acanthaceae (29 species) and Rubiaceae (28 species). For the total 644 species encountered in this inventory, phytogragraphic analysis and database preparation of RET and economically important species, with their abundance are in progress and such data will be of immense use in conservation measures.

Keywords: Eastern Ghats, Tropical forests, Plant diversity, Bioresources, Phytogeographic analysis, Conservation.

Introduction

The Indian subcontinent, with its rich biodiversity, is one of the 12 mega-diversity centres of the world. The Eastern Ghats, the Western Ghats and the north-eastern hills are the main biodiversity hotspots of India. Forests in India were cleared for huge hydroelectric projects, for setting up heavy industries, for urbanisation and so on. In the late thirties, Indian forests were about 33% of the land surface, but by 1951, this was reduced to about 23%, indicating deleterious human impact on ecosystem. Though human impacts on forests date back to antiquity and even to pre-history, documenting such impacts on genetic diversity of forest trees is a difficult matter and little quantitative data exist (Ledig 1992). Primary forests of Asia, particularly those of the Western Ghats and the Eastern Ghats of peninsular India are disappearing at an alarming rate due to anthropogenic activities and are replaced by forests comprising inferior species or their land use pattern changed (Parthasarathy 1999; Chittibabu & Parthasarathy 2000). Deforestation is recognized as one of the most serious environmental and economic problems for many countries in the tropical and subtropical regions of the world (Kadavul and Parthasarathy 1999). The disappearance of tropical forests comes at a time when our knowledge on their structure and dynamics is woefully inadequate (Hubbell and Foster 1992). Understanding of forest processes is necessary for assessment of potential impacts, the amelioration of effects of disturbance, optimization of productivity and rehabilitation of ecosystem (Congdon and Herbohn 1993). Lianas are woody climbers that are only capable of growing taller when mechanical support is available. However, in three special cases: (i) when there are environmental limitations such as low light conditions; (ii) in juvenile phases of growth; and (iii) during episodes of expansion, renewal or repair growth; lianas may be self-supporting (Caballe 1998).

Lianas form an important structural and functional component of tropical rain forests (Hegarty & Caballe 1991). The presence of lianas is one of the important physiognomic features for identifying tropical lowland and lower montane forests (Grubb 1977; Whitmore 1984). The distribution and abundance of lianas is influenced by biotic factors, in particular the archiarchitecture of host trees (Balfour & Bond 1993; Chalmers & Turner 1994). The presence of trellises (young plants and small-diameter branches of hosts) is an important factor limiting liana access to the canopy, and it has been suggested that trellis availability influences the distribution of lianas within the forest (Putz et al. 1984). Information on tropical plant species is needed because of its potential usefulness in understanding the relative extent of plant biodiversity across the tropics and its implication for conservation and management. In peninsular India, although a few quantitative plant biodiversity inventories are available from the forests of Western Ghats and the Coromandel coast, the Eastern Ghats remain as a neglected area for such studies. Hence this investigation was undertaken, to

determine the extent of tree, liana, shrub and herb species richness, their population density and dispersion patterns in covering a range of tropical forests from thorn forests to evergreen forests.

Materials and Methods

Study area

The study area includes the major hill forests of southern Eastern Ghats ($12^0$18′ to $9^0$95′N latitude) viz., Bodamalai, Chitteri, Kalrayan, Kolli, Pachaimalai and Shervarayan. These hill forests are located in Dharmapuri, Namakkal, Perambalur, Salem, Thiruvannamalai and Villupuram districts of Tamil Nadu. The southern Eastern Ghats comprises masses of charnockite associated with gneisses and varied metamorphic rocks. The mountainous part has a thin veneer of soil and the rolling plains possess ferruginous sandy soil.

Climate

Climatological data of Salem (alt. 278 m; lat. and long. 11^0 39' N and 78^0 10' E), the nearest station to the study area, available for a 30-year period (1951–1980) reveals a mean annual temperature of 28.3^0C and the mean annual rainfall 1014 mm. The mean monthly temperature ranged from 25^0C during December–January to 31^0C in April–May for the same period (minimum temperature 19.2^0C, maximum 37.2^0 C). The study area receives bulk of the rainfall during the south-west (June to September) and the north-east (retreating) monsoons (October to November). December to February experience mild winter with cold nights and dewy mornings. During the three dry months (March to May) of summer also, there are occasional showers. Salem records a mean wind speed of 8.0 km h^{-1}, and relative humidity ranging from 78% in October to 66% in March at 08:30 hrs for the period 1951 to 1980. The mean total cloud observed during the period was 4.6 Oktas of sky (Chittibabu & Parthasarathy 2000).

Vegetation

The southern Eastern Ghats consists of heterogeneous vegetation along an elevation gradient. The five major hill complexes inventoried (Bodamalai, Chitteri, Kalrayan, Kolli, Pachaimalai and Shervarayan hills) harbor five distinct forest types - tropical evergreen, semi-evergreen, mixed deciduous, dry deciduous and thorn forests. The foothills are clothed with thorn forests, while with increasing elevation occur dry deciduous, mixed deciduous, semi-evergreen and evergreen forests. The evergreen forests are found with a veritable mixture of species, rendering a scenic beauty. The trees housed in them are robust, tall (~30 m) and branchy with dense crowns. These forests are two to three storeyed. Branches are often clothed with epiphytic moss, ferns, lichens and orchids. Epiphylls are also abundant. Herbaceous and woody vines are not infrequent.

Disturbance

Though the forests of southern Eastern Ghats, comes under reserve forests category, the population has unlimited and unspecified rights of firewood collections, felling, lopping, herding cattle for grazing, browsing, etc. The cultivation of horticultural crops pineapple, banana, jackfruit, mango, pepper and cloves, and agricultural crops paddy, millet, ragi and tapioca were common near the forests. Further, encroachment of forest area for cultivation is evident.

Field methods

The entire stretch of southern Eastern Ghats (10^0 93' – 12^0 18' N) was divided into 6.25 km x 6.25 km grids and within each grid a 0.5 ha transect (5 m x 1 km) was established. Trees (>= 30 cm gbh) and lianas (>= 5 cm gbh) were inventoried in the whole transect. At the beginning and end of each transect shrubs (in 5m x 5m quadrat) and herbs (in 1m x 1m quadrat) were sampled. All plants were identified from their vegetative and reproductive features using the regional floras (Nair and Henry 1983; Henry et al. 1987, 1989; Gamble and Fischer 1915–1935; Matthew 1991) and the field key of Pascal and Ramesh (1987). Voucher specimens are deposited in the herbarium of Department of Ecology and Environmental Sciences, Pondicherry University.

Results

Plant diversity inventory from a total of 116 transects distributed one each in 116 grids from five major hill forests of southern Eastern Ghats viz., Bodamalai, Chitteri, Kalrayan, Kolli, Pachaimalai and Shervarayan hills, yielded a total of 644 species which belonged to 112 families. The identity of 45 species awaits confirmation. Contribution of trees to the total species was high - 257 species, followed by herbs 209 species, lianas 160 species and shrubs 18 species (Figure 1). Out of the total 112 families, the most speciose family was Euphorbiaceae with 44 species, followed by Papilionaceae (30 species), Poaceae (30 species), Acanthaceae (29 species) and Rubiaceae (28 species). The list of predominant plant species in southern Eastern Ghats is given in Table 1. Quantitative biodiversity data of Eastern Ghats will be useful in forest management and conservation, as a substantial area of the hill forests has already been converted to plantations. Occasionally wild animals such as wild boar and other animals are hunted. Trees are selectively felled for firewood, household furniture, and fencing and for making minor agricultural implements. The collection of medicinal plants (fruits of *Terminalia chebula*, *Terminalia bellirica*, etc.), conversion of fertile forest lands by slash and burn agriculture, and quarrying, all need to be checked. It is essential to prevent

further expansion of mining and plantation area, as the protection of existing forests here is crucial for biological conservation of the species. For the total 644 species encountered in this inventory, phytogragraphic analysis and database preparation of RET and economically important species, with their abundance are in progress and such data will be of immense use in conservation measures.

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Table 1. List of the predominant plant species in southern Eastern Ghats

Evergreen forest

1. *Nothopegia heyneana*
2. *Neolitsea scrobiculata*
3. *Memecylon edule*
4. *Diploclisia glaucescens*
5. *Gnetum ula*
6. *Embelia basaal*
7. *Cycas circinalis*
8. *Cassia auriculata*
9. *Breynia retusa*
10. *Alpinia calcarata*
11. *Peperomia dindigulensis*
12. *Pteris quadriaurita*
13. *Curcuma neilgherrensis*

Semi-evergreen Forest

1. *Syzygium cumini*
2. *Hiptage benghalensis*
3. *Cassia auriculata*
4. *Cymbopogon martini*
5. *Canthium umbellatum*
6. *Grewia rhamnifolia*
7. *Jatropha gossypifolia*
8. *Oxalis corniculata*
9. *Memecylon edule*
10. *Combretum albidum*
11. *Breynia retusa*
12. *Bidens pilosa*
13. *Nothopegia heyneana*
14. *Dalbergia rubiginosa*
15. *Dodonaea viscose*
16. *Ceropegia candelabrum*

Mixed-deciduous forest

1. *Commiphora caudata*
2. *Cansjera rheedii*
3. *Cassia auriculata*
4. *Cymbopogon martinii*
5. *Ficus benghalensis*
6. *Derris scandens*
7. *Catunaregam spinosa*
8. *Asparagus racemosus*
9. *Hardwickia binata*
10. *Ventilago maderaspatana*
11. *Tecoma stans*
12. *Dioscorea oppositifolia*
13. *Anogeissus latifolia*
14. *Combretum albidum*
15. *Calotropis gigantea*
16. *Lepidagathis cristata*

Dry deciduous

1. *Albizia amara*
2. *Hugonia mystax*
3. *Calotropis gigantea*
4. *Asparagus racemosus*
5. *Chloroxylon swietenia*
6. *Secamone emetica*
7. *Cassia auriculata*
8. *Dioscorea oppositifolia*
9. *Anogeissus latifolia*
10. *Jasminum angustifolium*
11. *Catunaregam spinosa*
12. *Tribulus terresteris*
13. *Diospyros Montana*
14. *Ziziphus oenoplia*
15. *Tecoma stans*
16. *Passiflora edulis*

Thorn forest

1. *Euphorbia antiquorum*
2. *Pterolobium hexapetalum*
3. *Carmona retusa*
4. *Tribulus terresteris*
5. *Acacia planifrons*
6. *Acacia caesia*
7. *Catunaregam spinosa*
8. *Heteropogon contortus*
9. *Acacia horrida*
10. *Acacia torta*
11. *Cassia auriculata*
12. *Barleria cuspidate*
13. *Albizia amara*
14. *Capparis sepiaria*
15. *Calotropis gigantean*
16. *Abutilon crispum*

Variable	Trees	Lianas	Shrubs	Herbs	Total
Species richness	257	160	18	209	644
Families	61	34	13	54	112

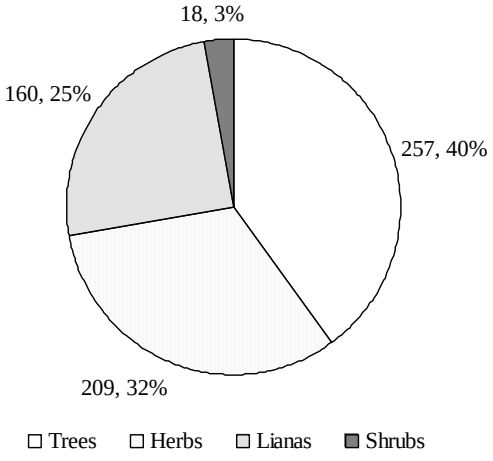

Figure 1. Contribution of plant species to total species richness classified by four major life-forms viz., trees, herbs, lianas and shrubs.

Site and species photos of southern Eastern Ghats

Argyreia elliptica

Meyenia hawtayneana

Hiptage benghalensis

Alpinia calcarata

Drypetes roxburghii

Miliusa eriocarpa

Canarium strictum

Litsea deccanensis

Agri-Biodiversity of Eastern Ghats - exploration, collection and conservation of crop genetic resources

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Abstract

Eastern Ghats is a rich abode and a treasure trove for ethnic diversity in different agri-horticultural crops, their wild/ weedy relatives, medicinal, aromatic and dye yielding plants. However, due to socio-economic developmental programmes and other biotic pressures the endemic crop genetic diversity accumulated through years of evolution under domestication and natural selection by the tribal groups is being wiped out from the nature. Keeping in view, the importance and potential of this vast genetic resources, NBPGR Reg.Station, Hyderabad have been making earnest efforts to explore, collect and conserve this endemic Agri-diversity in the Eastern Ghat areas in the South East Coastal India. From 1986 till date a total of 22 crop specific surveys were undertaken for the collection of germplasm diversity in different agri-horticultural crops and others which resulted in the collection of 3,637 accessions of germplasm. Also, most of the germplasm collected had been accessioned and being conserved for characterization, evaluation and utilization of the germplasm in various crop improvement programmes. Two varieties one in paddy (Maruteru Sannalu) and the other in coriander (Sudha) could already been released from the material collected. Concerted and systematic efforts have to be made in future as there is a tremendous urgency and scope for collection and conservation of Agri-diversity in general and medicinal plants, wild relatives and endemic tree species in particular for sustainable utilization from the Eastern Ghats.

Keywords – Agri-biodiversity, Germplasm, Conservation, Tribal groups

Introduction

The Eastern Ghats, one of the major hill ranges of India, located between $77^0$22 and $85^0$20 E and $11^0$30 and $21^0$0 N form an assembly of discontinuous ranges, hills, plateaus, escarpments, narrow basins and spread in an area of about 75,000 Km^2. The Eastern Ghats stretching from Orissa, Chattisgarh, through Andhra Pradesh to Tamil Nadu and parts of Karnataka are endowed with a large variety of biological species, geological formations and indigenous tribal groups. For Eastern Ghats, the Mahanadi basin marks the northern boundary while the southern boundary lies in the Nilgiri hills. While the tips of Bastar, Telangana, Karnataka plateaus and Tamil Nadu uplands form the boundary in the West, the coastal belt forms the boundary in the east. The Eastern Ghats region is inhabited by nearly 54 tribal communities, which constitute nearly 30% of total population (Chauhan, 1998). The Major tribes in the Eastern Ghats are *Arondhan*, *Irular*, *Kota*, *Kotanayakam*, *Kurmar*, *Puniyan*, *Pulayan*, *Sholaga* and *Tuda*, *Malayali* in the southern region, *Bagata*, *Chenchu*, *Gadaba*, *Jatapu*, *Kammara*, *Kondadora*, *Kondakapu*, *Kondareddy*, *Kandha*, *Kotiobenthu Oriya*, *Koya/ Goud*, *Kulia*, *Mali*, *Mukadora*, *Mannedora*, *Nayaka*, *Paraja*, *Reddidora*, *Savara*, *Valmiki*, *Yenadi* and *Yerukala* in central region and *Bathudi*, *Birjhal*, *Bhuiyan*, *Dhuma*, *Bhumis*, *Bhuttada*, *Gond*, *Khana*, *Kisan*, *Kolba*, *Munda*, *Oraon*, *Soarha* and *Sounti* in the northern region. The variations in altitude and climatic conditions, especially in rainfall have immensely contributed in the evolution of rich floristic diversity in the Eastern Ghats. This region is very rich in terms of natural wealth, which is manifested, in its greatest biological diversity. Out of 2,500 species of flowering plants belonging to Angiosperms, Gymnosperms and Pteridophytes known to occur in Eastern Ghats, about 77, species (67 Dicots, 9 Monocots and 1 Gymnosperms) are endemic.

Agricultural diversity

In the Eastern Ghats, the natural flora includes many economic plant species that offer food, fibre and shelter. The sowing of selected seeds of different crop plants in limited pockets or under some trees and harvesting them later was the practice over a number of years initially. The farming community in the Eastern Ghats constitutes only the tribal population initially. With the increasing requirements of quantity and the spectrum of food, the pressure to bring in more land for organized cultivation came in to existence. As the gathering of wild seeds, beans and tubers stopped, the hill slopes are brought in to cultivation with the slash and burn (*podu*) cultivation. As the soil is virgin, the ash and the plant debris acted up on as the needed organic fertilizer**.** In this process, the forest felling, degradation and denudation paved a way for Agriculture in the Eastern Ghats. The Agriculture is practiced by all the tribal groups among others concentrated in the forest areas like Kondaporas, Kondareddy, Chenchus, Gonds (Andhra Pradesh), Sholingars, Kurumbas, Thodas, Irulas, Nari kuravas (Tamil Nadu) and Porjas, Gadabas, Bondas, Savaras, Samanthas and santhals (Orissa) mainly by *podu* cultivation. Due to intensified ITDA extension programmes the tribals have been given some hill slopes for cultivation and all the required inputs to divert them to agriculture. There are instances very recently where the PTG (Primitive tribal groups) have been persuaded by the ITDA officials to come down the hills and settle down near the foothills and join the mainstream.

Exploration and collection

Keeping in view the overall conservation of the Agri-biodiversity in general several exploration missions were undertaken in important pockets in Eastern Ghats areas in the South East Coastal India for collection of germplasm diversity in different Agri-horticultural crops and their wild relatives from cultivated and wild/ natural habitats by NBPGR Regional Station, Hyderabad basically focussing on collection, conservation and documentation.

Geographical features of the explored area

The explored area is mainly sub-humid and sub-tropical in nature and consists of the entire Andhra Pradesh, Gajapathi and Koraput districts of Orissa and Bastar, Kanker and Dantewada districts of Chattisgarh. Surveys were mainly organized in the tribal areas, forest areas, high altitude ghat sections and some in the foothills and plains. The help, cooperation and collaboration of Department of Agriculture, Department of Forests, Government of Andhra Pradesh, progressive members belonging to Vana Samrakshana Samithis (VSS) and Research Stations of the State Agricultural University (SAU) located in the collection area was requested for liaison and collection of germplasm. In the surveyed region, the average annual rainfall varies from 1,000 to 1,400mm and the average annual temperature from 5^0 to 37^0C. The altitude ranges between 100 - 4,600 metres above the MSL, the latitude between 13.39 - 19.43 and the longitude between 78.02 - 86.47. Black soils are frequently encountered in this area and the range of soil types includes red loams, red sandy loams and red soil with clay base etc..

Logistics & Collection Strategy

The basic collection tactics and logistics were taken into consideration as emphasized by Bennett (1970). The general strategy adapted for collection of cultivated agri-biodiversity was based on the theories suggested by Bothmer and Seberg (1995) and for collection of wild species by Huaman *et al.* (1995). The sampling, sampling site and intervals depended on the variation in the environmental and edaphic factors and the frequency of occurrence. The type of material collected included both the seed collections as well as vegetatively propagated collections as suggested by Hawkes (1980). NBPGR tried its level best to collect from far and wide and assemble a large number of collections under different crops.

Germplasm Collected

A total of 22 explorations missions were undertaken for collection of germplasm diversity in different agri-horticultural crops, medicinal, aromatic, dye yielding plants and wild species in collaboration with ANGRAU, ICRISAT, CRIDA and IISR which resulted in the collection of a total of 3,637 accessions of germplasm from the Eastern Ghat areas falling in South East Coastal India. The passport data pertaining to accession number, latitude, longitude, village/ place of collection, mandal/ taluq, district, state, ethno-botanical uses, ethnic group of the individual sharing the information, plant part/ s used etc. are enlisted at the time of collection in the field for each and every accession.

Nature and spectrum of diversity

Given the history of development of modern agriculture especially that of improved varieties, the importance of agri-diversity and germplasm encompassing landraces, primitive cultivars, wild and weedy relatives of crop species need not be emphasized, which is the basic material in any crop improvement programme. Out of the existing native floristic wealth many plant species are yet to be utilized/ explored by man especially with regards to the future needs/ requirements.

The contribution of the tribal groups in the domestication and enrichment of the genetic variability in different agri-horticultural crops is immense and indispensable in the crop improvement programmes. The way the tribal groups utilize different crops as food material is very interesting and throws light on the trials and errors, permutations and combinations of culinary processes perfected over a period of time. The diversity of plants under cultivation include an array of crops belonging to cereals, millets, legumes, tubers, vegetables by the tribal groups who inhabited the Eastern Ghats in six states of the country. Pandravada *et al*, (2004) have given an account of the spectrum of agri-biodiversity that is available in the Eastern Ghat areas.

Cereals and Millets

Significant ethnic diversity is reported in rice, sorghum, pearl millet, finger millet, italian millet, proso millet, little millet, kodo millet and barnyard millet from Eastern Ghats. Rice is known in India from about 2,000 BC or even earlier (Vishnu-Mittre, 1968). It can be deduced from the available evidences that, eastern India is the area of domestication of Asian rice (Harlan, 1975). Tremendous diversity in both the cultivated and wild *Oryza* species occurs in Koraput (Orissa), which could be the place of origin and domestication for the Asian rices. Rich diversity occurs in paddy germplasm especially for scented ness, plant height, seed dormancy, grain slenderness, and resistance to pests and diseases, resistance to lodging, moisture stress, maturity, panicle structure, grain size, glume colour, kernel colour and in endosperm. The endemic scented rice diversity (*isuka ravvalu*, *kampusannalu*, *vasanodlu*) occurs in Visakhapatnam (Araku hill tracts), pockets of Vizianagaram, Srikakulam and Nizamabad districts. Some of the tall cultivars like *basangi*, *krishnakatukalu*, *bayahunda*, *gottedlu* and *kodakkullu* are grown in the coastal districts specifically for the straw to thatch the huts and as a feed for cattle. Landraces from Srikakulam (*pottibasangi*, soppiri and *jajati*) are reported to have seed dormancy and do not germinate on standing. Landraces of upland rainfed with very fine-grained medium/ long slender seed (*voodasannalu*, *chinnakondengi*, *mettabudagalu*) with good potential either for direct selection and/ or for crossing are found in the tribal belts of Srikakulam district. In the Telangana and Rayalaseema regions also there are diffused pockets in which indigenous variability occurs in upland rice.

These landraces have high degree of resistance to pests and diseases. The list of some of the landraces collected from districts of Andhra Pradesh, Orissa and Chattisgarh is given in Table-1.

Most of the above landraces are being fast replaced with the high yielding varieties ignoring the specific qualities for high yield/ income particularly in the tribal areas of north coastal districts of Andhra Pradesh. The practice of cultivating early maturing (3 months) upland rice in mixed cropping mainly with sorghum, pearl millet and small millets and some times even with pigeon pea is disappearing and currently improved varieties of rice are mostly grown as sole crop. Cultivation of upland rice itself is replaced by the high-income crops such as tomato, cauliflower, cabbage etc. in high altitude tribal pockets. The important areas of diversity for *kharif* sorghum are districts of Adilabad, and Kurnool in Andhra Pradesh, Many distinct landraces (*chiru talavalu, moti jowar, motitura, jinghri jowar, leh jowar, pottithimmalu, tellamalle jonna*) belonging to *durras* and *roxburghiis* are the main races grown under *kharif* sorghums. Mainly variability occurs in plant height, peduncle shape and size, ear head shape and size, glume and grain colour. Landraces of *rabi* sorghums (*markandi jonna, gattumalle jonna, sai jonna, mudda jonna, pelala jonna, erra jonna* etc.) are grown to a great extent especially in the tribal pockets of Adilabad, Khammam, Kurnool and Cuddapah. Sorghum belonging to races *durra, bicolor, guinea, caudatum* and their intermediate types occur in these areas. Potential diversity occurs for panicle compactness/ shape and glume covering. Sources of resistance for drought and birds (fully covered glumes) occur in the northern Telangana areas. The list of some of the Sorghum landraces collected from parts of Eastern Ghats in Andhra Pradesh is given in Table-1.

Improved varieties and hybrids almost replaced the *kharif* sorghums during the past two decades particularly in Ranga Reddy, Mahaboobnagar and Medak districts. Sorghum, a staple food in certain pockets of Andhra Pradesh, lost its status due to the replacement of landraces having special taste, which the people are used to relish. In most of the traditional sorghum growing areas, the crop is replaced with remunerative crops such as sunflower. Pearl millet germplasm variability is known to occur in Visakhapatnam, Vizianagaram, Srikakulam, Nalgonda, Mahaboobnagar, Kurnool and Prakasam districts. *Pittaganti*, a popular landrace of north coastal districts is an early maturing and highly tillering type. Variability occurs in plant height, stem thickness, tillering, spike length, size and shape and seed characters. The list of some of the pearl millet landraces collected from parts of Andhra Pradesh is given in Table-1. In small millets, the important crops are finger millet, italian millet, proso millet, kodo millet, little millet and barnyard millet. Variability in plant height., tillering, finger compactness, number of fingers/ ear and ears/ plant exists in finger millet in the districts of Visakhapatnam, Vizianagaram, Srikakulam, Ranga Reddy and Mahaboobnagar. Endemic local variability occurs in the other small millets. The list of some of the small millets landraces collected from parts of Andhra Pradesh is given in Table-1. However the area under small millets has been coming down very alarmingly because of the introduction of subsidized rice scheme in Andhra Pradesh. It has insidiously contributed in the replacement of small millets with improved varieties of crops such as chillies and other vegetables in north coastal districts and sunflower and castor in Telangana and Rayalaseema regions, there by losing the endemic diversity of small millets.

Pulses

The important pulse crops in which significant endemic diversity occurs are Pigeon pea, Lima bean, French bean, Cowpea, Hyacinth bean and Rice bean. In Pigeon pea variability exists in the north coastal tribal belt and Telangana region in Andhra Pradesh and Koraput and Gajapati districts of Orissa for days to maturity, flower colour, plant height, pod size, seed shape/ colour etc.. Local landraces, which are tolerant to pod borers viz. '*Konda kandulu*' which is perennial with very bold white seeds, exists in the above areas. The landraces with red/ brownish-red seed are cultivated in the north coastal areas where as white/ creamish-white seeded landraces are preferred in the Telangana region. The list of some of the pigeon pea landraces collected from parts of Eastern Ghats is given in Table-1. In Cowpea (*chittibobbarlu, bobbarlu*) the variability mainly includes cultivars with bushy/ viny forms, days to maturity, pod character and seed colour.

Oil Seeds

The important oil seed crops in which good variability still occurs are sesame and niger. Sesame is an important ancient and traditional Oil seed crop for which the sub-continent is the secondary centre of diversity. There is significant variability in the cultivars with regards to specific planting season and region specificity due to photosensitivity. Variability was available in plant height, days to maturity, seed size, colour, oil content and the extent of tolerance/ resistance to different biotic/ abiotic stresses. Among the oilseeds, niger is the crop of the tribals, by the tribals and for the tribals and plays a significant role in the tribal economy. Rich variability exists in Visakhapatnam, Medak and Mahaboobnagar districts of Andhra Pradesh, Koraput of Orissa and Jagdalpur of Chattisgarh especially for height, stem colour, leaf size, branching habit, days to maturity, capitulum size, number of florets, achene size/shape, yield and oil content. The landraces do possess drought tolerance also. Germplasm accessions having High oil content were found and collected from the Koraput region.

Vegetables

The important vegetables for which good native diversity occurs are brinjal, chillies, okra, cucumber, gourds, onion, beans, tuber crops, and leafy vegetables. The districts of Srikakulam, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Chittoor and Ranga Reddy, Koraput and Gajapati are important for

Brinjal diversity. Variability occurs for plant height, fruit shape, colour, spini ness of the pedicel and clustering and presence of blotches/stripes on the fruit surface. In Koraput the *pottangi* variety of very primitive landrace which is the progenitors of the present day cultivars *of Solanum melongena* occur. The important landraces that are under the cultivation include tellacharakaya, nallavanga, namalakaya, tellakaya, guttivanga, neetivanga, mettavanga, chigurukotavanga, jeguru paduvanga, tantikondavanga, medichinta etc. In chillies the local diversity for growth habit, fruit colour, bearing, shape and size and pungency occur all along the Eastern Ghats. Chillies with small round cherry types, small oblong stout and small conical stout, extra long broad and tapering fruits occur in the north coastal districts of Andhra Pradesh. Cultivation of chilli local landrace which bear yellow fruits (*pachchamirapa*) is confined to Gollaprolu area in the East Godavari district. Indigenous paprika chilli landraces with low pungency are mostly confined to Warangal (*doddukaya, warangalkaya, tomato chilli*) and Rayalaseema region (*byadige* types) which are characterized by folds after drying. *Capsicum frutescence* (Bird's pepper) occurs in all the tribal ghat areas in the Eastern Ghats. In Okra diversity is mainly concentrated in the districts of Kurnool, Visakhapatnam, East Godavari and Adilabad. The important landraces that occur are *edakula benda, pasara benda, patcha benda* and *sudibenda*. Native diversity occurs for plant height, pigmentation and fruit characters. Very tall, robust, purple pigmented, tolerant to cold and late maturing types (*chalibenda*) occur in the Adilabad district of Telangana region.

The important gourds for which local ethnic diversity especially for fruit size and shape occur are bottle gourd, pumpkin, snake gourd, ridged gourd and bitter gourd. The important districts under gourds cultivation where local diversity occurs are East Godavari, Warangal, Khammam, Adilabad, Karimnagar, Visakhapatnam, Koraput and Gajapati districts. Bottle gourd with different fruit shapes occurs in the tribal pockets in the above districts. The wild forms will be very bitter and trailed on the huts and harvested after drying to use them for carrying water and arrack and also for storage. Extra large fruited types (*Nelabeera*) almost to one metre are found in the Adilabad district. In tuber crops the important districts are Srikakulam, Visakhapatnam Vizianagaram, East Godavari, West Godavari Krishna, Nellore, Koraput and Gajapati. Local cultivars and wild tubers which are well adapted and are being grown/ collected from the forests occur in Elephant foot Yam (*pedda kanda, chinna Kanda, theepi kanda*), *Colacasia*, *Dioscorea*, *Xanthosoma* and Tapioca. In the leafy vegetable the important types for which local variability occur are amaranth, spinach, *Rumex*, *Basella*, *Trigonella* etc. in all the districts of Eastern Ghats. In Amaranth types which are green, completely/ partially purple and spiny generally occur.

Fruit crops

The important fruits which have native diversity are mango, banana, citrus fruits, custard apple, ber, pine apple, wood apple, bael and jamun etc. In Mango the main variability occurs in the coastal areas, Khammam district in the Telangana and eastern Rayalaseema regions. Diversity occurs for tree size, maturity, bearing, fruit colour, size, flesh characters, keeping quality and yield. Also cultivars specific for table and pickling and resistant for hoppers and which can withstand wind and drought are also found. The wild species occur in the tribal dominated hilly areas of Visakhapatnam and Vizianagaram districts. In banana the districts which are important for germplasm variability are East Godavari, West Godavari, Kurnool, Vizianagaram, Visakhapatnam, Cuddapah Koraput and Gajapati. The traditionally and popular varieties (*amruthapani* and *chakkarakeli*) are alarmingly replaced by the improved varieties. Good local varieties occur both in table and vegetable types. Diversity occurs in plant height, maturity, bunch size, fruit shape, size and aroma. *Musa ornata* and *Ensete glaucum* occur in the hills of Eastern Ghats interspersed in East Godavari and Visakhapatnam districts. Among the *Citrus* species, *Citrus madurensis* has been naturalized in the hills of East Godavari and Srikakulam. The other fruits in which significant local diversity exist is pine apple in the Visakhapatnam (Simhachalam). Custard apple which occurs in semi-wild state in the hills has good diversity for habit, plant type, fruit and reticulation size, seed size and number in Mahaboobnagar, East Godavari and Anantapur. In jack, the important local types include *kharja panasa* and *tene panasa*. Good local diversity for fruit size and shape occur in the coastal areas. In the hills, good variability occurs in wood apple, bael and jamun.

Spices

The crops of importance in spices include turmeric, ginger and Indian long pepper etc. In turmeric landraces are still popular because of their adaptability and significant levels of tolerance/ resistance to biotic/ abiotic stresses. Native and wild types occur in Araku (*kasturipasupu, hinga, woldi, kodipasupu*) and Mahendragiri hills with good variability for days to maturity, rhizome shape and size, inside colour, surface colour, aroma and yield. In ginger the important areas of diversity are Araku hill tracts and other areas of Visakhapatnam, Medak, Koraput and Gajapati districts. The native types (*pandimallelu, rellakommalu*) possess variability for rhizome shape, size, in side and surface colour, aroma and resistance/ tolerance to rhizome rot and other diseases.

Fibre Crops

The important fibre crops in Eastern Ghats are cotton and mesta. Among the old world diploid asiatic cottons rich genetic diversity occurs in *Gossypium arboreum* and *Gossypium herbaceum*. The landraces under *G.arboreum* include srisailam, errapathi, pandapur, mudhole, nandyal, mungari etc. and *javvari* and *jayadharu* in *G.herbaceum.* Diversity occurs in the cotton germplasm in plant height, boll shape, size and surface, lint

colour and in seed characters. The perennial types of *G.arboreum* (jadapathi, pagadapathi, pydipathi etc.) are grown in temples, backyards of the house holds and as escapes through out the ghats. Also it is amazing that both the annual and perennial types of *G.arboreum* cottons are disease/ pest free and are sources of resistance for black arm, boll warm and sucking pests. However, with the introduction of superior long stapled new world cottons of *Gossypium hirsutum*, the desi cottons are being replaced at an alarming rate. In *Mesta* diversity in *Hibiscus sabdariffa* and *H.cannabinus* occurs in the north coastal districts. Variability could be observed in stem pubescence, stem colour, branching habit, fruit pubescence, stem diameter, seed colour and other seed characters.

Medicinal, Aromatic & Dye yielding plants

About 1,000 species are known to occur in the region out of the estimated 7,500 plants of medicinal value reported in India (John Joseph, 1998). At least 50 dye yielding and 40 aromatic plant species are also known to occur in the region. In medicinal, aromatic and dye yielding plants rich variability exists and some species are endemic/ occur in greater population in this part of the country. Species of *Rauvolfia* are reported to occur in the moist forest undergrowth at levels of 3,000 ft. of East Godavari, Visakhapatnam and Srikakulam districts. Also reported are *Sarcostemma* and *Strychnos* species from northern circar districts, Kurnool and Veligonda hills in Nellore district. Varaprasad *et al*. (2006) gave an account of the important genera, species, the families representing the germplasm collected, their medicinal utility and passport data of the collections made. Sivaraj *et al*. (2006) dealt with the indigenous knowledge systems utilizing the medicinal plant wealth from Eastern Ghats. The rare/ endangered/ endemic medicinal plants collected include *Acorus calamus*, *Aegle marmelos*, *Costus speciosus*, *Cycus beddomii*, *Gloriosa superba*, *Gymnema sylvestre*, *Mucuna pruriens*, *Plumbago indica*, *Rauvolfia serpentina* and *Withania somnifera.* The collections under aromatic plants include *Artemesia spp.*, *Cymbopgon spp.*, *Ocimum spp.*, and *Vetiveria zizoinoides* etc. and the dye yielding plants mainly include *Bixa orellana* and *Mallotus philippensis* from the Eastern Ghats.

Wild relatives of crop plants

The wild relatives of crop plants and related species are gaining significance in crop improvement and evolutionary studies. At least 91 wild related species of crop plants are reported in the region (Arora and Nayar 1984). The important crops/ crop groups (paddy, sorghum, millets, castor, sesame, vegetables etc.) for which wild relatives are available and collected from the Eastern Ghats are given in Table-2. They occur as members of disturbed, bio-edaphic communities within the major vegetation types. Some of the important genera are *Abelmoschus*, *Alpinia*, *Amaranthus*, *Atylosia*, *Artocarpus*, *Coccinia*, *Citrus*, *Coleus*, *Corchorus*, *Cucumis*, *Dioscorea*, *Diospyros*, *Elaeocarpus*, *Ficus*, *Grewia*, *Luffa*, *Momordica*, *Moringa*, *Mucuna*, *Oryza*, *Panicum*, *Phyllanthus*, *Piper*, *Sesamum*, *Setaria*, *Solanum*, *Trichosanthes*, *Vigna*, *Vitis* and *Ziziphus* etc. Many wild species of the above genera are distributed throughout the Eastern Ghats which is the sources of genes for different biotic/ abiotic stresses. *Piper attenuatum* is reported to occur in the northern Circar areas in the hills of Visakhapatnam and Godavari districts at 2000-3000 ft. Species of Curcuma, Zingiber and Cinnamomum are reported to occur in the Coastal areas in the Dummukonda, Rampa and Bison hills of East Godavari and Khammam districts.

Conservation efforts

The Agri-biodiversity is a vibrant and indispensable component in the overall conservation strategies for Eastern Ghats. The seed material of different Agri-horticultural crops of orthodox nature is stored at -20^{0}C with the seed moisture brought down to 5 - 8% and RH being maintained at 25 - 32% at NBPGR HQ. In some difficult species, which are recalcitrant, pollen and seed material is stored at -180^{0}C in liquid nitrogen in the Cryo tanks at NBPGR HQ. For medium term conservation, the seed material is stored at 5^{0}C with the seed moisture brought down to 5 - 8% and RH being maintained at 25-32% in the cold storage modules at NBPGR Reg.Station, Hyderabad. The crops which are multiplied by vegetative means and medicinal plant species which are non seed bearing (stem cuttings/ root cuttings/ whole plant) are being maintained in the Glass house/ Field gene bank at NBPGR Reg.Station, Hyderabad in live condition. To effectively plan a conservation programme especially for the in-situ approaches, the passport data enlisted will be useful in delineating species rich areas in general and diversity rich pockets for a particular crop/ species in the surveyed region for adapting suitable *In-Situ* conservation strategies. The important areas for initiating an *In-Situ* conservation are given in Table-3.

Utilization of diversity in crop improvement

Keeping in view, the importance and potential of the crop genetic diversity, NBPGR Reg.Station, Hyderabad have been making earnest efforts to explore, collect and conserve this endemic Agri-diversity in the Eastern Ghat areas in Andhra Pradesh and adjoining areas of other States. A paddy accession Voodasannalu, a super fine grained upland drought resistant landrace collected jointly by NBPGR RS, Hyderabad and ANGRAU from the Jatapu tribal group from Seethampeta Mandal, Srikakulam district was released as a variety as Maruteru Sannalu in Andhra Pradesh. A coriander accession collected from Ongole Mandal, Prakasam district was released as a variety Sudha by ANGRAU as per the state varietal release committee recommendations. A Roselle landrace which was found to be quite promising as a leafy vegetable and designated as UJWALA is in the minikit trials of ANGRAU for release as a variety. Significant number of

Sorghum accessions found to be promising got included in the ICRISAT core collections (*kharif* and *rabi*) for utilization in crop improvement programmes. Some collections in Paddy and Chillies were found to be promising against biotic stresses as well.

Factors contributing to genetic erosion

The Eastern Ghats is a vibrant habitat for ethnic diversity in different agri-horticultural crops, their wild/ weedy relatives, medicinal, aromatic and dye yielding plants. However, due to degradation of forests as a result of *podu* cultivation by the tribals, encouragement for raising plantations by the departments of Agriculture/ Horticulture, increase in population and the need to produce more food and non-food agricultural commodities, changing food habits and initiation of other socio-economic developmental programmes by the Government and NGOs, the endemic genetic diversity accumulated through years of evolution under domestication and natural selection by the tribal groups is being wiped out from the nature. The local landraces/ traditional cultivars and even some crops are gradually being replaced by improved HYV/ Hybrids and other profitable crops.

The nutritional balance of the soil and the ecological foundations of the Ghats has been affected by inappropriate land use (shifting cultivation cycles), changes in agricultural systems, overgrazing of grasslands by herbivores, deforestation due to over exploitation of forest resources, land clearance for developmental activities such as mining, thermal and hydro-projects and the lack of pollution control measures are adding to the problem. With the increase in the population, the demand of land for agricultural purposes has been increasing, thus resulting in the encroachment of large forest area by the people.

The subsidized rice scheme especially in north coastal Andhra Pradesh has made the hitherto subsistence farming being practiced by the tribal groups in to commercial farming looking for remuneration and profits in cultivation as they were getting rice at a very cheap rate for consumption. This has resulted in unforeseen changes in the cropping patterns and replacement of traditional crops like sorghum, pearl millet and small millets with either coffee/ tea/ cashew or mango plantations there by loosing the diversity in those crops. The practices of raising of crops in the kitchen gardens and seed storage for next season sowing being stopped made them to rely on market forces and middle men. This also contributed in erosion of ethnic diversity in several agri-horticultural crops. The reduction/ abandonment of utilization of wild tubers, fruits, millets etc.. as sources of food also has resulted in the loss of diversity and indigenous traditional knowledge (ITK). The dependence on modern medicine is gradually leading to erosion of ethno botanical knowledge.

Conclusions

There is a tremendous urgency and scope for collection and conservation of Agri-diversity in general and medicinal plants, wild relatives and endemic tree species in particular for sustainable utilization from the Eastern Ghats. As the replacement of local cultivars has become very fast and alarming, rapid efforts have to be resorted to collect and conserve the Crop Genetic Resources from Eastern Ghats. Another concern is the collection of wild/ weedy relatives of crop plants and endemic diversity in medicinal and aromatic plants before the natural habitats are destructed. Concerted and systematic efforts have to be initiated involving all the agencies/ institutes concerned to avoid duplication of efforts. It should be ensured that, participation of the communities and stakeholders in comprehensive documentation of tribal life systems including ITK, folklore and domestication of plant species etc. should be carried out. In view of changing scenario in both agri and vegetational diversity, a suitable conservation strategy should be evolved for addressing sustainable development to save the Eastern Ghats for the people of present and future generations.

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Table-1. Landrace diversity collected in some of the Agricultural crops from Eastern Ghats

Crop	Landrace	Areas of diversity (District/s)
Paddy	Akkullu, Anjan, Attedlu, Bandabudamalu, Battadhanyam, Bodadhanyam, Badshabhog, Bagni dhan, Baiganmangi, Bakti chudi, Bandabudamalu, Bandhichudi, Baradhai, Barangi, Bayahunda, Bhayagunda, Bhus Katia, Budama, Chudi Dhan, Dasarabhogalu, Dawalakavanji, Dengichudi, Desidhan, Dhagruvanji, Dhanwakitaka, Dhavaralvanji, Dhonanellu, Dhubraj, Doddodlu, Ekhlo, Errabudduma, Erra Mallelu, Errodlu, Garadavadlu, Isukaravvalu, Jajati, Kondadhanyam, Kondabudamalu, Kukumbanthulu, Lalat, Meher, Mettadhanyam, Moddugarikalu, Mullodlu, Nallamettadhanyam, Nallasathikalu, Nevarivari, Nimmalosari, Yerradhanyam, Regativadlu, Sannadhanyam, Seethammasavaralu, Tellabudamalu, Umri Chudi, Vattodlu, Voodasannalu, Yerrakondadhanyam, Yerramallelu	Adilabad, East Godavari, Visakhapatnam, Khammam,Vizianagaram, Srikakulam, Koraput, Bastar, Kanker and Dantewada
Sorghum	Billi jola, Kempujola, Kondajonna, Kondamuddajonna, Natujonna, Pachchajonna, Padijonna, Palepujonna, Podujonna Seethammavarijonna, Tella Jonna, Yerra Jonna	Adilabad, East Godavari, Khammam, Warangal, Gulbarga, Srikakulam, Visakhapatnam, Vizianagaram
Pearl millet	Gantlu, Pedda ganti, Pitta ganti, Podu ganti, Punasa ganti	East Godavari, Vizianagaram, Khammam, Vizianagaram
Finger millet	Burada chollu, Chinna chollu, Garuvu chodi, Metta chodi, Mudda chodi, Nadipi chollu, Pedda chodi, Punasa chollu, Pyru chollu, Tella ragulu, , Tholakari chollu,	Visakhapatnam, Koraput, Vizianagaram, Srikakulam, Mahaboobnagar
Foxtail millet	Chinna korra, Erra korra, Jada korra, Konda korra, Kukka toka korralu, Nakka toka gaddi, Punasa korra	East Godavari, Koraput, Srikakulam, Vizianagaram, Visakkapatnam
Little millet	Badasuan, Burada samalu, Chinna samalu, Koyya Sama, Maghi sama, Malle sama, Nalla samalu, Pedda sama	East Godavari Koraput, Vizianagaram Visakhapatnam
Barnyard millet	Bonthalu, Burka sama, Chinna oodalu, Konda voodalu, Voodalu, Pedda voodalu, Punasa voodalu	East godavari, Mahaboobnagar, Vizianagaram, Srikakulam, Srikakulam, Visakapatnam
Pigeonpea	Erra kandulu, Kandulu, Mabbu kandi, Natu kandulu, Srikandi, Tellakandulu, Chirukandi, Konda kandi, Parimi kandulu, Pedda kandi, Podu kandi, Siri kandulu, Tandur	Visakhapatnam, Khammam, Srikakulam, Visakhapatnam, Vizianagaram, Ranga Reddy

Table-2. Occurrence and collection of some of the important wild species of cultivated crops from Eastern Ghats

Name of the Species	Family Name	Area/s of occurrence & collection (District/s / Pockets)
Abelmoschus ficulneus	Malvaceae	Nellore
Abelmoschus moschatus	Malvaceae	Bastar, Vizianagaram, Ranga Reddy, East Godavari and Visakhapatnam
Amorphophallus paeoniifolius	Araceae	East Godavari, Vizianagaram, Gajapati and Srikakulam
Cajanus cajanifolius	Papilionaceae	Gajapati
Capsicum frutescens	Solanaceae	West Godavari, East Godavari, Visakhapatnam and Vizianagaram
Citrullus colocynthis	Cucurbitaceae	Gajapati, Anantapur, East Godavari and Chittoor
Cucumis hardwickii	Cucurbitaceae	Adilabad, East Godavari and Visakhapatnam
Cucumis pubescence	Cucurbitaceae	Visakhapatnam, Bastar, Adilabad, Mahaboobnagar, Nalgonda, Nizamabad and Ranga Reddy
Curcuma angustifolia	Zingiberaceae	Sirkakulam
Dioscorea oppositifolia	Dioscoriaceae	Visakhapatnam
Luffa acutangula var. *amara*	Cucurbitaceae	Kurnool, Cuddapah, Nalgonda and Prakasam
Luffa cylindrica	Cucurbitaceae	Visakhapatnam, Khammam, East Godavari, Nalgonda, Krishna and Guntur
Luffa tuberosa	Cucurbitaceae	Kurnool
Lycopersicon pimpinellifolium	Solanaceae	Warangal, East Godavari, Bastar, West Godavari, Prakasam and Nalgonda
Momordica dioica	Cucurbitaceae	East Godavari, Vizianagaram and Karimnagar
Moringa concanensis	Moringaceae	East Godavari
Moringa pterigosperma	Moringaceae	Visakhapatnam
Mucuna monosperma	Papilionaceae	East Godavari, Srikakulam, Visakhapatnam, Khammam and West Godavari
Murraya paniculata	Myrtaceae	East Godavari and Visakhapatnam
Musa ornata	Musaceae	Visakhapatnam and East Godavari
Ocimum americanum	Lamiaceae	Srikakulam and Visakhapatnam
Ocimum basilicum	Lamiaceae	East Godavari, Vizianagaram, Srikakulam, West Godavari and Bastar
Oryza malampuzhaenis	Poaceae	Kurnool (Nallamalais)
Oryza nivara	Poaceae	Karimnagar
Oryza rufipogon	Poaceae	Khammam, Medak Nellore and Nizamabad
Pennisetum hohenackeri	Poaceae	Medak and Nizamabad
Piper longum Linn.	Piperaceae	East Godavari, Visakhapatnam, Koraput, Vizianagaram and Khammam
Sesamum alatum	Pedaliaceae	Anantapur
Solanum incanum	Solanaceae	East Godavari, Visakhapatnam and Mahaboobnagar
Solanum indicum	Solanaceae	Visakhapatnam, Anantapur, East Godavari and Chittoor
Solanum nigrum	Solanaceae	East Godavari, West Godavari, Gajapati and Visakhapatnam
Solanum pubescens	Solanaceae	Nalgonda, Guntur, Kurnool and Anantapur
Solanum surattense	Solanaceae	Srikakulam, Khamman, West Godavari, East Godavari, Nizamabad, Prakasam and Adilabad
Solanum torvum	Solanaceae	East Godavari, Visakhapatnam, West Godavari, Chittoor, Nalgonda and Kurnool
Solanum trilobatum	Solanaceae	West Godavari, East Godavari and Visakhapatnam
Sorghum halepense	Poaceae	Adilabad
Trichosanthes bracteata	Cucurbitaceae	Srikakulam, Visakhapatnam and, Nizamabad
Trichosanthes cucumerina	Cucurbitaceae	Nalgonda, Khammam, Vizianagaram, East Godavari, Nizamabad and Medak
Vanilla wightiana	Orchidaceae	East Godavari
Vigna trilobata	Papilionaceae	Nalgonda, Kurnool, Visakhapatnam, Prakasam, Krishna, Nellore and Medak
Zingiber cassumnar	Zingiberaceae	East Godavari
Zingiber roseum	Zingiberaceae	East Godavari and Visakhapatnam
Ziziphus oenoplia	Rhamnaceae	Vizianagaram
Ziziphus xylopyrus	Rhamnaceae	Gajapati and Visakhapatnam

Table-3. Important species and pockets for *In-Situ On-Farm* conservation of Agri-biodiversity in Andhra Pradesh

Crop	**Region**	**Area for *In-Situ On-Farm* Conservation**
Wild relatives		
Oryza malampuzhaensis	Rayalaseema	Kurnool (Nallamalais)(Endemic)
Oryza jeyporensis	Koraput	Koraput (Endemic)
Cajanus cajanifolius	N.Coastal	Visakhapatnam, Gajapathi
Solanum pubescens, *Luffa acutangula* var. *amara*	Rayalseema	Kurnool, Cuddapah, Chittoor, Anantapur (Endemic)
Curcuma aromatica	N.Coastal	Visakhapatnam
Ensete glaucum, *Musa ornata*	N.Coastal	East Godavari, Visakhapatnam
Cycas beddomeii, *Pimpinella tirupatiensis*	Rayalaseema	Chittoor (Tirumala hills) (Endemic)
Crop species (Diversity/ Landrace)		
Small millets, Pearl millet (*Pittaganti*) (need for reintroduction)	N.Coastal	Vizianagaram, Srikakulam
Small millets and Under-utilized crops	Kolli hills	Salem
Okra (landraces/ primitive forms/ wild/ weedy forms)	N.Telangana	Adilabad
Mango	N.Coastal	Vizianagaram (Bobbili)

Legumes of Eastern Ghats - A reappraisal and in conservation perspective

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Abstract

A total of 86 genera, 348 species and 16 infraspecific taxa of legumes are documented in the present account. A tabulation of all the accounted genera with number of species and infra-specific taxa recorded from Eastern Ghats is provided. The relative distribution of legume taxa in the Eastern Ghats of Andhra Pradesh, Orissa and Tamil Nadu was analysed. Out of 308 indigenous taxa of legumes reported from Eastern Ghats of these states, Andhra Pradesh exhibits the highest number (267 taxa) followed by Tamil Nadu (230) and Orissa (186). Only 10 legumes are exclusively endemic to Eastern Ghats and 52 other endemic taxa of India are known to be distributed in Eastern Ghats. Data on habit, distribution and present status are also provided for the endemic legumes. A table comprising 55 cultivated and naturalized taxa in the Eastern Ghats is also given. The nomenclature has been updated by referring to various literature including the website of International Legume Database and Information Service (ILDIS). The paper emphasizes the importance of the Eastern Ghats as supportive to endemic/economically important/wild relative legumes of the country. Issues concerning to conservation and management options of legumes are also addressed.

Key words: Eastern Ghats, legumes, endemics, cultivated and naturalized taxa, conservation.

Introduction

The Eastern Ghats are discontinuous hill ranges lying on the eastern side of the Deccan Plateau, located between 77°22' and 85°20' E longitudes and 11°30' and 22° N latitudes. The Eastern Ghats lies in a Northeast-Southwest direction in the Indian Peninsula, covering an area of ca 75,000 sq. kms. with an average width of 200 kms. in the North and 100 kms. in the South and stretches to about 1750 kms. The Eastern Ghats is recognized as one of the phytogeographical zones of India by authors like Mani (1974), Nayar *et al.* (1984) and Jain (1989-90). The ghats form a chain of sporadically isolated hill ranges traversing through Orissa, Andhra Pradesh, Tamil Nadu and a small part of Karnataka. These hill ranges are separated from one another by major rivers like Mahanadhi, Godavari, Krishna, Pennar and Cauvery. The Eastern Ghats are broadly grouped under three regions namely, (i) the Northern, (ii) the Middle and (iii) the Southern Eastern Ghats. The Northern Eastern Ghats runs from little above the river Mahanadhi in Orissa to the river Godavari in Andhra Pradesh. Some of the important hill ranges of Northern Eastern Ghats are Gandhamandan hills, Khondan hills, Mahendragiri hills, Madgol hills, Anantagiri hills, Chintapalli - Saparla Gudem - Maripakalu hill ranges, Guntur - Addateegda, Rampehadavaram–Maredimalli ranges and Polavaram–Papikonda ranges with Mahendragiri hill with a highest peak of 1501 m. The middle Eastern Ghats spans from the river Krishna in Andhra Pradesh to river Palar in Tamil Nadu, comprising Kondapalli ranges, Nallamalais, Yerramalais, Veligonda and Palakonda-Seshachalam-Lankamala–Nagari hill ranges. The hill ranges that run from North Arcot district in Tamil Nadu to Mysore in Karnataka represents South Eastern Ghats. The important hills in this region are Javadi hills, Gingee hills, Shevoroy, Kollimalai, Bodimallai hills, Meghamalai hills, Pachamalai hills in Tamil Nadu and Sandoor, Kolar and Biligirirangan hills in Karnataka. The Eastern Ghats harbours many economically and medicinally important plant species apart from diverse fauna and minerals. Legumes are economically important and potentially a rich source of vegetable proteins, distributed throughout the world, comprising about 18,000 species under 650 genera (Polhill & Raven, 1981). The family Leguminosae (Fabaceae) is ranked as one of the three dominant families of Indian flora (Hajra & Mudgal, 1997) and is represented by about 199 genera and 1252 species (Sanjappa, 2001).

Legumes of Eastern Ghats

In the last decade, Sri Ramamurthy *et al*. (1998) and Satyanarayana and Sanjappa (1998) dealt specifically on the legumes of Eastern Ghats and Endemic legumes of Eastern Ghats respectively in which they projected 328 species and 314 species are found in the Eastern Ghats. Two years later, Pullaiah and Sri Ramamurthy (2000) enumerated a total of 330 species belonging to 74 genera. In the present work, 86 genera, 348 species and 16 infraspecific taxa are recognized to be found in Eastern Ghats, which includes 55 cultivated and naturalized taxa belonging to 28 genera (Table 1 & 5). The considerable increase in number of genera in the present account is mainly due to splitting of the two genera *Cassia* and *Desmodium*. The nomenclature has been updated as far as possible by referring various literature (Bennet, 1987; Chakaravarty & Gangopadhyay, 1991, 1996a, b; Matthew, 1983; Nair & Henry, 1983; Saxena & Brahmam, 1994; Rajasekhar Reddy & Pullaiah, 1998a, b; Saldanha, 1986; Sanjappa, 1991, 2001; Satyanarayana *et al*., 1987; Singh, 2001) and ILDIS website. The major deviation from Pullaiah & Sri Ramamurthy (2000) are listed in Table 2. Interestingly, the subfamilies *Caesalpinoideae* and *Mimosoideae* comprise only 28 and 30 indigenous taxa respectively, while the subfamily *Papilinoideae* has 251 taxa (Figure 1) and these 309 taxa are placed under 72 genera (Table 1), the remaining 14 genera are exclusively introduced and non-indigenous.

Distribution

As mentioned above, the hill ranges of Eastern Ghats runs through four states. A maximum area of about 48% of Eastern Ghats traverse through Andhra Pradesh, while in Orissa and Tamil Nadu almost equally of about 25% and the remaining 2% pass through Karnataka. An analysis of relative distribution of genera, species and infraspecific taxa distributed in the first three states of the Eastern Ghats are carried out and represented through Venn diagrams (Fig. 2). Out of 72 indigenous genera, 52 are common to three states of Eastern Ghats. In Andhra Pradesh part all but 4 genera are represented, while in Tamil Nadu and Orissa, 66 and 56 genera are recorded respectively. On the other hand, three genera, *Ohwia*, *Ophrestia* and Trifolium are known only from Andhra Pradesh part. Similarly, two genera, Hylodesmum and Spatholobus, and one genus Eriosema are reported only from Tamil Nadu and Orissa respectively. Whilst, eleven genera viz., Adenanthera, Aeschynemene, Desmodium, Eleiotis, Hardwickia, Indigofera, Mundulea, Neonotonia, Pterolobium, Pycnospora and Stylosanthes are common to Andhra Pradesh and Tamil Nadu; two genera, *Dumasia* and *Ormocarpum* are found only in Andhra Pradesh and Orissa; one genus, *Macrotyloma* is found in Tamil Nadu and Orissa, and yet to be reported from Andhra Pradesh part. With regard to the 309 indigenous specific and infraspecific taxa (Figure 1), 308 are reported from these three states. One species, *Crotalaria sandoorensis* Bedd. is endemic to Sandoor hills in Karnataka. From figure 3, it can be inferred that 132 taxa are common to all the three states. In Andhra Pradesh a maximum of 267taxa is distributed, followed by Tamil Nadu with 230 and Orissa with 186 taxa (Fig. 2).

Endemism

Nayar *et al*. (1984), and Ahemedullah & Nayar (1987) specifically dealt about the endemic species of Eastern Ghats. According to them, 77 taxa are endemic to Eastern Ghats, which includes 67 species of Angiosperms and one Gymnosperm (*Cycas beddomei* Dyer). Reddy *et al*. (2002) reported that 98 out of 3200 species are endemic to Eastern Ghats. However, a rough estimate reveals that about 2500 flowering plants occur in Eastern Ghats, of which less than 4% are strictly endemic. In this presentation, only ten legumes are recognized strictly endemic to Eastern Ghats (Table 4) compared to 13 reported by Ahmedullah and Nayar (*op. cit.*). Indeed, three endemics, *Alysicarpus mahaboobnagarensis*, *Rhynchosia fischeri* and *R. hainesiana* are described after the publication of Ahmedullah and Nayar (*l.c.*). Of the six other endemics listed by them, four are treated as synonyms *viz*., *Acacia donaldii* Haines under *A. pennata* (L.) Willd.; *Albizia orissensis* Sahni & Bennet under *A. odoratissima* (L. f.) Benth.; *A. sikharamensis* Sahni & Bennet under *Acacia caesia* (L.) Willd. and *Mucuna minima* Haines under *M. pruriens* (L.) DC. The remaining two species, *Cajanus cajanifolius* (Haines) Maesan and *Sophora interrupta* Bedd. were reported to occur outside Eastern Ghats. Similarly, of the 24 taxa listed by Satynarayana & Sanjappa (1998) as endemic legumes to Eastern Ghats, 15 are eliminated for almost similar reasons and most of them are recorded in the list of endemic legumes of India occurring in the Eastern Ghats (Table 3). One species, *Millettia orissae* Panigr. & Mishra, described from Eastern Ghats is treated here as a synonym of *Endosamara racemosa* (Roxb.) R. Geesink by following Saxena & Brahmam (1994) as the diagnostic characteristics are untenable at least species level (Table 2). However, we refrain from relegating the former as infraspecifric without studying the type materials.

Conservation Aspect

Conservation is the planned management of the available biological resources, to retain the natural balance, diversity and evolutionary changes in the environment (Lincoln *et al*., 1982). It also intends to prevent the loss of species or genetic diversity, to save a species from extinction and to protect an ecosystem from damage; thus it promotes sustained utilization of natural resources (Kameswara Rao *et al*., 2003). As in other phytogeographical zones of India, the ecosystem of Eastern Ghats is under threat due to extensive '*podu*' cultivation (slash and burn), monoculture, large scale mining, loss of green cover and habitats. Although series of protected areas have been established in Eastern Ghats to conserve the biodiversity, their effectiveness is often questionable, collection of non-timber forest products, bamboo harvesting and grazing of livestock continues in all areas (Rawat, 1997). However, its counterpart Western Ghats have received relatively better attention partly because of its status as one of the biogeographical zones of the world. The loss of habitat not only results in reduction of number and genetic variability in native species, but also provides room for flourishing of exotic species. Some of the introduced species found dominant in Eastern Ghats are *Alternanthera tenella* Colla (*Amaranthaceae*), *Chromolaena odorata* (L.) R.M. King & H. Robin. (*Asteraceae*), *Hyptis scandens* Poit. (*Lamiaceae*), *Lantana camara* L. (*Verbenaceae*) and *Parthenium hysterophorus* L. (*Asteraceae*). Vajravelu & Daniel (1983) recorded 10 taxa of legumes from E. Ghats in the threatened plant lists of peninsular India. The same number were also listed by various authors in the Red Data Book of Indian plants (Nayar & Sastry, 1987-1990). From tables 3 and 4 it is apparent that the number has changed considerably and the increase of rare and threatened taxa is mainly due to destruction of habitats for various human activities like establishment of agriculture, accommodation and Industrial units, mining and promotion of tourism industry. The ability of legumes to fix soil nitrogen through a symbiotic process of nitrogen fixation and their protein-rich seeds, apart from their use in industrial products like drugs, dyes, resins, tannins, gums and a variety of timber products places them next to cereals in their economic importance. The total world value for leguminous crops is thought to be approximately two billion US dollars per annum. Many more legumes are used as local food plants. In addition to those legumes cultivated for human consumption many yield important fodders, green manures and forages, e.g. *Lupinus* (Lupin),

Medicago (Alfalfa) and *Trifolium* (Clover). Apart from this, some of them like *Cajanus albicans* (Wight & Arn.) Maesen, *C. cajanifolius* (Haines) Maesan, *C. scrabaeoides* (L.) du Petit, *Mucuna gigantea* DC., *M. monosperma* DC. ex Wight, *M. pruriens* (L.) DC., *Vigna pilosa* (Willd.) Baker, *V. sublobata* (Roxb.) Babu *et al*. and *V. umbellata* (Thunb.) Ohwi & Ohashi are cultivated wild relatives found in Eastern Ghats. The wild relatives are extremely useful in the development of drought, pest and disease resistant as well as high yielding crop varieties.

For conservation of plant genetic resources, two basic approaches namely *in situ* and *ex situ* have been advocated and adapted. The former system has the potential to conserve wild relatives of crop plants, their land races and traditional cultivars and also to allow the natural forces of evolution to function thus generating further variability for natural or conscious selection in favourable combinations over generations (Kariahaloo and Bisht, 2006). *In situ* conservation can also be seen as a conservation strategy that is complementary to *ex situ* conservation (Vissar and Engels, 2000; Almekinders *et al*., 2000; Almekinders and Elings, 2001). The economic importance of the family is likely to increase as human pressure places greater demand on marginal land. Many Legume species are characteristic of open and disturbed places and are thus well adapted to grow under poor conditions. Further, plants like *Entada rheedii* Spreng is used as potential tribal food and medicine. If necessary steps are not taken, many unexplored wild endemic legumes may become extinct before knowing their potential use as already happened to many plant species in the globe.

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Website

34. ILDIS International Legume Database and Information Service: http://www.ildis.org/Legumeweb/

Table 1. List of Legume genera found in the Eastern Ghats with number of specific and infraspecific taxa (Numbers in parenthesis indicate endemics)

S. No.	Name of the genus	No. of species in India	Eastern Ghats		
			No. of species	No. of infra-specific taxa	No. of introduced taxa
	Subfamily: **Caesalpinoideae**				
1.	*Bauhinia* L.	31	06	--	01
2.	*Caesalpinia* L.	20	05	--	02
3.	*Cassia* L.	09	02	--	01
4.	*Chamaecrista* Moench	11	05	01	--
5.	*Delonix* Rafin.	02	--	--	02
6.	*Hardwickia* Roxb.	01	01	--	--
7.	*Parkinsonia* L.	01	--	--	01
8.	*Peltophorum* (Vogel) Benth.	02	--	--	01
9.	*Pterolobium* R. Br. ex Wight & Arn.	02	01	--	--
10.	*Saraca* L.	05	--	--	01
11.	*Senna* Mill.	36	07	--	08
12.	*Tamarindus* L.	01	--	--	01
	Subfamily: **Mimosoideae**				
13.	*Acacia* Mill.	93	13	01	05
14.	*Adenanthera* L.	02	01	--	--
15.	*Albizia* Durazz.	20	06	--	--
16.	*Calliandra* Benth.	09	--	--	01
17.	*Desmanthus* Willd.	01	--	--	01
18.	*Dichrostachys* (DC.) Wight & Arn.	02	01	--	--
19.	*Entada* Adans.	02	01	--	--
20.	*Lysiloma* Benth.	01	--	--	01
21.	*Mimosa* L.	10	04	--	02
22.	*Neptunia* Lour.	03	02	--	01
23.	*Parkia* R. Br.	06	--	--	02
24.	*Pithocellobium* Mart.	02	--	--	01
25.	*Prosopis* L.	05	01	--	02
26.	*Samanea* (DC.) Merr.	01	--	--	01
27.	*Xylia* Benth.	02	01	--	--
	Subfamily: **Papilinoideae**				
28.	*Abrus* Adans.	03	03	--	--
29.	*Aeschynomene* L.	03	01	--	03
30.	*Alysicarpus* Neck. ex Desv.	18	13 (01)	04	--
31.	*Arachis* L.	01	--	--	01
32.	*Butea* Roxb. ex Willd.	02	02	--	--
33.	*Cajanus* Adans.	16	06	--	01
34.	*Canavalia* DC.	07	04	--	--
35.	*Clitoria* L.	05	01	--	--
36.	*Codariocalyx* Hassk.	02	01	--	--
37.	*Crotalaria* L.	97	51 (01)	02 (02)	02
38.	*Cullen* Medik.	03	01	--	--
39.	*Dalbergia* L.f.	33	06	01	--
40.	*Derris* Lour.	22	02	--	--
41.	*Desmodiastrum* (Prain) A. Pramanik & Thoth.	02	01	--	--
42.	*Desmodium* Desv.	40	16	01	--
43.	*Dolichos* L.	03	01	--	--
44.	*Dumasia* DC.	02	01	--	--
45.	*Dunbaria* Wight & Arn.	07	02	--	--
46.	*Eleiotis* DC.	02	01	--	--
47.	*Endosamara* R. Geesink	01	01	--	--
48.	*Eriosema* (DC.) G.Don	02	01	--	--
49.	*Erythrina* L.	20	05	--	01
50.	*Flemingia* Roxb. ex Ait. & Ait.f.	20	09	01	--
51.	*Galactia* P. Browne	02	02	02	--
52.	*Hylodesmum* H. Ohashi & R.R. Mill.	01	01	--	--
53.	*Indigofera* L.	60	24 (01)	01	02
54.	*Indigastrum* Jaub. & Spach.	01	01	--	--

55. *Macroptilium* (Benth.) Urb.	02	--	--	02
56. *Macrotyloma* (Wight & Arn.) Verdc.	03	01	--	01
57. *Millettia* Wight & Arn.	13	02	--	01
58. *Mucuna* Adans.	09	04	01	--
59. *Mundulea* (DC.) Benth.	01	01	--	--
60. *Neonotonia* (Wight & Arn.) Lack.	01	01	--	--
61. *Ohwia H.* Ohashi	01	01	--	--
62. *Ophrestia* Forbes	01	01	--	--
63. *Ormocarpum* Beauv.	02	01	--	--
64. *Paracalyx* Ali	01	01	--	--
65. *Phyllodium* Desv.				
66. *Pongamia* Vent.	01	01	--	--
67. *Pseudarthria* Wight & Arn.	01	01	--	--
68. *Pterocarpus* Jacq.	05	02 (01)	--	--
69. *Pueraria* A. DC.	13	01	--	--
70. *Pycnospora* R. Br. ex Wight & Arn.	01	01	--	--
71. *Rhynchosia* Lour.	27	16 (03)	--	--
72. *Rothia* Pers.	01	01	--	--
73. *Sesbania* Scop.	10	02	--	02
74. *Shuteria* Wight & Arn.	04	01	--	--
75. *Smithia* W.Ait.	18	03	--	--
76. *Sophora* L.	07	03	--	--
77. *Spathlobus* Hassk.	06	01	--	--
78. *Stylosanthes* O. Sw.	03	01	--	--
79. *Tadehagi* (Schindl.) H. Ohashi	01	01	--	--
80. *Tephrosia* Pers.	27	12 (01)	--	--
81. *Teramnus* P. Br.	08	02	--	--
82. *Trifolium* L.	12	01	--	--
83. *Uraria* Desv.	08	03	--	--
84. *Vigna* Savi	24	10	01	03
85. *Virgilia* Poir.	02	--	--	01
86. *Zornia* J.F. Gmelin	03	02	--	--

Table 2 – Nomenclatural changes made in the previous work of the Legumes of Eastern Ghats by Pullaiah & Sri Ramamurthy (2000)

S. No.	Previous Work	Present Work
1.	*Alysicarpus racemosus* Benth.	*Desmodiastrum racemosum* (Benth.) A. Pramanik & Thoth.
2.	*Cassia absus* L.	*Chamaecrista absus* (L.) H.S. Irwin & Barneby
3.	*Cassia alata* L.	*Senna alata* (L.) Roxb.
4.	*Cassia auriculata* L.	*Senna auriculata* (L.) Roxb.
5.	*Cassia didymobotrya* Fresen.	*Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby
6.	*Cassia floribunda* Cav.	*Senna floribunda* (Cav.) H.S. Irwin & Barneby
7.	*Cassia hirsuta* L.	*Senna hirsuta* (L.) H.S. Irwin & Barneby
8.	*Cassia italica* (Mill.) Lam. ex Andrews	*Senna italica* Mill.
9.	*Cassia kleinii* Wight & Arn.	*Chamaecrista kleinii* (Wight & Arn.) V. Singh
10.	*Cassia leschenaultiana* DC.	*Chamaecrista leschenaultiana* (DC.) Degener
11.	*Cassia mimosoides* L.	*Chamaecrista mimosoides* (L.) Greene
12.	*Cassia montana*	*Senna montana* V. Singh
13.	*Cassia obtusifolia* L.	*Senna obtusifolia* (L.) H.S. Irwin & Barneby
14.	*Cassia occidentalis* L.	*Senna occidentalis* (L.) Link
15.	*Cassia pumila* Lam.	*Chamaecrista pumila* (Lam.) K. Larsen
16.	*Cassia senna* L.	*Senna alexandrina* Mill.
17.	*Cassia siamea* Lam.	*Senna siamea* (Lam.) H.S. Irwin & Barneby
18.	*Cassia sophora* L.	*Senna sophora* (L.) Roxb.
19.	*Cassia suffruticosa* Koen. ex Roth	*Senna surattensis* (Burm.f.) H.S. Irwin & Barneby
20.	*Cassia surattensis* Burm.f.	*Senna surattensis* (Burm.f.) H.S. Irwin & Barneby

21.	*Cassia timoriensis* DC.	*Senna timoriensis*(DC.) H.S. Irwin & Barneby
22.	*Cassia tora* L.	*Senna tora* (L.) Roxb.
23.	*Dalbergia paniculata* Roxb.	*Dalbergia lanceolaria* L.f. ssp. p*aniculata* (Roxb.) Thoth.
24.	*Desmodium caudatum* (Thunb.) DC.	*Ohwia caudata* (Thunb.) H. Ohashi
25.	*Desmodium motorium* (Houtt.) Merr.	*Codariocalyx motorium* (Houtt.) H. Ohashi
26.	*Desmodium pulchellum* (L.) Benth.	*Phyllodium pulchellum* (L.) Desv.
27.	*Desmodium repandum* (Vahl) DC.	*Hylodesmum repandum* (Vahl) H. Ohashi & R.R. Mill
28.	*Desmodium triquetrum* (L.) DC.	*Tadehagi triquetrum* (L.) H. Ohashi
29.	*Entada pursaetha* DC.	*Entada rheedii* Spreng.
30.	*Flemingia bracteata* (Roxb.) Wight	*Flemingia strobilifera* (L.) W.T.Aiton
31.	*Flemingia nana* Roxb.	*Flemingia macrophylla* (Willd.) Prain ex Merr.
32.	*Flemingia semialata* Roxb.	*Flemingia macrophylla* (Willd.) Prain ex Merr.
33.	*Flemingia wallichii* Wight & Arn.	*Flemingia macrophylla* (Willd.) Prain ex Merr.
34.	*Galactia tenuiflora* (Klein ex Willd.) Wight & Arn. var. *minor* Baker	*Galactia striata* (Jacq.) Urb.
35.	*Galactia tenuiflora* (Klein ex Willd.) Wight & Arn. var. *villosa* (Wight & Arn.) Benth.	*Galactia striata* (Jacq.) Urb. var. *villosa* (Wight & Arn.) Verdc.
36.	*Indigofera parviflora* Heyne ex Wight & Arn.	*Indigastrum parviflorum* (Heyne ex Wight & Arn.) Schrire
37.	*Indigofera spicata* Forssk.	*Indigofera hendecaphylla* Jacq.
38.	*Indigofera trita* L.f. var. *subulata* (Vahl ex Poir.) Ali	*Indigofera trita* L.f. var. *scabra* (Roth) Ali
39.	*Leucaena latisiliqua* (L.) Gillis [& Stearn]	*Lysiloma latisiliqum* (L.) Benth.
40.	*Macroptilium lathyroides* (L.) Urb. var. *semierectum* (L.) Urb.	*Macroptilium lathyroides* (L.) Urb. var. *lathyroides*
41.	*Macrotyloma dispermus* (Klein ex Willd.) Verdc.	*Macrotyloma ciliatum* (Willd.) Verdc.
42.	*Millettia orissae* Panigr. & S.C. Mishra	*Endosamara racemosa* (Roxb.) R. Geesink
43.	*Mimosa intsia* L.	*Acacia intsia* (L.) Willd. and *Mimosa rubicaulis* Lam.
44.	*Ougeinia oojeinensis* (Roxb.) Hochr.	*Desmodium oojeinense* (Roxb.) H. Ohashi
45.	*Psoralea corylifolia* L.	*Cullen corylifolium* (L.) Medik.
46.	*Tephrosia pulcherrima* (Wight ex Baker) Drumm.	*Tephrosia tinctoria* Pers.

Table 3. Endemic taxa of the Eastern Ghats

S. No.	NAME OF THE TAXA	HABIT	DISTRIBUTION	STATUS
1.	*Alysicarpus mahabubnagarensis* Ragh. Rao & al.	Ascending herb	AP (Nallamalais)	Rare
2.	*Crotalaria madurensis* Wight & Arn. var. *kurnoolica* Ellis & Swaminath.	Erect herb or Undershrub	AP (Nallamalais)	Rare
3.	*Crotalaria paniculata* Willd. var. *nagarjunakondensis* Thoth.	Undershrub	AP (Nagarjunakonda Valley) & TN	Rare
4.	*Crotalaria sandoorensis* Gamble	Annual herb	KA (Sandoor hills)	Endangered
5.	*Indigofera barberi* Gamble	Undershrub	AP & TN	Rare
6.	*Pterocarpus santalinus* L.f.	Tree	AP & TN	Rare & Threatened
7.	*Rhynchosia beddomei* Baker	Shrub	AP, TN & KA	Rare
8.	*Rhynchosia fischeri* P. Satyanar. & Thoth.	Undershrub	TN	Rare
9.	*Rhynchosia hainesiana* P. Satyanar. & Thoth.	Climbing shrub	AP & OR	Rare
10.	*Tephrosia roxburghiana* Drum.	Erect herb	AP, OR & KA	Rare

Table 4. Endemic Indian Plants distributed in the Eastern Ghats

S. No.	NAME OF THE TAXA	HABIT	DISTRIBUTION	STATUS
1.	*Acacia hohenackeri* Craib.	Sh	AP, KA, TN; KL	Rare
2.	*Albizia thompsonii* Brandis	Tr	AP, OR, TN; BR, MH, MP	Rare
3.	*Alysicarpus bupleurifolius* (L.) DC. var. *hybridus* DC.	Hb	AP, KA, TN; BR, CH, KL, MH, MP, PB, RJ, UP, WB	Common
4.	*Alysicarpus hamosus* Edgew.	Hb	AP, OR; BR, DD, DL, GA, GJ, HR, JK, KL, MH, MP, PB, PY, RJ, UP, WB	Common
5.	*Alysicarpus pubescens* J.S. Law	Hb	AP, KA, OR; BR, GA, GJ, JH, KL, MH, MP, WB	Common
6.	*Alysicarpus roxburghianus* Thoth. & A. Pramanik	Hb	AP, BR, GA, GJ, KA, KL, OR, MH, MP, RJ, TN, UP	Common
7.	*Alysicarpus scariosus* (Spreng.) Thwaites var. *pilifer* (Prain) A. Pramanik & Thoth.	Hb	AP, KA, KL, PY, TN	Rare
8.	*Cajanus cajanifolius* (Haines) Maesen	Hb/Sh	AP, BR, CH, JH, MP, OR, TN	Rare
9.	*Cajanus sericeus* (Baker) Maesen	Sh	AP, GA, GJ, KA, KL, MP, MH, OR, RJ	Rare
10.	*Cassia nilgirica* V. Singh [=*Chamaecrista nilgirica* (V. Singh) V. Singh]	Hb/Sh	AP, TN; KL	Rare
11.	*Crotalaria candicans* Wight & Arn.	Hb/Sh	AP, TN	Occasional
12.	*Crotalaria clarkei* Gamble	Hb	AP, KA , KL, OR, TN	Rare
13.	*Crotalaria clavata* Wight & Arn.	Sh	TN	Endangered
14.	*Crotalaria digitata* Hook.	Sh	KA , TN	Rare
15.	*Crotalaria epunctata* Dalzell	Hb/Sh	AP, KA, MH, OR, TN, WB	Common
16.	*Crotalaria fysonii* Dunn	Hb	TN, KL	Rare
17.	*Crotalaria globosa* Wight & Arn.	Hb	AP, JH, KA, TN	Rare
18.	*Crotalaria hirta* Willd.	Hb	AP, BR, GA, GJ, JH, KA, KL, MH, MP, OR, RJ, TN, UP, WB	Occasional

19.	*Crotalaria longipes* Wight & Arn.	Ush	AP, KL, TN	Endangered
20.	*Crotalaria lunulata* Heyne ex Wight & Arn.	Hb/Sh	AP, KA, MH, TN	Rare
21.	*Crotalaria ovalifolia* Wall. ex Fyson	Sh	KA, KL, TN	Occasional
22.	*Crotalaria priestleyoides* Benth. ex Baker	Hb/Sh	KA, MH, TN	Rare
23.	*Crotalaria pulchra* Andrews	Hb/Sh	AP, KA, TN	Occasional
24.	*Crotalaria pusilla* DC.	Clhb	AP, BR, GA, GJ, JH, KA, KL, MH, MP, OR, TN	Common
25.	*Crotalaria ramosissima* Roxb.	Hb/Sh	AP, KA, MH, MP, OR, TN, UP, WB.	Common
26.	*Crotalaria rigida* B. Heyne	Hb/Sh	AP, KA, TN	Rare
27.	*Crotalaria salicifolia* Heyne ex Wight & Arn.	Hb/Sh	KA, KL, TN	Occasional
28.	*Crotalaria speciosa* Roth	Sh	AP, KA, TN.	Occasional
29.	*Crotalaria willdenowiana* DC.	Hb	AP, TN	Rare
30.	*Dalbergia congesta* Grah. ex Wight & Arn.	Clsh	KL, TN	Rare
31.	*Dalbergia rubiginosa* Roxb.	Scsh	AP, GA, GJ, KA, KL, MH, MP, OR, PY, TN	Common
32.	Des*modiastrum racemosum* (Benth.) A. Pramanik & Thoth.	Hb	AP, GA, GJ, KA, KL, MH, OR, TN.	Rare
33.	*Desmodium benthamii* N.P. Balakr.	Ush	AP, CH, JH, MH, OR, TN, UP, WB	Occasional
34.	*Galactia longifolia* (Jacq.) Benth.	Clhb	AP, GA, GJ, KA, KL, MH, MP, OR, TN, WB	Common
35.	*Hardwickia binata* Roxb.	Tr	AP, KA, TN; BR, DL, GA, GJ, JH, KL, MH, MP, PB, PY, RJ, UP	Common
36.	*Indigofera karuppiana* Pallithanam	Sh	KA, KL, TN	Rare
37.	*Indigofera mysorensis* Rottl. ex DC.	Sh	AP, TN, KA, WB	Rare
38.	*Indigofera prostrata* Willd.	Phb	AP, BR, GA, GJ, HR, HP, KA, KL, MH, OR, PB, PY, TN, UP, WB	Common
39.	*Mimosa angustisiliqua* Gamble	Sh	AP, KA, OR; KL, MP	Occasional
40.	*Mimosa. prainiana* Gamble	Ssh/Tr	AP, KA, TN; BR, CH, GJ, MH	Occasional
41.	*Ophrestia pentaphylla* (Dalzell) Verdc.	Clhb	AP, KA, MH, ML, TN	Not Rare
42.	*Rhynchosia courtallensis* Maesan	Clsh	AP, KA, TN	Occasional
43.	*Rhynchosia filipes* Benth.	Trlush	KL, TN	Rare
44.	*Rhynchosia heynei* Wight & Arn.	Hb/Ush	AP, TN, KA	Rare
45.	*Senna montana* (Heyne ex Roth) V. Singh	Sh/Smtr	AP, KA , TN; GJ, KL, MH	Common
46.	*Sesbania procumbens* (Roxb.) Wight & Arn.	Hb	AP, CH, GJ, KA, MH, MP, OR, RJ, TN	Common
47.	*Sophora interrupta* Bedd.	Sh	AP, KA, MP, OR, TN	Rare
48.	*Tephrosia calophylla* Bedd.	Ush	AP, KA, TN	Rare
49.	*Tephrosia roxburghiana* J.R. Drumm.	Ush	AP, KA, OR	Rare
50.	*Vigna hainiana* Babu *et. al.*	Twhb	AS, BR, MP, PB, OR, TN, UP, WB	Occasional
51.	*Vigna vexillata* (L.) A.Rich. var. *wightii* (Benth. ex Bedd.) Babu & Sharma	Clhb	TN, KL, KA	Occasional
52.	*Vigna vexillata* (L.) A.Rich. var. *stocksii* Benth. ex Baker	Trhb	AP, BR, KA, KL, MH, MP, OR, TN	Occasional

Distributional Abbreviations

AP – Andhra Pradesh
AS – Assam
BR – Bihar
CH - Chhattisgarh
DD – Dadra Nagar Haveli, Daman & Diu
DL – Delhi
GA – Goa
GJ – Gujarat
HP – Himachal Pradesh
HR – Haryana
JH – Jarkhand
JK – Jammu & Kashmir
KA – Karnataka
KL – Kerala
MH – Maharashtra
ML – Meghalaya
MP – Madhya Pradesh
OR – Orissa
PB – Punjab
PY – Pondicherry
RJ – Rajasthan
TN – Tamil Nadu
UP – Uttar Pradesh

Habit Abbreviations

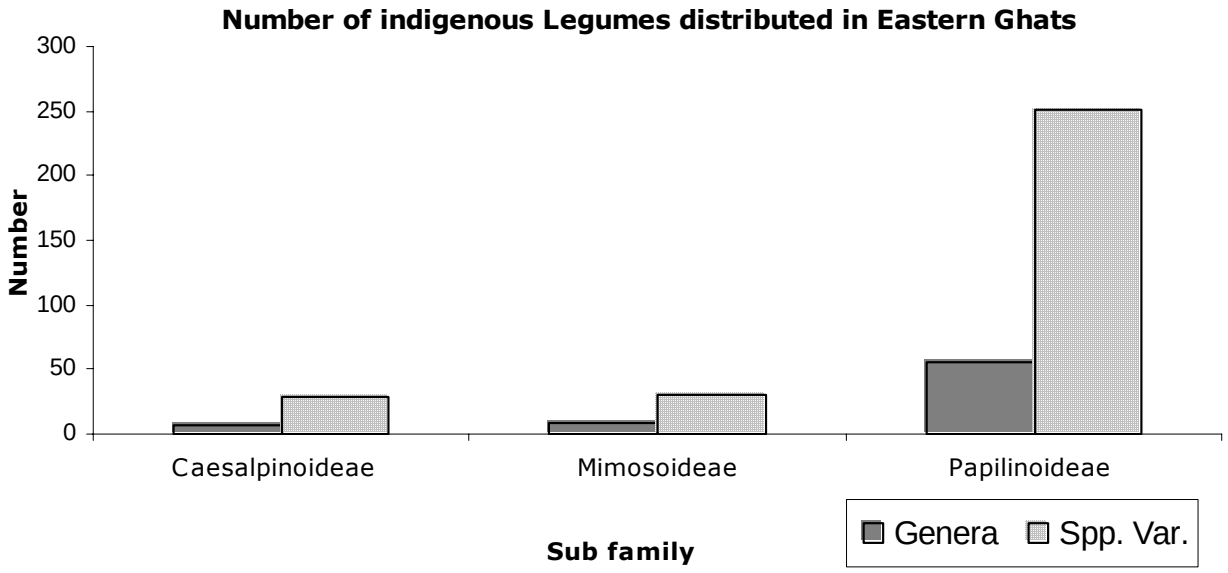
Cl – Climber
Clhb – Climbing herb
Clsh – Climbing shrub
Hb – Herb
Phb – Prostrate herb
Scsh – Scandent shrub
Sh – Shrub
Smtr – Small tree
Ssh – Subshrub
Tr – Tree
Trhb – Trailing herb
Trlush – Trailing undershrub
Twhb – Twining herb
Ush – Undershrub

Table 5. Cultivated/Naturalized Legumes of Eastern Ghats

S.No	Name of the taxa	Habit	Status	Native country / region
1.	*Acacia auriculiformis* A. Cunn. ex Benth.	Tree	Cultivated	Australia
2.	*Acacia dealbata* Link	Tree	Cultivated	Australia
3.	*Acacia decurrens* Willd.	Tree	Cultivated	Australia
4.	*Acacia farnesiana* (L.) Willd.	Tree	Naturalized	Tropical America
5.	*Acacia modesta* Wall.	Tree	Cultivated	South Asia
6.	*Aeschynomene americana* L.	Shrub	Cultivated	Tropical America
7.	*Aeschynomene aspera* L.	Undershrub	Cultivated	Tropical Africa
8.	*Aeschynomene indica* L.	Herb or Undershrub	Naturalized	Probably America
9.	*Arachis hypogaea* L.	Annual herb	Cultivated	South America (Brazil, Argentina & Bolivia)
10.	*Bauhinia variegata* L.	Tree	Cultivated	Probably China / South Asia
11.	*Caesalpinia coriaria* (Jacq.) Willd.	Tree	Naturalized	Tropical America
12.	*Caesalpinia pulcherrima* (L.) Sw.	Shrub or Small tree	Cultivated	Probably Tropical America
13.	*Cajanus cajan* (L.) Millsp.	Shrub	Cultivated	Probably Africa / South Asia
14.	*Calliandra inermis* (L.) Druce	Shrub	Cultivated	Mexico
15.	*Cassia grandis* L.f.	Tree	Cultivated	Tropical America
16.	*Crotalaria agatiflora* Schweinf.	Tree	Cultivated	Tropical Africa
17.	*Crotalaria micans* Link	Shrub	Naturalized	Tropical America
18.	*Delonix elata* (L.) Gamble	Tree	Cultivated	Ethiopia, Arabia
19.	*Delonix regia* (Bojer ex Hook.) Raf.	Tree	Cultivated	Madagascar
20.	*Desmanthus virgatus* (L.) Willd.	Undershrub	Cultivated	Tropical America
21.	*Erythrina crista-galli* L.	Tree	Cultivated	South America
22.	*Indigofera stachyodes* Lindl.	Shrub	Cultivated	Southeast & East Asia
23.	*Indigofera zollingeriana* Miq.	Tree	Naturalized	Southeast & East Asia

24.	*Lysiloma latisiliquum* (L.) Benth.	Tree	Naturalized	Tropical America
25.	*Macroptilium atropurpureum* (DC.) Urb.	Perennial creeping herb	Cultivated	South America
26.	*Macroptilium lathyroides* (L.) Urb.	Perennial herb	Naturalized	Tropical America
27.	*Macrotyloma uniflorum* (Lam.) Verdc.	Perennial climbing herb	Cultivated	India / Southeast Asia
28.	*Millettia peguensis* Ali	Tree	Cultivated	Southeast Asia
29.	*Mimosa polyancistra* Benth.	Shrub	Cultivated	Europe and West Indies
30.	*Mimosa pudica* L.	Spreading herb	Naturalized	Tropical America
31.	*Neptunia plena* (L.) Benth.	Undershrub	Naturalized	Tropical America
32.	*Parkia biglandulosa* Wight & Arn.	Tree	Cultivated	Tropical Asia
33.	*Parkia clappertoniana* Keay	Tree	Cultivated	Tropical Africa
34.	*Parkinsonia aculeata* L.	Tree	Cultivated	Tropical America
35.	*Peltophorum pterocarpum* (DC.) Baker ex K. Heyne	Tree	Cultivated	Australia and Tropical Asia
36.	*Pithocellobium dulce* (Roxb.) Benth.	Tree	Naturalized	Tropical America
37.	*Prosopis chilensis* (Molina) Stuntz	Tree	Naturalized	North America
38.	*Prosopis glandulosa* Torr.	Tree	Naturalized	North America
39.	*Samanea saman* (Jacq.) Merr.	Tree	Cultivated	Tropical America
40.	*Saraca asoca* (Roxb.) Willd.	Tree	Cultivated	South and Southeast Asia (Probably India)
41.	*Senna alata* (L.) Roxb.	Shrub or Small tree	Naturalized	South America
42.	*Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby	Shrub or Small tree	Cultivated	Tropical Africa
43.	*Senna floribunda* (Cav.) H.S. Irwin & Barneby	Tree	Naturalized	Tropical America
44.	*Senna hirsuta* (L.) H.S. Irwin & Barneby	Shrub	Naturalized	Tropical America
45.	*Senna obtusifolia* (L.) H.S. Irwin & Barneby	Shrub	Naturalized	Tropical America
46.	*Senna occidentalis* (L.) Link	Shrub	Naturalized	Probably South America
47.	*Senna siamea (*Lam.) H.S. Irwin & Barneby	Tree	Naturalized	Tropical Asia
48.	*Senna tora (*L.) Roxb.	Herb or Undershrub	Naturalized	South America ? (Uncertain)
49.	*Sesbania grandiflora (L.) Poir.*	Tree	Naturalized	Probably Indonesia / Tropical Asia
50.	*Sesbania sesban* (L.) Merr.	Tree	Cultivated	Tropical Africa and Asia
51.	*Tamarindus indica* L.	Tree	Cultivated	Tropical Africa / Madagascar / India (uncertain)
52.	*Vigna mungo* (L.) Hepper	Annual herb	Cultivated	Probably India
53.	*V. radiata* (L.) R.Wilczek	Perennial herb	Cultivated	Probably India
54.	*Vigna unguiculata* (L.) Walp. subsp. cylindrica (L.)Verdc	Perennial herb	Cultivated	Asia
55.	*Virgilia oroboides (*P.J. Bergius) T.M. Salter	Tree	Cultivated	South Africa

Fig. 1. Number of Indigenous Legumes distributed in Eastern Ghats



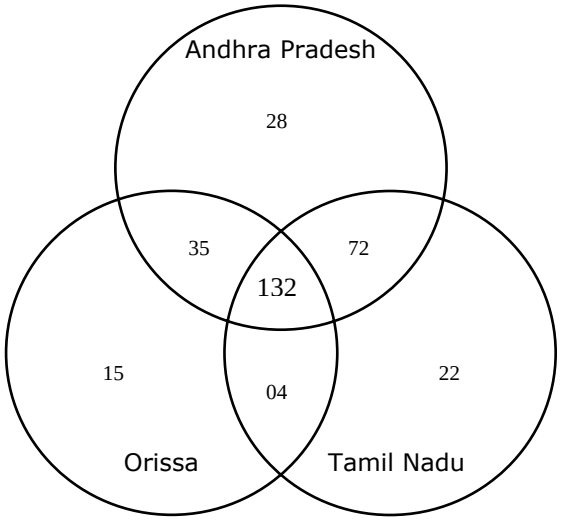


Figure 2. Distribution of Specific and infraspecific taxa of indigenous legumes in the three states

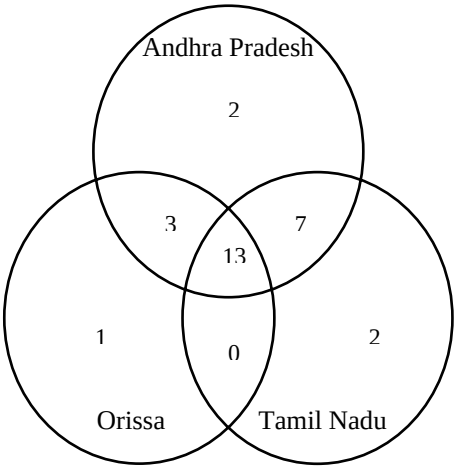


Figure 3. Distribution of Specific and infraspecific taxa of indigenous legumes in the three states

Invasion of exotic species: Threat to the biodiversity

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Abstract

Biodiversity loss caused by invasive species may soon surpass the damage done by habitat destruction. Invasive exotic species are now a major focus of global conservation concern. The decisions need to be made on whether benefits derived from the invasive spread of an exotic species outweigh the reduced value of ecosystem services, e.g. the loss of grazing land in areas invaded with Prosopis juliflora. It is necessary to consider actions to deal with the current problems caused by invasive species and to reduce the magnitude of the problem in the future. In view of this, the present study attempted to document the invasive exotic plant species in the flora of Eastern Ghats. At present, there are 61 species of invasive exotic plants invaded on natural ecosytems of Eastern Ghats. These include the most serious invasives, such as Alternanthera tenella, Cassia uniflora, Chromolaena odorata, Hyptis suaveolens, Lantana camara, Parthenium hysterophorus and Prosopis juliflora.

Introduction

An exotic plant, also referred to as alien, introduced, foreign, non-indigenous or non-native, is one that has been introduced by humans intentionally or otherwise through human agency or accidentally from one region to another. An exotic plant that has escaped from its original ecosystem and is reproducing on its own in the regional flora is considered a naturalized species. Those naturalized exotics that become so, successful as to spread in the flora and displace native biota or threatens valued environmental, agricultural or personal resources by the damage it causes are considered invasive.

"Loss of habitat constitutes the greatest threat to the existence of biodiversity,

The second worst threat is the biological invasion of exotic species (Convention for Biological diversity, 1992)"

The invasion of exotic species is recognized as a primary cause of global biodiversity loss. The problem of invasive species is great and probably become more severe since the growing human population will result in more disruption of ecosystems and hence systems that are more invasion prone. The opportunity of accidental introductions may become more with rapidly increasing global commerce. Humans have been transporting animals and plants from one part of the world to another for thousands of years, sometimes deliberately for social or personal gain and sometimes accidentally. In most cases, such introductions are unsuccessful, but when they do become established as an invasive exotic species (defined by IUCN (2000) as "an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity"), the consequences can be catastrophic. In addition to the biodiversity loss, also impose high costs to agriculture, forestry, and aquatic ecosystems. In fact, introduced species are a greater threat to native biodiversity than pollution, harvest, and disease combined.

The global extent and rapid increase in invasive species is homogenising the world's flora and fauna (Mooney & Hobbs, 2000). Bio-invasion may be considered as a form of biological pollution and significant component on global change and one of the major causes of species extinction (Mooney and Drake, 1987; Drake *et al*., 1989). Foresters, taxonomists and ecologists are now well aware of the problems caused by the invasion of exotic species into natural areas and the associated negative effects on global patterns of native biodiversity. Once established, some exotic species have the ability to displace or replace native plant and animal species, disrupt nutrient and fire cycles, and cause changes in the pattern of plant succession. Studies are underway to better understand the impacts of these species on native ecosystems. Many invasive plants continue to be admired by people who may not be aware of their weedy nature. Others are recognized as weeds but property owners fail to do their part in preventing their spread. Some species do not even become invasive until they are neglected for a long time. Invasive plants are not all equally invasive. Some only colonize small areas and do not do so aggressively. Others may spread and come to dominate large areas in just a few years. The loss due to invasive species in United States estimated to be ~$125-150 billion each year and 25% of US agriculture gross national product lost due to foreign pests and weeds (McNeely *et al*. 2001). Exotic plants can spread rapidly because of our mobile society and the intentional transportation of ornamental and forage plants (Randall and Marinelli, 1997).

Characteristic features of Invasive species*:*

Invasive species possess characteristic features like "pioneer species" in varied landscapes, tolerant of a wide range of soil and weather conditions, generalist in distribution, produces copious amounts of seed that

disperse easily, grows aggressive root systems, short generation time, high dispersal rates, long flowering and fruiting periods, broad native range, abundant in native range. Preliminary data from one interesting study shows that invasive species are likely to have relatively small amounts of DNA in their cell nuclei. Apparently, the cells in these plants are able to divide and multiply more quickly and consequently the entire plant can grow more rapidly than species with higher cellular DNA content. This gives them a leg up in disturbed sites.

***Global trade and Species introductions: intentions and accidents*:**

The trade-based global economy stimulates the cultivation of economically important species. However, it also stimulates the accidental spread of same species or others. International law regulating the unintentional introduction of harmful exotic species through trade is weak. There are two major conventions with provisions on exotics. One is the International Plant Protection Convention (IPPC), which presently addresses crop pests only. The IPPC could be expanded in scope to explicitly protect native (non-agricultural) plant life from introduced pests. The other major international agreement addressing exotic species, the Convention on Biological Diversity, lacks teeth (Jenkins, 1999). Article 8(h) addresses alien species by calling for the parties to: "as far as possible and as appropriate: …Prevent the introduction of, control or eradicate those exotic species which threaten ecosystems, habitats or species".

Monitoring

Monitoring is required in the invasive species management to *determine:* location/early detection of problematic species, whether a species is likely to become a problem in an area, whether a species is responding to management efforts (if taken?), the impact of exotic plant control methods on native species. Monitoring of Invasion can be done through *qualitative approach* like species inventory (seasonally) and *quantitative approach* using phytosociological methods and *mapping* using ground-based methods (via map overlays or GPS), remotely-sensed images (aerial photos, high resolution multi-spectral digital data).

Control

Current control methods for invasive exotics are expensive, lengthy, and risky because total eradication is required to prevent reestablishment. Effective site-eradication procedures require multi-year treatments, continued monitoring, and follow-up treatments. All infestations on adjacent lands must be treated to prevent reinvasion. Unfortunately, infestations common along railway tracks, roads, and utility right-of-ways are rarely treated for eradication, fostering widespread immigration to adjacent lands. Common methods for control of invasive weed species are: Mechanical, Chemical and Biological control.

Mechanical Control

It is one of the common method employed for control of invasive species. Mechanical control involves ploughs, scythes, mowers, hoes, cultivators, rotary weeders etc. Using these tools, the weeds are physically lifted from the soil, cut off or buried. But it is laborious and needs lot of man power. *Chemical Control*: This method has proved costly and partly successful in several cases. Using of chemicals is not desirable due to pollution that they cause. *Biological Control*: In most cases of exotic pest invasions, biological control has proven the most effective and environmentally sound approach to their management. Introducing a natural enemy (e.g. water hyacinth weevil *Neochetina spp.* for *Eicchornia; Lantanophaga pussilidactyla* insect for *Lantana camara, Zygogramma bicolorata* insect for *Parthenium hysterophorus*) for eradication of invasive species is a current focus of interest for biological conservationists. But biological control may not be evenly effective over all areas infested by the invasive species. Control projects for invasive species, offer a logical, long-term solution but none have been seriously attempted in India. The high investments and long-term research required for control programs have been made only for western rangeland exotic plant species, and more recently for tropical exotics in Florida.

Research Issues, Legal and Institutional Needs:

There is no question that understanding and dealing with the invasive problem is an enormous challenge. Research initiatives are now needed to improve the understanding of the ecology of the invasive process, the knowledge on predictive powers on which species are likely to become invasive and under what conditions, characteristics of invasive species, impacts of global climate change on invasive species. It is realized that a legal and institutional approach to the country's biosecurity threat is a prerequisite to long-term success against introduction of invasive species. The government should strengthen its quarantine authority through new legislations which prohibits the introduction of alien species without an approved consent or permit. Also unauthorized introduction of wild and domesticated animals and plants into new areas, between states and within the country should be reviewed and monitored by several government departments, *viz*. Forest, Agriculture, Environment, Veterinary and Public Health.

We need to develop techniques to make rapid assessment of the status and movement of invaders and of their potential ecosystem impacts. At present our knowledge about the status of invaders is generally of two states only – it is present (which is derived from flora lists) or it is firmly established and doing overwhelming damage (often learned from the popular newspapers). Information is needed between these two extremes. In order to acquire this information a rapid sapling approach is needed that would produce a

quantitative assessment of the status of invading species, that could be repeated at intervals, to provide a clear focus on emerging problems, helping to alleviate the crisis management approach to invaders. Efforts are needed to utilize developing technologies for tracking invasives including remote sensing and GIS. Further, we need to develop global maps of the distributions of the most abundant and most devastating invasive species, as well as the most sensitive ecosystem types (Mooney, 1999).

It is very difficult to choose exotic species, from all over the Eastern Ghats, that really are "invasive" or "worse" than any others. Species and their interactions with ecosystems are very complex. Of these, some species may have invaded only a restricted region, but have a huge probability of expanding, and causing great damage. Some species are ready colonizers in disturbed areas and may have less impact on natural populations. Other species may already be globally widespread and causing cumulative but less visible damage.

Invasive exotic species in Eastern Ghats:

According to World Conservation Monitoring Centre (WCMC), 1,604,000 species have been described at the global level. Thus, India accounts for 8 % of the global biodiversity existing in only 2.4% land area of the world. Hajra & Mudgal (1997) report 5400 endemics in 17,000 angiospermous species of India, which comes to 31.76 %. The flora of India shows close affinity with the flora of Indo-Malayan and Indo-Chinese region. According to Nayar (1977) 35% of Indian flora has south-east Asian and Malayan, 8% temperate, 1% steppe, 2% African, and 5% Mediterranean-Iranian elements. The cultivated and naturalized aliens constitute only 18%. The Eastern Ghats stretch along the eastern fringes of Orissa, Andhra Pradesh, Tamil Nadu and Karnataka in Peninsular India. The geographical area of Eastern Ghats is about 2,24,290 sq.kms with natural vegetation cover of 98,780 sq.kms (44%). After an extensive review of literature on global invasive species and of India and their spread based on history and field observations, a list of 61 species was prepared for Eastern Ghats (table 1). This checklist will help in the district-wise or region-wise survey, controlling and monitoring of these invading species. Majority of these invasive exotics are belongs to five families, viz. *Asteraceae*, *Poaceae*, *Caesalpiniaceae*, *Amaranthaceae* and *Convolvulaceae*. These families contribute 52% of the species. Most of the invasive species are native of Tropical America (neotropics). Of these *Alternanthera tenella*, *Cassia uniflora* and *Nicotiana plumbaginifolia* were recorded recently and now prevalent in Eastern Ghats of Andhra Pradesh (Reddy & Raju, 1997; Reddy *et al*. 1999; Reddy *et al*. 2000). In addition to negative impact on indigenous flora and economy, some exotic plants were very much useful to local people. A prominent example is *Prosopis juliflora*. Among the reasons for the admiration expressed are adaptability, rapid growth and multiple uses. *Prosopis juliflora* used for coal extraction, firewood, erosion control, fencing. Several exotic weedy plants like *Argemone mexicana*, *Cassia tora*, *Cleome viscosa*, *Croton bonplandianum*, *Ipomoea carnea*, *Malachra capitata*, *Mimosa pudica* were used in native medicine. *Alternanthera philoxeroides* is used as leafy vegetable (Reddy & Raju, 2005).

Conclusion

Foresters, environmentalists, field researchers and conservation managers are need to pay urgent attention on the ecological impact of invasive exotics both at the species and at the ecosystem levels. The decisions need to be made on whether benefits derived from the invasive spread of an exotic species outweigh the reduced value of ecosystem services, e.g. the loss of grazing land in areas invaded with *Prosopis juliflora*. A better planning is needed for early detection and reporting of infestations of spread of new and naturalized weeds by creation of *Plant Detection Network* in each State by establishing communication links between taxonomists, ecologists and forest managers to monitor and control.

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Table 1. List of Invasive Exotic species in Eastern Ghats.

S.No.	Species	Family	Nativity
1	*Acanthospermum hispidum*	Asteraceae	Brazil
2	*Ageratina adenophora*	Asteraceae	Tropical America
3	*Ageratum conyzoides*	Asteraceae	Tropical America
4	*Alternanthera philoxeroides*	Amaranthaceae	Tropical America
5	*Alternanthera pungens*	Amaranthaceae	Tropical America
6	*Alternanthera tenella*	Amaranthaceae	Tropical America
7	*Argemone mexicana*	Papaveraceae	Tropical America
8	*Blainvillea acmella*	Asteraceae	Tropical America
9	*Blumea eriantha*	Asteraceae	Tropical America
10	*Blumea lacera*	Asteraceae	Tropical America
11	*Blumea obliqua*	Asteraceae	Tropical America
12	*Cassia absus*	Caesalpiniaceae	Tropical America
13	*Cassia hirsuta*	Caesalpiniaceae	Tropical America
14	*Cassia obtusifolia*	Caesalpiniaceae	Tropical America
15	*Cassia tora*	Caesalpiniaceae	Tropical America
16	*Cassia uniflora*	Caesalpiniaceae	Tropical America
17	*Celosia argentea*	Amaranthaceae	Tropical Africa
18	*Chloris barbata*	Poaceae	Tropical America
19	*Chromolaena odorata*	Asteraceae	Tropical America
20	*Cleome viscosa*	Cleomaceae	Tropical America
21	*Crotalaria pallida*	Papilionaceae	Tropical America
22	*Croton bonplandianum*	Euphorbiaceae	Temperate America
23	*Cuscuta chinensis*	Cuscutaceae	Mediterranean
24	*Cuscuta reflexa*	Cuscutaceae	Mediterranean
25	*Dinebra retroflexa*	Poaceae	Tropical America
26	*Echinops echinatus*	Asteraceae	Afghanistan
27	*Eichhornia crassipes*	Pontederiaceae	Tropical America
28	*Evolvulus nummularius*	Convolvulaceae	Tropical America
29	*Galinsoga parviflora*	Asteraceae	Tropical America
30	*Gnaphalium polycaulon*	Asteraceae	Tropical America
31	*Hyptis suaveolens*	Lamiaceae	Tropical America
32	*Impatiens balsamina*	Balsaminaceae	Tropical America
33	*Ipomoea carnea*	Convolvulaceae	Tropical America
34	*Ipomoea staphylina*	Convolvulaceae	Tropical Africa
35	*Lagascea mollis*	Asteraceae	Tropical America
36	*Lantana camara*	Verbenaceae	Tropical America

37	*Malachra capitata*	Malvaceae	Tropical America
38	*Martynia annua*	Pedaliaceae	Tropical America
39	*Mimosa pudica*	Mimosacceae	Brazil
40	*Nicotiana plumbaginifolia*	Solanaceae	Tropical America
41	*Ocimum canum*	Lamiaceae	Tropical America
42	*Parthenium hysterophorus*	Asteraceae	Tropical America
43	*Pennisetum purpureum*	Poaceae	Tropical America
44	*Peristrophe paniculata*	Acanthaceae	Tropical America
45	*Pistia stratiotes*	Araceae	Tropical America
46	*Prosopis juliflora*	Mimosacceae	Mexico
47	*Rhynchelytrum repens*	Poaceae	Tropical America
48	*Saccharum spontaneum*	Poaceae	Tropical West Asia
49	*Salvinia molesta*	Salviniaceae	Brazil
50	*Scoparia dulcis*	Scrophulariaceae	Tropical America
51	*Sesbania bispinosa*	Papilionaceae	Tropical America
52	*Sida acuta*	Malvaceae	Tropical America
53	*Sonchus asper*	Asteraceae	Mediterranean
54	*Sonchus oleraceus*	Asteraceae	Mediterranean
55	*Stachytarpheta jamaicensis*	Verbenaceae	Tropical America
56	*Tribulus lanuginosus*	Zygophyllaceae	Tropical America
57	*Tribulus terrestris*	Zygophyllaceae	Tropical America
58	*Triumfetta rhomboidea*	Tiliaceae	Tropical America
59	*Typha angustata*	Typhaceae	Tropical America
60	*Waltheria indica*	Sterculiaceae	Tropical America
61	*Xanthium strumarium*	Asteraceae	Tropical America

Leaf functional trait measurements in Eastern Ghats

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Abstract

This study documents leaf trait measurement on 290 individuals distributed among 136 species of the southern Eastern Ghats, in an area covering an altitudinal range from the sea level to 1362 m above msl. The traits measured include weight, thickness and area. Parameters that help evaluate interesting ecophysiological attributes viz., leaf size classes, leaf area development, maximum hydration value, sclerophylly and succulence, were estimated using the measured traits. These data are collected with a long-term objective of exploring the strong linkages between climate and ecosystem dynamics. Our study, for the first time, systematically documents together the life form, phenology and leaf size, quantitatively. The data presented here have interesting applications from the point of view of conservation–management of forests.

Key words: *Leaf trait measurements, Sclerophylly, Succulence, Southern Eastern Ghats.*

Introduction

Plant functional types are defined as the set of similar characteristics of plants with reference to their habitat or climatic conditions. Plant communities can be classified into associations, and these into larger groups called formations. The formations are grouped according to the character of their dominant life forms (Burtt Davy, 1938). Plants were grouped based on form, by the ancient Greeks. Theophrastus, Father of Botany, classified plants based on the structure into trees, shrubs, herbs and climbers. More recently, Raunkiaer gave a new look for this classification. He classified plants based on the form and function and he termed it as 'life form' classification (Raunkiaer, 1934). In his classification, he has chosen leaf size as one of the important criteria to classify plants into six different classes. Leaves play an important role in the life of plants and functioning of ecosystems. They are directly in contact with the external environments. The external environmental factors in turn regulate the functions of the leaf. Leaf traits are considered very important because leaves are the organs chiefly concerned with the physiological functions such as photosynthesis and transpiration. In other words, much of the functional attributes of plants happen in the leaf lamina. The wide variety of leaf structure and size along climatic gradients gives a fundamental base to understand the functional attributes of plants.

Other plant traits of interest are those of seeds, fruits and roots. Though measurable like leaves (Cornelissen *et al.,* 2003) there are some caveats, especially in tropical conditions: seeds and fruits may not always be retrieved in sufficient quantities while root traits are not always easy to quantify. Hence, in the first steps of the attempt to establish systematic plant trait measurements in south India, we have chosen to measure leaves because they are most often retrieved in quantities facilitating a sample size sufficient for statistical analyses. This can help unravel some fundamental functional attributes and relationships at the level of the species or individual and also at the level of the community or ecosystem. Wright *et al.* (2004) have compiled leaf trait measurements from 175 sites across the world in their delineation of a global leaf economics spectrum using the Global Plant Trait Network (Globnet) dataset that they have established and made available online. Even though this synthesis spans a wide geographic area there is still a big gap with reference to the Indian subcontinent, though two biodiversity hotspots are located here. For India, this compilation includes only two closely located dry tropical forest sites in the North by Lal *et al.* (2001a & 2001b). Hence the relevance of leaf trait measurements in Eastern Ghats - a new initiative, that allows us to present data hitherto unavailable. As demonstrated clearly by Wright *et al.* (2004, 2005) and Barboni *et al.* (2004), actual trait measurements and analyses do add a distinct dimension to the field of functional ecology, especially from the point of view of conservation and management of forests and/or natural and human modified ecosystems (Lavorel *et al.*, 1999; Landsberg *et al.*, 1999).

Study Site

This study focuses on the area consisting of the Javadi, Kalrayan, Chitteri, Shevaroy, Kolli and Pachamalai hills (Tamil Nadu) section of Eastern Ghats. (Fig. 1). The Eastern Ghats fall under tropical monsoon climate receiving rainfall from both south-west monsoon and north-east retreating monsoon. The study area receives a mean annual rainfall within a small range from 805 to 1055.5 mm, although the altitudinal range is wide: 16 to 1362 m above MSL. The location of some low elevation sampling sites close to the coastal zone accounts for this apparent discrepancy. The vegetation in this area can be divided into Evergreen forests, Tropical semi-evergreen forests, Tropical moist deciduous forests, Dry deciduous forests, Tropical dry evergreen forests and Dry evergreen scrubs (Champion & Seth, 1968; Legris & Meher-Homji, 1982).

Methodology

In this study, the emphasis has been on measuring leaf traits of the dominant constituent of the forest canopy - the tree species. Standard protocols proposed by Cornelissen *et al*. (2003); Garnier *et al*. (2001); and Roderick *et al.* (1999) have been adapted with minor changes. Plants were identified systematically using various local floras available (Gamble & Fischer, 1915-1935; Matthew, 1983; Nair & Henry, 1983 and Henry *et al.*, 1987) and the Herbarium Institut français de Pondichéry (HIFP), where several specimens collected in this study were deposited for future reference.

Briefly, distinct sets of leaves were collected from each individual for two sets of measurements: immediately on the field and after the complete rehydration of the leaf in the lab. Measurements made consisted of leaf mass, thickness and area. Thus, totally 2 sets of trait measurements were carried out on (i) fresh leaves and (ii) rehydrated leaves. In each case, measurements were again made after completely drying the respective leaves. Hence finally we have four distinct sets of measurements (Field Fresh Leaves (FFL), Field Dry Leaves (FDL), Rehydrated Fresh Leaves (RHFL), Rehydrated Dry Leaves (RHDL)). Based on this, various parameters, such as specific leaf area, were calculated. Some of the other important parameters (after Camerik & Werger, 1981) using measured values of the rehydrated leaf fresh (a) and dry weights (b) in grams and the fresh area (c) in cm^2 estimated are:

(a) Maximum hydration level (MHL): maximal water content of the leaf ((a-b)/a) (Werger, *Pers. Com.*);
(b) Degree of leaf-area development (DLA): bifacial leaf area per unit fresh weight of the leaf (2c/a) reported in dm^2/g;
(c) Degree of sclerophylly (DSC): leaf's dry weight per unit (bifacial) leaf area (b/2c) reported in g/dm^2;
(d) Degree of succulence (DSU): maximal water content of the leaf per unit (bifacial) leaf area ((a-b)/2c) reported in g/dm^2.

To correlate these parameters spatially, with the site climatic parameters, Arc info software was used to interpolate climatic variables for each specific longitude-latitude grid point (sample point). The main climatic parameter used here was the Precipitation. As most of our sites are located in the high variability north-east monsoon zone, the total mean annual rainfall, and the mean values of south-west and north-east monsoon precipitations were considered separately. However, within the limits of the present study area, as the actual range of precipitation variation is very small, (800 to 1100 mm, total mean annual rainfall), trends rather than actual correlations are sought.

Results and Discussion

Globally, leaves have been classified into seven size classes (Raunkiaer, 1934; Webb, 1959). Of the seven four were found in our study area (Table 1). The studied species from Eastern Ghats have been classified into different leaf classes and life forms as well as leaf habits based on the field observations and trait measurements (Figs. 2-4; Table 2). Of the 290 individuals that were studied, 240 were trees, 42 shrubs and 8 climbing shrubs (Fig. 2). Among these life forms, nearly 45% of the leaves measured were mesophyllous, while ~ 20% were microphyllous and 30% notophyllous (Fig. 4). The higher proportion of mesophylls is expected within our tropical study area and the moderate proportions of microphylls and notophylls correspond to the fact that we have sampled some of the higher elevation sites comprising some subtropical elements (Webb, 1959, Table 2). It is long known that environmental conditions can lead to heterophylly *i.e.*, two or more distinct leaf forms in the same species (Vaughan & Wiehe, 1939). In this study, such behaviour was recorded for species such as *Memecylon umbellatum* and *Atalantia monophylla*. Among the individuals studied, 187 were observed to be evergreen and 101 deciduous (Fig. 3). The remaining 2 were marked unclassified, as their leaf longevity was not recorded. Among the evergreen species in this study are those from lowland tropical dry evergreen formations and also those from high elevation shola forests (Table 2). This is an important base line data as frequently field-based information on the leaf phenology is not readily available; particularly so because the study area considered here comprises forests often referred to as semi-evergreen or moist deciduous or even semi-deciduous formations, increasing the ambiguity further. Though not explored here, the proportion of evergreen, leaf-exchanging and deciduous trees in tropical forest is obviously related to climate, particularly to the length and severity of the dry seasons. Leaf-fall and longevity depend on various parameters, both internal and external. Leaf-fall can be connected with climatic factors as well as edaphic factors but some trees are independent of both these factors and can follow sporadic rhythm of timing for leaf shedding (Schimper, 1903). Since leaves play the vital function of providing plants with carbon, there is a strong selection on species to produce leaves that maximize carbon gain over the lifetime of the leaf (Santiago, 2007). These, along with the various parameters to be considered when classifying any vegetation type, are explored at length by Richards *et al.* (1940) and Richards (1996).

Degree of Leaf Area Development (DLA): Values for leaf area development range between 0.19 and 1.72 dm^2/g, with nearly 35% of the studied individuals showing values of less than 0.7 dm^2/g. Values below this level are often regarded as characteristic of xeromorphous leaves (Schratz, 1932; Pisek, 1956; Lebrun, 1962). However, the actual assignment as xerophytes is established taking into account the second parameter discussed below, the degree of Sclerophylly.

Degree of Sclerophylly (DSC): Sclerophylly estimated here ranged between 0.18 and 1.2 g/dm^2 with more than 80 % of studied individuals recording less than 0.7 g/dm^2. Müller-Stoll (1947) considered species with values of 0.7 g/dm^2 and higher as true xerophytes; according to this criterion, only 18% of the studied individuals belongs to that category. As expected, sclerophylly and area are negatively correlated (Table 3). Globally, the predominant leaf form is the sclerophyll though the functional significance of sclerophylly remains controversial (Turner, 1994).

Degree of Succulence (DSU): Degree of succulence ranged between 0.02 and 1.55 g/dm^2 (Fig. 5). The one exception (*Euphorbia nivulia)* recorded 4.8 g/d^2. For real succulents the value ranges from 5.0 to 12.0 g/dm^2, and semi-succulents between 2.8 and 4.0 g/dm^2 (Delf, 1912). According to Lebrun (1962) mesophytes show succulence values of less than 1.4 g/dm^2. Thus, in this study most of the studied plants are mespohytes and only one species belonging to succulent category was recorded, *i.e*., *Euphorbia nivulia*.

Correlations with climatic parameters

The above scatter diagram (Fig. 5) shows the degree of succulence against the mean annual precipitation of the study area. It shows a trend decreasing degree of succulence with increasing precipitation, though, as mentioned previously, the variation in precipitation is minimal in the study area. A consistent trend (of increasing sclerophylly with decreasing precipitation) is however not discernible in this data (Fig. 6) because most (~ 80%) of the leaves are non xerophytic (DSC < 0.7 g/dm^2) and the remaining do not cover a wide enough precipitation range. Further, it is of interest to note in this context that elsewhere, succulence is described as an adaptation to the tropical mountain climate with its rapid and strong changes in solar radiation fluxes and air humidity between clear and clouded skies (Camerik & Werger, 1981). Thus, we are able to observe its change here even within a limited precipitation gradient, as our sampling comprises an altitudinal gradient from 16 to 1362m above MSL. One of the outliers (Fig. 6) is interesting in itself: the only species showing a clearly succulent nature (DSU > 4g/dm^2), *Euphorbia nivulia* is recorded at a site with a high annual precipitation (1056 mm) but very long hot and dry seasons!

This study documents leaf trait measurements on 290 individuals distributed among 136 species of the southern Eastern Ghats. The traits measured include weight, thickness and area. Parameters that helped evaluate interesting ecophysiological attributes such as sclerophylly were estimated using the measured traits. There are strong linkages between climate and ecosystem dynamics, plant traits, palaeoecology and these linkages can be deduced from the present (data) to past (data) in order to predict or validate the future models (Anupama *et al.,* 2007). The results presented here show that it is possible to classify vegetation based on the various parameters that have been used in this study. Similar studies were undertaken in other regions. For example, Australian rain forests were classified into several sub-types based on the various parameters *i.e*., Evergreen microphyll forest, Wet sclerophyll forest, etc. (Webb, 1968). Hodgson *et al.* (2005) studied European grasslands in order to classify them based on a functional method to use in ecological and economic studies. Even though they come across number of problems in their approach, their estimates may provide a crucial mathematical bridge between ecology and economics to conserve European biodiversity. Any change in the life form composition away from its phytoclimatic zone is considered as an indicator of alteration in vegetation either due to biotic or edaphic factors or both (Jamir *et al.,* 2006). It is proven that vegetation types can be described in terms of climatic parameters. Blasi *et al.* (1999) studied the vegetation along Mediterranean-Temperate boundary in central Italy and identified six phytoclimatic groups in terms of climatic parameters, vegetation types and morphological and chronological traits. Deriving plant functional types is a convenient way of simplifying the diversity of plant physiological function in discrete, manageable groups that can be modeled more easily (Gitay *et al*., 1999). But these physiological traits vary among growth forms (Santiago & Wright, 2007).

Our study, for the first time, systematically documents together the life form, phenology and leaf size, quantitatively. Exploratory data analysis reveals interesting parameters (such as succulence) that are related to climatic variables such as precipitation. It also suggests the future course of analyses with reference to other climatic parameters such as the length of the dry season and evapotranspiration. There are indications that the plant adaptations are not only with reference to the amount of precipitation received but also with reference to the intensity and duration of the precipitation. Estimated parameters such as sclerophylly can be of use also from the management-conservation point of view.

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Table 1: Classification of leaf classes based on leaf size

Leaf Class	*Area in mm²*
Microphyll	225 - 2,025
Notophyll	2,025 - 4,500
Mesophyll	4,500 - 18,225
Macrophyll	18,225 - 164,025

Table 2: The studied species from Eastern Ghats: life form, leaf phenology & leaf classes

S. No.	Species Name	Family	Life form	Phenology	Leaf class
1	*Alangium salvifolium*	Alangiaceae	T	D	3
2	*Alseodaphne semecarpifolia*	Lauraceae	T	E	2
3	*Anogeissus latifolia*	Combretaceae	T	D	3
4	*Antidesma menasu*	Euphorbiaceae	T	E	3
5	*Ardisia solanacea*	Myrsinaceae	S	E	3
6	*Atalantia monophylla*	Rutaceae	T	E	1
7	*Bauhinia racemosa*	Caesalpiniaceae	T	D	2
8	*Beilschmiedia wightii*	Lauraceae	T	E	3
9	*Bischofia javanica*	Euphorbiaceae	T	E	3
10	*Bridelia crenulata*	Euphorbiaceae	T	D	3
11	*Buchanania axillaris*	Anacardiaceae	T	D	1
12	*Buchanania lanzan*	Anacardiaceae	T	E	3
13	*Callicarpa tomentosa*	Verbenaceae	T	D	3
14	*Canthium dicoccum*	Rubiaceae	T	E	2
15	*Careya arborea*	Lecythidaceae	T	D	4
16	*Casearia elliptica*	Flacourtiaceae	S	D	2

17	*Cassine glauca*	Celastraceae	T	E	3
18	*Catunaregam torulosa*	Rubiaceae	T	D	2
19	*Celtis philippensis*	Ulmaceae	T	E	2
20	*Chionanthus mala-elengi*	Oleaceae	T	E	2
21	*Chionanthus ramiflora*	Oleaceae	T	E	
22	*Chionanthus zeylanica*	Oleaceae	T	E	1
23	*Cipadessa baccifera*	Meliaceae	S	D	2
24	*Cordia macleodii*	Boraginaceae	T	D	3
25	*Croton sp.*	Euphorbiaceae	T	D	4
26	*Cryptocarya sp.*	Lauraceae	T	E	3
27	*Daphniphyllum neilgherrense*	Daphniphyllaceae	T	E	3
28	*Diospyros ebenum*	Ebenaceae	T	E	2
29	*Diospyros melanoxylon*	Ebenaceae	T	D	3
30	*Diospyros montana*	Ebenaceae	T	D	1
31	*Diospyros nilgirica*	Ebenaceae	S	E	1
32	*Diospyros ovalifolia*	Ebenaceae	T	E	2
33	*Diospyros sp.*	Ebenaceae	T	E	3
34	*Dodonaea viscosa*	Sapindaceae	S	D	1
35	*Drypetes roxburghii*	Euphorbiaceae	T	E	1
36	*Drypetes sepiaria*	Euphorbiaceae	T	E	1
37	*Ehretia laevis*	Boraginaceae	T	D	2
38	*Ehretia ovalifolia*	Boraginaceae	T	D	2
39	*Elaeocarpus serratus*	Elaeocarpaceae	T	E	3
40	*Embelia sp.*	Myrsinaceae	CS	E	3
41	*Erythroxylum monogynum*	Erythroxylaceae	T	D	1
42	*Euodia lunu-ankenda*	Rutaceae	T	E	3
43	*Euphorbia nivulia*	Euphorbiaceae	T	D	2
44	*Ficus amplissima*	Moraceae	T	D	2
45	*Ficus arnottiana*	Moraceae	T	D	3
46	*Ficus beddomei*	Moraceae	T	E	3
47	*Ficus drupacea*	Moraceae	T	E	3
48	*Ficus microcarpa*	Moraceae	T	E	2
49	*Ficus mollis*	Moraceae	T	E	2
50	*Ficus racemosa*	Moraceae	T	D	2
51	*Ficus sp.*	Moraceae	T	D	2
52	*Ficus tsjahela*	Moraceae	T	D	3
53	*Ficus virens*	Moraceae	T	E	3
54	*Garcinia spicata*	Clusiaceae	T	E	3
55	*Gardenia gummifera*	Rubiaceae	T	D	1
56	*Gardenia latifolia*	Rubiaceae	T	D	3
57	*Gardenia resinifera*	Rubiaceae	T	D	3
58	*Glochidion malabaricum*	Euphorbiaceae	T	E	3
59	*Gmelina arborea*	Verbenaceae	T	D	3
60	*Grewia orbiculata*	Tiliaceae	T	D	2
61	*Hardwickia binata*	Caesalpiniaceae	T	D	1
62	*Helicteres isora*	Sterculiaceae	S	D	3
63	*Hiptage benghalensis*	Malpighiaceae	CS	E	3
64	*Holoptelea integrifolia*	Ulmaceae	T	D	1
65	*Hugonia mystax*	Linaceae	CS	E	1
66	*Hymenodictyon orixense*	Rubiaceae	T	D	3
67	*Ixora pavetta*	Rubiaceae	T	E	2
68	*Lepisanthes senegalensis*	Sapindaceae	T	E	2
69	*Ligustrum perrottetii*	Oleaceae	S	E	1
70	*Litsea deccanensis*	Lauraceae	T	E	3
71	*Litsea oleoides*	Lauraceae	T	E	3
72	*Macaranga peltata*	Euphorbiaceae	T	E	4
73	*Madhuca longifolia*	Sapotaceae	T	D	3
74	*Maesa indica*	Myrsinaceae	T	E	3

75	*Mallotus philippensis*	Euphorbiaceae	T	E	2
76	*Mallotus sp.*	Euphorbiaceae	T	E	3
77	*Mallotus stenanthus*	Euphorbiaceae	T	E	2
78	*Mangifera indica*	Anacardiaceae	T	E	3
79	*Manilkara hexandra*	Sapotaceae	T	E	2
80	*Maytenus emarginata*	Celastraceae	S	D	1
81	*Meliosma simplicifolia*	Sabiaceae	T	E	4
82	*Memecylon talbotianum*	Melastomataceae	T	E	2
83	*Memecylon umbellatum*	Melastomataceae	S	E	1
84	*Miliusa sp.*	Annonaceae	T	E	2
85	*Mimusops elengi*	Sapotaceae	T	E	2
86	*Morinda pubescens*	Rubiaceae	T	D	3
87	*Myristica dactyloides*	Myristicaceae	T	E	3
88	*Neolitsea cassia*	Lauraceae	T	E	3
89	*Nothopegia beddomei*	Anacardiaceae	T	E	2
90	*Nothopegia heyneana*	Anacardiaceae	T	E	1
91	*Ochna obtusata*	Ochnaceae	T	D	3
92	*Olea dioica*	Oleaceae	T	E	2
93	*Olea paniculata*	Oleaceae	T	E	3
94	*Pavetta indica*	Rubiaceae	T	E	2
95	*Pavetta tomentosa*	Rubiaceae	T	D	3
96	*Persea macrantha*	Lauraceae	T	E	3
97	*Phoebe wightii*	Lauraceae	T	E	3
98	*Polyalthia cerasoides*	Annonaceae	T	D	3
99	*Pongamia pinnata*	Fabaceae	T	D	2
100	*Premna latifolia*	Verbenaceae	T	D	4
101	*Premna tomentosa*	Verbenaceae	T	D	3
102	*Prunus ceylanica*	Rosaceae	T	E	3
103	*Psychotria sp.*	Rubiaceae	S	E	2
104	*Psychotria sp.*	Rubiaceae	S	E	3
105	*Pterospermum canescens*	Sterculiaceae	T	E	3
106	*Pterospermum reticulatum*	Sterculiaceae	T	E	2
107	*Rapanea wightiana*	Myrsinaceae	T	E	1
108	*Santalum album*	Santalaceae	T	E	1
109	*Sapindus emarginatus*	Sapindaceae	T	D	2
110	*Sarcococca indica*	Buxaceae	S	E	3
111	*Schefflera stellata*	Araliaceae	CS	E	3
112	*Schleichera oleosa*	Sapindaceae	T	D	3
113	*Scolopia crenata*	Flacourtiaceae	T	E	2
114	*Securinega leucopyrus*	Euphorbiaceae	S	D	1
115	*Semecarpus anacardium*	Anacardiaceae	T	D	4
116	*Shorea sp.*	Dipterocarpaceae	T	E	3
117	*Streblus asper*	Moraceae	T	E	1
118	*Strychnos minor*	Loganiaceae	CS	E	1
119	*Strychnos nux-vomica*	Loganiaceae	T	D	3
120	*Strychnos potatorum*	Loganiaceae	T	D	2
121	*Suregada angustifolia*	Euphorbiaceae	T	E	1
122	*Symplocos cochinchinensis*	Symplocaceae	T	E	2
123	*Syzygium alternifolium*	Myrtaceae	T	D	3
124	*Syzygium cumini*	Myrtaceae	T	E	2
125	*Tarenna asiatica*	Rubiaceae	S	E	3
126	*Terminalia alata*	Combretaceae	T	D	3
127	*Terminalia arjuna*	Combretaceae	T	D	3
128	*Terminalia chebula*	Combretaceae	T	D	3
129	*Unidentified Climber*		C		1
130	*Uvaria narum*	Annonaceae	CS	E	3
131	*Vaccinium neilgherrense*	Vacciniaceae	S	E	1
132	*Vernonia arborea*	Asteraceae	T	D	4

133	*Viburnum punctatum*	Caprifoliaceae	T	E	3
134	*Walsura trifoliata*	Meliaceae	T	E	2
135	*Wendlandia thyrsoidea*	Rubiaceae	T	D	2
136	*Wrightia tinctoria*	Apocynaceae	T	D	3

Life forms: T = tree; S = shrub; CS = climbing shrub; C = climber.
Leaf phenology: D = Deciduous; E = Evergreen.
Leaf class: 1 = microphyll; 2 = notophyll; 3 = mesophyll; 4 = macrophyll.

Table 3: Correlation matrix of five leaf variables

	Leaf Class	***MHL***	***DLA***	***DSC***	***DSU***
Leaf Class	1				
MHL	0.546186	1			
DLA	0.026882	-0.20732	1		
DSC	-0.17641	0.014926	-0.69128	1	
DSU	0.063882	0.335348	-0.60745	0.25881	1

Fig. 1. Map of study area showing the sampling sites

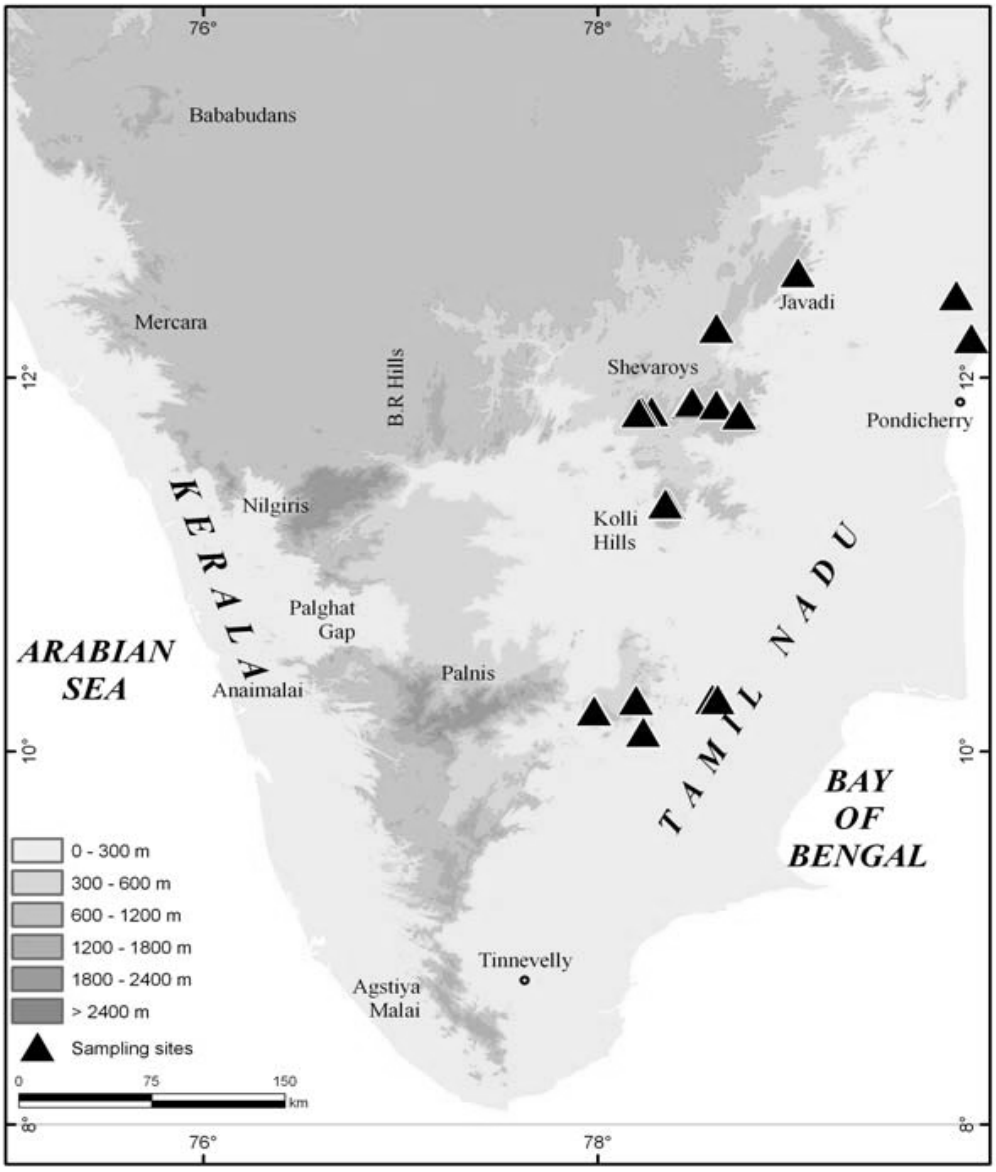


Fig. 2. Variation in life form within the study area

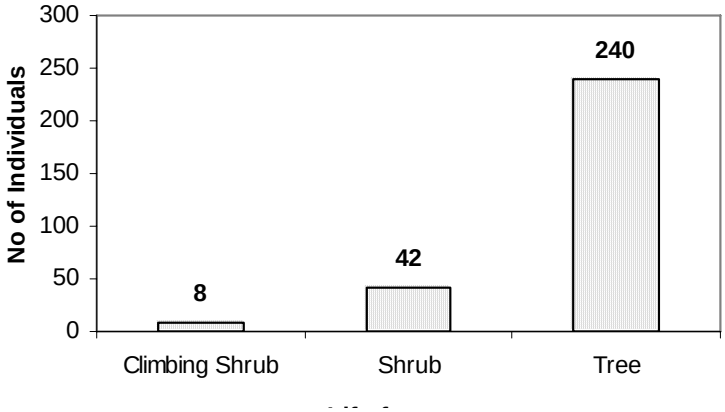
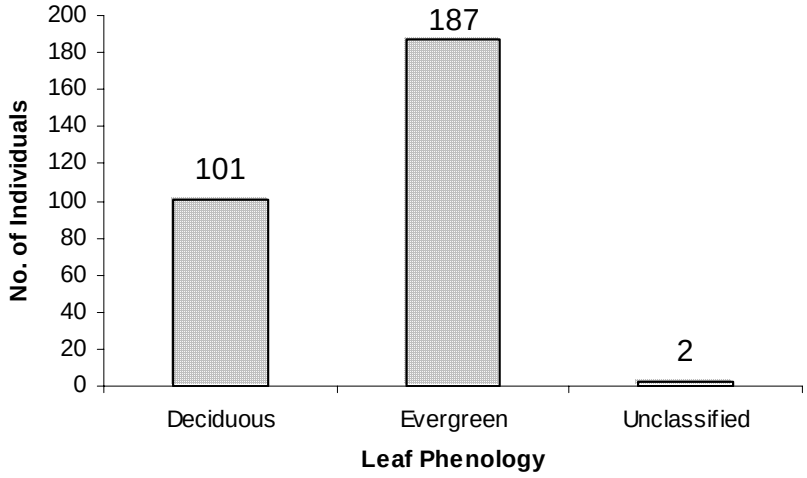


Fig. 3. Variation in leaf phenology within the study area



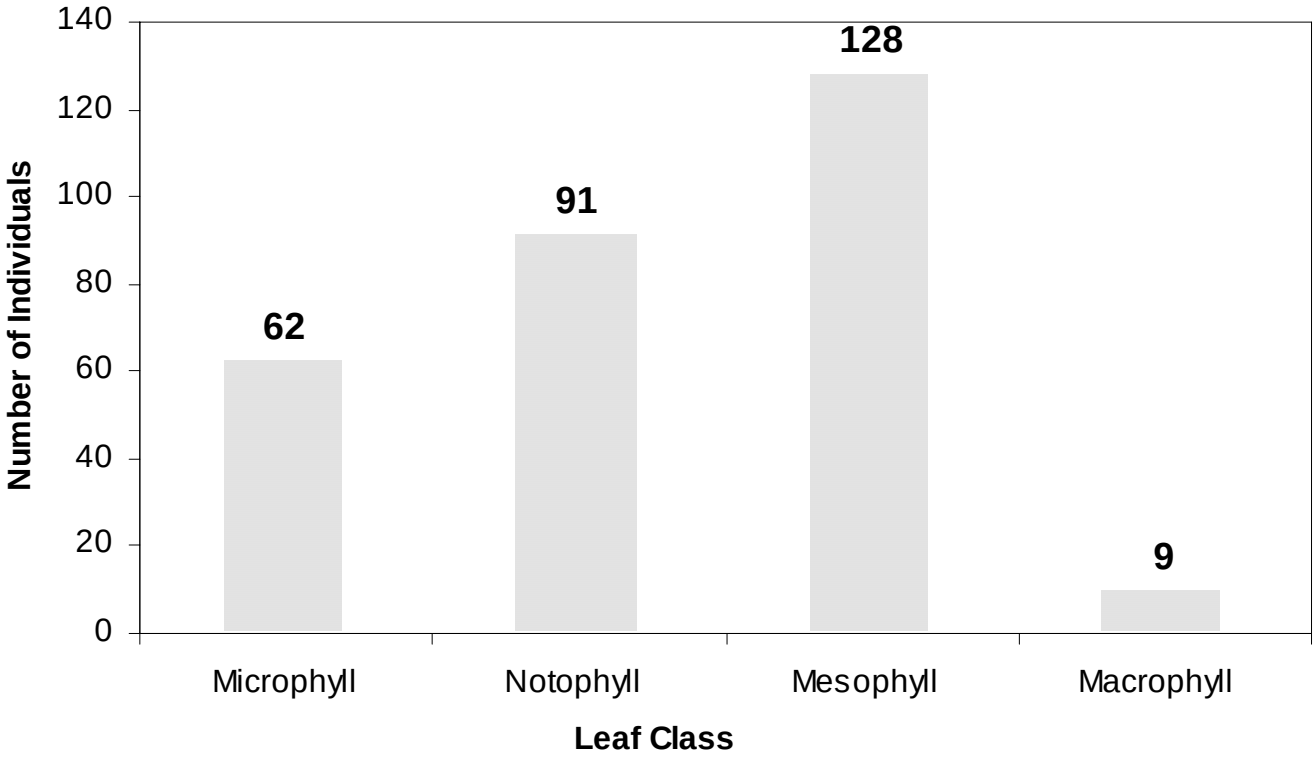


Fig. 4. Variation in leaf class (size) within the study area

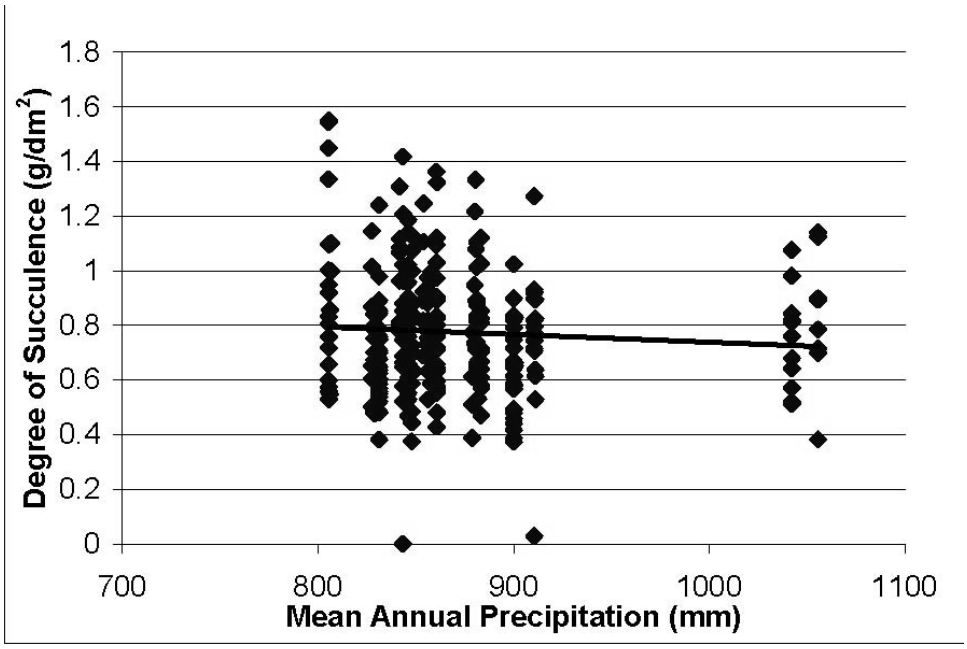


Fig. 5. Scatter diagram of degree of succulence values of plants with reference to mean annual precipitation

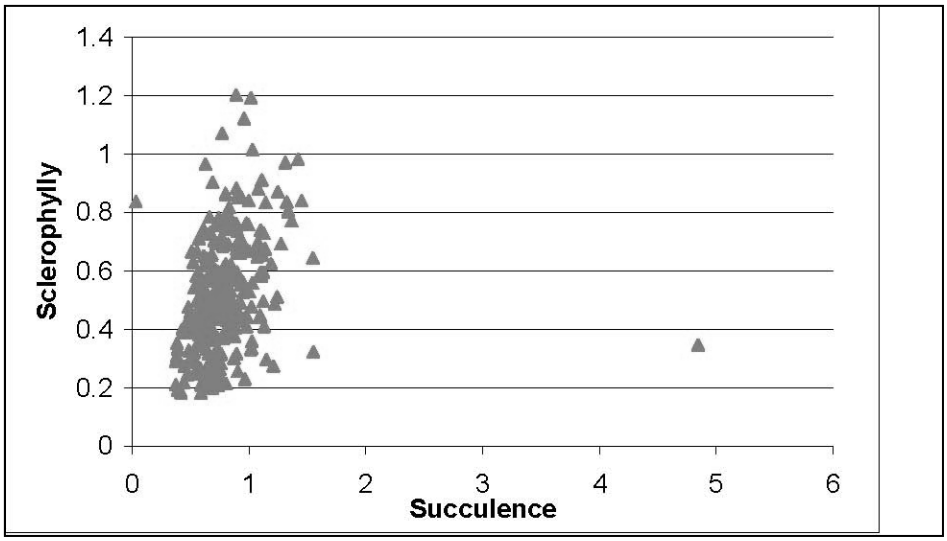


Fig. 6. Scatter diagram of sclerophylly and succulence values of plants of Eastern Ghats (outlier represents *Euphorbia nivulia*)

Notes on the vegetation of Kolli hills of Eastern Ghats

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Introduction

Kolli hills of Eastern Ghats lie between $11^0$19′ - $11^0$30 N latitude and $75^0$15′ - $75^0$30′ E longitude in Namakkal district of Tamilnadu. It forms the southern Eastern Ghats and extends to an area of 418 sq. km. with an elevation of hill ranges between 1000 – 1500 m above MSL. It stretches 29 kms from north to south an 19 km from east to west. Kolli hills is a part of the Talaghat stretch and Eastward of the hill lies Pachamalai. Kolli hills and Pachamalai are divided by a broad valley. Kolli hills on the western, eastern and southern sides rise abruptly from the plains and on the northern side ascend to the plains by numerous long and gently sloping spurs. Of the many rivulets on the Kolli hills, only Akasha Ganga is perennial though with scanty flow during the dry months. Kolli hills composed of acid charnokites with general granite gneissic rocks. The soil is red loamy and black. Many places soil is rich with bauxite. In high altitudes on the evergreen forests, humus substratum covered about 5 feet of the soil surface. Average annual rainfall is about 1200 mm and temperature ranges from 10^0C (December) - 30^0C (May). Forest occupies 44 % of the total geographical area and agricultural activities take place in 51.6%. The other activities occupy less than 5% of the total geographical area. The total population of Kolli hills is 33,888 living in 6840 households, as per 1991 census. Vegetation of the Kolli hills varied from scurb forest to evergreen types. Earlier forest settlers of the Kolli hills are Kollimalayalis belonging to Vellalar Community migrated from Kanchipuram area (Gazetteer of Salem District, 1918).

Methodology

Frequent field trips to Kolli hills for the purpose of vegetational survey were made and all the plant specimens were collected to prepare voucher specimens in the standard method (Jain and Rao, 1977). The collected specimens were identified by matching the authentic specimens at the Botanical Survey of India, southern Circle, Coimbatore. Correct binomial were made for each specimen as per standard taxonomic literature (Nair and Henry, 1983; Henry *et al*, 1987; 1989). The identified specimens were categorized the endemic, endangered and other categories followed by Red Data Book (Nayar and Sastry, 1987) and IUCN (2006). Voucher specimens were deposited in the herbarium of Sri Krishnadevaraya University (SKU), Anantapur, Andhra Pradesh.

Floristic analysis

Present study accounts for a collection of 1055 taxa. Of this 982 species constitute angiosperms, representing 136 families and 538 genera, 68 species constitute Pteridophytes representing 48 genera, and 5 species account for Gymnosperms representing 4 families. Floristic analysis reveals that the maximum representation is from Angiosperms constituting 93.08%, followed by Pteridophytes accounting 4.54% while Gymnosperms constitute only 0.47%.

Vegetation analysis

The vegetation on the Kolli hills broadly falls under the Tropical Dry Deciduous type (Champion, 1936). Owing to continued human interference, most of the vegetational types show stages of degradation and transition from one to another, making it difficult to delimit the types. The vegetation is grouped under the two distinct zones; the outer slopes of the hills and the plateau covers the hill tops with ridges and valleys. Outer hill slopes composed of Scurb forests, Dry deciduous forests, Savannah woodland forests and Dry evergreen forests.

Scrub forests

This forest forms a continuous belt around the hill extending from the base to 650 m elevation on all the slopes. In general they are characterized by three layered vegetation: the tree canopy, the undergrowth and the ground cover. The tree canopy consists mostly deciduous trees, 4-8 m tall. All sides of slopes owing to frequent lopping for firewood, the tree canopy shows various stages of degradation. The common trees are *Acacia leucopholea*, *Alangium salvifolium*, *Albizia amara*, *Commiphora acudata*, *Givotia molucana*, *gyrocarpus asiaticus*, *Morinda pubescens* and *Tamarindus indica.* Western slope of the base hill, scrub forest vegetation eliminated by native bamboo community *Dendrocalamus strictus*. The undergrowth is made up mostly of thorny, deciduous, erect or scandent, large shrubs and small trees less than 5 m tall and associated with a few climbers and twiners. The following are common: *Acacia horrida*, *Atalantia monophylla*, *Capparis sepiaria*, *Commiphora berryi*, *Dichrostachys cinerea*, *Erythroxylum monogynum*, *Euphrobia antiquorum*, *Hugonia mystax*, *Gyrocarpus americana*, *Pleiospermum alatum*, *Pterolobium hexapetalum*, *Rhus mysorensis*, *Scutia myrtina*, *Symphorema involucratum* and *Zizyphus oenoplia*. Some other shrubs are sparsely distributed among the scrub vegetation such as *Atalantia racemosa*, *Canthium parviflorum*, *Catunaregum spinosa* and *Dalbergia coromandeliana*. Common climbers are: *Aganosma cymosum*, *Canavalia catharitica*, *Cardiospermum*

canescens, Coccinea grandis, Cocculus hirsutus, Ipomoea staphylina, Jasminum angustifolium var. *sessiliflorum, Reissantia indica, Rivea hypocrateriformis* and *Watakakka volubilis*.

The ground cover consists of under shrubs and herbs. In places where there is sufficiently good surface soil, they form dense growth. In the places of stone grounds, pebbles and gravels, the ground cover is poorly developed and represented only by a few hardy undershrubs and herbs. Common shrubs are *Clausena dentata, Dodonaea viscose, Glycosmis pentaphylla* and *Tarenna asiatica*. Undershrubs included *Acalypha fruticosa, Barleria acuminata, B. longiflora, B. nitida, Hibiscus micranthus, Justicia glauca,Kleinia grandiflora, Tephrosia villosa* and *Waltheria indica*. Herbaceous ground cover include *Blepharis maderaspatensis, Boerhavia diffusa, Endostemon viscosus, Euphorbia hirta, Evolvulus alsinoides, Leucas aspera, Mollugo pentaphylla, Hedyotis umbellata, Polycarpaea corymbosa* and *Vernonia cinerea*. Herbaceous vegetation is dominant only rainy season and immediately after October to February. Grasses are poorly represented is scrub forest except along its upper border where it merges into the Savannah. The common grasses are: *Bothriochloa pertusa, Chloris roxburghiana, Dactyoctenium aegyptiacum, Heteropogon contortus, Perotis indica, Tragus roxburghii, Trachys muricata* and *Urochloa setigera.*

Dry deciduous forest

The vegetation is characterized by a top canopy of taller trees usually 10 m tall, lower storey of smaller trees 5-6 m tall, undergrowth and ground cover herbs on all the side slopes of above 700 m elevation. The top canopy is made up of mostly deciduous tress, with more or less straight stems and crown irregular, lax branches touching laterally to form a continuous canopy. The common trees are *Anogeissus latifolia, Bridelia crenulata, Dlabergia paniculata, Gmelina arborea, Grewia tiliifolia, Pterocarpus marsupium, Redermachera xylocarpa* and *Vitex altissima*. *Albizia odoratissima, Buchanania lanzan* and *Shorea roxburghii* are found only above 800 m. The second storey is sparsely represented by *Buchanania axillaries, Gardenia resinifera, Helicteres isora, Pyllanthus emblica, Polyalthia cerosoides, Premna tomentosa, Schefflera stellata* and *Terminalia chebula*. The undergrowth is a continuous stretch of grasses together with a few small shrubs and undershrubs. The two dominant grasses are *Cymbopogon coloratus* and *Themeda triandra*. Common undershrubs are *Breynia vitis-idaea, Decaschistia crotonifolia, Grewia hirsute, Lantana camara, Sida cordifolia* and *Toddalia asiatica.* Herbaceous vegetation included in this forest *Desmodium triflorum, Euphorbia hirta, Orthosiphon thymiflorus, Oxalis corniculata* and *Phyllanthus virgatus*.

Savannah woodland forest

This forest characterized by the dominance of tall grasses with scattered small trees. The ground is covered with red or greyish soil mixed with pebbles and broke stones. The trees are deciduous, about 6 m tall, often with irregular crown. The following trees are common *Buchanania axillaries, Dlabergia paniculata, Givotia moluccana, Lannea coromandelica, Morinda pubescens, Pteocarpus marsupium* and *Terminalia chebula*. Common grass communities are *Cymbopogon coloratus, Heteropogon contortus* and *Themeda triandra*. *Crotalaria mysorensis, Endostemone viscosus, Knoxia sumatrensis, Leucas aspera, Rhynchosia rufescens, Sebastiania chamaelia* and *Trichodesma zeylanicum* are common herbs among the grasses. *Phoenix loureirii* is an economically viable palm usually occurs in all over the forests. Chiefly along small gyllies in restricted areas, trees are close and together with other small trees, large shrubs and climbers, form dense thickets. The following are common in such thickets: *Acacia pennata, A. torta, Cipadessa baccifera, Memecylon umbellatum, Opilia amentacea, Premna wightiana,Pterolobium hexapetalum, Stenosiphonium cordifloium, Strychnos potatorum, Walsura trifoliata* and *Zizyphus oenoplia*. Owing to continuous felling of valuable trees in Savannah forests begin to appear as doted grasslands here and there with small trees.

Dry evergreen forest

This forest is characterized by three layered vegetation. The upper layer of tall trees up to 15 m. They occur close together with a crown of irregular branches forming a continuous, shady canopy. Most of the trees are evergreen, their branches arise 3-5 m above ground level. Climbers are abundant in this forest. This forest occurs between 975 m to 1050 m in isolated patches of all slopes. Common trees of the upper layer composed of *Alseodaphne semecarpifolia, Chukrasia tabularis, Memecylon grande, Olea dioica, O. paniculata, Persea macrantha, Pittosporum neelgherrense, Syzygium cumini* and *Vitex altissima*. The middle layer is sparse in the well-shaded interior, but dense the edge and in place where the top canopy is somewhat broken. The following are common *Atalantia racemosa, Diospyros ferrea, Fluggea virosa, Glycosmis pentaphylla, Ligustrum perrottii, Miliusa montana, Murraya paniculata, Ochna lanceolata, Pavetta indica* and *Strobilanthes consanguinea*. Where ever the natural forests were degraded that places were invariably occupied the *Lantana camera*. Common climbers are *Acacia pennata, Dioscorea oppositifolia, Diploclisia glaucescens, Hiptage benghalensis, Ventilago maderaspatana* and *Zizyphus oenoplia*. Herbs are common along the edges of the forests that the same as those in adjacent deciduous forests.

Evergreen forests

These are locally called 'sholas' but differ from the typical shoals found in Western Ghats. Kolli hills were formerly well known for their semi-evergreen and evergreen forests. The forests were largely cleared for timber extraction, pineapple cultivation and coffee plantation. At present they are restricted to only two places such as Kulivalavu and Ariyur. These forests are about 1 km long and 0.8 km breadth. Both the forests

bounded with ghat road, they are facing great threatening by humankinds. The forests showed three four vegetation. Tall trees, with their crowns15-30 m above, canopy is compact. The second layer is made up of small trees, 7-10 m tall. Woody shrubs and undergrowth are common in this forest. Herbs are very scarce but small epimerals and saprophytic plants are common.

Common trees of the upper layer are *Aglaia jainii, Alseodaphne semecarpifolia, Beilschmiedia gemmiflora, Bischofia javanica, Canarium strictum, Celtis tetrandra, Elaeocarpus serratus, Ficus virens, Litsea oleoides, Mallotus philippensis, Meliosma simplicifolia, Myristica dactyloides, Syzygium cumin* and *Toona ciliata*. In the second layer, in addition to smaller specimens of the upper layer, the following are common *Calliacrpa tomentosa, Chrysophyllum lanceolatum, Cinnamomum malabatrum, Diopyros ovalifolia, Ligustrum perrottii, Litsea insignis, Memecylon edule, Nothopegea heyneana, Sclopia crenata* and *Terminalia paniculata*. Common shrubs of the layer are *Ardisia solanacea, Canthium rheedii, Cipadessa baccifera, Murraya paniculata, Oxyceros rugulosa* and *Strobilanthes consanguinea*. Common herbs and grasses of the forests are *Achyranthes bidentata, Adenostemma lavenia, Ageratum conyzoides, Brachiaria semiundulata, Cyrtococcum trigonum, Dicliptera cuneata, Digitaria ciliaris, Dyrmaria cordata, Hydrocotyle javanica, Oplismenus compostius, Rungia apiculata* and *Spermacoce hispida*. *Arisaema leschenaultii, Rhemusatia viviparia, Raphidpora pertusa* are common aroids in the evergreen forests of Kolli hills. Common woody climbers are *Caesalpinia decapetala, Clematis gouriana, Dioscorea oppositifolia, Diploclisia glucescens, Diplocyclos palmatus, Entada pursaetha, Gnetum edule, Maclura spinosa, Piper hymenophyllum, Tetrastigma leucastaphyllum* and *Toddalia asiatica*. Epiphytic are represented only by the following common Orchids: *Bulbophyllum elegantulum, B. gaitense, Diplocentrum recurvum, Eria reticulata, Eria pauciflora, Gastrochilus acaulis, Luisia birchea, L. zeylanica, Oberonia santapaui* and *Vanda testacea*. *Epipogium roseum* is only a saprophytic Orchid observed in Kolli hills. *Balanophora indica* is common root parasite in evergreen forests area. Humus cover of the evergreen forests has ground Orchids *Cheirostylis flabellata, Nervilea argoana, Tropidia angulosa* and *Zeuxine longilabris.* In high altitudes, the water fringing areas have specialized ecosystems which are being specific vegetations. Small herbaceous species and some tuberous perennials are common in this vegetation. The following herbs are abundant in this area: *Cyperus halpan, Drosera burmanii, D. peltata, Eleocharis congesta, Eriocaulon odoratum, E. quinquangulare, Habenaria decipiens, H. rariflora, Lindernia caespitosa, Murdannia esculenta, Osbeckia zeylanica, Utricularia polygaloides, U. striatula* and *Henckelia incana*.

Cultivated fields

Cultivation on the hills must have started at east in the 18th Centaury. Tapioca and pineapple are predominant crops cultivated at presently. In addition to that coffee, banana, paddy, pepper are common crops. Common weeds in cultivated fields are Ageratum conyzoides, Cyanotis tuberose, *Drymaria cordata, Galinsoga parvifloa, Mirabilis jalapa, Oxalis latifolia,* and *Solanum nigrum. Artocarpus heterophyllus* and *Grevillea robusta* are common shade trees growing in Estates. Along hedges around the estates and paths connecting villages there is a dense growth small trees and shrubs with several twiners, undershrubs and herbs: *Aristolochia tagala, Asystasia crispata, Ficus hispida, Ipomoea nil, Lantana camara, Litsea deccanensis, Mallotus philippensis, Phoebe paniculata, Solanum erianthum, Solanum torvum* and *Tinospora sinensis*. Other common undershrubs found nearby cultivated areas are *Acalypha racemosa, Dicliptera cuneata, Girardenia diversifolia, Malvastrum coromandelianum, Phaulopsis imbricata, Sida cordata, Triumfetta rhomboidea* and *Urena lobata*.

Seasonal changes in vegetation

There is only one marked seasonal change that affects the vegetation on the hills. February to August (September) is the dry months. March to June (July) being the hottest period. The few showers in April – May do not appreciably reduce the heat. The dry season is followed by a few showers in September and the setting in of the North East monsoon. The North East monsoon rains and cold winds bring down the temperature considerably and keep the soil moist till January – February. The effect of this seasonal change is quite evident on the vegetation. As the soil becomes more and more dry from February onward and heat increases, herbaceous annuals disappear in the course of February – April. Shrubs in the underground growth of forests become dormant. Leaves of deciduous trees are shed from late February onwards. Leaves of the grasses in Savannah forest dried up and changed the yellow in colour. The sporadic rains during the South West monsoon merely help the perennials to just survive. However several of the large shrubs and trees in scrub, deciduous and evergreen forests, flower during this hot season. Flowering starts by the middle of February and peak during March to July.

The few showers in September moisten the soil and the annuals begin to appear. By the middle of October the forest floor of scrub and open hills is a green carpet of seedlings, a striking and pleasing contrast to the bare look of previous months. Undershrubs and twiners produce numerous branches and leaves; trees develop new foliage. By the first half of November the whole landscape, except the steep rock slopes, is one mass of gree vegetation. Twiners like *Coccinea grandis, Rivea hypocrateriformis, Ipomoea staphylina* and *Pergularia daemia* spread and cover entire bushes in scrub forest with their leaves and flowers, while *Clematis gouriana, Entada pursaethai* and *Jasminum flexile* does the same at higher elevations. Grasses become

prominent on the hill tops, *Themeda cymbaria* and *Cymbopogon coloratus* grow densely and reaching 2 m high.

Kolli hills covering an area of 282.93 sq.km. consists of heterogeneous vegetation along an elevation gradient. This hills comes under reserve forest category, the population has limited and unspecified rights of felling, herding cattle for grazing, browsing, etc. Vegetation monitoring study of three years intervals (Jaya Kumar *et al*, 2002) showed that 2.08 ha from deciduous forest and 4.99 ha from semi-evergreen forest cover decreased per year. The possible reasons that could be attributed to the degradation include to the intensive fuel wood, fodder extraction, clearing of forest for agriculture, illicit felling etc., by local people. Apart from, shunting of around 20 lorry loads per day, each 10 tonnes of excavated soil to cement factories, and 40 lorry loads per day, each 10 tonnes to aluminium factories for the past seven years indicates the extent of human exploitation of natural resources. The above said reasons highly threatened the natural biodiversity of the Kolli hills. The following species are recorded for endangered species of Kolli hills: *Cycas circinalis, Gnetum uls, Psilotum nudum* and *Vernonia arborea. Psilotum nudum* is confined only in Kulivalavu shola in very scarcely. The following plants species recorded for endemic to Eastern Ghats which are distributed in Kolli hills: *Decalepis hamiltonii*, *Sarcostemma intermedium* (Asclepiadaceae), *Heracleum rigens* (Apiaceae), *Habenaria multicaudata, Nervilia aragona, N. plicata, Polystachya concreta* (Orchidaceae) and *Curcuma neigherrensis* (Zinziberaceae). 27 species of Orchids were reported in this hills, from which five species are very rare such as *Epipogium roseum, Gastrochilus acaulis, Nervilia aragona, Polystachya concreta* and *Vanilla wlkeriae*. *Pineria kollimalayana* is a narrow endemic reported from this hill.

A few ethnobotanical reports compiled on medicinal uses plants for healing ailments in Kolli hills. About 150 species used for healing the local ailments by Kollimalayali tribes (Dwarakan and Ansari, 1992; Ranjithakani et al, 1992; Ansari *et al*, 1993). Some tribal families practice magico-religious activities over the year. A few alone are medicinemen. They collect plant materials from their local environment and cure diseases. Elderly and middle–aged medicinemen in these tribal areas practice but the system is maintained as a closely guarded secret. Present study enumerated that about 20 species of plant species are exploited for its medicinal uses such species are: *Andrographis paniculata, Brynia scabra, Bulbophyllum elegantulum, Bulbophyllum gaitens, Celastrus paniculatus, Centella asiatica, Cryptolepis buchananii, Curcuma neilgherrensis, Cyahtea gigantea, Cycas circinalis, Drynaria quercifolia, Entada pursaetha, Gymnema sylvestre, Hupragia phlegmaria, Myristica dactyloides, Rhapidophora pertusa, Schefflera stellata, Uraria tuberosa* and *Zanthoxylum armatum*. As human activities keep escalating with ever-increasing population, ecosystem near human settlements is made fragile. The tropical evergreen forests of Kolli hills found in secluded patches are unique. Evergreen forests of Kolli hills is indicate very species rarity (Chittibabu and Parthasarathy, 2000). Intensive research on specific reproduction strategies of protection of natural ecosystem from the anthropogenic activities are urgently needed for Kolli hills.

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Ethno medicinal wealth of Eastern Ghats from Srikakulam District, Andhra Pradesh with a note on conservation

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Introduction

This paper presents the study of 386 plants species included in 309 genera and 111 familes have been recorded from Srikakulam District. Curing different ailments / diseases by a single species ranging from 1-13. One hundred and thirty nine different ailments are cured by these plants with 1419 ethnomedicinal practices. Of the 386 ethnomedicinally effective plant species, 77 are employed to treat both human and veterinary ailments, 4 are exclusively used in veterinary purpose whereas 305 plants are exclusively used in treating human ailments. The present investigation is taken up in Srikakulam District of Andhra Pradesh, India with the objectives of collection, identification and inventorisation of plant species employed in ethonomedicinal practices by the tribal groups as a part of their culture and way of life, to bring some new plant species on to the agenda of medicinal plants and to contrbute to the development of modern medicine, which the tribals have identified as alternatives to some traditional plant species, which are being depleted or missing from their vicinity due to over exploitation and to explore the ways and means of protection, conservation and preservation of medicinal plants and ethonomedicinal practices for the cause of health and healthy living.

Srikakulam District, the northernmost part of the 23 districts of Andhra Pradesh State, lies along the coast of Coromandel. The District is located within the geographical coordinates of 80^0 50' - 19^0 12' of the Northern latitude and 83^0 32' - 84^0 47' Eastern longitude with an altitude range of 50 – 1120m. The District is bounded by Orissa State on th North, Bay of Bengal in the East and South East and Vizianagaram District in the West and South West, and Srikakulam District falls under upper Godavari Region of eastern ghats of Andhrapradesh. The geology and soil is of considerable variation from deltaic alluvial to red sandy soils presents an interesting floristic data. The vegetation is mainly of dry-deciduous forest type with a few pockets of moist decidous patches at higher altitudes. The use of plants and animals as a source of food and medicine is as old as humanity. Ethnomedicine is an area of research that deals with medicine derived from plants, animals and minerals etc. All the systems of medicine of the world had their origins in traditional or ethnomedicinal practices only. Out of thousands of plants used by the tribals to cure ailments, hundreds only found their way in all the systems of medicine in vogue today. The ethnomedicinal knowledge endowed with the aborigines is the resultant of millennia of experience, transmitted from generation to generation by oral tradition. The extensive ethonomedicinal information that still exists in many parts of the world for scientitific scrutiny and adoption for posterity, lest it be lost under the debris of modernism.

Srikakulam District is inhabited by major tribal communities like Savara and Japapu followed by Kuttiya, Gadaba, Yerukula and Kondadora. Almost all the tribal groups in the District practice podu cultivation on the hill slopes and plough cultivation in the plains. Culturally all the tribes are not in the same level of development. The tribals generally depend on priests, sorcerers and herbalists for curing their ailments. Most of the drug preparations are either single or in combination of plant products and occasionally with animal products and minerals. The ethnomedicinal data of the present study are the outcome of series of intensive filed trips over a period of five years in 74 interior tribal pockets of Srikakulam, Palakonda, Pathapatnam, Tekkali and Kasibugga forest ranges of Srikakulam District. In addition to randomly selected informants in the field, tribal villages and shandies, the ethnomedicinal information furnished by 41 Vaidhyas have been recorded. Utility based classification of Ethonomedicinal data for curing different ailments of humans as well as cattle population by different parts of various plant species have been incorporated.

Discussion and Conclusions

In the present investigation the 386 plants species used by Savara, Jatapu, Gadaba, Kondadora, Kuttiya, tribes of Srikakulam District in healthcare have been identified. The tribal folk have a wide range of herbal remedies which are most popular, time tested, and effective according to their faith and understanding should find a place in village health care programmes after clinical validation. An attempt has been made to focus new remedies for various diseases through herbal plants by correlating information gathered from Srikakulam District and else ware in India. For example, the root bark, root, root, root powder and seed powder of *Celastrus paniculatus* are used in curing leucorrhoea, amenorrhea, tumor cancer and cold and cough, respectively in the present study area. Whereas seed oil is used in curing allergy in children, wounds and pneumonia (Sahu, 1986) and pleurisy, tuberculosis and body ache in Chotanagpur area (Topno and Ghosh, 1999) It is used as hair tonic, stimulant for increasing memory, skin diseases, paralysis and cough in Northern India (Badoni, 1995) and Central India for the cure of eczema and wounds (Maheshwari et al., 1982).

Fruit, root bark, stem bark, root extract of *Helicteres isora* are used by aboringinals of the present study for curing stomach pain, cough and cold, snake and dog bites respectively. Whereas fruit is used to cure stomach pain and polio in Chotanagapur area (Topno and Ghosh, 1999) and North India (Paliwal and Badoni, 1990). Seeds are used in Central India for dysentery and stomach pain (Maheshwari e t al., 1982) and bark and roots are used for relief in chest pain in Chotanagapur area (Topno and Ghosh, 1999). Sahu (1986) observed the use of bark and roots for body ache, while they are used to cure diarrhea in North West India (Sebastian and Bhandari, 1984) Root is used to treat cholera in Chotanagapur area (Topno and Ghosh, 1999), for snake bite in Central India (Roy and Chaturvedi, 1986), for sciatica, asthma and cough in North West India (Singh and Pandey, 1980) and as a cure for diabetes and snake bite in North India (Sharma et al, 1979). Rao (1977) reported the use of roots of *Plumbago zeylanica* in curing leprosy and piles from Mysore, South India and Badoni (1995) in rheumatism from North India. Bedi (1978) mentioned similar use from North West India. Jatapu and Savara tribal communities of Srikakulam District are used then to treat rheumatic pains, piles, boils, skin diseases and contraction of uterus after child birth. Topno and Ghosh (1999) reported its use in Chotanagapur area by Mundas to treat hydrocele, enlargement of liver and in the early stages of leucoderma. Bhalla et al. (1982) observed its use in piles and rheumatism from Central India. Therefore it is necessary to ascertain actual medicinal properties of each plant by thorough screening for pharmaceutical properties.

In the present study 267 plant species are used singly and the other 119 plants in combinations to cure various ailments. For example *Cyperus rotundus* is used in 13 medicinal practices. To treat traumatic injuries it is used in combination with turmeric and sesame oil, and in other 12 practices singly. *Pongamia Pinnata* which finds its use in 10 medicinal practices. To treat leucorrhoea it is used in combination with in stem bark of *Alangium savifolium*, *Syzygium cuminii* and *Terminalia arjuna*. For treatment of epilepsy it is used in combination with root bark of *Caesalpinia bonduc* and in all other practices it is used singly. *Bacopa monnieri* is used alone in curing seven different ailments, of the five ethnomedicinal practices for which *Curcuma longa* is used, to treat psoriasis it is used in combination with *Argemone mexicana* and *Coldenia procumbens*; for bone fracture with *Ficus bengalenis* and *Borreria articularis*; for expelling worms turmeric is used s combination, whereas in skin diseases and cough and cold it is used singly. *Careya arborea* which finds its use in curing four ailments; it is administered singly for oedema and swelling, to treat diarrhea it is used in combination with black pepper and to treat chest pain it is used in combination with *Streblus asper*, *Gmelina arborea* and black pepper *Aerva lanata* is used to cure three ailments. To check leucorrhoea it is used in combination with roots of *Smilax zeylanica* and *Asparagus racemosus* whereas in other two practices it is used singly. *Hyptis suaveolens* is used singly to treat two ailments.

Information from the ethnic groups on traditional herbal medicine had always played a vital role in the discovery in new drugs. In general the success of medicine depends on standard proportion and intelligent combinations of different plants. Therefore further investigations on compound formulations to check their efficacy and safety are necessary so that they can be further utilized for medicinal purpose. The use of single plant in different compound formulations prepared for treating various diseases also need more investigation for chemical constituents and biological screening. Large number of plants or their parts is used singly to treat different ailments give a clue, of their use in combination with other suitable plants or plant parts and the resultant experiences can be exploited in future practices by the Vaidhyas and Medicine men for effective cure of diseases. Plants are real benefactors, whereas the aboriginals are real researchers, who in their struggle to have healthy living, confront with nature and explore new medicinal herbs for self help which in turn are exploited or over exploited by the ethnic groups and this aspect is clearly understood in the present investigation. Few decades back, the root of Rauvolfia serpentina was used as an antidote to snake poison, due to its over exploitation, they had to switch on to the root of Aristolochia indica and then to Stchytarpheta urticaefolia, and now the most commonly used antidote for snake poison is the root bark of *Tiliacora acuminata*, which is available abundantly in up hill as well as down hill areas of the forests of Srikakulam District. Singh (1999) suggested alternate sources for some of the conventionally used medicinal plants, so as to converse them to show their magnificent benevolence on man kind as they have been doing since the dawn of history.

The present investigation revealed an important and most alarming situation with respect to utilization of morphological parts in ethno medicinal practices. Leaves are used in the quantum of 26.77% and stem in above 10.06%, which may not cause harm to plant life, whereas whole plant, stem, root or root bark is utilised in 44.27% quant um, where the entire plant will be uprooted and causes danger to its very existence. In about 15.95% quantum where seeds and flowers are used, propagation and dissemination problems arise. These findings warn us from popularization of ethnomedicinal practices in common folk before alternate steps are taken up to grow medicinal flora in a campaign approach. However, the present study clearly establishes the fact that even after a long period of neglect, and a century after the introduction of western medicine which became the sole recipient of official help, ethno and herbal folklore medicined used to serve majority of the rural and tribal people very effectively and economically. There is an urgent need to document and inventorise information on ethno veterinary practices from rural folk and tribal populations of the region, as the modern veterinary medical facilities are not in access, to cater the needs of the large cattle population in the District. It is true, that entombing of traditional ethnobotanical knowledge takes place by acculturation of

the ethnic world, at the same time we should not ignore the fact that with the advancement of modern science which gave impetus to modern civilization, where the cultural renaissance started and the feudal societies started transforming into democratic societies. Democratization sets acculturation and helps the ethnic and under developed people to absorb into the modern culture and civilization as its objective.

Industrialization, urbanization, modernization and the consequent developmental activities on one side, and acculturation of the ethic societies on the other have set in motion causing destruction of forests and devastation of ethnobotanical knowledge. It is high time now, that all the Governmental and Non-Governmental Organization should redouble their efforts to conserve plants of potential economic value, particularly medicinal plants and the ecosystems they inhabit. These can be achieved by involving local people persuading them to change their attitudes and behaiviour. Appropriate legislation to control land use should be introduced. Majority of plants can best be saved by conserving the places where they grow, that is, establishing more National Parks and Nature Reserves as protected areas. More over *ex situ* conservation can be achieved by preserving samples of germ plasm such as seeds and cuttings. The utilization of biotechnology also can complement ethnobotanical resource conservation through its special applications like *in vitro* conservation, cryopreservation and "DNA library".

The natural vegetation of Srikakulam District is also being destroyed at an alarming rate as a direct consequence of human activities. There are certain forest pockets with rich vegetation and forest cover like Tankidi, Samarelli, Malli, Althi, Tivvakonda, Cheepi, Himagiri, Savara Mukundapuram etc., where rich tribal populations also inhabit. The main tribal communities like Savaras, Jatapus, Kuttiyas, Kondadoras and Gadabas are mostly dependent on medicinal plants growing in nearby forests for their health care. The plight of the Vaidhyas, Medicine men and other folk medicinal practitioners is horrible and there is no patronage or even a pat for their services. Unless some immediate financial assestnance are support is given to them in some suitable form, all the ethnomedicinal knowledge transmitted from millennia of experience is lost. As preservation and conservation of plants, preservation and conservation of this knowledge is also very import ant. Most of the important medicinal plant species like *Alstonia venenata, Argyreia nervosa, Aristolochia indica, Celastrus paniculata, Commifera caudata, Gymnema sylvestre, Helicteres isora, Holarrhena antidysenterica, Rauvolfia serpentine, Tylophora indica, Urgenia indica, Vitex altissima, Woodfordia fruticosa* etc. are critically endangered or in endangered state. Huge trees like *Strychnos potatorum, Choroxylum swietenia*, which are in critically endangered state, must be adopted by the social forestry to grow them as avenue trees.

In this context it is suggested that medicinal plant cultivation or farming should be taken up in all the open forest areas by the tribals. In order to avert marketing problems crude drug processing industries must be established in mandals like Seethampeta, Meliaputti, Bhamini, Pathapatnam, Mandasa, Kanchili, Kotturu, Saravakota and kaviti, where the size of the tribal population is more. This helps in alleviating poverty of tribals as well as, conservation and presentation of original germplasm. All the Vaidhyas, Medicine men, folk ethnomedicinal practioners must be identified and training should be given to them to enhance their expertise, and they must be employed as ethnomedicinal practioners by the government with some honorarium to support their living, so that their services can be made accessible to the remote tribal people. Ethnomedicinal knowledge endowed with them can be recorded without further loss in a campaign approach. The same knowledge can further be scrutinized, so that it can be utilized by the researchers and subsequently by the different systems of medicine, particularly so with the modern medicine.

Utility – Based Classification of Ethnomedicinal Data

The ethnomedicinally important/ plants along with the part used in bracket for different diseases/ailments are classified based on their utility. Under each group, the botanical names are arranged alphabetically. This classification presents a comprehensive picture of the whole text and forms an easy reference.

ABORTION : 1.*Annona suamosa* (Root); 2.*Caesalpiia bonduc(*Seed); 3.*Costus specious (*Rhizome) 4)*Dandrocalamus (*Whole Plant); 7)*Gloriosa superba (*Tuber); 8)*Holoptelea integrifolia (*Root bark) 9) *Ricinus comunis (*Root); 10)*Viscum articulatu (*Stem).
ABSCESS : 1)*Abution indicum (*Leaf); 2) *Ziziphus oenopila (*Bark)
ACIDITY : 1)*Centella asiatica (*Leaf); 2) *Cyperus rotundus (*Corm); 3)*Desmodium gangeticum (*Leaf)
ALLERGY: 1)*Crotolaria laburnifolia (*Leaf); 2) *Mirabilis Jalapa (*Leaf);.3) *Vetiveria zizaniodes (*Root).
AMOEBIC DYSENTERY : 1) *Artocarpus heterophyllus(*Fruit); 2.*Carica papaya (*Fruit); 3) *Shorea rabusta (*Latex).
AMENORRHOEA: 1) *Ananas comosus (*Root); *2) Buteamonosperma(*Seed); *3) Cassia fistula (*Leaf) ; *4. Celastrus paniculatus (*Root); *5)Datura metel* (Leaf); 6) *Sida cordata* (Root).
ANAEMIA : *1)Centella asiatica(*Leaf); *2)Curculigo orchioides(*Root); *3)Lygodium flexuosum (*Root).
ANALGESICS : *1)Clerodendrum serratum (*Root); *2)Neolamarckia cadamba (*Bark), *3)Carica papaya(*Fruit)
ANASARCA: *1)Achyranthes aspera (*Whole Plant);*2) Alangium Salvifolium(*Leaf); *3)Bauhinia purpurea (*Bark); 4)*Cardiospermum halicacabum (*WholePlant); 5)*Careya arborea(*Bark); 6) *Curcuma pseudomontana (*Tuber);

7)*Cycas circinalis(*Bark); *8)Diospyros Montana(*Bark); 9)*Elytraria acaulis (*Roots); 9) *Holoptelea integrifolia (*Bark); *10)Phyllanthus reticulates(*Bark); 11.*Solanum nigrum (*Whole Plant)

ANTHELMINTICS : *1) Alstonia venenata(*Bark); 2)*Azadirachta India (*Leaf); *3)Balanties aegyptiaca (*Fruit); 4.*Centratherum anthelminticum (*Leaf); 5) *Holarrhena antidysenterica (*Root); 6)*Mallotus philippensis (*Root); 7) *Melia azadarach (*Leaf); 8) *Pterospermum xylocarpum (*Fruit); 9) *Urena lobata (*Root).

ANTIFERTILITY : *1) Butea monosperma (*Bank); *2)Haldina cordifolia (*Steam, Root bark); *3) Ipomoea pes-caprae (*Whole plant).

ANTINARCTICS / LIQUOR ADDICTION : *1.Cassia fistula (*Root); *2.Cryptolepis buchanani (*Root); *3.Psidium guajava (*Leaf).

APHRODISIACS : *1Capparis zeylanica (*Root bark); *2.Caryota urens (*Whole plant); *3.Erythrina variegata (*Flower); *4. Mucuna utilis (*Root).

ARTHRITIS : *1.Brassica nigra (*Seed); *2.Calotropis giantea (*Root); 3) Capsicum frutescens (Fruit); 4) Citrus aurantifolia (Leaf); *5.Clitoria ternatea (*Root bark); *6. Commiphora caudate (*Resinous gum); *7.Holarrhena antidysenterica (*Bark); *8. Murraya paniculata (*Leaf); *9. Tephrosia Purpurea (*Root); *10.Thespesia populnea (*Bark)

ASTRINGENT : *1) Acacia chundra (*Bark)

ASTHMATIC ATTACK: *1).Boerhaavia diffusa (*Root); 2*)Butea monosperma (*Flower); 3) *Cassia fistula (*Fruit); 4) *Cissus quadrangularis (*Stem); 5)*Curculigo orchioides (*Root tuber); 6*. Datura metel (*Seeds, Fruit); 7.*Holoptelea integrifolia (*Bark); *8.Indigofera tinctoria (*Root); *13. Justicia adhatoda (*Leaf, Flowers);*14.Tylophora indica (*Leaf); *15. Vitex negundo (*Leaf).

BACK ACHE : *1.Baswellia serrata (*Bark); *2.Centratherum anthelminicum (*Root); *3.Erythrina variegata (*Bark); *4.Vicoa Indica (*Root).

BELCHING : *1.Murraya koenigii (*Leaf)

BLOOD PRESSURE : *1.Arachis hypogaea (*Seed); *2.Cassia obtusifolia (*Leaf); *3.Flocouritia indica (*Root);*4.Momordica charantia (*Leaf); *5.Moringa oleifera (*Leaf); *6. Rauvolfia serpentina (*Root); *7. Terminalia arjuna (*Bark); *8.Tinospora cordifolia (*Whole Plant).

BLOOD PURIFICATION: *1.Hemidesmus indicus (*Root); *2.Nyctanthes arbor-tristis (*Leaf)

BLOOD PURIFICATION: *1.Hemidesmus Indicus (*Root); *2.Nyctanthes arbor-trisits(*Leaf)

BOILS / BLISTERS / BURNS : *1.Abutilon indicum (*Leaf) 2.*Ammania baccifera (*Herb paste); 3*. Argyreia nervosa (*Leaf); 4*. Buchanania lanzan (*Bark); 5*. Cardiospermum halicacabum (*Leaf); 6) *Cassia auriculata (*Leaf); 7)*Cayratia auriculata(*Leaf); 7*. Cissus repens(*Root); 8.*Cleome viscosa (*Leaf); 9.*Combretum roxburghii (*Leaf) ; 10. *Desmodium gangeticum (*Leaf); 11*. Eclipta prostrate (*Leaf); 12.*Elytraria acaulis (*Leaf); 13*. Euphorbia hirta (*Whole Plant) ; 14.*Ficus bengalensis (*Latex); 15*. Heliotropium indicum (*Leaf); 16.*Hibiscus rosa-sinensis (*Leaf); 17.*Holop telea integrifolia (*Leaf); 18.*Jatropha curcas (*Latex); 19*. Ja tropha gossypifolia (*Leaf); 20*. Kalanchoe pinnata (*Leaf); *21.Leonotis nepetaefolia(*Flower); 22*. Plumbago zeylanica (*Plant); 23.*Pongamia pinnata(*Seed); 24. *Portulaca oleracea (*Plant); 25.*Sarcostemma secamone (*Leaf).

BONE-FRACTURES : *1.Alternanthera sessilis(*Whole plant); *2. Andrographis paniculata (*Whole Plant); *3.Cassia auriculata(*Leaf); 4.*Cissus quadrangularis(*Whole Plant); *5.Cissus repens Lam. (*Root) ; *6. Curcuma longa (*Rhizome) ; *7.Desmodium triflorum (*Plant); *8.Dichrostachys cinerea (*Root Bark) ; *9.Diospyros melanoxylon(*Fruit); *10.Dodonaea viscose(*Leaf) ;*11.Euphorbia nivulia(*Bark) ;*12.Ficus bengalensis(*Root); *13.Garuga pinnata (*Root); *14. Lannea coromandelica (*Bark);*15. Mimosa intsia (*Root Bark); *16.Oxalis corniculata (*Whole Plan) ; *17. Rhaphidophora pertusa(*Root); *18. Sida acuta (*Leaf) ; *19.Spermacoce articularis (*Root); *20. Ziziphus mauritiana* (Bark).

BRAIN TONIC : *1. Bacopa monnieri (*Whole Plant) *2. Centella asiatica (Leaf); 3.Evolvulus alsinoides(*Plant)

BRONCHITIS : *1.Bacopa monnieri(*Leaf); *2.Citrus aurantifolia (*Rind); *3.Eclipta prostrate(*Plant); *4.Flacourtia indica(*Root) ; *5. Indigofera tinctoria(*Leaf); *6.Martynia annua(*Root); *7.Ocimum temuiflorum (*Leaf); *8.Wrightia tinctoria*;(Latex).

BRUISES : *1. Agave cantula(*Leaf) ; *2. Emilia sonchifolia(*Leaf); *3.Litsea glutinosa (*Bark) ; *4.Mallotus philippensis (*Leaf)

CANCER: *1.Ammania baccifera (*Leaf); *2.Celastrus paniculatus(*Root)

CARBUNCLE: *1. Abutilon indicum (*Leaf) ; *2.Albizia lebbeck(*Flower); 3*. Argyreia nervosa (*Leaf) ; *4. Hibiscus rosa-sinensis (*Leaf)

CATARRH : *1.Barleria prionitis(*Leaf); *2. Clerodendrum viscosum (*Leaf).

CENTIPEDE BITE : *1. Adiantum philippense(*Rhizome);

CHEST PAIN: *1.Aloe vera (*Leaf); *2. Aristolochia indica(*Root);*3. Asparagus racemosus (*Root tubers); *4.Buchanania lanzan(*Bark); *5. Careya arborea*;(Bark); *6. Casearia elliptica* (Bark); *7.Cheilanthes tenuifolia* (Whole Palnt); *8. Chloroxylum Swietenia(*Bark) ; *9. Cissampelos pareira (*Root); *10. Shorea robusta (*Resinous secretion).

CHICKEN POX: *1.Achyranthes aspera(*Leaf); *2.Azadirachta indica(*Leaf);*3. Bombax ceiba (*Flower); *4.Cayratia auriculata(*Leaf); *5.Dendrophthoe falcata (*Flower); *6. Gloriosa superba (*Tuber); *7.Sesbania grandiflora(*Bark).

COLD: *1.Acorus calamus (*Rhizome); 2*. Celastrus paniculatus(*Seed); *3.Curcuma longa (*Rhizome);*4.Dioscorea bulbifera(*Rhizome); *5.Euphorbia tirucalli (*Stem) ; *6. Glycosmis pentaphylla (*Root Bark); *7. Justicia adhatoda* (Stem); 8) Leucas caphalotes (Flower); 9) Phyllanthus embilica (Leaf); *10.Piper nigrum(*Leaf).

CONSTIPATION : *1.Amaranthus tricolor(*Stem); *2. Carica papaya (*Fruit); *3. Cassia fistula (*Fruit); *Luffa acutangula (*Seed) ; *5.Operculina turpethum(*Root).

CONTRACEPTION : *1. Abrus precatorius(*Seed Coat); *2. Bombax ceiba(*Flower); *3. Costus speciosus(*Rhizome); *4.Mimosa pudica(*Root) ; *5.Opuntia dillenii (*Plant) ; *6.Pueraria tuberose (*Tuber) ; *7. Spermadictyon suaveolens (*Root).

COOLING EFFECT: *1. Blumea mollis (*Leaf) ; *2.Cipadessa baccifera(*Leaf) ; *3.Cocculus hirsutus(*Leaf) ; *4. Erythrina fusca (*Leaf) ; *5.Phoenix loureirii (*Fruit); *6. Sansevieria roxburghiana(*Rhizome) ; *7. Tephrosia purpurea (*Leaf).

COUGH : *1. Abrus precatorius(*Leaf); *2.Acacia sinuata (*Leaf) ; *3. Acalypha indica (*Whole plant); *4.Allium cepa(*Onion juice) ; *5.Aloe vera(*Leaf); *6.Carissa spanarum (*Fruit, Flower); *7.Celastrus paniculatus(*Seed); *8. Coleus ambonicus(*Leaf); *9. Curcuma longa(*Rhizome); *10.Diospyros melanoxylon (*Bark); 11.*Euphorbia tirucalli. (*Stem); *12. Helicteres isora (*ruit decoction) ; *13.Kalanchoe pinnata (*Leaf); *14.Justica adhatoda (*Leaf); *15.Ocimum tenuiflorum(*Leaf) ; *16.Phyla nodiflora (*Plant) ; *17.Piper longum (*Fruit) ; *18. Piper nigrum (*Leaf); *19.Solamum nigrum (*Fruit); *20.Solamum torvum (*Fruit, Leaf); *21. Terminalia chebula (*Bark); *22. Zingiber officinale (*Rhizome)

CRACKS : *1. Anisochilus carnosus(*Leaf)

CROUP : *1. Acalypha indica (*Whole plant)

DANDRUFF / LICE : *1.Aloe vera* (Leaf); 2. *Annona Squamosa* (Seed); *3.Caryota urens(*Nut); *4.Cochlospermum religiosum(*Leaf); *5. Gloriosa superba (*Leaf) ; *6.Gmelina asiatica(*Fruit); *7.Hibiscus rosa sinensis(*Leaf); *8. Lannea coromandelica (*Seed); *9. Maytenus emarginata(*Leaf) ; *10. Mruuaya koenigii(*Leaf) ; *11.Nyctanthes arbor-tristis (*Seed); *12. Ocimum tenuiflorum(*Leaf); *13. Pongamia pinnata(*Bark, *Leaf)* ; *14. Pterospermum xylocarpum*(Leaf) ; *15. Thespesia populnea (*Bark).

DIABETES : *1. Aegle marmelos(*Leaf) ; *2.Azadirachta indica (*Seed); *3.Bougainvillea spectabilis (*Leaf) ; *4.Cassia auriculata(*Whole plant); *5.Catharanthus roseus(*Leaf); *6. Centratherum anthelminticum(*Leaf); *7.Clitoria ternatea(*Flower); *8.Crucuma pseudomontana (*Tuber); *9.Glycosmis pentaphylla (*Leaf); *10.Gymnema sylvestre(*Leaf); *11.Momordica charantia(*Fruit) ; *12.Syzygium cuminii(*Seed, leaf); *13. Terminalia chebula (*Fruit); *14.Tinospora coriacea (*Stem).

DIAPHORETIC : 1. Toddalia asiatica (Root bark)

DIARRHOEA : 1.Actinopteris radiata (whole plant); 2.Aegle marmelos (Fruit) ; 3.Andrographis paniculata (Root, leaf); 4. Bacopa monnieri (Leaf); 5.Barringtonia acutangula(Kernels); 6.Bauhinia recemosa (Root bark) ; 7.Brassica nigra (Seed); 8. Buchanania lanzan(Bark); 9.Careya arborea (Bark) ; 10.Catharanthus roseus(Leaf); 11. Citrus Medica(Fruit) ; 12. Cyperus routundus (Root); 13.Diospyros chlorozylon(Leaf); 14. Elephantopus scaber(Root) ; 15. Ficus hispida (Latex); 16.Hemidesmus indicus(Root); 17. Kalanchoe pinnanta (Leaf); 18.Maranta arundinacea (Rhizome) 20.Murraya paniculata(Leaf); 21) Oxalis corniculata(Plant); 22)Punica granatum. (Fruit); 23. Sida cordata(Whole plant) ; 24. Soymida febrifuga(Bark) ; 25.Strychnos nuz vomica (Bark) ; 26. Strychonos potatorum (Seed) ; 27.Woodfordia fruticosa (Flower).

DIPHTHERIA : *1. Crateva magna (*Bark)

DIURETIC : *1. Alysicarpus Monilifer(*Whole plant) ; *2.Kalanchoe lanceolata (*Leaf) ; *3.Rivea hypocrateriformis (*Plant)

DOG BITE : *1.Alangium salvifolium(*Root bark) ; *2. Calotropis gigantean(*Flower) ; *3. Detura metal (*Leaf) ; *4. Helicteres isora(*Root) ; *5. Pithecellobium duice (*Root) ; *6.Strychnos potatorum(*Seed)

DROPSY : *1. Barleria longiflora (*Root) ; *2. Oroxylum indicum (*Root bark)

DYSENTERY : *1. Actinopteris radiata (*Whole plant) *2. Ailanthus excelsa (*Bark) *3. Anogeissus acuminata(*Bark) *4. Canthium parviflorum (*Root bark); *5.Diospyros melanoxylon (*Fruit); *6. Euphorbia hirta(*Leaf) ; *7. Jatropha curcas (*Latex); *8. Lagerstroemia parviflora (*Leaf); *9. Limonia acidissima (*Fruit); *10.Maranta arunjdinacea(*Rhizome); *11. Murraya koenigii (*Leaf); *12.Murraya paniculata (*Leaf);*13.Naringi cremulata (*Bark) ; *14. Piper nigrum (*Root); *15.Pithecellobium dulce(*Bark) ; *16.Psidium guajava (*Shoot) ; *17. Punica grantum (*Fruit) ; *18. Scoparia dulcis(*Root) ;*19. Sida cordata(*Whole plant) ; *20. Sterculia urens(* Gum) ; *21.Syzygium cuminii(*Bark).

EAR ACHE / EAR PROBLEMS / TYMPANITES : *1.Borassus flabelifer(*Petiole); *2. Capparis zeylanica (*Root bark); *3. Capsium annuum(*Flower);*4.Cleome viscose (*Leaf); *5.Costus speciosus(*Rhizome) ; *6.Diplocyclos palmatus(*Fruit) ;

*7. Pueraria tuberosa(*Root) ; *8. Solamum nigrum (*Leaf) ; *9.Solamum torvum(*Fruit) ; *10. Vanda tessellata (*Leaf).

ECZEMA: *1. Acacia nilotica(*Bark); *2. Citrus medica(*Leaf) ; *3.Coldenia procumbens. (*Whole plant); *4. Elephantopus scaber (*Root); *5. Jatropha curcas(*Latex) ; *6. Thespesia populnea(*Fruit) ; *7. Ziziphus oenoplia(*Bark)

EMETICS : *1. Acalypha indica(*Leaf) ; *2. Ageratum conyzoides (*Leaf) ; *3. Alternanthera sessilis (*Root); *4.Cassia occidentalis(*Root) ; *5. Dalbergia sissoo(*Leaf).

EPILEPSY : *1. Allium sativum(*Cloves) ; *2.Bauhinia racemosa(*Bark) ; *3. Boerhaavia diffusa(*Root) ; *4. Coesalpinia bonduc (*Root bark) ; *5. Coldenia procumbens(*Leaf); *6. Cuscuta reflexa(*Plant) ; *7. Dodonaea viscose (*Leaf); *8.Hibiscus rosa sinesis(*Bark); *9.Ichnocarpus frutescenes(*Root); *10. Merremia tridentate(*Fruit); *11.Ocimum americanum(*Leaf); *12. Pavetta tomentosa(*Bark); *13. Semecarpus anacordium(*Seed); *14. Streblus asper(*Bark); *15. Terminalia arjuna(*Bark); *16.Tylophora indica(*Leaf) ; *17. Vitex negundo(*Leaf).

ERUPTIONS : *1. Albizia lebbeck(*Flowers)

EYE DISEASES : *1. Alternathera sessills(*Leaf) ; *2. Carissa spinarum (*Flower) ; *3. Cassia auriculata (*Leaf) ; *4. Coccinia grandis(*Leaf) ; *5.Colebrookia oppositifolia(*Leaf) ; *6. Dendrocalamus strictus(*Leaf) ; *7. Eclipta prostrata(*Plant) ; *8. Emilia sonchifolia(*Leaf) ; *9. Gymnema sylvestre(*Root); *10. Kalanchoe pinnata (*Leaf); *11. Moringa oleifera (*Leaf) ; *12. Phaseolus trilobus (Leaf); 13) Phyllanthus amarus (*Whole plant); *14. Piper betle (*Leaf); *15. Sesbania grandiflora(*Flower) ; *16. Solena heterophylla (*Leaf).

FERTILITY : *1. Diplocyclos palmat rus(*Seed); *2. Ficus racemosa(*Bark) ; *3. Limonia acidissima(*Bark).

FEVER : *1. Bixa orellana (*Root bark) ; *2. Boerhaavia diffisa (*Leaf); *3.Bridelta retusa (*Bark); *4. Canthium parviflorum (*Leaf); *5. Celastrus paniculatus(*Seed); *6. Chloroxyhum swietenia(*Bark); *7. Clerodendrum serratum (*Root) ; *8.Crateva magna (*Bark); *9. Dalbergia latifolia(*Bark) ; *10. Evolvulus nummularius(*Whole plant); *11. Hyptis suaveolens (*Root); *12. Lagerstroemia parviflora(*Root bark); *13. Lannea coromandelica (*Bark); *14. Merremia tridentate (*Plant); *15.Momordica charantia(*Fruit); *16. Naringi crenulata(*Bark); *17. Pergularia daemia(*Shoot); *18. Phaseolus trilobus (*Leaf); *19. Polycarpaea corymbosa(*Plant); *20. Polygola arvensis (*Plant); *21. Rauvolfial serpentina(*Root); *22. Ricinus communis(*Root); *23. Scoparia dulcis(*Root) ; *24. Strychnos potatorum(*Bark) ; *25. Terminalia bellirica (*Fruit); *26. Tinospora cordifolia(*Root) ; *27. Trichosanthes tricuspidata (*Fruit) ; *28. Vernonia cineria(*Leaf).

FILARIASIS : *1. Cassia occidentials(*Root bark); *2. Mimosa pudica(*Leaf) ; *3. Mucuna utilis (*Root*).*

FISSURES : *1. Alagium salvifolium(*Leaf) ; *2. Anisochilus carnosus (*Leaf) ; *3.Ficus bengalensis(*Latex) ; *4. Lawsonia inermis(*Leaf).

FISTULA : *1. Cajanus cajan(*Root, Leaf) ; *2. Carica papaya(*Latex) ;

FLATULENCY: *1. Ageratum conyzoides(*Whole palnt) ; *2.Aristolochia bracteolate (*Plant).

GALACTOGOGUE: *1. Asparagus racemosus(*Root); *2.Carica Papaya(*Root bark); *3. Costus speciosus*(Rhizome); *4. Curcuma pseudomontana(*Tuber); *5.Cyperus rotundus (*Root*)*; *6. Gmelina arborea(*Root); *7. Gymnema sylvestre (*Root) ; *8.Hemidesmus indicus(*Root); *9.Leptadenia reticulata(*Leaf); *10. Modhuca longifolia (*Stem or root bank).

GASTRIC TROUBLES / DYSPEPSIA : *1. Barleria prionitis(*Whole Plant) ; *2. Cissus repens(*Root) ; *3. Crateva magna(*Bark) ; *4.Cucumis melo (*Fruit) ; *5. Lannea coromandelia(*Bark); *6. Mimosa intsia untrang (*Root); 7*. Pueraria tuberosa(*Root); *8.Terminalia chebula(*Bark).

GIDDINESS: *1. Colebrookia oppositifolia(*Bark); *2. Trichosanthes tricuspidata (*Tuber).

GONORRHOEA : *1. Agave cantula (*Leaf) ; *2. Calotropis procera (*Flower); *3. Clitoria ternatea (*Root); *4. Cocculus hirsutus(*Leaf) ; *5. Cuminum cyminum(*Seed) ; *6. Ficus bengalensis (*Latex); 7*. Ficus religiosa(*Bark); *8. Jatropha gossypifolia(*Latex) ; *9. Pedalium murex. (*Plant); *10. Phyla nodiflora(*Whole plant); *11.Plumeria rubra(*Root bark) ; *12. Shorea robusta(*Gum powder) ; *13. Solanum nigrum(*Whole plant).

HAEMATURIA: *1.Ammania baccifera(*Plant);*2.Bambusa arundinacea (*Culms); *3. Butea superba (*Plant); *4. Cuscuta reflexa (*Plant); *5. Phyla nodiflora (*Leaf) ; *6. Smilax zeylanica(*Root)

HAEMORRHAGE: *1. Amaranthus Spinosus(*Root); *2.Artemisia vulgaris.(*Leaf) ; *3. Catharanthus roseus (*Leaf)

HAIR TROUBLES :*1. Citrullus colocynthis(*Seed); *2.Eclipta prostrata(*Leaf) ; *3.Hibiscus rosa sinensis(*Leaf).

HEADACHE: *1.Barringtonia acutangula (*Seed); *2.Capsium frutescens(*Leaf); *3. Cissus quadrangularis.(*Stem) ; *4. Cissus repens (*Root); *5.Cleome gynandra(*Leaf) ; *6. Datura innoxia (*Leaf); *7. Leucas cephalotes*;(Leaf); *8. Merremia hederacea (*Leaf); *9.Oxalis corniculata (*Leaf); *10. Piper longum(*Fruit) ; *11. Sebastiania chamelea (*Leaf) ; *12. Zingiber offcinale(*Rhizome).

HEAL CRACKS : *1.Anacordium occidentale(*Pericarp) ; *2. Cayratia pedata (*Tuber) ; *3. Semecarpus anacardium(*Pericarp).

HERPES : *1. Adiantum philippense(*Rhizome) ; *2. Xanthium strumarium(*Leaf).

HICCUPS : *1. Evolvulus alsinoides(*Plant)

HOARSENESS OF VOICE : *1. Acorus calamus.(*Rhizome)

HYDROCELE : *1.Caesalpinia bonduc (*Leaf) ; *2. Cassytha filiformis(*Whole plant) ; *3. Pedalium murex (*Fruit)

HYPER TENSION : *1. Allium sativum(*Cloves) ; *2. Arachis hypogaea(*Seed. Pod)

IMPOTENCY : *1.Chloroxylum swietenia(*Root bark); *2. Hybanthus* enneasperums *(*Whole plant) ; *3. Sphaeranthus indicus(*Root, Inflorescence)

INDIGESTION : *1. Amaranthus spinosus (*Root); *2.Aristolochia bracteolate(*Whole plant) ; *3. Cadaba fruticosa(*Leaf); *4. Colebrookia oppositifolia(*Leaf); *5. Cyperus rotundus (*Root); *6. Maranta arundinacea (*Rhizome); *7.Piper betle(*Leaf); *8. Pogostemon bengalensis(*Root); *9.Pueraria tuberosa(*Tuberous root); *10. Syzygium cuminii(*Bark); *11. Zingiber officinale(*Rhizome) ; *12.Maranta arundinacea (*Rhizome)

INFLAMMATION : *1. Alangium salvifolium(*Leaf) ; *2.Gmelina asiatica(*Fruit); *3. Jatropha gossypifolia* (Whole Plant)*; 4.Memecylon umbellatum(*Bark); *5. Rubia cardifolia (*Root); *6. Waltheria indica(*Root).

INFLATED STOMACH : *1.Physalis minima(*Leaf) ; *2.Pimpinella heyneana (*Seed)

INSOMNIA : *1. Arachis hypogaea(*Leaf) ; *2.Oxalis corniculata(*Leaf)

INTERMITTENT FEVER : *1. Anisomeles indica(*Leaf) ; *2.Bixa orellana(*Bark) ; *3.Calotropis procera(*Root bark) ; *4. Cyperus rotundus(*Root) ; *5.Viscum articulatum (*Plant).

INTESTINAL WORMS : *1. Acalypha indica(*Leaf); *2.Ananas comosus(*Leaf) ; *3. Andrographis paniculata(*Root, Leaf); *4. Argemone mexicana(*Latex) ; *5. Aristolochia bracteolate(*Leaves); *6. Boerhaavia diffusa(*Root); *7.Calycopteris floribunda (*Leaf); *8. Cissampelos pareira (*Root); *9. Citrullus colocynthis (*Fruit); *10. Curcuma longa (*Rhizome) ; *11.Erythrina variegata(*Leaf)

ITCHES : *1. Abutilon indicum (*Leaf) ; *2. Aloe vera (L.) Burm.(*Leaf) ; *3.Jatropha gossypifolia (*Leaf)

JAUNDICE: *1.Acacia sinuate(*Leaf); *2. Andrographis paniculata(*Whole plant) ; *3. Azadirachta indica (*Flower) ; *4. Blumea mollis (*Whole plant) ; *5. Boerhaavia diffusa (*Root) ; *6. Bridelia retusa (*Bark); *7. Centella asiatica(*Whole plant); *8. Curcuma pseudomontana (*Tuber) ; *9. Eclipta prostrata(*Leaf); *10. Evolvulus alsinoides(*Leaf) ; *11.Flacourtia indica(*Leaf) ; *12. Ixora pavetta (*Bark) ; *13. Lygodium flexuosum(*Leaf); *14. Madhuca longifolia (*Bark); *15. Operculina turpethum (*Bark); *16.Oroxylum indicum (*Bark); *17. Phyllanthus amarus(*Whole plant) ; *18. Polycarpaea corymbosa(*Whole plant) ; *19. Polygomum glabrum (*Root) ; *20. Pterocarpus marsupium (*Bark) ; *21. Ricinus communis(*Tender Leaf) ; *22. Tamarindus indica (*Flower) ; *23.Tribulus terristris (*Whole plant) ; *24. Tridax procumbens(*Plant) ; *25.Woodfordia fruticosa(*Bark)

KIDNEY STONES : *1. Aerva lanata(*Whole plant); *2. Amaranthus viridis(*Root) ;*3. Barleria longiflora(*Root); *4. Coleus ambonicus (*Whole plant);*5.Dichrostachys cinerea (*Root); *6. Musa paradisiacal(*Rhizome) ; *7. Scoparia dulcis(*Plant) ; *8. Sesbania grandiflora(*Plant).

LABOUR PAINS : *1.Cissampelos pareira(*Shoot decoction); *2.Sphaeranthus indicus (*Plant) ; *3. Sterculia urens (*Bark) ; *4. Zingiber officnale(*Rhizome).

LAXATIVE : *1. Abutilon indicum (*Seed); *2. Acalypha indica (*Leaf); *3. Acorus calamus (*Rhizome); *4.Ailanthus excelsa (*Bark); *5.baliospermum montanum (*Seed oil) ; *6. Cassia fistula (*Root bark, leaf, Fruit); *7. Delonix elata(*Leaf) ; *8.Hibiscus sabdariffa(*Leaf) ; *9. Jatropha curcas (Seed Oil); 10. Kalanchoe lancelata (Leaf); 11.Ricinus communis(*Seed); *12. Rivea hypocrateriformis(*Plant); *13.Terminalia bellirica (*Seed) ; *14. Terminalia chebula (*Seed).

LEPROSY : *1. Anacardium occidentale (*Bark); *2. Cassia fistula (*Bark); *3. Centella asiatica (*Leaf); *4. Dalbergia latifolia (*Bark, Leaf); *5. Gloriosa superba (*Tuber); *6. mallotus phillippensis (*Fruit)

LEUCODERMA : *1. Cassia fistula (*Bark) ; *2. Catharanthus reoseus (*Plant latex); *3. Coldenia procumbens (*Leaf); *4. Ficus hispida (*Latex) ; *5.Lawsonia inermis(*Leaf) ; *6. Vernonia cineria (*Seed).

LEUCORRHOEA : *1. Aerva lanata (*Root) ; *2. Aristolochia bracteolate(*Stem) ; *3. Asparagus racemosus(*Root) ; *4. Bombax ceiba* (Flower) ; *5. Cardiospermum halicacabum.(*Root) ; *6. Celastrus paniculatus(*Root bark) ; *7. Cocculus hirsutus (*Leaf); *8. Curculigo orchioides(*Tuber) ; *9. Drythrina variegata(*Bark) ; *10.Euphorbia hirta(*Leaf) ; *11. Ficus religiosa (*Bark) ; *12. Flocourtia indica (*Stem) ; *13. Jatropha gossypifolia (*Latex) ; *14. Litsea glutinosa (*Bark) ; *15. Memecylon umbellatum(*Root bark) ; *16. Mucuna utilis (*Seed) ; *17. Paracalyx scariosa (*Root) ; *18. Phyllanthus emblica (*Pericarp) ; *19. Pongamia pinnata(bark)* ; *20.Prosopis cineraria (*Root bark) ; *21.Smilax zeylanica(*Root) ; *22. Streblus asper (*Root) ; *23. Terminalia arjuna(*Bark) ; *24.Urgenia indica(*Bulb)

MALARIA : *1. Andrgraphis paniculata(*Whole plant) ; *2.Azadirachta indica (*Root bark) ; *3. Cassia obtusifolia (*Seed); *4. Cipadessa baccifera(*Root); *5.Clerodendrum serratum(*Root) ; *6.Dendrophthoe falcate(*Flower); *7.Desmodium triflorum(*Whole plant); *8.Melia azedarach(*Bark); *9. Mimosa pudica (*Root) ; *10.Moringa oleifera(*Bark) *11. Musa paradisiacal(*Pseudo stem);*12.Nyctanthes arbortristis(*Leaf); *13.Ocimum tenuiflorum(*Leaf);*14.Pedalium murex(*Leaf); *15.Raphanus sativus(*Seed);*16.Ricinus communis(*Leaf); *17. Sida rhombifolia (*Root);*18.Solamum surrattense Burm.(*Root); *19. Tamarindus indica(*Fruit) ; *20.Toddalia asiatica(*Bark) ; *21.Wrightia arborea (*Root) ; *22.Xanthium strumarium (*Plant).

MENTAL DISORDERS : *1.Biophytum nervifolium(*Whole plant) ; *2.Calotropis gigantean (*Flower)

MUMPS : *1. Dendrophthoe falcate(*Whole plant); *2. Hibiscus rosa sinensis* (Leaf); *3) Sansevieria roxburghiana (*Leaf)

NASAL BLEEDING : *1. Punica granatum (*Flower)

NAUSEA : *1. Citrus aurantifolia(*Rind); *2.Cariandrum sativum (*Seed) ; *3. Cyperus rotundus(*Corm).

NERVOUS DISORDERS : *1. Artimisia vulgaris (*Leaf); *2.Bacopa monnieri (*Whole plant); *3. Citrus aurantifolia(*Rind) ; *4. Phoenix sylvestris (*Fresh Toddy)

NEURALGIA : *1. Brassica nigra (*Seed)

OBESITY : *1. Commiphora caudata(*Resinous gum) ; *2. Macrotyloma uniflorum(*Seed)

OEDEMA : *1. Careya arborea (*Bark); *2. Kydia calycina (*Root)

PARALYSIS : *1. Allium sativum(*Bulb); *2. Atlantia monophylla (*Fruit) ; *3.Capparis zeylanica (*Root bark) ; *4. Cassia occidentalis(*Root) ; *5. Ficus racemosa (*Leaf); *6. Ficus religiosa(*Bark) ; *7. Sida cordata(*Leaf) ; *8 Smilax zeylanica (Root tuber); 9. Solanum surattense (Fruit); 10.Tephrosia purpurea (*Root)

PEPTIC ULCERS : *1. Aegle marmelos(*Leaf) ; *2. Cissampelos pareira (*Root) ; *3. Cleome gynandra(*Whole plant) ; *4.Mimosa intsia (*Plant) ; *5. Mitragyna parvifolia (*Bark) ; *6. Momordica charantia (*Root) ; *7. Pueraria tuberosa (*Tuberous root) ; *8. Solena heterophylla (*Root) ; *9. Sterculia urens (*Bark)

PILES : *1. Abutilon indicum (*Seed) ; *2. Achyranthes aspera(*Root); *3. Aegle marmelos (*Fruit) ; *4. Amorphophallus paeoniifolius (Corm)* ; *5. Azadirachta indica(*Leaf) ; *6.Carica papaya (*Latex) ; *7. Celosia argentea var. cristata (*Inflorescence) ; *8. Cynodon dactylon(*Grass) ; *9. Jatropha gossypifolia(*Latex) ; *10.Manilkara hexandra (*Bark) ; *11. Plumbago zeylanica (*Root bark) ; *12. Polygonum glabrum(*Root) ; *13. Pterocarpus marsupium (*Bark)

PNEUMONIA : *1. Trichosanthes tricuspidata (*Tuber)

POST PATRUM PROBLEMS : *1. Ailanthes excelsa (Leaf); 2) Bueta monosperma (Bark); 3.Coccinia grandis(*Whole plant); 4. *Leonotis nepetaefolia (*Inflorescence); *5. Macrotyloma uniforum(* Seed) ; *6. Plumbago zeyanica (W*hole plant) ; *7.Pongamia pinnata (*Bark).

PSORIASIS : *1. Argemone mexicana (*Whole plant); *2. Coldenia procumbens(*Leaf) ; *3. Curcuma longa(*Rhizome) ; *4. Justica adhatoda (*Leaf)

RASHES : *1. Datura innoxia (*Seed) ; *2. Datura metel(*Seed)

RAT BITE : *1. Entada pursaetha (*Leaf)
RHEUMATISM : *1. Amorphophallus paeoniifolius(*Corm) ; *2. Atalantia monophylla (*Fruit) ; *3. Azima tetracantha(*Leaf, root) ; *4. Brassica nigra (*Seed) ; *5. Calotropis gigantean (*Root) ; *6. Cissampelos pareira(*Root) ; *7. Cissus repens (*Root) ; *8. Cryptolepis buchanani(*Root) ; *9. Cycas circinalis(*Root) ; *10.Datura innoxia(*Leaf) ; *11. Datura metel(*Leaf, fruit) ; *12. Dichrostachys cinerea(*Root) ; *13. Ficus microcarpa(*Latex) ; *14. Guizotia abyssinica (*Seed) ; *15. Kalanchoe lanceolata(*Leaf) ; *16. Lagerstroemia parviflora(*Bark); *17. Ocimum tenuiflorum (*Leaf); *18. Plumbago zeylanica (*Root) ; *19. Pueraria tuberosa (*Tuber) ; *20. Ricinus communis (*Root); *21. Sesamum indicum(*Oil); *22. Sterculia turens (*Bark) ; *23.Terminalia chebula (*Fruit) ; *24. Urena labata(*whole plant) ; *5. Vanda tessellata(*Root) ; *26. Vitex negundo(*Root, Leaf) *27. Woodfordia fruticosa (*Leaf)
RIBMUSCLE PAIN : *1. Alangium salvifolium (*Root bark) ; *2. Baliospermum montamum (*Root) ; *3. Borassus (*Stem) ; *4. Cascabela thevetia (*Latex) ; *5. Datura Innoxia (*leaf) ; *6. Datura metel (*Leaf, Fruit) ; *7. Momordica dioica (*Tuber); *8. Streblus asper (*Bark).
ROTTING TOES : *1. Impatiens balsamina (*Leaf)
BRAIN TONIC : *1. Bacopa monnieri(*Whole plant)
SCABIES : *1. Abutilon indicum(*Leaf) ; *2. Asparagus racemosus(*Leaf) ; *3.Crinum asiaticum (*Bulb) ; *4. Crotalaria verrucosa (*Leaf) ; *5. Holoptelea integrifolia (*Bark); *6. Pergularia Daemia(*Fruit, Leaf)
SCORPION STING / INSECTSTING : *1. Adiantum philippense(*Rhizome); *2. Bridelia retusa (*Bark); *3. Crotalaria larburnifolia (*Leaf) ; *4. Diplocyclos palmatus (*Leaf) ; *5. Heliotropium indicum (*Leaf) *6. Luffa acutangula (*Tendril) ; *7. Selaginella repanda (*Plant); *8. Strychnos nux-vomica(*Root bark) ; *9. Tamarindus indica (*Seed);*10. Tinospora cordifolia(*Tuber, aerial root)
SCROFULA : *1. Plumbago auriculata(*Root) ; *2. Xanthium strumarium(*Leaf)
SCURVY : *1. Anacardium occidentale(*Fruit) ; *2. Phyllanthus emblica (*Fruit) ; *3. Portulaca oleracea(*Plant)
SKIN DISEASES : *1. Acalypha indica (*Leaf) ; 2. *Argemone mexicana(*Leaf) ; *3. Biophytum nervifolium (*Leaf); *4. Blumea mollis(*Leaf); *5. Calamus viminalis(*Rechis, petiole) ; *6. Cleistanthus collinus (*Root bark); *7. Coldenia procumbens(*Whole plant) ; *8. Combretum roxburghii (*Leaf); *9. Crotalaria verrucosa(*Leaf) ; *10. Cucumis melo (*Fruit) ; *11. Curcuma longa (*Rhizome) ; *12. Desmodium triflorum (*Leaf) ; *13.Entada Pusaetha (*Seed) ; *14. Indoneesiella echiodes(*Leaf) ; *15. Kydia calycina(*Bark) ; *16.Momordica dioica(*Leaf) ; *17. Murraya koenigii (*Bark) ; *18. Moringa oleifera (*Bark) ; *19. Plumbago auriculata (*Root) ; *20. Plumeria rubra (*Latex) *21. Pueraria tuberosa* (Tuber);*22. Strychnos nuxvomica(*Leaf); *23. Vicoa indica(*Leaf).
SMALL POX : 1. *Sesbania grandiflora(*Bark)
SNAKE BITE / ANTIDOTE FOR POISON : *1. Acorus calamus(*Root bark) ; *2. Aristolochia indica (*Root) ; *3. Calotropis procera(*Leaf) ; *4.Entada pursaetha (*Seed) ; *5. Helicteres isora(*Bark) ; *6. Hybanthus enneaspermus (*Plant) ; *7. Indoneesiella echiodes(*Plant) ; *8. Lantana camara (*Seed) ; *9. Murraya koenigii (*Bark); *10.Polygala arvensis (*Plant); *11. Rauvolfia serpentina(*Root) ; *12. Solena heterophylla(*Root bark) ; *13. Stachytarpheta urticaefolia(*Plant) ; *14. Strychnos nux-vomica (*Root bark) ; *15. Strychnos potatorum (*Seed); *16. Tiliacora acuminata(*Root); *17. tinospora cordifolia (*Plant, Tuber) ; *18. Trichosanthes tricuspidata (*Root) ; *19. Urgenia indica(*Bulb) ; *20. Woodfordia fruticosa(*Bark) ; *21. Wrightia arborea (*Latex)
SPERMATORRHOEA : *1. Barleria prionitis (*Leaf) ; *2.Evolvulus alsinoides (*Whole plant) ; *3.Ficus bengalensis (*Fruit) ; 4. *Mucana utilis(*Seed) ; *5. Smilax zeylanica (*Root tuber) ; *6. Tinospora cordifolia* (Plant).
SPLEEN DISORDERS : *1. Barringtonia acutangula(*Seed); *2. Canavalia gladiata (*Root) ; *3. Citrullus colocynthis (*Root).
SORES: *1.Leonotis nepetaefolia (*Inflorescence, seed); *2.Commelina benghalensis(*Plant) ; *3. Moringa oleifera (*Bark)
SPRAINS : *1. Aganosma caryophyllata(*Leaf of plant); *2. Cascabela thevetia(*Latex); *3. Cassytha filiformis(*Stem) ; *4. Chromolaena odorata (*Whole plant) ; *5. Ichnocarpus frutescens(* Leaf, Flower); *6. Kalanchoe lanceolata (*Leaf) ; *7. Ixora pavetta (*Root or stem bark) ; *8. Lannea coromandelica (*Bark) ; *9. Madhuca longifolia(*Flower) ; *10. Mirabilis jalapa (*Root); *11 .Terminalia chebula (*Fruit).
STERILIZATION : *1. Canavalia gladiata (*Seed) ; *2. Carica papaya (*Seed) ; *3. Datura metal(*Root) ; *4. Pandanus odoratissimus(*Root) ; *5. Tragia involucrate(*Leaf) ; *6. Tribulus terrestris (*Root)
STIMULANT DRINK : *1. Hemidesmus indicus (*Root) ; *2. Piper betle (*Leaf)
STOMACH PAIN : *1. Andhographis paniculata (*Root, leaf) ; *2. Aristolochia indica (*Root); *3. Asparagus racemosus(*Root tubers) ; *4. Baliospermum montanum (*Root); 5. Borreria pusilla)(Whole plant) ; 6. Cheilanthes tenuifolia (Root); *7. Clerodendrum serratum* (Root) ; *8. Cyperus rotundus (Corn)* ; *9. Elephantopus scaber (*Root) ; *10. Garuga pinnata (*Bark); *11. Haldina cordifolia* (Bark) ; *12. Helicteres isora(*Fruit) ; *13. Holarrhena antidysenterica (*Root bark); *14. Limonia acidissima (*Leaf); *15.Lygodium flexuozum (*Root) ; *16. Pergularia daemia (*Root); *17. Pterospermum xylocarpum (*Fruit); *18. Soymida febrifuga (*Bark); *19. Tephrosia purpurea(*Root) ; *20. Wrightia tinctoria(*Bark).
SYPHILIS : *1. Agave cantual (*Leaf) ; *2. Cocculus hirsutus(*Leaf) ; *3. Lawsonia inermis (*Leaf) ; *4. Vitex altissima (*Root *bark).*
TEETH INFECTION / TROUBLES : *1. Achyranthes aspera (*Root) ; *2.Barleria prionitis(*Leaf); *3. Crateva magna (*Leaf); *4. Evolvulus alsinoides(*Whole plant); *5. Ficus microcarpa (*Fruit); *6. Indigofera tinctoria(*Leaf); *7.Indoneesiella echioides (*Root); *8. Jatropha curcas (*Root);*9. Jatropha gassypifolia (*Whole plant);*10.Madhuca longifolia(*Bark); *11.Nyctanthes arbor-tristis (*Bark); *12. Phyla nodiflora (*Whole plant); *13. Piper nigrum*

*(*Root); *14. Psidium guajava (*Leaf); *15. Solamum surattense (*Whole plant); *16. Streblus asper (*Stem, Branches).

THROAT TROUBLES : *1. Abrus precatorius(*Root) ; *2. Allium cepa (*Bulb); *3. Coriandrum sativum (*Plant) ; *4. Crotalaria laburnifolia (*Leaf); *5. Nyctanthes arbor-tristis (*Bark).

TUBERCULOSIS : *1. Actinopteris radiate (*Leaf); *2. Artocarpus heterophyllus (*Fruit); *3. Capparis zeylanica (*Root bark); *4. Justicia adhatoda (*Leaf); *5. Schleichera aleosa (*Bark); *6. Thespesia lampas(*Seed)

TYPHOID : *1. Adintum philippense (*Whole plant) ; *2. Balanites aegyptiaca (*Seed) ; *3. Diospyros melanoxylon (*Bark); *4. Thespesia lampas (*Root) .

ULCERS : *1. Anacardium accidentale (*Bark); *2. Biophytum nrevifolium (*Leaf);*3. Buchanania lanzan (*Bark); *4. Calycopteris floribunda (*Root bark); *5. Canscora diffusa (*Whole plant); *6. Catunaregam spinosa(*Root) ; *7. Centella asiatica(*Whole *Plant)* ; *8. Cuscuta reflexa(*Plant)*; 9. Cyperus rotundus (*Root)*;10. Elephantopus scaber(*Root)*; 11. Ficus hispida (*Bark)*; 12. Heliotropium indicum (*Leaf)*; 13. Hyptis suaveolens (*Seed)*; 14. Kydia calycina (*Bark) ; 15.Maytenus emarginata (*Leaf)*; 16. Nyctanthes arbor-tristis(*Bark) ; 17. Pongamia pinnta (*Bark, Leaf)*; 18. Selaginella repanda (*Plant) ; 19. Waltheria indica* (Plant).

URINARY DISORDERS : *1. Anogeissus latifolia (*Gum); *2. Artemisia vulgaris.(*Leaf); *3. Caryota urens (*Whole Plant); *4. Crateva magna (*Bark); *5. Cynodon dactylon(*Leaf); *6. Justicia adhatoda (*Leaf) ; *7.Martynia annua (*Leaf) ; *8. Mimosa pudica* (Root) ; *9. Tribulus terristris (*Whole plant) ; *10. Vetiveria zizanioides (*Root).

URETERAL STONES : *1. Aerva lanata (*Whole *plant)* ; *2. Coleus ambonicus (*Whole *Plant)* ; *3. Dichrostachys cinerea (*Root) ; *4. Phyla nodiflora (*Leaf)

UTERINE BLEEDING: *1.Celosia argentea var. cristata (*Inflorescence)

WHITE DISCHARGE / GLEET : *1. Wrightia arborea (*Root); *2. Xanthium strumarium (*Plant).

WHOOPING COUGH : *1. Artemisia vulgaris (*Leaf) ; *2. Desmodium gangeticum (*Root); *3. Limonia acidissima (*Root bark) ; *4. Pterolobium hexapetalum (*Bark).

WITHLOW : *1.Calotropis gigantean (*Latex) ; *2. Citrus aurantifolia (*Fruit)

WOUNDS / CUTS : *1. Ageratum conyzoides(*Plant); *2. Borassus flabellifer (*Male flower); *3. Calamus viminalis (*Rachis, petiole) ; *4. Carica papaya (*Fruit) ; *5. Cassia obtusifolia (*Leaf) ; *6. Chromolaena odorata (*Whole plant); *7. Cleome viscose (*Leaf); *8. Cyperus rotundus (*Root); *9. Eclipta prostrata (*Leaf) ; *10. Emilia sonchifolia(*Leaf) ; *11. Euphorbia hirta(*Plant); *12. Euphorbia nivulia Buch. (*Latex); *13. Ficus hispida (*Root *bark)*; *14. Ficus micrpcarpa (*Root *bark)*; *15. Garuga pinnata(*Leaf); *16.Gmelina asiatica (*Fruit); *17. Heliotropium Indicam (Leaf); 18. Hibiscus sabdariffa (*Leaf);*19.Kalanchoe pinnata (*Leaf); *20. Leonotis neptoaefolia(*Inflorescence); *21. Mallotus Phillippensis (*Leaf); *22. Mangifera indica(*Gum of Bark); *23. Maytenus emargianta (*Leaf); *24. Portulaca oleracea(*Plant); *25. Sarcostemma secamone (*Leaf); *26. Semecarpus anacardium (*Pericarp) ; *27.Shorea robusta (*Bark); *28. Stachytarpheta urticaeflia(*Leaf); *29. Terminalia chebula (*Fruit); *30. Tridox procumbens (*Plant); *31. Urena lobota (*Leaf); *32. Wrightia tinctoria(*Latex) ;

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Ethnomedicinal data for veternary diseases / ailments / uses

S. No.	Name of the Plant	Disease / Ailment / Uses	Parts Used
1.	*Abrus precatorius*	Wounds	Root
		Sore mouth	Root, *leaf*
2.	*Abul\tilon indicum*	Sore *eye*	Leaf
3.	*Anona reticulata*	Wounds	Leaf
4.	*Annona swuamosa*	Wounds	Leaf
5.	*Anogeissus latifolia*	Snake bite	Seed
6.	*Aristolochia bracteolate*	Indigestion *& Flatulence*	Whole *Plant*
7.	*Atylosia scarabeoides*	Diarrhoea, Gastric disorders	Whole *Plant*
8.	*Azadirachta indica*	Ulcers, Wounds, *Skin* & *Liver* Diseases, Cough, *&* Anthelmintic.	Leaf
9.	*Boerhaavia diffusa*	Diuretic	Whole *plant*
10.	*Butea monosperma*	Intestinal worms	Leaf
11.	*Caesalpinia bonduc*	Inflammation *of Umbilicus*	Leaf , Seed
12.	*Carissa spinarum*	Intestinal worms, *Cholera* Wounds	Root
13.	*Casearia elliptica*	Wounds, Ulcers *& Urinary* troubles	Bark
14.	*Chlorozylum swietenia*	Wounds *&* Ulcers	Leaf
15.	*Cissus guadrangularis*	Fractured bones	Stem
16.	*Citrus Medica*	Scabies	Leaf
17.	*Citrus sinensis*	Ulcers *&* Worms	Leaf
18.	*Cleistanthus collinus*	Sores	Bark
19.	*Clematis gouriana*	Wounds	Leaf
20.	*Coccinia grandis*	Galactagogue	Leaf
21.	*Colebrookea oppositifolia*	Cataract	Leaf
22.	*Coleus ambonicus.*	Eye *infection & Worms*	Leaf
23.	*Commelina benghalensis*	Yoke *sores*	Plant
24.	*Cateva magna*	Diphtheria	Bark
25.	*Cryptolepis buchananii*	Galactagogue	Leaf
26.	*Dalbergia sissoo*	Diarrhoea	Leaf
27.	*Dendrocalamus strictus*	Anthrax	Leaf
28.	*Dendrophthoe falcate*	Bone fractures	Plant
29.	*Dodonaea viscose*	Bone fracture	Leaf
30.	*Drosera burmanii*	Wounds	Root
31.	*Diospyros melanoxylon*	Dirrhoea	Bark
32.	*Elephantopus scaber*	Wounds	Root

33.	*Enatada pursaetha*	Vermifuge	Seed
34.	*Ficus hispida*	Galactagogue	Fruit
35.	*Glycosmis pentaphylla*	Wounds	Leaf
36.	*Grewia hirsute*	Bone fracture	Root
37.	*Grewia tiliaefolia*	Dislocated joints	Root *bark*
38.	*Hemionitis arifolia*	Wounds and ulcers	Plant
39.	*Holoptelea integrifolia*	Bronchial disorders	Leaf
40.	*Jatropha gossypifolia*	Eye injures, Bone fracture	Plant Root
41.	*Kalanchoe pinnata*	Skin infection	Leaf
42.	*Lawsonia inermis*	Loose motions	Leaf
43.	*Leonotis nepetaefolia*	Mastitis *(*Inflammation*)*	Root
44.	*Leucas cephalotes*	Ulcerous wounds	Leaf*, Seed*
45.	*Litsea glutinosa*	Bone fracture	Bark
46.	*Luffa acutangula*	Yoke *gal sore*	Leaf
47.	*Macaranga peltata*	Wounds *&* Worms	Bark
48.	*Macrotyloma uniflorum*	Galactagague	Seed
49.	*Madhuca longifolia*	Intestinal worms, Joint pains for stiffness	Flower, Seed
50.	*Manilkara hexandra*	Throat *infections*	Bark
51.	Martynia *annua*	Wounds & sores	Leaf
52.	*Melia azedarach*	Anthelmintic & Fever	Leaf
53.	*Morinda pubescens*	Cracks on the neck	Leaf
54.	*Mucana utilis wall.*	Gastric disorders *& Worms*	Seed
55.	*Murraya paniculata*	Bone fracture	Leaf
56.	*Ocimum americanum*	Wounds	Leaf
57.	*Oroxylum indicum*	Wounds	Root *bark*
58.	*Pergularia daemia*	Muscular pains & *Eye diseases*	Leaf
59.	*Phyllanthus reticulates*	Dysentery	Leaf
60.	*Piper longum.*	Wounds *&* Ulcers	Fruit
61.	*Plumbago zeylanica*	Wounds	Plant
62.	*Plumeria rubra*	Wounds *& Skin Infections*	Latex
63.	*Pongamia pinnata*	Bronchial problems*,* Galactagogue*.* Skin diseases*,* Sores *&* Wounds	Leaf, Seed
64.	*Prosopis cineraria*	Mouth *ulcers*	Leaf
65.	*Pterocarpus marsupium*	Wounds *&* Worms	Bark
66.	*Pterolobium hexapetalum*	Dyspepsia	Bark
67.	*Rubia cordifolia*	Post natal problems	Bark
68.	*Schiechera oleosa*	Wounds *& Ulcers*	Seed
69.	*Semecarpus anacardium*	Wounds	Seed
70.	*Shorea robusta Gaertn.*	Dysentery	Bark
72.	*Solena heterophylla*	Cuts on the tongue	Tuberous *root*
73.	*Spermodictyon suaveolens*	Wounds	Leaf
74.	*Strychnos potatorum*	*Eye* infections	Seed
75.	*Terminalia chebula*	Anthrax	Fruit
76.	*Thespesia Lampas*	*Eye* diseases	Root
77.	*Trema orientalis*	Mouth diseases	leaf
78.	*Trichosanthes tricuspidata*	Dysentery	Tuber
79.	*Tridax procumbens*	Wounds	Root
80.	*Urena lobata*	Wounds	Leaf
81.	*Xanthium strumarium*	Gland swellings	Plant

Liana diversity in Eastern Ghats

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Abstract

Eastern Ghats are a discontinuous chain of hill ranges running parallel to the east coast of peninsular India, extending through parts of four states; Orissa, Andhra Pradesh Karnataka and Tamil Nadu. Eastern Ghats are part of Deccan peninsula biogeographic zone supporting diverse dry tropical forests comprising of all plant life forms. Lianas (woody climbers) are one of the significant groups of vascular plants. Lianas are woody climbing plants that rely on external physical support to ascend to the canopy. It is reported that approximately one half of the families of vascular plants contain climbing species and the climbing habit has apparently evolved independently Lianas have a variety of adaptations for climbing towards the forest canopy such as stem twining, tendrils arising from leaf and branch modifications, thorns and spines. Lianas contribute heavily to high above ground biomass, whole forest transpiration, Carbon sequestration and also provide essential food and canopy structure to many forest animals. Lianas are found to be diverse and higher in abundance in disturbed forest areas as they can better utilize the sunlight and the gaps formed. A total of 149 liana species representing 31 families and 90 genera are present in the Eastern Ghats. Fabaceae is the dominant family with 28 species followed by Asclepiadaceae with 14 species and Convolvulaceae comprising of 12 species. All the climbing mechanisms – twining, tendril climbing, hook climbing, and straggling except root climbing are observed in this region. Among them, twiners with 109 species (74%) are the dominant lianas followed by stragglers with 32 species (22%) and the rest 4% include 4 hook climbers and 3 tendril climbers. Among lianas different kinds of diaspore types adapted for wind, animal, water and autochorous modes of dispersal were observed. Forty six species (31%) bore wind dispersed diaspores like samara, seeds with tufts of hairs and 44 species (30%) had reward producing diaspores meant for dispersal by animals and 57 species can be categorized as featuring autochorous mode of dispersal.

Key words: Climbing mechanism, Dispersal modes, Eastern Ghats, Lianas

Introduction

Eastern Ghats are a discontinuous chain of hill ranges running parallel to the east coast of peninsular India, extending from river Mahanandi in the North to Vaigai river in the south through parts of four states; Orissa, Andhra Pradesh, Karnataka and Tamil Nadu. Eastern Ghats are part of Deccan peninsula biogeographic zone supporting diverse tropical forests like semi evergreen, moist deciduous dry deciduous and scrub that comprises of all plant life forms with a wider variety of shapes, sizes and architecture (Rawat 1997). Among them lianas are abundant and diverse group being strictly defined as woody climbing plants that rely on external physical support to ascend to the canopy (Schnitzer & Bongers 2002). It is observed that approximately 50% of the families of vascular plants contain climbing species and nearly 60% of all dicotyledonous plant orders have at least one representative climber and families such as Hippocrateaceae and Vitaceae contain all species showing climbing habit (Putz 1984). This implies that the climbing habit has apparently evolved independently in a diverse array of taxa including the Gymnospermae (Gnetaceae), Monocotyledonae (eg. Palmae) and Dicotyledonae (eg. Bignoniaceae).

Lianas have a variety of adaptations for attaching themselves to their host and climb towards the forest canopy. These adaptations include stem twining (twiners), tendrils arising from leaf and branch modifications (tendril climbers), thorns and spines that are helpful for the liana to climb the host (scramblers). Many of the times scramblers just lean on but do not attach firmly to the supports. In addition to lianas contribution to high above ground biomass, whole forest transpiration, Carbon sequestration they provide essential food and canopy structure to many forest animals(Schnitzer & Bongers 2002).. It is noticed that lianas richness and abundance varied greatly from one forest type to another and even between forest areas and their abundance is positively related to soil fertility, length of dry season and mainly with natural and anthropogenic disturbances (Putz & Chai 1987). Thus the fact being forests are increasingly disturbed will increase the relative importance of lianas in forest dynamics.

Results

A total of 149 liana species representing 31 families and 90 genera are present in the Eastern Ghats (Table 1) (Pullaiah *et al.* 1997; Saxena & Brahmam 1994 and 1995; Mathew 1991; Sharma *et al*. 1984). Fabaceae is the dominant family with 28 species followed by Asclepiadaceae with 14 species and Convolvulaceae comprising of 12 species. Among 30 families 22 (73%) families have constituted less than 5 species and single species was present in 4 families and 9 families comprised of two species (Fig. 1). *Gnetum ula* is the lone gymnosperm climber that occurs conspicuously in moist areas of moist deciduous forests. All the climbing mechanisms – twining, tendril climbing, hook climbing, and straggling except root climbing are observed among lianas of this region. Among them, twiners with 109 species (74%) are the dominant lianas

followed by stragglers with 32 species (22%) and the rest 4% include 4 hook climbers and 3 tendril climbers. It is noted that few species such as *Naravelia zeylanica*, *Strychnos sps*, *Ventilago sps* show multiple climbing strategies to climb.

Different kinds of diaspore types adapted for wind, animal, water and autochorous modes of dispersal were observed among these lianas. A comparison of dispersal modes revealed that there is no significant difference among species with different dispersal modes ($^2_{(2)}$ = $p<0.05$). Forty six species (31%) bore wind dispersed diaspores like samara as in *Hiptage benghalensis*, *Ventilago maderaspatana* etc., and seeds with tufts of hairs featured by *Marsdenia tenacissima*, *Decalepis hamiltonii* etc. Forty four species (30%) like *Hugonia mystax*, *Ziziphus oenoplia* etc. had reward producing diaspores meant for dispersal by animals and no categorization of diaspores that are specially dispersed by birds and animals is done in this exercise. Majority of species (57 lianas) especially belonging to Fabaceae and Caesalpiniaceae members with legume fruits can be categorized as featuring autochorous mode of dispersal. *Entada pursaetha* a large girthed liana with distinct large woody pod comprising of 10-12 big round seeds is apparently found to be dispersed by water owing to its distinct distribution along the stream beds. Among twiners 39 species (36%) possess diaspores favorable to be dispersed by wind and 24 species to be dispersed by animals and among stragglers 56% (18 species) of species bore fruits and seeds to be dispersed by animals (Fig 2). Species such as *Hemidesmus indicus*, *Decalepis hamiltonii*, *Gymnema sylvestre*, *Tinospora cordifoloa*, *Entada purseatha*, *Acacia sinuate*, *Caesalpina bonduc*, *Secamone emetica* etc. are found to be of medicinal value and leaves of *Bauhinia vahlii* are of economic value and they form an important component of NTFP products generating money to the local people.

Conclusion

The diversity of 149 lianas comprising nearly 5% of the total state plant diversity indicates a significant proportion of this life form among plants in Eastern Ghats. The presence of lianas in all the forest types and nearly 44% of them bearing different kinds of fruits that form a rich source of food for animals, especially birds are found congregated on these plants, indicate their effective role in forest ecosystem. In addition the leaves may also form a rich source of food for many insects and their hanging and twining branches form ideal perches for birds and animals to lay their nests and resting positions and also to reach the canopy.

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Table 1. List of lianas, their climbing mechanism and dispersal mode of Eastern Ghats

Plant Name	Climbing type	Dispersal mode
RANUNCULACEAE		
Clematis smilacifolia Wall.	TW	Wind
Clematis wightiana Wall. ex Wight & Arn.	TW	Wind
Naravelia zeylanica (L.) DC.	TW+TC	Wind
ANNONACEAE		
Artabotrys hexapetalus (L.f.) Bhandari	HC	Animal
Uvaria lurida Hook.f. & Thoms.	TW	Wind
MENISPERMACEAE		
Anamirta cocculus (L.) Wight & Arn.	TW	Animal
Cocculus hirsutus (L.) Diels in Engl.	TW	Animal
Pachygone ovata (Poir.) Miers ex Hook.f.&Thoms.	TW	Animal
Parabaena sagittata Miers	TW	Animal
Tiliacora acuminata (Lam.) Miers	TW	Animal
Tinospora cordifolia (Willd.) Miers ex Hook.f.& Thoms.	TW	Animal
Tinospora sinensis (Lour.) Merr.	TW	Animal
CAPPARACEAE		
Capparis floribunda Wight III.	STR	Animal
Capparis roxburghii DC.	STR	Animal
Capparis sepiaria L.	STR	Animal
Capparis zeylanica L.	STR	Animal
Maerua oblongifolia (Frossk.) A. Rich.	STR	Autochorous
TILIACEAE		
Grewia obtusa Wall. Ex Dunn	TW	Animal
Grewia rhamnifolia Heyne ex Roth.	STR	Animal
LINACEAE		
Hugonia mystax L.	HC	Animal
MALPIGHIACEAE		
Aspidopterys cordata (Heyne ex Wall.) A. Juss.	TW	Wind
Hiptage benghalensis (L.) Kurz	TW	Wind
RUTACEAE		
Paramignya monophylla Hook.f.	STR	Animal
Paramignya scandens (Griff.) Craib	STR	Animal
Zanthoxylum limonella (Dennst.) Alston	STR	Animal
Toddalia asiatica (L.) Lam. var. *floribunda* Gamble	STR	Animal
OLACACEAE		
Olax imbricata Roxb.	TW	Autochorous
Olax scandens Roxb.	STR	Animal
OPILIACEAE		
Cansjera rheedii Gmel.	TW	Animal
Opilia amentacea Roxb.	TW	Animal
ICACINACEAE		
Natsiatum herpeticum Ham. ex. R. Br.	TW	Autochorous
Pyrenacantha volubilis Wight	TW	Autochorous
CELASTRACEAE		
Celastrus paniculatus Willd.	TW	Animal
Loeseneriella obtusifolia (Roxb.) A.C. Smith	TW	Wind
Reissantia grahamii (Wight) Ding Hou	TW	Wind
Reissantia indica (Willd.) Halle	TW	Wind
Salacia chinensis L.	TW	Animal
Salacia oblonga Wall. ex Wight & Arn.	TW	Animal
Salacia reticulata Wight	TW	Animal
RHAMNACEAE		

Gouania leptostachya DC.	TC	Autochorous
Helinus lanceolatus Hook.f.	TC	Autochorous
Sageretia filiformis (Roem. & Schultes) G.Don	STR	Animal
Ventilago denticulata Willd.	HC+STR	Wind
Ventilago gamblei Susseng.	HC+STR	Wind
Ventilago maderaspatana Gaertner	HC+STR	Wind
Ziziphus funiculosa Buch.-Ham.	STR	Animal
Ziziphus oenoplia(L.)Mill.	STR	Animal
Ziziphus rugosa Lam.	TW	Animal
CONNARACEAE		
Connarus paniculatus Roxb.	TW	Wind
*Rourea minor (*Gaertn.) Alston	TW	Autochorous
FABACEAE		
Abrus fruticulosus Wall. ex Wight & Arn.	TW	Autochorous
Abrus precatorius L.	TW	Animal
Atylosia albicans (Wight & Arn.) Benth.	TW	Autochorous
Atylosia volubilis (Blanco) Gamble	TW	Autochorous
Butea parviflora Roxb.	TW	Autochorous
Butea superba Roxb.	TW	Autochorous
Canavalia mollis Wight & Arn.	STR	Autochorous
Canavalia virosa (Roxb.) Wight & Arn.	TW	Autochorous
Dalbergia candenatensis Dennst.	TW	Autochorous
Dalbergia rubiginosa Roxb.	STR	Autochorous
Dalbergia spinosa Roxb.	STR	Autochorous
Dalbergia volubilis Roxb.	TW	Autochorous
Derris scandens (Roxb.) Benth.	TW	Wind
Derris trifoliata Lour.	TW	Wind
Dunbaria ferruginea Wight & Arn.	TW	Autochorous
Millettia auriculata Banker ex Brandis	TW	Autochorous
Millettia racemosa (Wight & Arn.) Benth.	TW	Autochorous
Mucuna atropurpurea DC.	TW	Autochorous
Mucuna gigantea DC.	TW	Autochorous
Mucuna hirsuta Wight & Arn.	TW	Autochorous
Mucuna monosperma DC. ex Wight	TW	Autochorous
Mucuna nigricans (Lour.) Steud.	TW	Autochorous
Paracalyx scariosus (Roxb.) Ali	TW	Autochorous
Pueraria tuberosa DC.	TW	Autochorous
Rhynchosia bracteata Benth.	TW	Autochorous
Rhynchosia hirta (Andrews) Meikle & Verdc.	TW	Autochorous
Rhynchosia rothii Benth. ex Aitch.	TW	Autochorous
Rhynchosia viscosa (Roth) DC.	TW	Autochorous
CAESALPINIACEAE		
Bauhinia vahlii Wight & Arn.	TW	Autochorous
Caesalpina cucullata Roxb.	STR	Wind
Caesalpina bonduc (L.)Roxb.	STR	Animal
Caesalpinia digyna Rottl.	STR	Autochorous
Pterolobium hexapetalum (Roth) Sant. & Wagh	STR	Wind
MIMOSACEAE		
Acacia caesia (L.) Willd.	STR	Autochorous
Acacia pennata (L.) Willd.	STR	Autochorous
Acacia sinuata (Lour.) Merr.	STR	Autochorous
Entada pursaetha DC.	TW	Hydrophily
Mimosa intsia L.	STR	Autochorous
Mimosa polyancistra Benth.	STR	Autochorous
Mimosa prainiana Gamble	STR	Autochorous
COMBRETACEAE		

Calycopteris floribunda	TW	Wind
Combretum albidum G.Don	TW	Wind
Combretum latifolium Bl.Bijdr.	TW	Wind
Combretum roxburghii Spreng.	TW	Wind
PASSIFLORACEAE		
Adenia cardiophylla (Mast.) Engler	TC	Wind
RUBIACEAE		
Morinda umbellata L.	TW	Autochorous
Oxyceros rugulosus (Thunb.)Tiry.	TW	Animal
MYRSINACEAE		
Embelia basal (Roemer ex Schultes) A. Dc.	STR	Animal
Embelia ribes Burm.f.	STR	Animal
OLEACEAE		
Jasminum angustifolium Vahl.	TW	Animal
Jasminum roxburghianum Wall.	TW	Autochorous
Jasminum scandens Vahl.	TW	Animal
Jasminum sessiliflorum Vahl.	TW	Animal
APOCYNACEAE		
Aganosma cymosa (Roxb.) G.Don	TW	Wind
Aganosma dichotoma (Roth) K. Schum.	TW	Wind
Anodendron paniculatum (Roxb.) A. DC.	TW	Wind
Carissa inermis Vahl,Symb.	STR	Animal
Ichnocarpus frutescens (L.) R. Br.	TW	Wind
Vallaris solanacea (Roth) O. Kuntze	TW	Wind
ASCLEPIADACEAE		
Cosmostigma racemosum (Roxb.) Wight	TW	Wind
Cryptolepis buchanani Roem. & Schult.	TW	Wind
Cryptostegia grandiflora R.Br.	TW	Wind
Decalepis hamiltonii Wight & Arn.	TW	Wind
Gymnema sylvestre (Retz.) R.Br.	TW	Wind
Gymnema hirsutum Wight & Arn.	TW	Wind
Gymnema tingens Wight & Arn.	TW	Wind
Hemidesmus indicus (L.) R.Br. var. *indicus*	TW	Wind
Holostemma ada-kodien Schult.	TW	Wind
Leptadenia reticulata (Retz.) Wight & Arn.	TW	Wind
Marsdenia brunoniana Wight & Arn.	TW	Wind
Marsdenia tenacissima (Roxb.) Moon.	TW	Wind
Secamone emetica (Retz.) R. Br.	TW	Wind
Wattakaka volubilis (L.f.) Stapf.	TW	WInd
LOGANIACEAE		
Strychnos colubrina L.	TW	Animal
Strychnos lenticellata Hill	TW	Animal
Strychnos wallichiana Steud.	TW	Animal
CONVOLVULACEAE		
Argyreia arakuensis Bal.	TW	Autochorous
Argyreia cymosa (Roxb.) Sweet Hort.	TW	Autochorous
Argyreia daltoni C.B. Clarke	TW	Autochorous
Argyreia hirsuta Arn.	TW	Autochorous
Argyreia involucrata C.B. Clarke	TW	Autochorous
Argyreia nervosa (Burm.f.) Boj.	TW	Autochorous
Argyreia roxburghii Choisy	TW	Autochorous
Argyreia setosa (Roxb.) Choisy	TW	Autochorous
Erycibe paniculata Roxb.	TW	Autochorous
Hewittia scandens (Milne) Mabb.	TW	Autochorous
Rivea hypocrateriformis (Desr.) Choisy	TW	Wind
Rivea ornata Choisy	TW	Wind

VERBENACEAE		
Holmskioldia sauguinea Retz.	TW	Autochorous
Sphenodesme involucrata (Presl) Roxb.	TW	Autochorous
Symphorema involucratum Roxb.	TW	Wind
Symphorema polyandram Wight	TW	Wind
POLYGONACEAE		
Polygonum chinense L.	TW	Autochorous
EUPHORBIACEAE		
Bridelia stipularis (L.) Bl.	TW	Animal
Dalechampia indica Wt.	TW	Autochorous
Mallotus repandus Muell.-Arg.	TW	Wind
Pterococcus corniculatus (Sm.) Pax & Hoffm.	TW	Autochorous
MORACEAE		
Plecospermum spinosum Trecul.	STR	Animal
GNETACEAE		
Gnetum ula Brongn.	TW	Animal

Note: HC – Hook climbers, STR- Stragglers, TC-Tendril climbers, TW- Twiners.

Fig. 1 Lianas showing four different Climbing mechanisms and Dispersal modes of lianas

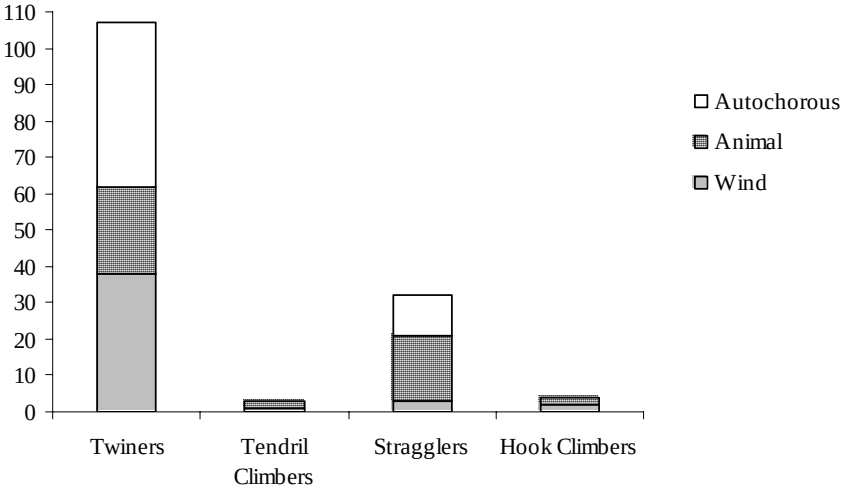
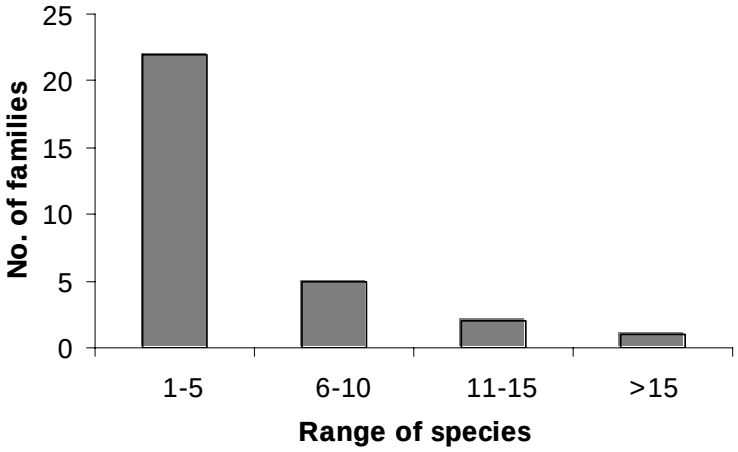


Fig. 2 No. of Families showing their frequency of liana species.



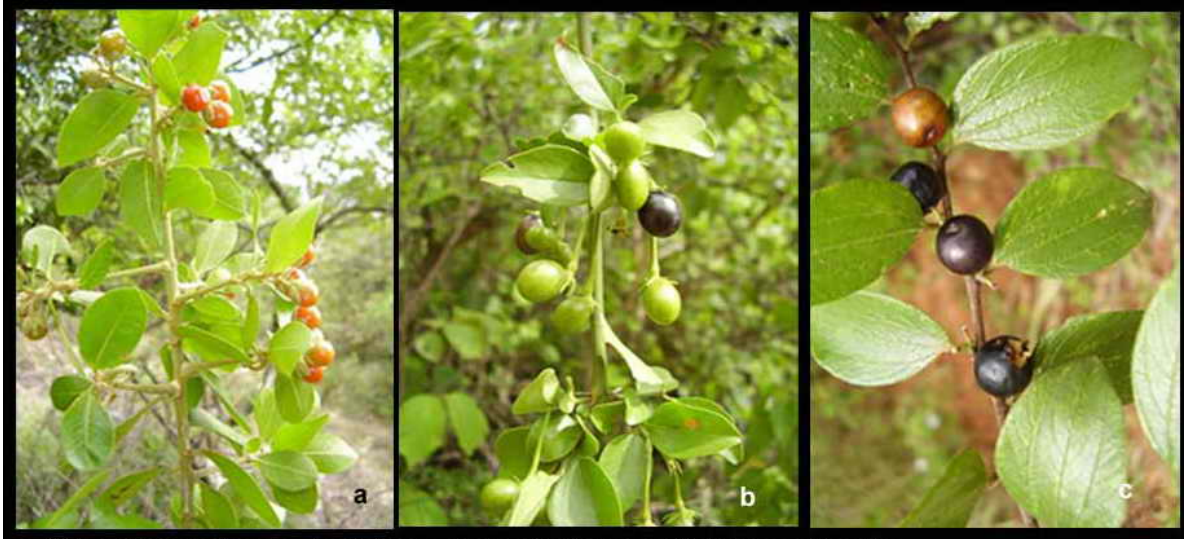
CLIMBING MECHANISMS

a. *Secamone emetica*; b. *Hugonia mystax*; c. *Argyrea sp.*; d. *Strychnos lenticellata*; e. *Jasminum angustifolium*

WIND DISPERSAL SYNDROMES

a. *Combretum albidum*; b. *Hiptage benghalensis*; c. *Decalepis hamiltonii*; d. *Ventilago maderaspatana*

REWARDS MEANT FOR ANIMAL DISPERSAL



a. *Hugonia mystax*; b. *Jasminum angustifolium*; c. *Ziziphus oenoplia*

Traditional medicinal plants of Valmikis of Visakhapatnam District, Andhra Pradesh, India

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Abstract

Ethnobotanical information of Valmikis have been collected from Visakhapatnam district of Andhra Pradesh, India during 2001-2005. A total of 42 plant species belonging to 37 genera and 30 families were used in traditional medicine to heal different diseases. The present work is an attempt to identify and conserve the medicinal plants in Visakhapatnam district. The study shows a high degree of ethnobotanical novelty and the use of plants among the Valmikis reflects the revival of interest in traditional folk culture.

Key words: Ethnomedicine; Valmikis; Visakhapatnam; Andhra Pradesh; India.

Introduction

Approximately two thirds of the biological diversity of the world is found in tropical zones. India has the second largest tribal population in the world after Africa (Jagtap *et al.*, 2006). With enormously diversified living ethnic groups and rich biological resources, India represents one of the great emporia of ethnobotanical wealth. Indigenous medicine is now recognized world wide as a health care resource. Visakhapatnam district is situated in between 17°15' and 18°32' N latitude and 81°48' and 83°31' E longitude of north eastern part of Andhra Pradesh. The district is bounded by Vizianagarum district on the North, East Godavari district on the South, Koraput of Orissa on the West and Bay of Bengal on the East (Ramesh, 1979). Visakhapatnam is a home of 14 tribes, namely Bagata, Gadaba, Gond, Konda Kammara, Konda Dora , Kotiya, Khond, Kulia, Mali, Manne Dora, Nooka Dora, Porja, Reddi Dora and Valmiki. Percentage of ST population in Visakhapatnam district is 13.74%. The geographical area of Visakhapatnam district is 11,161 km^2 and covers the forest area of 3435 km^2 (41.40%).

According to 1991 census, the tribal population in the State was 41.99 lakhs. Of these 42,944 Valmikis are living in the agency tracts of Visakhapatnam district. The Valmiki tribe is divided in to following Gotrams in order to regulate the marriage institution among them in Visakhapatnam tribal areas. Naga Bowse (snake), Mastya Bowse (fish), Pangi Bowse (kite), Jilla Bowse (tiger), Vantala Bowse (monkey), Korra Bowse (sun), Bhallu Bowse (bear), Poolu Bowse (flower) and Chilli Bowse (goat). Marriage by mutual consent, Marriage by elopement, widow marriages and divorce are permissible[5]. Valmikis are agriculturists and now became laborers. Some of them become traders and petty money lenders. They practice Podu cultivation on the slopes of hills (Rao, 1993). Interviewing traditional healers for accurate information about medicinal recipes, their component herbs, and their medicinal and other uses constitutes an important activity in ethno pharmacological field investigation (Lipp, 1989). The knowledge and experience of a traditional healer is considered valuable as it comes from thousands of years of trial and error and forms the basis of modern medicine and therapeutics. Ethnobotanical information of Valmikis is poorly known. Hemadri (1987) surveyed the parts of Andhra Pradesh ethnobotanically. Hence, the present work is under taken to communicate the ethnobotanical plants of Valmikis. The present work is gives additional information on ethnobotanical plants.

Material and Methods

Ethnobotanical exploration trips were carried out in Valmikis dominated villages during 2001-2005. The area understudy was thoroughly covered and the people were interrogated for information.The informants were chosen because they claimed to be professional practitioners of the traditional medicine of the region. Most of the healers refuse to join a local union or even to cooperate with local physicians because they are afraid that they will be forbidden to practice. Majority of herbal ingredients used by traditional healers are collected from the wild directly by these healers. Interviews were conducted in a place where the informants were most comfortable. At the end of each interview, specimens of plants mentioned for medicinal uses were collected and identified. Identification of species made with the help of Floras (Gamble & Fischer, 1915-1935; Subba rao & Kumari, 2003). These specimens have been housed in the Herbarium of the Laila Research Centre, Vijayawada, Andhra Pradesh for further reference.

Enumeration

In the enumeration, the taxa arranged alphabetically. The name of species is followed by, family name, local name, habit, disease and medicinal uses are given in the table -1.

Table –1: Name of species, family name, local name, habit, disease and medicinal uses:

1. *Acacia pennata* (L.) Willd. (Mimosaceae)	L. Name: Korintha. Habit: Climber.	Whooping cough: 5-6g of stem bark juice administered daily twice for five days.
2.*Acanthospermum hispidum* DC. (Asteraceae)	L. Name: Chinna palleru. Habit: Herb.	Jaundice: 2-3 teaspoons of root decoction administered daily twice for three days.
3. *Achyranthes aspera* L. (Amaranthaceae)	L. Name: Uttareni, Korruchu. Habit: Herb.	Rotting of teeth: Root piece is used as a toothbrush and the paste (5-6g) is taken orally daily twice for a week.
4. *Aegle marmelos* (L.) Corr. (Rutaceae)	L. Name: Maaredu. Habit: Tree.	Cold: Stem bark crushed with the leaves of *Ocimum tenuiflorum* (1:1 ratio), paste applied over the temples daily once for until cure.
5. *Alstonia scholaris* (L.) R.Br. (Apocynaceae)	L. Name: Konda ganneru. Habit: Tree.	Red & white leucorrhoea: 20ml of stem bark juice administered daily once for a week.
6.*Andrographis paniculata* (Burm.f.) Nees (Acanthaceae)	L. Name: Nelavemu. Habit: Herb.	Jaundice: 10-15g of leaves are crushed with 2-3 pepper, extract given daily once for three days.
7. *Ardisia solanacea* Roxb. (Myrsinaceae)	L. Name: Kondamamidi. Habit: Shrub.	Cough: Fresh tender tips (six pieces) are consumed thrice a day for two days.
8. *Argemone mexicana* L. (Papaveraceae)	L. Name: Swarnakshiri. Habit: Herb	Skin diseases: The seed paste used as an ointment.
9. *Argyreia nervosa* (Burm.f.) Boj. (Convolvulaceae)	L. Name: Kokkita tiga. Habit: Climber.	Hydrocele: Leaf paste is applied over the affected area and bandaged with soft cotton cloth thrice in a week.
10. *Bridelia montana* (Roxb.) Willd. (Euphorbiaceae)	L. Name: Balli chettu. Habit: Shrub.	Cold in children's: Half teaspoonful of leaf paste administered daily twice for until cure.
11. *Caesalpinia bonduc* L. (Caesalpiniaceae)	L. Name: Gachaaku. Habit: Climber.	Hydrocele: The boiled leaf paste is poultice daily once for fortnight.
12. *Cassia fistula* L. (Caesalpiniaceae)	L. Name: Rella. Habit: Tree.	Stomach-ache: One teaspoon of stem bark juice administered thrice in a day.
13. *Cassia occidentalis* L. (Caesalpiniaceae)	L. Name: Kasinindu. Habit: Shrub.	Acute stomach-ache: 15-20g of fresh roots crushed with 1-2 pepper, extract administered twice in a 1-2 hours.
14. Cassia tora *L. (Caesalpiniaceae)*	L. Name: Chinnatanthemu. Habit: Herb.	Loose motions: 2-3 teaspoons of root decoction given thrice a day for two days.
15. *Celastrus paniculatus* Willd. (Celastraceae)	L. Name: Maneru tiga. Habit: Climber.	Dysentery: 15g of fruits are consumed daily twice for until cure.
16. *Cyclea peltata* (Lam.) Hook.f. & Thoms. (Menispermaceae)	L. Name: Pullagontica. Habit: Climber.	Venereal diseases: The root is crushed with sufficient quantity of pepper, extract (20ml) administered daily once for 3-4 days.
17.*Dendrobium herbaceum* Lindl. (Orchidaceae)	L. Name: Radam. Habit: Herb.	Earache: The tender tips juice is used as an ear drops daily twice for until cure.
18. *Diospyros sylvatica* Roxb. (Ebenaceae)	L. Name: Nalla gatha. Habit: Tree.	Stomach ache: 10-15ml of stem bark juice administered twice in a day.
19. *Euphorbia hirta* L. (Euphorbiaceae)	L. Name: Macchaaku, Paalaaku. Habit: Herb.	Jaundice: 5-10g of fresh leaf paste administered daily once at early morning for three days. *Diet*: Only cow milk with rice is taken.
20.*Glochidion zeylanicum* (Gaertn.) Juss. (Euphorbiaceae)	L. Name: Kokkera tiga. Habit: Tree.	Snake bite: 10-12 g of root bark extract administered twice in an hour.
21. *Gloriosa superba* L. (Liliaceae)	L. Name: Langali. Habit: Climber.	Rheumatic pains: Leaf paste used as an ointment.
22. *Leea indica* (Burm.f.) Merr. (Leeaceae)	L. Name: Neerub tiga. Habit: Shrub.	Cold, cough: 1-2 teaspoons of fresh root extract administered daily once for three days.

23. *Leucas aspera* (Willd.)Link (Lamiaceae)	L. Name: Tummi. Habit: Herb.	Headache: Leaf paste used as an ointment on temples. Aphrodisiac: Leaves used as a curry. Evil spirits: 1-2 drops of leaf juice used as an eye drops.
24. *Litsea glutinosa* (Lour.) C.B. Robins (Lauraceae)	L. Name: Nara mamidi. Habit: Tree.	Body pains: 4-5 spoons of stem bark juice administered daily twice for 2-3 days.
25. Mimosa pudica *L. (Mimosaceae)*	L. Name: Siggu chettu, Attipatti. Habit: Herb.	Toothache: Root used as a toothbrush.
26. *Oroxylum indicum* (L.)Vent. (Bignoniaceae)	L. Name: Dundilum, Pampena. Habit: Tree.	Cold, cough: 1-2 teaspoons of stem bark extract administered daily once for three days.
27. *Plumbago zeylanica* L. (Plumbaginaceae)	L. Name: Chitramoolum. Habit: Herb.	Abortion: The root bark along with those of *Arygereia nervosa* (Kokkitha) and the leaves of *Leucas cephalotes* (Tummi) [each 5-10g] are crushed, extract administered daily once for three days.
28. *Plumeria rubra* L. (Apocynaceae)	L. Name: Nooruvaraala chettu. Habit: Tree.	Menstrual pains: 2 teaspoons of stem bark extract administered daily once for one week.
29. *Pouzolzia auriculata* Wt. (Urticaceae)	L. Name: Pitha tuppa, Endriga tuppa. Habit: Herb.	Leucoderma: Leaf paste used as an ointment.
30. *Schefflera stelleta* (Gaertn.) Harms (Araliaceae)	L. Name: Puligoru. Habit: Climber.	Evil spirits: Stem bark fiber is used as waist thread.
31. *Sida acuta* Burm.f. (Malvaceae)	L. Name: Ganne tuppa. Habit: Herb.	Skin diseases: Leaf paste used as an external application. To seal the holes of iron tins: Leaf paste mixed with coal ash, mixture applied on holes.
32. *Solanum anguivi* Lam. (Solanaceae)	L. Name: Vaakudu, Mulaka. Habit: Herb.	Cough: Two spoons of boiled fruit decoction administered daily once for three days.
33. *Solanum torvum* Sw. (Solanaceae)	L. Name: Chitra. Habit: Herb.	Cough: Three teaspoons of boiled fruit decoction administered twice a day for three days.
34. *Soymida febrifuga* (Roxb.)Juss. (Meliaceae)	L. Name: Somi. Habit: Tree.	Epilepsy: 1-2 drops of fresh stem bark juice used as a nasal drops.
35. *Syzygium cumini* (L.) Skeels (Myrtaceae)	L. Name: Neredu. Habit: Tree.	Dysentery: 20g of stem bark crushed with those of *Mangifera indica* (each 20 g), extract administered daily twice for until cure.
36. *Tephrosia purpuria* (L.)Pers. (Papilionaceae)	L. Name: Vempili. Habit: Shrub.	Rotting of teeth: Root decoction is used as a gargle / Leaf decoction also used as a gargle daily twice or thrice for until cure.
37. Terminalia chebula Retz. (Combretaceae)	L. Name: Karaka. Habit: Tree.	Throat infections: Fruits pulp chewed and sap swallowed daily twice for until cure.
38. *Tinospora malabarica* (Lam.)Miers (Menispermaceae)	L. Name: Kodipurru tiga. Habit: Climber.	Rotting of teeth: Leaves chewed and paste kept on affected teeth to overnight in the mouth.
39. *Woodfordia fruticosa* (L.)Kurz. (Lythraceae)	L. Name: Gaddapotica. Habit: Shrub.	Diarrhoea: 1-2 teaspoons of leaf decoction administered daily twice for until cure.
40. *Wrightia tinctoria* R.Br. (Apocynaceae)	L. Name: Kodisha paala. Habit: Tree.	Tooth ache: Stem bark decoction is used as a gargle daily twice for until cure.
41. *Xanthium strumarium* L. (Asteraceae)	L. Name: Geeta kayalu. Habit: Herb.	Weeping of children's: 4-5g of root paste administered daily once for until cure.
42. Ximenia americana *L. (Olacaceae)*	L. Name: Nakkera. Habit: Tree.	Dog bite: Stem bark paste applied over the bitten area and tied with bandage.

Results and Discussion

The present study focused mainly on the plant species used by the Valmiki tribes in Visakhapatnam district for various medicinal uses. The reported plants were arranged according to their scientific name and family. Vernacular (local) names as recorded during the field work and uses are presented. During the study period, 42 plant species belonging to 37 genera and 30 families were identified as medicinal plants. Of these 15 species are herbs, followed by trees (13), climbers (8) and shrubs (6). In addition, *Leucas cephalotes* (herb), *Ocimum tenuiflorum* (herb) and *Mangifera indica* (tree) were used as potential ingredients in three diseases. Medical administration includes oral administration of decoctions, poultice and plant parts as paste. The study shows a high degree of ethnobotanical novelty and the use of plants among the Valmikis reflects the revival of interest in traditional folk culture.

Conclusion

The rapid denudation of natural vegetation in general and medicinal plants in particular has caused much concern among vegetation managers, botanists, ethnobotanists, ecologists and environmentalists. It is therefore necessary to document the first hand information of the region and stress on their conservation to the future generations before the species become extinct. There is a need to support indigenous practices about medicinal plants with a vision to conservation and community development.

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Aquatic plant diversity of Similipal Biosphere Reserve, Orissa, India

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Abstract

Aquatic plants have been used for diverse purposes since historical times and are used often particularly for the purpose of food, fibre and medicine. Similipal Biosphere Reserve (SBR) is located in Mayurbhanj district of Orissa comprising of an area about 5569 km^2. It has varied topographical, edaphic and climatic conditions. The present study on aquatic plants of Similipal Biosphere Reserve report as many as 149 aquatic species, which include 79 species of dicotyledons belonging to 51 genera under 30 families, 69 species of monocotyledons belonging to 45 genera under 14 families and 4 species of Pteridophytes belonging to 4 genera under 4 families. Some of the useful aquatic plants in the study area include Bacopa monnieri, Centella asiatica, Hygrophila auriculata as medicine, Echinochloa colona, Hygrorhiza aristata, Oryza meyeriana ssp. granulata as fodder grasses, Oryza rufipogon as a wild relative of Oryza sativa, Ludwigia adscendens and Nymphaea nouchali as food plants for migratory birds.

Keywords: Wetlands, Aquatic Plants, Similipal Biosphere Reserve, Orissa.

Introduction

Wetlands play important role in the natural environment in various ways. The nutrient dynamics of wetlands owes to aquatic plants which absorb excessive amount of nutrients. Aquatic plants play vital role in the form of tapping of solar energy and in determing the primary productivity of aquatic ecosystem. The studies of wetlands of India have received a good deal of attention in recent years (Trisal & Zutsi, 1985). The studies on wetlands and aquatic plants on various aspects were carried out by many biologists (Biswas *et. al.*, 1965; Menon, 1971; Mahajan, 1982; Gupta, 1987). The studies of wetlands of India are relatively recent (Trisal & Zutsi, 1985) and have received a good deal of attention in recent years. Valuable information on flora of Orissa was contributed by many workers (Haines, 1921-1925; Bal, 1942; Raizada, 1948; Mooney, 1950; Choudhury and Patnaik, 1985; Panigrahi, 1983 & 1990; Saxena and Brahmam; 1989 & 1994-96; Reddy *et al.* 2006). However, H.S. Das (1994) had provided ecofloristic studies concentrating especially on wetlands of eastern coast of Orissa. The ecological and taxonomic status of aquatic flora is lacking in many parts of the State. Keeping in view of the above, the present study on aquatic plants of Similipal biosphere reserve was undertaken.

Study Area

Similipal the only biosphere reserve in the State of Orissa, India, lies between 21º28' - 22º08'N latitude and 86º04' - 86º37'E longitude in northern most section of Eastern Ghats part of the State in Mayurbhanj district. It is one of the 14 biosphere reserve of the country. It comprises about 5569 km^2 including core area of 845 km^2, buffer zone of 2129 km^2 & transitional zone of 2595 km^2. Altitudinally, the Similipal Biosphere Reserve area stretches from 200m to 1162m (Fig.1). Due to its varied topographical, edaphic and climatic conditions, Similipal harbors about 1076 species of angiosperms, the richest floral diversity of the state (Saxena and Brahmam, 1989). Of the 130 species of orchids occurring in the state, 92 are existing in Similipal. Tropical Semivergreen, Moist deciduous, Dry Deciduous forest types are exists in this region, besides savannah and grasslands (Champion and Seth, 1968). It is the origin point of major river system of North Orissa. It is the home of Birhors, Hill Kharias and Ujias, the primitive tribes of the state. The tribes are custodian of grand repository of indigenous knowledge pertinent to ethnobiological and traditional ecological studies. Being located centrally, Similipal contributes to ecological equilibrium of three bordering states namely Orissa, Jharkhand and West Bengal.

Three distinct season of summer, rainy and winter are well felt during the year. Summer is tolerable as the temperature hardly goes above 40°C. Rainy season starts from middle of June till October with rainfall of about 1250 mm in the monsoonic leeward valleys; over 2000 mm is the general spread of the rainfall in the plateau. Frequent annual receiptal of 2500mm is experienced in some pockets and more in higher elevation inside the biosphere reserve. Geologically, the formation of Similipal Biosphere Reserve is unique in the world. Outcrops of metamorphics and stone and quartzites are found to be all over Similipal hills. They produce a reddish and sandy soil in which Sal appears to be doing well. Most of the Similipal have rich spread of red loam. Extensive pockets of laterite soil also come across the plateau. Heavy clay is also found in the wide flat of basin.

Materials and Methods:

Exploration:

An extensive field study was made in different forest blocks of Similipal during the period from December 2006 to May 2007. Field data were recorded in the field notebook in connection with locality, habit, flowering, fruiting time, frequency, status, distribution and uses etc. by interviewing with individuals and by own observation. The specimens were collected, processed and housed in the Herbarium of Department of Botany, North Orissa University. The correct names of the plants have been assigned in consultation with International code of Botanical Nomenclature (1988), Flora of Orissa (1994-96), Flora of Madhya Pradesh (1993-2001) and Flora of Bihar (2001).

Enumeration:

In the enumeration, the families are arranged according to classification proposed by Bentham & Hooker (1862-1883). The species are arranged alphabetically under families. Ecological notes of each species have been provided after enumerartion.

DICOTYLEDONS (MAGNOLIOPSIDA)

RANUNCULACEAE

1. *Ranunculus pennsylvanicus* L.f. Suppl. Pl. 272.1781; Saxena & Brahmam, Fl. Orissa 1:6.1995. Rare, along streams and water courses in wet places in the hills.

NYMPHACEAE

2. *Nymphaea nouchali* Burm.f. Fl.Ind., 120.1768; Saxena & Brahmam, Fl. Orissa 1:44.1995. Frequent in ponds and water bodies.

POLYGALACEAE

3. *Salmonia cantoniensis* Lour.Fl.Cochinch.1:14.1790; Saxena & Brahmam, Fl. Orissa 1:94.1995. In moist lands.

CARYOPHYLLACEAE

4. *Drymaria cordata* (L.) Willd. ex Roem. & Schult., subsp. ***diandra*** (BI.) Duke, Ann. Missouri Bot. Gard. 48:253.F.18D-E.1961; Saxena & Brahmam, Fl. Orissa 1:98.1995. *D. cordata* Sensu Edgew. & Hook F. in Hook F. Fl.Brit.India 1;224;1874. Found in moist and shady places.

MALPIGHIACEAE

5. *Aspidopterys tomentosa* (Bl.) Juss. A. Juss.var. *hutchinsonii* (Haines).Srivastava, J. Bombay. Nat. Hist. Soc.81:728.1984; Saxena & Brahmam, Fl. Orissa 1:212.1995. *A. hutchinsonii* Haines, Kew Bull. 1920:66-67.1920. Found in moist places.

BALSAMINACEAE

6. Impatiens kleinii Wt. and Arn. Prod. 140. 1834; Saxena & Brahmam, Fl. Orissa 1:225.1995. Occasional in moist and shady places

FABACEAE

7. *Aeschynomene indica* L.Sp.Pl.713.1753; Saxena & Brahmam, Fl. Orissa 1:448.1995. Common in wet places. Pantropical weed.

8. *Alysicarpus vaginalis* (L.) DC.Prod.2:353.1825 var.vaginalis; Saxena & Brahmam, Fl. Orissa 1:453.1995. *Hedysarum vaginalis* L.Sp.Pl.746.1753. Common weed in cultivated land, along ponds etc.

9. *Smithia conferta* J.E.Sm.in Rees, Cyclop. 33:n.2. 1819; Saxena & Brahmam, Fl. Orissa 1:590.1995. *S.geminiflora* Roth, Nov.Pl.Sp.352.1821. Common in open wet places and along rice field.

10. ***Smithia sensitiva*** Ait. Hort.Kew ed. 1.3:496.1789; Saxena & Brahmam, Fl. Orissa 1:591.1995. Common in open wet places along, rice field etc.

DROSERACEAE

11. ***Drosera burmannii*** Vahl.Symb.Bot.3:50.1794; Saxena & Brahmam, Fl. Orissa 2:643.1995. Occassional in open, wet ground, mostly among grasses near streams.

LYTHRACEAE

12. ***Ammania baccifera*** L.Sp. Pl. 120. 1753; Saxena & Brahmam, Fl. Orissa 2:707.1995. Common in rice fields and wet places.

13. ***Rotala densiflora*** (Roth ex Roem. & Schultes) Koehne, Bot. Jahrb.1:164.1880; Saxena & Brahmam, Fl. Orissa 2:715.1995. *Ammannia densiflora* Roth ex Roem & Schultes Syst. Veg. 3:304:.1818; Haines, Bot. Bihar & Orissa 2:378(395).1922. Common in wet places.

14. ***Rotala indica*** (Willd.) Koehne in Engl. Bot. Jahrb. Syst. 1:172.1881; Saxena & Brahmam, Fl. Orissa 2:718.1995. *Peplis indica* Willd.Sp.Pl. 2:244.1799. Common in rice fields and wet places.

15. ***Rotala mexicana*** Cham. & Schlecht. Linnaea 5:567.1830; Saxena & Brahmam, Fl. Orissa 2:718.1995. *R. pygmaea* (Kurz) Raja. & Ramayya, Kew Bull. 23:465.1969. Common on damp ground close to rice fields and water courses.

16. ***Rotala rotundifolia*** (Buch.-Ham. ex Roxb.) Koehne, Bot. Jahrb. 1:175.1880; Saxena & Brahmam, Fl. Orissa 2:720.1995. *Ammannia rotundifolia* Buch.-Ham. Ex Roxb. Fl. Ind. 1:446.1820. Common along streams and water courses, in wet or marshy places.

ONGRACEAE

17. ***Ludwigia adscendens*** (L.) Hara in J. Jap. Bot. 28:290.1953; Saxena & Brahmam, Fl. Orissa 2:726.1995. *Jussiaea adscendens* L. Mart., Pl. 1:69.1767.
Common in ponds and ditches.

18. ***Ludwigia hyssopifolia*** (G.Don) Exell, Garcia de Orta 5:471.1957; Saxena & Brahmam, Fl. Orissa 2:726.1995. *Jussiaea hyssopifolia* G.Don, Gen. Syst. 2:693.1832.
Common in wet places along tanks, streams, rice fields etc.

19. ***Ludwigia octovalvis*** (Jacq.) Raven, Kew Bull. 15:476.1962; Saxena & Brahmam, Fl. Orissa 2:728.1995. *Oenothera octovalvis* Jacq. Enum. Syst Pl. 19.1760.
Common in wet places along tanks, streams, rice fields etc.

20. ***Ludwigia prostrata*** Roxb.Fl.Ind. 1:441.1820; Saxena & Brahmam, Fl. Orissa 2:729.1995. *Jussiaea prostrata* (Roxb.) Leveille, Fedde Report. 8:138.1910.
On wet ground near stream.

TRAPACEAE

21. ***Trapa natans*** L. var. bispinosa (Roxb.) Makino in linuma, Somoku-Dzusetzu ed.3.1:137.1907. Saxena & Brahmam, Fl. Orissa 2:731.1995.
Common in ponds.

AIZOACEAE

22. ***Trianthema portulacastrum*** L. Sp. Pl. 223.1753; Saxena & Brahmam, Fl. Orissa 2:773.1995. Common weed.

APIACEAE

23. ***Centella asiatica*** (L.) Urban in Mart. Fl. Bras. 11:287.t.78.f. 1. 1879; Saxena & Brahmam, Fl. Orissa 2:778.1995. *Hydrocotyle asiatica* L.Sp.Pl.234.1753. Common in wet places.

RUBIACEAE

24. Dentella repens (L.) J.R. & G. Forst.Char.Gen.26.t.13.1776; Saxena & Brahmam, Fl. Orissa 2:818.1995. *Oldenlandia repens* L. Mant.Pl.40.1767.
Fairly Common in damp places along river beds, ponds, rice field etc.

25. *Hedyotis corymbosa* (L.) Lam. Encycl. 1:272.1792; Saxena & Brahmam, Fl. Orissa 2:832.1995. *Oldenlandia corymbosa* L. Sp. Pl.119.1753.
Fairly Common weed.

26. *Hedyotis diffusa* Willd.Sp.Pl. 1:566.1798; Saxena & Brahmam, Fl. Orissa 2:833.1995. *Oldenlandia diffusa*(Willd.) Roxb. Fl. India 1:444.1820.
Common in wet places near rivers, ponds, rice fields etc.

27. *Neanotis tubulosa* (G.Don) Mabberley in Manilal, Bot. Hist. Hort. Malab.92. 1980; Saxena & Brahmam, Fl. Orissa 2:859.1995. *Oldenlandia tubulosa* G.Don, Gen. Syst. 3:531.1834, pro parte.
In open grassland under partial shade.

ASTERACEAE

28. *Caesulia axillaris* Roxb.Pl. Corom. 1:64.t.93.1798; Saxena & Brahmam, Fl. Orissa 2:913.1995.
Common in marshy places.

29. *Cyathocline purpurea* (Buch.- Ham. Ex D.Don) Kuntze, Rev. Gen.Pl. 1:333.1891; Saxena & Brahmam, Fl. Orissa 2:923.1995. *Tanacetum Purpureum* Buch.-Ham. Ex D.Don, Prod.181.1825.
Occasional in moist places often near streams.

30. *Eclipta prostata* (L.) L. Mart. Pl. 286. 1771; Saxena & Brahmam, Fl. Orissa 2:926.1995. *Verbesina prostata* L. Sp. Pl. 902.1753.
Frequent in moist places along streams, borders of rice fields, cultivated land etc.

31. *Enydra fluctans* Lor. Fl. Cochinch 511.1790; Haines, BBO 2:479.1988; Saxena & Brahmam, Fl. Orissa 2:930.1995.
Common along edges of ponds and ditches.

32. *Gnaphalium luteo-album* L. subsp. *affine* (D.Don)Koster, Blumea 4:484.1941; Saxena & Brahmam, Fl. Orissa 2:935.1995. *G.affine* D.Don, Prod.173.1825.
Common in moist places, often along streams, especially in hills.

33. *Lobelia heyniana* Roem. & Schult. in L.Syst..Veg. 5:50. 1819-20; Saxena & Brahmam, Fl. Orissa 2:988.1995. *L. trialata* Buch.-Ham. Ex D.Don, Prod. 157.1825. Common in moist and shady places.

PRIMULACEAE

34. *Anagallis pumila* Sw.Nov.Gen.Pl.40.1788; Saxena & Brahmam, Fl. Orissa 2:996.1995. *Centunculus tenellus* Duby in DC. Prod. 8:72.1844.
Common in open damp places.

GENTIANACEAE

35. *Centaurium centaurioides* (Roxb.) Rao & Hemadri; Saxena & Brahmam, Fl. Orissa 2:1124.1995. *Chironia centaurioides* Roxb. Fl. Ind. 1:584.1820.
Abundant in the muddy black soil of the river bank and also in the crevices of rocks and boulders.

36. *Hoppea dichotoma* (Griseb.) C.B.Cl. in Hook.f.Fl.Brit. India4:100.1883; Saxena & Brahmam, Fl. Orissa 2:1128.1995.
Occasional in moist places.

37. *Swertia angustifolia* Buch.-Ham. Ex D.Don, Prod. 127.1825; Saxena & Brahmam, Fl. Orissa 2:1129.1995. *S.pulchella* Buch.-Ham. Ex D.Don, Prod. 127.1825. Rare in moist places.

MENYANTHACEAE

38. *Nymphoides hydrophylla* (Lour.) Kuntze, Revis. Gen. Pl. 2:429.1891. Saxena & Brahmam, Fl. Orissa 2:1131.1995. *Menyanthes hydrophylla* Lour. Fl. Cochinch. 1:129.1790.

Common in ponds and lakes.

HYDROPHYLLACEAE

39. *Hydrolea zeylanica* (L.) Vahl, Symb. Bot. 2:46.1791; Saxena & Brahmam, Fl. Orissa 2:1133.1995.
Occasional in wet places in lower elevation.

BORAGINACEAE

40. *Coldenia procumbens* L.Sp.Pl. 125.1753; Saxena & Brahmam, Fl. Orissa 2:1142.1995.
Common weed in cultivated land, wastelands, near ponds.

41. *Heliotropicum indicum* L. Sp. Pl. 130.1753; Saxena & Brahmam, Fl. Orissa 2:1146.1995. *Tiaridium indicum* Lehm.Pl.Asperif.Nucif.14.1818.
Common weed.

CONVOLVULACEAE

42. *Ipomoea aquatica* Forssk.Fl. Aegypt.-Arab. 44.1775; Saxena & Brahmam, Fl. Orissa 2:1171.1995.
Common in and on the margins of tanks.

43. *Ipomoea carnea* Jacq. Enum. Syst. Pl. 13.1760; Saxena & Brahmam, Fl. Orissa 2:1175.1995.
Fairly Common and naturalized in wastelands, roadsides, near water courses etc.

SCROPHULARIACEAE

44. *Angelonia salicariifolia* Hembs & Bonpl. Aequin 2:92.t.1812; Saxena & Brahmam, Fl. Orissa 2:1271.1995.
Planted in gardens and often escaped.

45. *Bacopa monnieri* (L.) Penell, Proc. Acad. Nat. Sci. Philadelphia 98:94.1946; Saxena & Brahmam, Fl. Orissa 2:1229.1995. *Lysimachia monnieri* L., Cent. PI. 11:9.1756.
Common in wet places near water courses.

46. *Centranthera indica* (L.) Gamble, Fl. Madras 2:971(683).1924; Saxena & Brahmam, Fl. Orissa 2:1231.1995. *Rhinanthus indica* L.Sp.Pl.603.1753.
Frequent in grassland and open moist places.

47. *Limnophila connata* (Buch.-Ham. Ex D.Don) Handb.-Mazz. Symb.Sin. 7:837.1936; Saxena & Brahmam, Fl. Orissa 2:1237.1995. *Cybbanthera connata* Buch.-Ham. Ex D.Don, Prod.87.1825.
Occasional along stream and ponds.

48. *Limnophila heterophylla* (Roxb.) Benth. Scroph. Ind. 25.1835; Saxena & Brahmam, Fl. Orissa 2:1237.1995. *Columnea heterophylla* Roxb. Fl.Ind. 3:97.1832.
In shallow stagnant water.

49. *Limnophila indica* (L.) Druce, Bot. Exch.Club Soc. Brit. Isles. 3:420.1914; Saxena & Brahmam, Fl. Orissa 2:1238.1995. *Hottonia indica* L.Syst.Nat. (ed.10) 919.1759.
Common along borders of ponds, flooded paddy fields, wet low lands.

50. ***Limnophila rugosa*** (Roth) Merr. Interpr.Herb.Amboin. 466.1917; Saxena & Brahmam, Fl. Orissa 2:1239.1995. *Herpestis rugosa* Roth, Nov.Pl.290.1821.
In wet ground along the stream.

51. *Limnophila sessiliflora* (Vahl) Bl. Bijdr.849.1826; Saxena & Brahmam, Fl. Orissa 2: 1240. 1995.
Occasional along streams and ponds.

52. *Lindernia anagallis* (Burm.f.) Pennell.J. Arnold Arbor.24.252.1943; Saxena & Brahmam, Fl. Orissa 2:1244.1995. *Ruellia anagallis* Burm.f.Fl. Ind. 135.1768.
Common in moist and mashy places.

53. *Lindernia antipoda* (L.) Alston in Trimen, Fl. Ceylon 6:214.1931; Saxena & Brahmam, Fl. Orissa 2:1245.1995. *Ruellia antipoda* L.Sp.Pl. 635.1753.
Common in wet places.

54. ***Lindernia caespitosa*** (Bl.) Panig. Taxon 33.320.1984; Saxena & Brahmam, Fl. Orissa 2:1246.1995. *Diceros caespitosus* Bl. Bijdr.753.1826.
Occasional in moist and shady places.

55. ***Lindernia ciliata*** (Colsm.) Pennell, Brittonia 2:182.1936; Saxena & Brahmam, Fl. Orissa 2:1248.1995. *Gratiola ciliata* Colsm. Prod.Descr.Gratiol.14.1793.
Common in moist places.

56. ***Lindernia crustacea*** (L.) F.V. Muell. Syst Census Austral.Pl.97.1882; Saxena & Brahmam, Fl. Orissa 2:1248.1995. *Capraria crustacean* L. Mant.Pl.87.1767.
Common in moist places.

57. ***Lindernia hookeri*** (C.B.Cl.) Wett. In Engl. & Prantl. Pflanzenf. 4(36):80.1891; Saxena & Brahmam, Fl. Orissa 2:1249.1995. *Vandellia hooeri* C.B.Cl. in Hook.f.Fl.Brit.India 4:280.1884.
Common in moist and shady places.

58. ***Lindernia nummularifolia*** (D.Don) Wettst. in Engl. & Prantl. Pfanzenf.4(36):79.1891; Saxena & Brahmam, Fl. Orissa 2:1251.1995. *Vendelia nummularifolia* D.Don., Prod. 86.1825.
Common in moist and shady places.

LENTIBULARIACEAE

59. ***Utricularia aurea*** Lour.Fl. Cochinch. 26.1790; Saxena & Brahmam, Fl. Orissa 2:1277.1995.
Common; floating in ponds, lakes and still water.

ACANTHACEAE

60. ***Hemiadelphis polysperma*** (Roxb.) Nees in Wall. Pl. As. Rar. 3:80.1832; Saxena & Brahmam, Fl. Orissa 3:1348.1995. *Justicia polysperma* Roxb.Fl.Ind.1:119.1832.
Common in wet places along the river banks.

61. ***Hygrophila auriculata*** (Schum.) Heine, Kew Bull. 16:172.1962; Saxena & Brahmam, Fl. Orissa 3:1352.1995. *Barleria auriculata* Schum. In Schum. & Tonn. Beskr.Guin.Pl.285.1827.
Common along water courses.

62. ***Hygrophila salicifolia*** (Vahl) Nees in Wall. Pl. As. Rar. 3:81.1832; Saxena & Brahmam, Fl. Orissa 3:1355.1995. *Ruellia salicifolia* Vahl, Sym. Bot. 3:84.1794.
Common in marshy places.

63. ***Justicia gendarussa*** Burm.f. Fl.Ind.10.1768; Saxena & Brahmam, Fl. Orissa 3:1362.1995.
Present along the stream.

VERBENACEAE

64. ***Lippia javanica*** (Burm.f.) Spreng. Syst. Veg. 2:752.1824; Saxena & Brahmam, Fl. Orissa 3:1414.1995. *Verbena javanica* Burm.f.Fl.Ind. 12.t.6.f.2.1768.
Frequent near water courses.

65. ***Phyla nodiflora*** (L.) Greene, Pittonia 4:46.1899; Saxena & Brahmam, Fl. Orissa 3:1415.1995. *Verbena nodiflora* L. Sp.Pl. 20.1753.
Frequent in open moist places.

LAMIACEAE

66. ***Pogostemon auricularius*** (L.) Hassk.
Tijdschr.Natuurl.Gesch.Physiol.10:127.1843; Saxena & Brahmam, Fl. Orissa 3:1480.1995. *Mentha auricularia* L.Mant.Pl.81.1767.
Along the margins of pond.

AMARANTHACEAE

67. ***Alternanthera sessilis*** (L.) R. Br. ExDC.Cat. Pl. Hort. Monosp. 4:77.1813; Saxena & Brahmam, Fl. Orissa 3:1506.1995. *Gompherna sessilis* L., Sp. Pl. 225.1753.
Common weed.

POLYGONACEAE

68. ***Polygonum barbatum*** L. Sp.Pl.362.1753; Saxena & Brahmam, Fl. Orissa 3:1533.1995.
Common along rivers and streams.

69. Polygonum barbatum *var.* ***stagninum*** (Buch.-Ham. Ex Meissn) Steward, Contr.Gray Herb.88.54.1930; Saxena & Brahmam, Fl. Orissa 3:1533.1995. *P. stagninum* Buch.-Ham. ex Meissn. In Wall.Pl. As. Rar. 3:56.1832.
Common along rivers and streams.

70. ***Polygonum chinense*** L. Sp.Pl.363.1753; Saxena & Brahmam, Fl. Orissa 3:1535.1995.
Occasional along streams.

71. ***Polygonum dichotomum*** Bl. Bijdr. var. **angustissima** (Hook.f.) Chandrasek. In Henry, Kumari & Chitra, Fl. Tamil Nadu 2:197.1987; Saxena & Brahmam, Fl. Orissa 3:1535.1995.
Occasional along the stream.

72. ***Polygonum glabrum*** Willd. Sp. Pl. 2:447.1799; Saxena & Brahmam, Fl. Orissa 3:1535.1995.
Common along streams, rivers and water courses.

73. ***Polygonum hydropiper*** L.**ssp** ***microcarpum*** Danser **var.** ***triquetrum*** Danser; Saxena & Brahmam, Fl. Orissa 3:1535.1995. *P. flaccidum* Meissn. in DC.Prod.14:107.1856.
Common along water courses.

74. ***Polygonum plebeium*** R.Br.Prod. 420.1810; Saxena & Brahmam, Fl. Orissa 3:1539.995. *P.indicum* Heyne in Roth,Nov.Pl.Spec.208.1821.
Fairly common weed in moist places.

75. ***Polygonum strigosum*** R.Br. Prod. 420.1810; Saxena & Brahmam, Fl. Orissa 3:1541.1995.
Present in wet places along the stream and pond.

EUPHORBIACEAE

76. ***Euphorbia thymifolia*** L.Sp.Pl.454.1753; Saxena & Brahmam, Fl. Orissa 3:1640.1995.
Common weed.

77. ***Homonoia riparia*** Lour. Fl. Cochinch.637.1790; Saxena & Brahmam, Fl. Orissa 3:1649.1995. *Adelia neriifolia* Roth, Nov. Pl.Spec.375.1821;Wight, Icon.t.1868.1852.
Common along stream and river.

CERATOPHYLLACEAE

78. ***Ceratophyllum demersum*** L. Sp. Pl. 992. 1753; Saxena & Brahmam, Fl. Orissa 3:1753.1995.
Common in still waters.

MONOCOTYLEDONS (LILIOPSIDA)

HYDROCHARITACEAE

79. ***Hydrilla verticillata*** (L.f.) Royle, III.Himal.t.376.1839; Saxena & Brahmam, Fl. Orissa 3:1759.1995. *Serpicula verticillata* L.f.Suppl.p1.416.1781.
Common submerged weed in still-fresh water ponds, tanks and lakes.

80. ***Ottelia alismoides*** (L.) Pers.Syn.Pl. 1:400.1805; Saxena & Brahmam, Fl. Orissa 3:1761.1995.
Common submerged weed in slow streams.

81. ***Vallisneria natans*** (Lour.) Hara, J.Jap. Bot. 49:136.1974; Saxena & Brahmam, Fl. Orissa 3:1762.1995. *Physkium natans* Lour.Fl.Cochinch.663.1790.
Common aquatic herb at the bottom of ponds, lakes and slow running river.

BURMANNIACEAE

82. ***Burmannia coelestis*** D.Don, Prod. 44. 1825; Saxena & Brahmam, Fl. Orissa 3:1764.1995. *B. pusilla*(Miers) Thw. Enum. Pl. Zeyl. 325.1864.
In wet grassy glades, rice fields, along ponds and streams.

AMARYLLIDACEAE

83*. Crinum defixum* Ker-Gawl.Sci.Arts(London) 3:105, 1817; Saxena & Brahmam, Fl. Orissa 3:1921.1995. Along muddy banks of rivers and often immersed.

PONTEDERIACEAE

84. *Eichhornia crassipes* (Mart.) Solms in A.DC. Monogr. Phan. 4:527.1883; Saxena & Brahmam, Fl. Orissa 3:1974.1995.
Fairly common in stagnant water.

85. *Monochoria vaginalis* (Burm.f.) Presl, Reliq.Haenk.1:128.1827; Saxena & Brahmam, Fl. Orissa 3:1977.1995.
Common in swampy places.

COMMELINACEAE

86. *Aneilema ovalifolium* (Wight) Hook.f.ex C.B.Cl. in A.& DC.Monog.Phan.3:218. 1881; Saxena & Brahmam, Fl. Orissa 3:1981.1995.
Occasional in damp places in forests.

87. *Commelina erecta* L.Sp.Pl.41.1753.; Saxena & Brahmam, Fl. Orissa 3:1986.1995. *C.undulata* R.Br.Prod.270.1810.
Common in forest and moist shady places.

88. *Commelina longifolia* Lamk.Encyl.1.129.1791; Haines, BBO 3:1076.1988; Saxena & Brahmam, Fl. Orissa 3:1988.1995.
Fairly common weed.

89. *Murdannia nudiflora* (L.) Brenan, Kew Bull. 7:189.1952; Saxena & Brahmam, Fl. Orissa 3:1997.1995. *Commelina nudiflora* L.Sp.Pl.41.1753, pro parte. Fairly common weed.

90. *Murdannia spirata* (l.) Brueck. In Engl. & Prantl. Pflanzenf.(ed.2) 15a:173.1930; Saxena & Brahmam, Fl. Orissa 3:1999.1995. *Commelina spirata* L. Mant.Pl.176.1767.
Fairly common weed.

91. *Murdannia vaginata* (L.) Brueck. In Engl. & Prantl. Pflanzenf.(ed.2) 15a:173.1930; Saxena & Brahmam, Fl. Orissa 3:1999.1995. *Commelina vaginata* L. Mant.Pl.177.1771. Fairly common in wet places along water courses.

92. *Tonningia axillaris* (L.) Kuntze, Rev.Gen.Pl.2:721.1891; Saxena & Brahmam, Fl. Orissa 3:2000.1995. *Commelina axillaris* L.Sp.Pl.42.1753.
Common in damp places.

93. *Cyanotis cristata* (L.) D.Don, Prod. 46.1825; Saxena & Brahmam, Fl. Orissa 3:1991.1995. *Commelina cristata* L.Sp.Pl.42.1753.
Common in damp and shady places.

JUNCACEAE

94. *Juncus prismatocarpus* R.Br.Prod.259.1810; Saxena & Brahmam, Fl. Orissa 4:2011.1996. Fairly common in wet places.

TYPHACEAE

95. *Typha angustata* Bory & Chaub. Exp. Sci. Moore Bot. 1:338.1833; Saxena & Brahmam, Fl. Orissa 4:2032.1996. Common in wet places & Rice fields

ARACEAE

96. *Alocasia fornicata* (Roxb.) Schott, Oesterr.Bot. Wochenbl.4:410.1854; Saxena & Brahmam, Fl. Orissa 4:2035.1996. *Arum fornicatum* Roxb.Fl.Ind.3:501.1832; Wight, Icon.t.792.1844. Along streams under shade.

97. *Colocasia esculenta* (L.) Schott in Schott & Endl.Melet.Bot.18.1832; Saxena & Brahmam, Fl. Orissa 4:2041.1996. *Arum esculentum* L.Sp.Pl.965.1763. Common in damp and shady places.

98. ***Lasia spinosa*** (L.) Thw. Enum.336.1864; Saxena & Brahmam, Fl. Orissa 4:2044.1996. *Dracontium spinosum* L.Sp.Pl.967.1753. Along muddy strem under shade.

99*.* ***Pistia stratiotes*** L.Sp.Pl.963.1753; Saxena & Brahmam, Fl. Orissa 4:2046.1996. Common in ponds and stagnant water.

100*.* ***Tenagocharis latifolia*** (D.Don) Buchen., Abh. Naturw. Ver. Bremen 2;2,3,6,1968; Saxena & Brahmam, Fl. Orissa 4:2061.1996. *Butomus latifolius* D.Don, Prod. 22.1825. Fairly common in wet places.

POTAMOGETONACEAE

101. ***Potamogeton nodosus*** Poir in Lam. Encycl. (suppl.4):535. 1861; Saxena & Brahmam, Fl. Orissa 4:2068.1996. Submerged aquatic, in fresh water with upper or all leaves floating.

APONOGETONACEAE

102. ***Aponogeton natans*** (L.) Engl. & Krause in Engl. Pflanzenr.24(IV.13):11.1906; Saxena & Brahmam, Fl. Orissa 4:2071.1996. *Saururus natans* L. Mant.Pl.2:227.1771. Common in stagnant and shallow water courses.

ERIOCAULACEAE

103. ***Eliocaulon ritchieanum*** Ruhl.in Engl.Pflanzenr. 13:73.1903; Saxena & Brahmam, Fl. Orissa 4:2086.1996. *E. horsleykondae* Fyson, J. Indian Bot. Soc. 3:13.t.43.1924. Common along streams.

104. ***Eliocaulon truncatum*** Buch.-Ham. In Wall.Pl.As. Rar.3:29.1832; Saxena & Brahmam, Fl. Orissa 4:2089.1996. Common along streams and rivers.

105. ***Eliocaulon xeranthum*** Mart.in Wall.Pl.As.Rar.3:29.1832; Saxena & Brahmam, Fl. Orissa 4: 2089.1996. Frequent in wet places.

CYPERACEAE

106. ***Carex phacota*** Spreng.Syst.3:826.1826; Saxena & Brahmam, Fl. Orissa 4:2101.1996. Along streams in the forest.

107. ***Cyperus brevifolius*** (Rottb.) Hassk.Cat.Bogor 24.1844; Saxena & Brahmam, Fl. Orissa 4:2115.1996. *Kyllinga brvifolia* Rottb. Descr.Icon.Rar.Pl. 13.t.4.f.3.1773. Common along streams and moist places.

108. ***Cyperus compactus*** Retz. Obs. Bot. 5:10.1788; Saxena & Brahmam, Fl. Orissa 4:2117.1996. *Mariscus compactus* (Retz.) Bold. Zakfl. Java 77.1916.
Frequent in wet places along streams.

109. ***Cyperus compressus*** L.Pl. 46.1753; Saxena & Brahmam, Fl. Orissa 4:2118.1996. Common in moist places, cultivated lands etc.

110. ***Cyperus cuspidatus*** H, B & K, Nov. Gen. Pl. 1:204.1815; Saxena & Brahmam, Fl. Orissa 4:2320.1996. Frequent in moist places.

111. ***Cyperus difformis*** L.Cent. Pl. 2:6.1756; Saxena & Brahmam, Fl. Orissa 4:2123.1996. Common in wet places.

112. ***Cyperus distans*** L.f.Suppl.Pl.103.1781; Saxena & Brahmam, Fl. Orissa 4:2126.1996. Common in wet places near water courses.

113. ***Cyperus flavidus*** Retz. Obs.Bot.5:13.1788; Saxena & Brahmam, Fl. Orissa 4:2130.1996. *C.capillaris* Koenig ex Roxb. Fl. Ind. 1: 198.1820. Common in wet places.

114. ***Fimbristylis aestivalis*** (Retz.) Vahl, Enum, Pl. 2:288.1806; Saxena & Brahmam, Fl. Orissa 4:2169.1996. *Scirpus aestivalis* Retz. Bot. 4:12.1768. Common in ditches.

115. ***Fimbristylis littoralis var. littoralis*** Gaudich. In Freye.Voy. Uranie 413.1826; Saxena & Brahmam, Fl. Orissa 4:2179.1996. *F.miliacea* Vahl, Enum.Pl. 2:287.1805. Common in wet places.

116. ***Fimbristylis miliacea*** (L.) Vahl, Enum.Pl.2:287.1806; Saxena & Brahmam, Fl. Orissa 4:2180.1996. *Scirpus miliaceus* L.Syst.Nat.(ed.10)868.1759. Common in moist and wet places.

117. ***Fimbristylis schoenoides*** (Retz.) Vahl, Enum. Pl. 2:286.1806; Saxena & Brahmam, Fl. Orissa 4:2185.1996. *Scirpus schoenoides* Retz. Obs. Bot. 5:14.1788. Common in wet places.

118. ***Indocourtoisia cyperoides*** (Roxb.) Bennet & Raizada, Indian For.107:432.1981; Saxena & Brahmam, Fl. Orissa 4:2193.1996. *Kyllinga cyperoides* Roxb. Fl. Ind. 1:187. 1820. Frequent in rice field and other wet places.

119. ***Lipocarpha chinensis*** (Osbeck) Kern, Blumea (suppl.) 4:167.1958 & in Steenis, Fl. Males. I. 7:521.1974; Saxena & Brahmam, Fl. Orissa 4:2195.1996. *Scirpus chinensis* Osbeck, Degb. Ostind. Resa 220.1757. Frequent in wet places near water courses.

120. ***Lipocarpha sphacelata*** (Vahl) Kunth, Enum.Pl. 2:267.1837; Saxena & Brahmam, Fl. Orissa 4:2196.1996. *Hypaelyptum sphacelatum* Vahl, Enum.Pl. 2:283.1806. In marshy places along water courses.

121. ***Scirpus articulatus*** L.Sp.Pl. 47.1753; Saxena & Brahmam, Fl. Orissa 4:2203.1996. *Schoenoplectus articulatus* (L.) Palla, Bot. Jahrb. Syst. 10:299.1889. Common in rice fields.

122. ***Scirpus grossus*** L.f.Suppl.Pl. 104.1781; Saxena & Brahmam, Fl. Orissa 4:2202:1996. *Schoenoplectus grossus* (L.f) Palla, Allg, Bot.Z.Syst. 17:Beibl.3.1911. Common in ditches.

123. ***Scirpus juncoides var. juncoides*** Roxb.Fl. Ind. 1:218.1820; Saxena & Brahmam, Fl. Orissa 4:2205.1996. *S. erectus* auct. Non Poir. 1829. Frequent in marshy land.

124. ***Scirpus mucronatus*** L.Sp.Pl.50.1753; Saxena & Brahmam, Fl. Orissa 4:2209.1996. *Schoenoplectus mucronatus* (L.) Palla, Verh. K.K. Zool. Bot. Ges. Wien 38.Sitzb:49.1988. Frequent in wet places.

125. ***Scirpus squarrosus*** L. Mart.Pl. 181.1771; Saxena & Brahmam, Fl. Orissa 4:2210.1996. *Rikliella squarrosus* (L.) Raynal, Adansonia (Ser.2) 13:154.1973.
Common in shallow water and ditches.

126. ***Scleria terrestris*** (L.) Fassett, Rhodora 26: 159.1924; Saxena & Brahmam, Fl. Orissa 4:2221.1996. *Zizania terrestris* L.Sp.Pl. 991.1753. Common in moist places.

POACEAE

127. ***Arundo donax*** L. Sp. Pl. 81.1753; Saxena & Brahmam, Fl. Orissa 4:2262.1996. Present along streams.

128. ***Echinochloa colona*** (L.) Link, Hort. Berol. 2:209.1833; Saxena & Brahmam, Fl. Orissa 4:2345.1996. *Panicum colonum* L., Syst. Nat.ed. 10.2:870.1759. Common in stagnant water and rice fields.

129. ***Echinochola stagnina*** (Retz.)P.Beauv. Ess. Agrost. 53, 161, 171.1812; Saxena & Brahmam, Fl. Orissa 4:2348.1996. *Panicum stagnium* Retz. Observ.Bot. 5:17.1789. Common in stagnant water.

130. ***Eragrostis japonica*** (Thunb.) Trin. Mem. Acad.Imp. Sci.St. Petersburg (Ser. 6) 1:405.1831; Saxena & Brahmam, Fl. Orissa 4: 2363.1996. *Poa japonica* Thunb. Fl. Jap. 51.1784. Common in moist places along streams.

131. ***Garnotia tenella*** (Arn.ex Miq.) Janawaski, Repert. Spec. Nov. Regni Veg. 17:86.1921; Saxena & Brahmam, Fl. Orissa 4:2379.1996. *Berghausia tenella* Arn. ex Miq. Nieuwe Verh. Eerste Kl. Ned.Inst. Wetensch Amsterdam 3:34.1851.
Frequent in moist places.

132. ***Hackelochloa granularis*** (L.) Kuntze, Rev. Gen. Pl. 2:776.1891; Saxena & Brahmam, Fl. Orissa 4:2383.1996. *Manisuris granularis* (L.) L.F. Nov. Gram. Gen. 40.1779. Common in rice field.

133. ***Hygroryza aristata*** (Retz.) Nees ex Wight & Arn. Edinburgh New Philos. J. 15:380.1833; Saxena & Brahmam, Fl. Orissa 4:2389:1996. *Pharus aristatus* Retz. Obs. Bot. 5:23.1789. Occasional aquatic grass.

134. ***Isachne globosa*** (Thunb.) Kuntze, Rev. Gen. Pl. 2:778.1891; Saxena & Brahmam, Fl. Orissa 4:2396.1996. *Milium globosum* Thunb Fl. Jap 49. 1784.
Frequent in marshy ground, rice field etc.

135. *Ischaemum hirtum* Hack. In A. & C. DC. Monog. Phan. 6:220.1889; Saxena & Brahmam, Fl. Orissa 4:2399.1996. Present along streams and ponds.

136. *Iseilema laxum* Hack. In A. & C. DC. Mong. Phan. 6:682.1889; Saxena & Brahmam, Fl. Orissa 4:2404.1996. Present in moist places near water courses.

137. *Leersia hexandra* Sw. Nov. Gen. Pl.21.1788; Saxena & Brahmam, Fl. Orissa 4:2407.1996. Frequent in tanks, lakes and marshes.

139. *Oplismenus compositus* (L.) P.Beauv. Essai Agrostogr. 54:168 & 169.1812; Saxena & Brahmam, Fl. Orissa 4:2419.1996. *Panicum compositum* L.Sp.Pl.57.1753. Common in damp forests.

140. Oryza meyeriana ssp. granulata (Zoll. & Mor.) Baill. Var. granulate (Nees & Arn. ex Watt) Duist. Blumea 32:185.1987.; Saxena & Brahmam, Fl. Orissa 4:2423.1996. *O. granulata* Nees & Arn. ex Watt, Dict. Econ. Prod. India 5:500.1891. Found along streams.

141. *Paspalum scrobilatum* L. Mart. Pl. 29.1767; Saxena & Brahmam, Fl. Orissa 4:2445.1996. Fairly common in moist and wet places.

142. *Saccharum spontaneum* L. Mant. Pl. 183.1771; Saxena & Brahmam, Fl. Orissa 4:2474.1996. Common in open wastlands along streams and rivers.

143. *Sacciolepsis indica* (L.) Chase, Proc. Biol. Soc. Wash. 21: 8. 1908; Saxena & Brahmam, Fl. Orissa 4:2476.1996. *Aira indica* L.Sp. Pl. 63.1753 & in errata 63.n.1. Frequent in open wet places.

144. *Sacciolepsis interrupta* (Wild.) Stapf in prain, Fl. Trop. Africa 9:757.1920; Saxena & Brahmam, Fl. Orissa 4:2477:1996. *Panicum interreptum* Wild. Sp. Pl. 1:341.1797. Common in marshy places or sub-aquatic lakes and ponds.

145. *Sporobolus indicus* (L.) R.Br. Var. Fertilis (Steud.) Jovet & Guedes, Taxon 22:163.1973; Saxena & Brahmam, Fl. Orissa 4:2497.1996. *Agrostis fertilis* Steud. Syn. Pl. Glum. 1:170.1854. Common in wet places.

PTERIDOPHYTA

EQUISETACEAE

146. *Equisetum ramosissimum* Desf. Subsp. debile (Roxb. Ex Vouch.) Hanke, Amer. Fern J. 52:33.1962; Saxena & Brahmam, Fl. Orissa 4:2548.1996. *E. debile* Roxb.ex Vauch. Mem. Soc. Phys. Hist Nat. Geneive 1:387.1822. In open or shady places close to stream.

PARKERIACEAE

147. *Ceraptoteris thalictroides* (L.) Brongn. Bull. Sci. Soc. Philom. Paris 1821:186.1822; Saxena & Brahmam, Fl. Orissa 4:2591.1996. *Acrostichum thalictroides* L.Sp.Pl.1070.1753. In marshy ground near water courses.

MARSILEACEAE

148. *Marsilea minuta* L. Mant. Pl. 308.1771; Saxena & Brahmam, Fl. Orissa 4:2593.1996. Common in wet places.

SALVINIACEAE

149. *Salvinia cucullata* Roxb. Ex Bory, Bel. Voy Bot. 2:6.1833; Saxena & Brahmam, Fl. Orissa 4:2653.1996. Floating aquatic.

Results and Discussion

Conservation of Biodiversity has assumed global significance from the point of view of ecological security and for ensuring a secured livelihood for the people. The biodiversity of Similipal with its typical ecosystems is the benevolent gift of nature to living being. In About 5,00,000 people live in the 1,265 revenue villages situated in the core, buffer and periphery area of reserve and depends for their livelihood. The over exploitation of natural resources, overgrazing, forest fire etc. have considerably affected the environment. In the present piece of study on aquatic plants of Similipal Biosphere Reserve many interesting findings on utilization value of plants were made (Table-1). Altogether about 149 aquatic plant species were enumerated

belonging to 100 genera and 48 families. Most of these plants were utilized by the local inhabitants for the purpose of medicinal uses, fodder grasses for domestic animals, thatching etc. The plants having high commercial value for the purpose of medicine in pharmaceutical sectors are need to be propagated by tissue cultue techniques in order to minimize the pressure due to over exploitation.

Conclusion

Since the establishment of Similipal biosphere reserve, the ecosystem enjoys adequate protection. But, biotic interference of various magnitude, the fragmentation of habitat is apparent in certain pockets of biosphere reserve. Some of the species namely *Coix aquatica* Roxb. and *Aspidopterys tomentosa* var. *hutchinsonii* are not observed during the present study and needs attention of further exploration. The species like *Salmonia cantoniensis* Lour. and *Swertia angustifolia* are rare in occurrence. *Equisetum ramosissimum* is occasionally found in Similipal. There is an urgent need of conservation prioritization of aquatic plants in order to conserve the species in particular and other threatened elements in general.

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Table -1: List of some aquatic macrophytes and their utility

S No.	Species	Family	Utility
1	*Centella asiatica*	Apiaceae	Medicinal
2	*Swertia angustifolia*	Gentianaceae	Medicinal
3	*Hygrophila auriculata*	Acanthaceae	Medicinal
4	*Echinochola colona*	Poaceae	Fodder Grass
5	*Hygroryza aristata*	Poaceae	Fodder Grass
6	*Oryza meyeriana ssp. granulata*	Poaceae	Fodder Grass
7	*Paspalum scrobilatum*	Poaceae	Fodder Grass
8	*Saccharum spontaneum*	Poaceae	Thatching Grass
9	*Sacciolepsis interrupta*	Poaceae	Fodder Grass

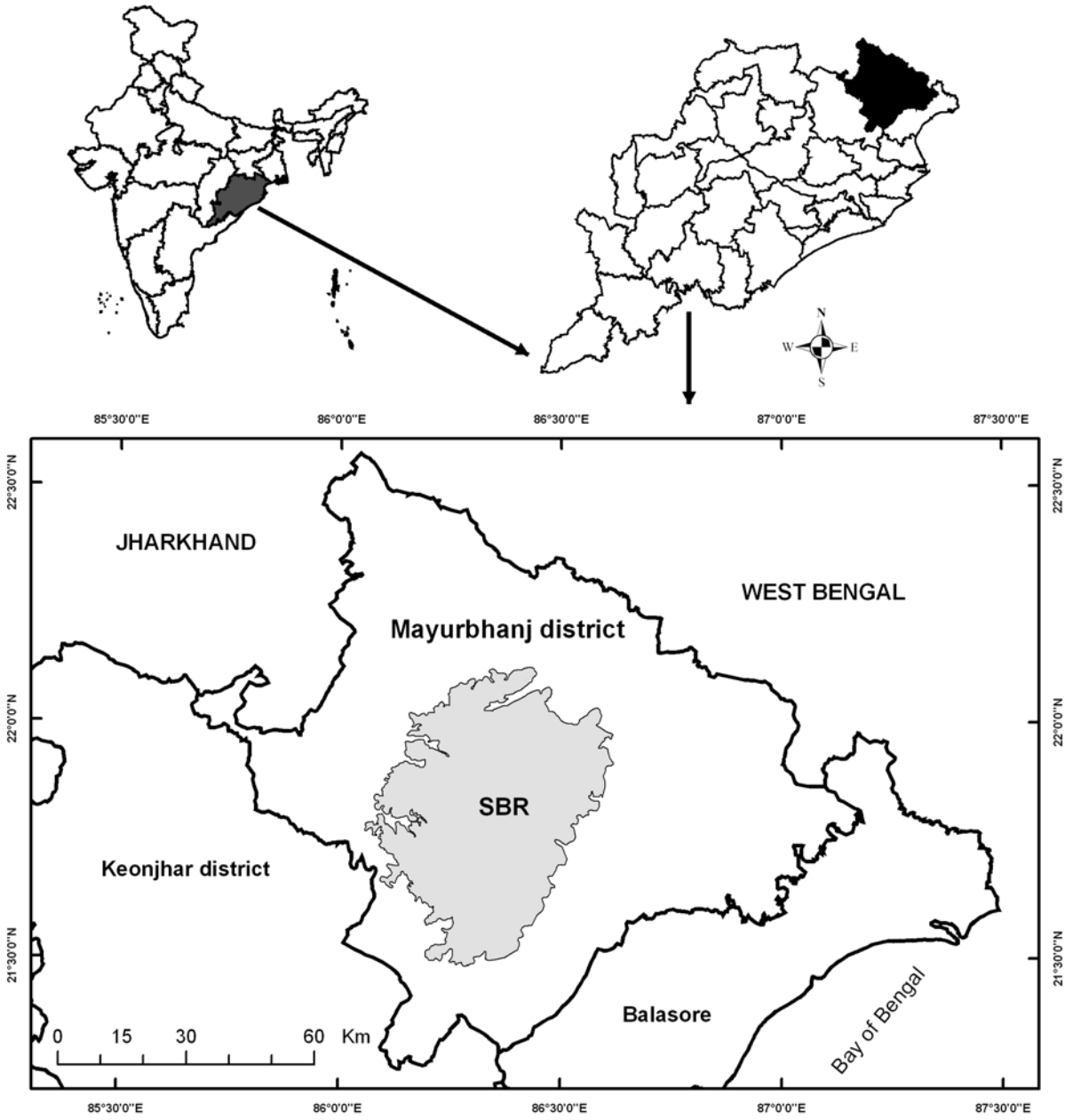

Fig:1 Location map of Similipal Biosphere Reserve, Orissa

Indices based study of herbaceous Vegetation in a South Indian tank bed at the foothills of Alagar Malai, Tamil Nadu

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Abstract

Tank bed herbaceous vegetation has been studied because herbs are important part of any natural and human modified ecosystems and existing documentation of the same is poor in South India. We present here a systematic documentation of the herbaceous taxa recorded in three different soil-moisture linked microhabitats within a rain fed tank from September to December when the northeast monsoon is active. The data presented have been analyzed to calculate conventional richness and diversity indices such as Simpson's index. Sorenson's ecological index of similarity is also estimated here. The uniqueness of the study is two fold. The first is the focus on herbs that still remain less documented and studied. The second is in the adaptation of the Sorenson index, which is usually applied to multi-site forest quadrats, where the estimate is of similarity between forest types or communities, whereas its application here to the single site herbaceous subplots, allows an estimation of the similarity of species occurrence or species associations.

Keywords: *Rain fed tank, Herbaceous vegetation, Diversity, Sorenson's index, Tamil Nadu*

Introduction

A detailed enumeration of species in a rain fed tank and its surroundings was carried out in Madurai District, Tamil Nadu, between September and December 2006. As tank beds harbor a good cover of herbaceous vegetation, a systematic and quantitative analysis of the herbs was carried out. The data have been analyzed for vegetational diversity and some other ecological indices. Many works have been carried out on the diversity of forests, but not much has been done on the diversity of herbs in an ecosystem such as rain fed tanks, especially in a semi-arid setting of India (Billore and Metha, 1975; Pandey, 2000; Dave and Krishnayya, 2004). Tanks are unique, albeit human modified ecosystems, for the main reason that changes in microclimatic conditions, such as water availability, soil texture and pH, are clearly evident and are manifested in the vegetation (Ariza *et al.*, 2007). Many workers have arrived at indices to measure the similarity among plant assemblages, the ones commonly used by modern ecologists being those proposed by Jaccard (1902), Sorenson (1948) and Cole (1949). Sorenson's similarly index that is widely used by ecologists has been used in this work. Though this index is mainly calculated for forest ecosystems covering large areas, it has been considered fit in this work to use it for a small ecosystem such as tank because 1. the species diversity observed in a smaller ecosystem like tank at the microcosmic level of subplots is comparable to that in large tracts of forests, 2. the abiotic factors in a tank such as pH, temperature and soil temperature fluctuate widely within a small area. Further, this index is adapted here for an estimation of the similarity of species occurrence or species associations, rather than similarity between forest (vegetation) types or communities, as in its conventional applications elsewhere (Jaccard, 1902; Sorenson, 1948; Rice and Belland, 1982; Real and Vargas, 1996 and Soosairaj *et al*., 2005).

Study area

The study area is a rain fed tank, Parambu Kanmai ($10^0$06' N, $78^0$18' E and 184msl.), in the Madurai District of Tamil Nadu (Fig.1a & 1b). This tank, fortified by a bund on the eastern side and a natural rocky weir on the southern side, has no inputs from any river and is fed only by the runoff of the rain in its catchments, the surrounding hills of Alagar Malai, Somagiri Malai and Muri Malai. The vegetation in the catchments ranges from scrubs on the rocky outcrops to good semi-evergreen forest patches in the slopes of the Alagar Malai. The tank remains dry for four to five months a year on an average. This tank services an ayacut of nearly 35 hectares, (Rognant, 2005)

Methods

The study of herbaceous species in the field of community ecology is usually carried out using1m x 1m quadrats (Bray, 1956; Yavitt and Smith, 1983 and Soosairaj *et al*., 2005). In the present study the same quadrat size was chosen and used because:

(i) In a tank environment the abiotic factors vary appreciably within a small area
(ii) Herbaceous communities have high species richness and diversity even within a $1m^2$quadrat
(iii) Herbaceous taxa are very sensitive to micro-level environmental and climatic fluctuations.

The quadrats were randomly laid, at intervals of 25–30m in three different parts of the tank based on water availability as illustrated in Fig. 1b & 2. All the individuals in each quadrat were systematically identified (Gamble and Fischer, 1915-1935; Mathew, 1983) and recorded during the period September to December (i.e., starting just before the northeast monsoon, through the monsoon and until after its cessation) of the year 2006. Observed data were tabulated using standard formulae (Curtis and McIntosh, 1950; Smith, 1966) for the richness and diversity of vegetation (Table 1).

Species similarity of occurrence or species associations

The degree of similarity between two communities or group of vegetation is given by the Sorenson index, Cs. This index is calculated by dividing the number of species that are common to both the groups by total number of species in the two groups: *Cs = 2 j/(a+b),* where j = the number of species that are common to both the groups, a is the number of species in the first group and b is the number of species in the second group. We have adapted this index to calculate the similarities of species occurrences in the herbaceous stratum in a tank bed. In our calculations of the index Cs, j = Number of quadrats in which both species are present, a and b are, respectively, the number of quadrats in which the first and the second species are found. This adaptation of the Sorenson similarity index provides a measure of interspecific association among the herbs in the tank bed.

Results

Species richness

In the randomly sampled 53 quadrats, 8905 individuals, taxonomically comprising of 10 families, 23 genera and 25 species were observed (Table1). Poaceae was the most dominant family (with 9 species), followed by Cyperaceae, Aizoaceae (with 3species), Boraginaceae, Euphorbiaceae, Rubiaceae (with 2 species). The remaining 4 families were represented by one species each. *Cyperus rotundus* with 2168 individuals is the most abundant species, followed by *Fimbristylis argentea* (1360), *Aristida setacea* (809), *Mollugo oppositifolia* (778), and least abundant species are *Heliotropium scabrum* (8), *Brachiaria reptans, Striga densiflora* (7) and *Oldenlandia umbellata* (6)(Table1).

Species similarity of occurrence or species associations

Of the 25 species, *Coldenia procumbens* and *Fimbristylis argentea* have been found to have Sorenson similarity index > 0 with the largest number of other species (22). For both these species, the degree of association with the others varies from very low, 0.06 to very high, 0.77 (Table 2). *Panicum repens* and *Cyperus compressus* also record a large number of associations with other species, 21 and 19 respectively. However, the highest index value for these species is 0.46 (Table 2). Although the smallest number of similarities with other species was found for *Striga densiflora* (3 species) and *Eragrostis nutans* (5 species), a high degree of similarity (0.67) was found between these two. This is to be expected because *Striga densiflora* was present in only one quadrat and *Eragrostis nutans* in two. The maximum degree of similarity was found between *Mollugo oppositifolia* and *Fimbristylis argentea* (0.77), followed by *Cyperus rotundus* with *Coldenia procumbens* (0.70) and *Glinus lotoides* with *Coldenia procumbens* (0.69) (Table 2).

Discussion and conclusion

From the results tabulated (Table-1), it is seen that *Coldenia procumbens, Fimbristylis argentea* (11.07) and *Cyperus rotundus* (10.72) have high RF (Tilman *et al*., 1994; Dave and Krishnayya, 2004). This can be attributed to their quick germination, less root penetration and prostrate growth. Soil conditions suitable for these species, loamy soil with high moisture content, is found in most parts of the tank bed. Species with lower RF, *Striga densiflora, Oldenlandia umbellata* (0.36) and *Brachiaria reptans* (0.71) only occurred in the periphery of the tank bed, where the dry and sandy soil was favorable to them. *Cyperus rotundus* and *Fimbristylis argentea,* that are monopodial and also bearing numerous seeds per individual are the most abundant of species in the tank studied. Among the low abundance species, *Coldenia procumbens* and *Merremia emarginata* are sympodial and were observed to have lesser number of seeds per individual as expected. For several medium to low abundance species recorded, especially the dicotyledons, the requirement of large space for growth is frequently a constraint.

Species Similarity

Though one of the advantages of Jaccard and Sorenson indices is their simplicity, this virtue is also a disadvantage in that the coefficients take no account of the abundances of species (Magurran, 1988). In this study Sorenson's index has been calculated for various species pairs (Table 2). To derive meaningful ecological associations, this index along with abundance (Table 1) is used in conjunction with field observations. This index has been preferred here, as it tends to have smaller relative bias than Jaccard index (Chao *et al*., 2006). Also, Sorenson's index is estimated by directly using the observed data without involving intermediary steps like the calculation of Chi square values, as in Cole's index (Cole, 1949) that has been widely applied too (Billore and Mehta, 1975; Soosairaj *et al.*, 2005).

The index for *Mollugo oppositifolia* and *Fimbristylis argentea* is 0.77 (Fig. 6), which is the highest value, taking into account all the species pairs in the study (Table 2). Consistent field observation of the co-occurrence of *Fimbristylis argentea* and *Mollugo oppositifolia* (frequently the former in the shade of the latter) supports this (Fig. 6). The next highest index (0.7) was recorded for the pair *Cyperus rotundus* and *Coldenia procumbens* (Fig. 3)**,** where interestingly the former is among the most abundant of species while the latter is among the least so. Their distribution among the quadrats suggests a common affinity for the same kind of slightly moist, but not soggy sandy-clay soil for these two species (Fig. 3). The indices for *Coldenia procumbens* with *Glinus lotoides* (0.69, Fig. 4) and *Mollugo oppositifolia* (0.54) are high but not so with

Mollugo nudicaulis (0.17, Fig. 5). Field observations indicate that while *Coldenia procumbens* and *Mollugo nudicaulis* are both procumbent herbs with completely different leaf structures, *Glinus lotoides* and *Mollugo oppositifolia* are erect herbs but share some similarities in leaf structure with *Coldenia procumbens*. These high associations may signify a deeper ecophysiological dimension in the perspective of the comparative study of leaf anatomy of *Coldenia procumbens* and *Mollugo* sp. by Saxton (1924). Of the species studied, the following 5 may be grouped together as an associated group because the Sorenson's index remains high for 9 of the 10 pairs between them: *Mollugo oppositifolia*, *Glinus lotoides*, *Cyperus rotundus*, *Fimbristylis argentea* and *Coldenia procumbens* (Fig. 2). Among the Poaceae species, a high index of association (0.67) was observed between the following pairs, with each occurring in moderate to high abundances: *Chloris barbata* with *Aristida setacea*; *Sporobolus coromandelianus* with *Paspalum scrobiculatum*. *Polygonum plebium*, *Dentella repens* and *Cynodon dactylon* seem to form an associated group preferring sandy clay during the dry season. *Mollugo nudicaulis*, *Oldenlandia umbellata*, *Striga densiflora* and *Eragrostis nutans* constitute a group, favouring the rainy season in sandy places, especially the channels. Several of the species in this study such *Coldenia procumbens*, *Mollugo oppositifolia*, *Glinus lotoides*, *Cynodon dactylon* and *Cyperus* sp. (Fig. 7) are among those listed by Dave and Krishnayya (2004) as species "abundant in undisturbed fragments that remain after disturbance". In contrast, not even one of the "invasive weed species of the roadside or wastelands" listed by them was documented in this study, though *Tridax procumbens* was observed on the fringes of the Parambu Kanmai tank indicating that this tank seems to be practically undisturbed.

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Table 1. Species diversities inside the tank bed during Sep.2006 – Jan.2007

Species	Total	F	RF	A	D	SI	SID	SRI
Aristida setacea	809	26.42	5.00	9.08	15.26	0.09	0.91	10.93
Brachiaria reptans	7	3.77	0.71	0.08	0.13	0.00	1.00	1263.71
Chloris barbata	615	18.87	3.57	6.91	11.60	0.07	0.93	14.38
Coldenia procumbens	98	58.49	11.07	1.10	1.85	0.01	0.99	90.27
Croton sparsiflorus	13	13.21	2.50	0.15	0.25	0.00	1.00	680.46
Cynodon dactylon	485	5.66	1.07	5.45	9.15	0.05	0.95	18.24
Cyperus compressus	108	15.09	2.86	1.21	2.04	0.01	0.99	81.91
Cyperus rotundus	2168	56.60	10.72	24.35	40.91	0.25	0.75	4.08
Dactyloctenium aegyptium	575	13.21	2.50	6.46	10.85	0.07	0.93	15.38
Dentella repens	25	1.89	0.36	0.28	0.47	0.00	1.00	353.84
Eragrostis nutans	56	3.77	0.71	0.63	1.06	0.01	0.99	157.96
Fimbristylis argentea	1360	58.49	11.07	15.27	25.66	0.15	0.85	6.50
Glinus lotoides	589	49.06	9.29	6.61	11.11	0.07	0.93	15.02
Heliotropium scabrum	8	11.32	2.14	0.09	0.15	0.00	1.00	1105.75
Indigofera euneaphylla	283	26.42	5.00	3.18	5.34	0.03	0.97	31.26
Merremia emarginata	63	11.32	2.14	0.71	1.19	0.01	0.99	140.41
Mollugo nudicaulis	15	7.55	1.43	0.17	0.28	0.00	1.00	589.73
Mollugo oppositifolia	778	50.94	9.64	8.74	14.68	0.09	0.91	11.37
Oldenlandia umbellata	6	1.89	0.36	0.07	0.11	0.00	1.00	1474.33
Panicum repens	203	15.09	2.86	2.28	3.83	0.02	0.98	43.58
Paspalum scrobiculatum	244	13.21	2.50	2.74	4.60	0.03	0.97	36.25
Phyllanthus niruri	228	47.06	8.91	2.56	4.30	0.03	0.97	38.80
Polygonum plebium	79	3.77	0.71	0.89	1.49	0.01	0.99	111.97
Sporobolus coromandelianus	83	13.21	2.50	0.93	1.57	0.01	0.99	106.58
Striga densiflora	7	1.89	0.36	0.08	0.13	0.00	1.00	1263.71

F= Frequency, RF= Relative frequency, A= Abundance, D= Density, SI= Simpson's index, SID= Simpson's index diversity and SRI= Simpson's reciprocal index.

Table 2. Sorenson's index for species pairs, within the tank bed.

	Ar. se	Br. re	Ch. ba	Co. pr	Cr. sp	Cyp. da	Cy. co	Cyp. ro	Da. ae	De. re	Er. nu	Fi. ar	Gl. lo	He. sc	In. eu	Me. em	Mo. nu	Mo. op	Ol. um	Pa. re	Pas. Sc	Ph. ni	Po. pl	Sp. co	St. de
Ar. se																									
Br. re	0.00																								
Ch. ba	0.67	0.00																							
Co. pr	0.31	0.06	0.29																						
Cr. sp	0.18	0.00	0.00	0.15																					
Cyp. da	0.00	0.33	0.14	0.17	0.17																				
Cy. co	0.27	0.00	0.11	0.36	0.13	0.17																			
Cyp. ro	0.52	0.00	0.38	0.70	0.20	0.11	0.35																		
Da. ae	0.29	0.00	0.47	0.26	0.00	0.18	0.27	0.31																	
De. re	0.00	0.00	0.00	0.06	0.00	0.40	0.22	0.00	0.00																
Er. nu	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00															
Fi. ar	0.39	0.12	0.24	0.60	0.25	0.17	0.25	0.53	0.10	0.06	0.06														
Gl. lo	0.44	0.00	0.27	0.69	0.11	0.06	0.40	0.61	0.18	0.07	0.00	0.64													
He. sc	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.11	0.18												
In. eu	0.34	0.12	0.32	0.35	0.00	0.21	0.17	0.34	0.18	0.13	0.00	0.47	0.43	0.00											
Me. em	0.00	0.00	0.00	0.16	0.29	0.00	0.14	0.16	0.00	0.00	0.00	0.16	0.18	0.00	0.00										
Mo. nu	0.00	0.00	0.14	0.17	0.00	0.25	0.17	0.17	0.36	0.00	0.33	0.11	0.00	0.00	0.00	0.00									
Mo. op	0.38	0.13	0.16	0.54	0.22	0.19	0.28	0.50	0.11	0.07	0.00	0.77	0.62	0.12	0.51	0.06	0.00								
Ol. um	0.00	0.00	0.00	0.06	0.00	0.00	0.22	0.06	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00							
Pa. re	0.26	0.18	0.32	0.30	0.12	0.46	0.35	0.20	0.38	0.20	0.18	0.15	0.17	0.00	0.42	0.00	0.31	0.16	0.20						
Pas. Sc	0.00	0.00	0.00	0.21	0.00	0.00	0.13	0.15	0.00	0.00	0.00	0.21	0.29	0.46	0.09	0.31	0.00	0.17	0.00	0.00					
Ph. ni	0.32	0.00	0.29	0.51	0.19	0.00	0.25	0.46	0.19	0.00	0.00	0.43	0.43	0.27	0.21	0.33	0.00	0.50	0.00	0.06	0.26				
Po. pl	0.00	0.50	0.00	0.12	0.00	0.67	0.20	0.00	0.00	0.67	0.00	0.12	0.07	0.00	0.24	0.00	0.00	0.13	0.00	0.36	0.00	0.00			
Sp. co	0.00	0.20	0.00	0.15	0.00	0.17	0.00	0.20	0.00	0.00	0.00	0.20	0.17	0.43	0.26	0.14	0.00	0.22	0.00	0.24	0.67	0.13	0.20		
St. de	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	

Ar. se= Aristida setacea, Br. re= Brachiaria reptans, Ch. ba= Chloris barbata, Co. Pr= Coldenia procumbens, Cr. sp= Croton sparsiflorus, Cy. da= Cynodon dactylon, Cyp. co= Cyperus compressus, Cyp. ro= Cyperus rotundus, Da. ae= Dactyloctenium aegyptium, De. re= Dentella repens, Er. nu= Eragrostis nutans, Fi. ar= Fimbristylis argentea, Gl. lo= Glinus lotoides, He. sc= Heliotropium scabrum, In. eu= Indigofera euneaphylla, Me. em= Merremia emarginata, Mo. nu= Mollugo nudicaulis, Mo. op= Mollugo oppositifolia, Ol. um= Oldenlandia umbellata, Pa. re= Panicum repens, Pas. sc= Paspalum scrobiculatum, Ph. ni.= Phyllanthus niruri, Po. pl= Polygonum plebium, Sp. co= Sporobolus coromandelianus, St. de= Striga densiflora

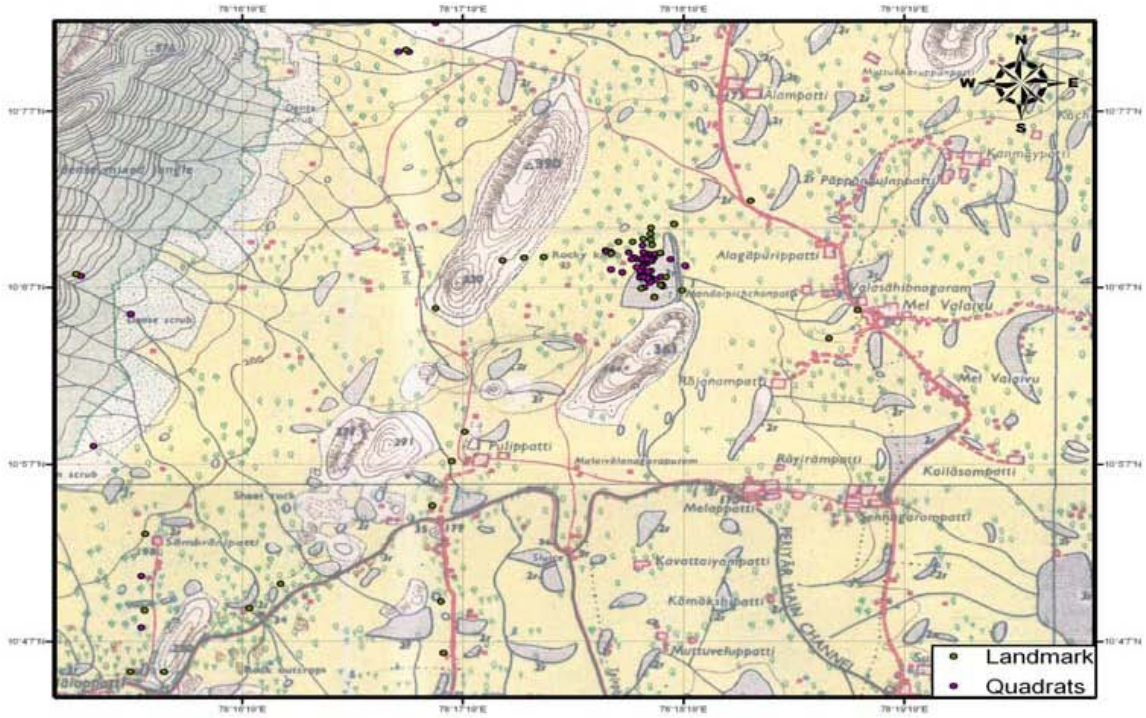

Fig. 1a. Route map of Parambu Kanmai tank site

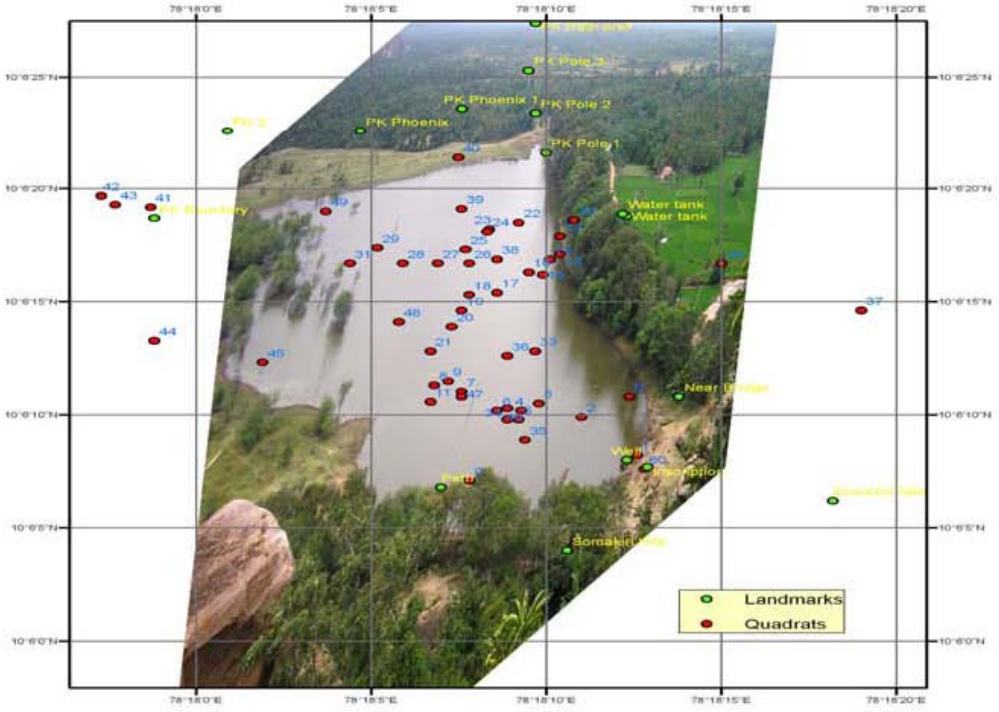

Fig. 1b. Parambu Kanmai individual Quadrats and Landmark GPS points

Fig 2. Co-occurrence of *Mollugo oppositifolia*, *Glinus lotoides*, *Cyperus rotundus* and *Coldenia procumbens*

Fig. 3. *Coldenia procumbens* & *Cyperus rotundus* on sandy clay, moist but not soggy soil

Fig. 4. Carpet vegetation of *Coldenia procumbens* and *Glinus lotoides*

Fig. 5. *Mollugo nudicaulis* in a sandy channel. in flower

Fig. 6. *Mollugo oppositifolia* and *Fimbristylis argentea* found together in a dry place s

Fig. 7. *Coldenia procumbens*, *Glinus lotoides*, *Cynodon dactylon* and *Cyperus* rotundus frequently found together

Structure and composition of Tropical forest of Eastern Ghats: A case study in R.V. Nagar Range, Visakhapatnam District, Andhra Pradesh, India

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Abstract

The aim of this investigation was to study three tropical forest types in R.V. Nagar Range, Visakhapatnam district, Andhra Pradesh. Three forest types, semievergreen, moist deciduous and savannah were distinct and differed in composition, dominance, diversity and structure. The study resulted in documentation of 274 species for floristic enumeration and phytosociological analysis. Tree stand density varied from 508-719 ha^{-1} with average basal area of 33.56 m^2ha^{-1} covering 120 species. Shannon–Wiener index (H') ranges from 3.71-5.50. Similarity index reveals that only 62.4% of floristic composition of semievergreen forest is similar with moist deciduous forest. Margalef's Species Richness Index varies from 3.04-9.50. Population density of tree species across girth class interval shows that around 73.3% of species and 36.3% of individuals belong to 30-60 cm gbh.

Keywords: *tropical forests, semievergreen, deciduous, species composition, diversity, Andhra Pradesh.*

Introduction

The ecological, social and economic roles of the forest were of great importance. In present scenario, most of the forests are prone to high anthropogenic disturbances, which bring out loss and extinction of valuable species. Understanding of vegetation composition, diversity of species and their habitats, and comparison with similar other habitats, may become a tool to estimate the level of adaptation to the environment and their ecological significance. Information on floral composition, diversity and phytomass are absolutely essential in understanding the forest ecosystem dynamics (Hartshorn 1990). In peninsular India, quantitative phytodiversity inventories are available from the forests of the Western Ghats. Eastern Ghats remain as a neglected area with very few attempts made for such studies in Eastern Ghats of Tamil Nadu (Kadavul and Parthasarathy 1999a&b, Chittibabu and Parthasarathy 2000, Jayakumar *et al* 2002, Natarajan *et al*. 2004), Andhra Pradesh (Reddy *et al*. 2007a) and Orissa (Reddy *et al*. 2007b). Hence, the present study was undertaken to determine the structure and floristic composition of tree diversity within three tropical forest types of R.V. Nagar Range, Visakhapatnam district, Andhra Pradesh, India.

Study area

The Eastern Ghats are located along the Peninsular India extending over 1750 km with average width of about 100 km and covering the area under 11°03' to 22°32"N latitudes and 77°02' to 87°02'E longitudes. The Eastern Ghats are delimited in the north by Similipal hills of Orissa State. The middle section extends from River Krishna (Andhra Pradesh) to near about Chennai city (Tamil Nadu) and includes the Nallamalais, Nigidi, Seshachalam and Veligonda hills. The last section runs in S-SW direction meeting the Western Ghats in the Nilgiris (Reddy *et al*. 2006). R.V. Nagar Range is situated between 17°48" to 18°00" N and 82° 02" to 82° 16" E in Visakhapatnam district, Andhra Pradesh and covers an area of 312 km^2. It is part of proposed Chintapally Biosphere Reserve and has unique vegetation composition with semievergreen forests in the tracts of Gudem valley. The highest peak in Andhra Pradesh is Sambarikonda (1527 m), which is found in this range. The forest area in the range was 224.5 km^2, covers 72% of the geographical area (Sudhakar & Reddy, 2005).

Materials and Methods

Field sampling

Phytosociological data were collected in three tropical forest types based on stratified random sampling method. The size and number of quadrats needed were determined using the species area curve (Misra, 1968). Sample plot (quadrat) size of 20x20m were placed and systematically surveyed for all trees/woody plants ≥30cm girth at breast height (gbh - above 130cm from the ground) during 2004-2005. In addition to the trees, data on herbs, shrubs, climbers and saplings were collected. Thus data were obtained from a total of 50 sample plots (total area sampled = 2 ha). Of the three forest types in the RV Nagar Range, Moist deciduous forest is the most common followed by Semi evergreen and Savannah. The species were identified with the help of Flora of Presidency of Madras (Gamble & Fischer, 1915-1935) and Flora of Visakhapatnam district (Subbarao & Kumari, 2002).

Data analysis

The vegetation data were quantitatively analyzed for relative density, relative frequency and relative dominance. The importance value index (IVI) for the tree species was determined as the sum of the relative

frequency, relative density and relative dominance (Cottam and Curtis, 1956; Phillips, 1959). Species diversity of each forest type was determined using Shannon-Weiner Index. (H') = -Sum ((ni/N) ln (ni/N)). (Shannon and Weiner, 1963; Odum, 1971)

Where ni = IVI of individual species.

N= IVI of all species.

Concentration of dominance was also measured using the formula (Simpson, 1949): C= -S (ni/N).

Where *ni* and *N* are the same as those for the Shannon–Weiner information function.

Species Richness was computes using well known Margalef's index (Margalef, 1958), as follows.

R= S-1/ln (n), where S = number of species; n= number of individuals.

Similarity between three forest types was determined using Sorenson's index of similarity (Sorenson, 1948).

Results and Discussion

Forest floristics

The predominant forest types in RV Nagar Range are Semievergreen, Moist Deciduous and Savannah (Champion & Seth, 1968). As typical of tropical forest ecosystem, a wide range of tree species was inventoried in the present study. On the whole, a total of 274 species of flowering plants were enumerated in the sample plots. Trees and herbs contribute 120 (43.8%) and 101 (36.9%) species respectively (table 1). The trees belong to 94 genera and distributed among 45 families. The species with the highest number of occurrence and relative density (most abundant species) is *Pterocarpus marsupium* with 51 stems/ha and a relative density of 7.56.This is followed by *Schleichera oleosa* with 46 stems/ha and a relative density of 6.89 (table 2). Forest type-wise tree species richness was 86 for semievergreen, 84 for moist deciduous and 18 for savannah with major differences between the plots. Similarity index reveals that only 62.4% of floristic composition of semievergreen forest is similar with moist deciduous forest. Interestingly, very low similarity (5%) was observed between Semievergreen forest and Savannah. Species diversity, viz, Shannon–Wiener index (H') ranges from 3.71-5.50. Moist deciduous forests shows high species diversity (H'= 5.50) and forms ecotone between moist systems to drier systems. Margalef's species richness index shows low value in savannah (3.04) and higher value in moist deciduous forest (9.50). Simpson index reveals the fact that in Savannah, individuals drawn at randomly from population belong to the same species. The apparent variation in species and the proportion of dominants in the three forest types can directly be attributed to altitudinal gradient. Semievergreen and moist deciduous forests are distributed in altitude of 500 to 1100 m, while Savannah forests were found on hill tops (>1100m). In Semievergreen forests, moisture indicating species are prevalent, i.e. *Schleichera oleosa, Mangifera indica, Michelia champaca, Pterocarpus marsupium, Syzygium cumini* and *Nothopegia heyneana* (table 3).Where as Moist deciduous forest species composition possess mixture of both moist and dry elements, indicating transitional type. In Moist deciduous forest, *Pterocarpus marsupium, Syzygium cumini, Xylia xylocarpa, Grewia tilifolia* and *Schleichera oleosa* are predominant. In savannah, *Terminalia chebula, Terminalia alata, Holarrhena antidysenterica, Phyllanthus emblica* and *Cassine glauca* are predominant (table 3). While in Semi evergreen forest top most 10 species represented 52.1% of individuals, where as in case of Moist deciduous forest and Savannah forest the proportions are 51.3% and 85.2% respectively.

Forest Structure:

A total of 669 individual trees per hectare having girth of >30 cm GBH were found in the study area (range 508-719 trees/ha) and mean basal area was 33.56m2/hectare. Basal area was ranging from 7.79 m^2 (Savannah) to 49.2m^2 (semi evergreen) (table1). The distribution of the basal area across the forest types, using gbh interval classes, reveals the dominance of small stemmed individuals in the plots (table 4). The mean diameter of top 10 dominant tree species covers 45.8% of ground cover. It means minority of species dominate the majority of the available resources. Population density of tree species across girth class interval shows that around 73.3% of species and 36.3% of individuals belong to 30-60cm gbh. The overall population structure indicates that study area represents typical mature stands with good regeneration. *Mangifera indica, Nothopegia heyneana,* and *Michelia champaca* represents highest girth of 422 cm, 394 cm and 367 cm respectively. The mean stand density of 669 stems ha^{-1} and range of 508-719 stems ha^{-1} in the tropical forests of study area is well within the range of 276-905 stems ha^{-1} reported in the tropics of India (Ghate et al. 1998; Sundarapandian and Swamy 1997; Prasad *et al.* 2007; Reddy *et al*. 2007). This range of stand density in the present study is higher when compared to other Eastern Ghats sites (Shervarayan hills - Kadavul and Parthasarathy 1999a; Kalrayan hills - Kadavul and Parthasarathy 1999b; Coromandel coast - Parthasarathy and Sethi 1997) and lower from other Western Ghats sites (Courtallam reserve forest – Parthasarathy and Karthikeyan 1997a; Sengaltheri – Parthasarathy 2001). The mean tree height is 15m with a height range from 1 to 35m. Tree distribution by height intervals shows that around 21.4% of individuals are in the height of 10-15 m, followed by 20.9% in the height of 15-20m, where as 2.7% of individuals are in the height class of >30m (table 5). The tallest individual trees were *Dillenia pentagyna*, *Bombax ceiba*, *Pterocarpus marsupium* and *Michelia champaca.* Tree species in savannah forests show tendency towards shorter stature (98.4% of individuals are with less than 5 m height) than trees in semievergreen (14.2%) and moist deciduous (17.6%). The girth and height of species relies greatly upon the climate, edaphic conditions and anthropogenic factors. Species rarity (those represented by ≤2 individuals) of 18.5% obtained in the present study area is lower as compared to Kuzhanthaikuppam and Thirumanikkuzhi (26% and 31%

respectively) dry evergreen forest sites on the Coromandel coast (Parthasarathy and Karthikeyan 1997b) and that of (43%) Vellimalai, in the Kalrayan hills, Eastern Ghats (Kadavul and Parthasarathy 1999b).

Conclusion

Structure and floristic composition of tree species have been studied. Presence of high species richness and diversity, stand density and species rarity indicates the uniqueness and potentiality of RV Nagar Range for conservation of ecosystem in its totality. The problem of shifting cultivation, forest fire, grazing, fuel wood extraction, medicinal plants collection, biological invasion is observed, which must be checked practically and should be given highest priority for habitat conservation. The immediate attention on people's participation is most essential for effective conservation. It may be concluded that some of the areas in Eastern Ghats are still rich in species diversity, even after disturbance in terms of fire, grazing, extraction of economic/medicinal species and invasion of exotic species.

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Table 1: Consolidated details of species inventory in RV Nagar Range:

Description	Semi evergreen	Moist Deciduous	Savannah	Grand total
No. of tree species	86	84	18	120
No. of tree genera	69	71	16	94
No of tree families	40	37	14	45
Density (stems/ha^{-1})	657	719	508	669
Species diversity index (H')	5.27	5.50	3.71	4.82
Simpson index	0.96	0.95	0.91	0.94
Basal area (m^2/ha^{-1})	49.2	43.7	7.79	33.56
No. of shrub species	15	10	1	21
No. of herb species	44	85	8	101
No. of climber species	16	9	4	25
Total species (incl. trees)	161	188	32	274
Similarity Index				
Semi evergreen	---	62.4	5	
Moist Deciduous	---	---	32	
Savannah	---	---	---	
Margalef's Species Richness Index	9.13	9.50	3.04	7.22

Table 2. Ecological dominance of top ten species (based on IVI values)

S.No.	Species	Relative Density	Relative Frequency	Relative Basal area	IVI
1	*Pterocarpus marsupium*	7.56	5.05	10.63	23.25
2	*Schleichera oleosa*	6.89	3.97	8.92	19.78
3	*Mangifera indica*	4.15	2.89	8.31	15.35
4	*Syzygium cumini*	3.65	4.15	7.34	15.15
5	*Michelia champaca*	2.57	2.89	7.93	13.39
6	*Bauhinia vahlii*	5.73	4.33	1.39	11.45
7	*Mallotus philippensis*	5.56	4.33	1.10	11.00
8	*Grewia tilifolia*	4.32	4.33	1.95	10.61
9	*Terminalia alata*	2.74	2.17	4.15	9.05
10	*Garuga pinnata*	2.66	2.35	3.86	8.87

Table 3: IVI of the ten most important species in forest types of RV Nagar Range

SEMI-EVERGREEN					
S.No.	Species	Relative Density	Relative Frequency	Relative Basal area	IVI
1	*Schleichera oleosa*	9.37	4.69	11.46	25.5
2	*Mangifera indica*	6.30	4.11	11.42	21.8
3	*Michelia champaca*	3.95	4.11	11.05	19.1
4	*Pterocarpus marsupium*	4.39	4.40	7.87	16.7
5	*Syzygium cumini*	4.25	4.69	7.70	16.6
6	*Bauhinia vahlii*	7.47	5.28	1.61	14.4
7	*Mallotus philippensis*	5.56	4.69	1.15	11.4

8	*Garuga pinnata*	3.66	2.93	4.65	11.2
9	*Nothopegia heyneana*	2.64	1.76	6.16	10.6
10	*Grewia tilifolia*	4.54	4.11	1.47	10.1
	MOIST DECIDUOUS				
1	*Pterocarpus marsupium*	13.3	6.67	16.03	36.0
2	*Syzygium cumini*	3.26	3.81	6.94	14.0
3	*Xylia xylocarpa*	5.65	0.95	6.49	13.1
4	*Grewia tilifolia*	4.35	5.71	2.88	12.9
5	*Schleichera oleosa*	4.13	3.81	4.56	12.5
6	*Mallotus philippensis*	6.09	3.81	1.01	10.9
7	*Cassia fistula*	4.78	4.29	1.21	10.3
8	*Terminalia alata*	2.61	2.38	4.98	10.0
9	*Diospyros sylvatica*	3.26	3.81	1.95	9.0
10	*Bauhinia vahlii*	3.91	3.81	1.03	8.8
	SAVANNAH				
1	*Terminalia chebula*	16.39	11.1	29.5	57.0
2	*Terminalia alata*	14.75	11.1	17.0	42.8
3	*Holarrhena antidysenterica*	14.75	7.41	9.4	31.5
4	*Phyllanthus emblica*	9.84	7.41	6.2	23.4
5	*Cassine glauca*	6.56	3.70	11.1	21.4
6	*Sterculia villosa*	6.56	7.41	3.5	17.5
7	*Bombax ceiba*	3.28	7.41	5.34	16.0
8	*Buchanania lanzan*	3.28	7.41	3.46	14.2
9	*Diospyros montana*	6.56	3.70	3.17	13.4
10	*Callicarpa arborea*	3.28	3.70	4.35	11.3

Table 4: Population density of tree species (≥ 30 cm gbh) across Girth Class intervals:

gbh class	Species	% of Species	% of Individuals
30-60	58	48.3	17.2
60-90	88	73.3	36.3
90-120	63	52.5	20.5
120-150	39	32.5	9.6
150-180	32	26.7	6.9
180-210	18	15.0	4.2
210-240	12	10.0	2.7
240-270	5	4.2	0.8
>270	18	15.0	1.9
Grand Total	**120**	**100.0**	**100.0**

Table 5: Height class wise proportion of tree individuals in R.V. Nagar range:

Height Class	Overall Vegetation		Semi evergreen	Moist deciduous	Savannah
	Species	% of Individuals	% of Individuals	% of Individuals	% of Individuals
<5m	71	18.5	14.2	17.6	98.4
5-10	62	16.7	14.2	19.3	1.6
10-15	59	21.4	21.8	23.5	-
15-20	62	20.9	23.1	20.4	-
20-25	41	15.1	18.2	12.6	-
25-30	27	4.6	4.8	4.8	-
>30	14	2.7	3.7	1.7	-
Grand Total	120	100	100	100	100

Medico-Botanical evaluation of certain Crude drugs used for alimentary disorders by adivasis in Eastern Ghats of Andhra Pradesh

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Abstract

The intensive exploration and repeated interviews, conducted with herbal doctors and tribal health practitioners, yielded the alimentary disorders as the most common and prevalent ailments in tribal hamlets of the Eastern Ghats of Andhra Pradesh. About 36 species belonging to 35 genera and 21 families of angiosperms were recorded as common crude drugs used for the purpose in the area. The comprehensive data pertaining to the botanical name, medicobotanical properties, mode of administration, etc was provided.

Key words: Crude drugs, alimentary disorders, Eastern Ghats.

Introduction

Eastern Ghats, located between 78° 50'-84° 46' E longitude and 12° 38'-22° N latitudes in Andhra Pradesh and pass through the districts of the Srikakulum, Visakhapatnam, Vijayanagaram, East Godavari, West Godavari, Krishna, Guntur, Prakasam, Nellore, Kurnool, Chittore, Kadapa and Mahaboobnagar. The great rivers such as Mahanadi, Godavari and Krishna cut across Eastern Ghats and formed a discontinuous range of hills mostly above 750 m height with a few peaks exceeding 1500m in elevation. The highest peak in these Ghats is Sambari Konda with an elevation of 2527m near Gudem village in Visakhapatnam district (Subba Rao et al., 1982). Tribes like Bagatas, Chenchus, Jatapus, Khonds, Kondareddis, Lombadas Porjas, Savaras, Yanadis, and Yerukalas have been inhabited in the forests of Eastern Ghats.

Materials and Methods

Intensive exploration and repeated interviews, conducted with herbal doctors and elder people whose empirical knowledge was respected by everyone in the area, yielded certain interesting information on alimentary disorders i.e., diarrhoea, diuretic, dysentery, indigestion and stomach ache, etc. The documented information was cross-checked with neighboring fellow practitioners and analysed in the light of available literature. The sample specimens were collected based on the information from the forests and identified with the help of local floras. Further, the tentative identification was confirmed by comparing with authenticated specimens housed at Sri Krishnadevaraya University Herbarium (SKU), Anantapur, Madras Herbarium (MH), Coimbatore and Central National Herbarium (CAL), Kolkata. The voucher specimens were deposited in Sri Krishnadevaraya University Herbarium (SKU), Anantapur.

Results and Discussion

The critical analysis of the data, resulted 36 species in which 17 species are hither to unknown, indicated with asterisk (Table-1). The crude drugs were analysed based on different alimentary ailments(Table-2), which revealed maximum number of crude drugs (12) were used for diarrhoea, followed by indigestion (11), dysentery (10), stomach ache (4), while minimum number were recorded as diuretic (3). Fabaceae, represented the maximum number of crude drugs (7 spp), followed by Asclepiadaceae and Caesalpiniaceae (3 spp each), Anacardiaceae, Euphorbiaceae, Malvaceae, Moraceae and Tiliaceae (2spp) and others are represented by only species (Table-3). The crude drug formulations used by the local tribes for alimentary disorders performed significantly. However, the active principle involved in therapeutic property has to be isolated and characterized. Attempts are being made in the laboratory to confirm the structural configuration of biodynamic compounds involved in the property.

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Table-1: Medico-botanical enumeration of crude drugs

Botanical name/Vernacular name/ Family	Part used	Disease	Mode of administration
Abrus precatorius L. / Guruvinda/ (Fabaceae)	L	Stomach ache	Chewed with sugar and swallowed for stomach ache
**Abutilon crispum* (L.) G.Don / Nelabenda / (Malvaceae)	R	Diuretic	Extract given orally once a day for 2-3 days
Allophyllus serratus (Roxb.)Kurz / Guvvagutti or Sallikunkudu / (Sapindaceae)	R	Diarrhoea	Decoction given orally
**Anisomeles indica* (L.) Ktze. / Adabeera / (Lamiaceae)	Wp	Stomach ache	Infusion given orally
**Aristolochia bracteolata* Lam. / Gadidagadapa, Aristolochiaceae	L(fr)	Indigestion	Juice mixed in mother milk , given orally
**Basella rubra* L. / Errabachhali / (Basellaceae)	L(fr)	Diuretic	Juice mixed with butter, given orally
Bauhinia purpurea L./ Bontachettu/ (Caesalpiniaceae)	Sd	Indigestion	Powdered and made paste with sesam oil and given orally
**Bauhinia vahlii* Wt.&Arn. / Vistarlaku / (Caesalpiniaceae)	Sd	Indigestion	Powdered and made into paste (with sesam oil), given orally
**Buchanania axillaris*(Desr.) Raman. / Sara / (Anacardiaceae)	G	Diarrhoea	Given orally with hot water
Cannabis sativa L. / Bangiaku/ (Cannabinaceae)	L	Diarrhoea	Mixed with tubers of *Withania somnifera* ground paste given orally
Cassia auriculata L. / Thangedu / (Caesalpiniaceae)	Sh	Diarrhoea	Ground in curds, given orally
Ceiba pentandra (L.) Gaertn. / Tellaburuga / (Bombacaceae)	Sb	Diarrhoea	Decoction given orally
Curculigo orchioides Gaertn. / Nelatadi / (Hypoxidaceae)	Tb	Indigestion	Mixed with garlic ground, given orally
Cissamopelos pareira L. / Vishaboddi / (Menispermaceae)	R	Indigestion	Mixed with pepper and garlic ground, extract given orally
**Derris scandens* (Roxb.) Benth./ Merugaku or Nallateega / (Fabaceae)	L	Indigestion	Mixed with ginger ground, extract given orally with butter milk
**Desmodium pulchellum* (L.) Benth./Teegavelaga/ (Fabaceae)	Sb	Diarrhoea	Decoction given orally
**Diospyros candolleana* Wt. / Jagada ganti / (Ebenaceae)	L	Diarrhoea	Paste mixed in curds given orally
Euphorbia hirta L. / Palaku / (Euphorbiaceae)	Wp	Dysentery	Milky juice given orally

Ficus racemosa L. / Medi / (Moraceae)	Fr	Dysentery	Paste mixed in curds, given orally
Grewia hirsuta Vahl. / Chitti jana / (Tiliaceae)	Fr&R	Diarrhoea & Dysentery	Decoction given orally
Gymnema sylvestre (Retz) R.Br. Podapatri / (Asclepiadaceae)	L	Diarrhoea	Mixed in curds, given orally
Hemidesmus indicus (L.) R.Br. / Sugandapala / (Asclepiadaceae)	R	Indigestion	Mixed with pepper and garlic ground, paste given orally
**Kedrostris foetidessima* (Jacquin) Cogn. / Muradandaku / (Cucurbitaceae)	Sb	Indigestion	Mixed with pepper and garlic ground, paste given orally.
**Morus alba* L. / Mulbari / (Moraceae)	Fr(fr)	Indigestion	Juices given orally
**Passiflora foetida* L. / Jukemalle, Tella tumiki / (Passifloraceae)	L	Diarrhoea	Paste mixed in goat milk, given orally
**Pavonia odorata* Willd. / Chittibenda / (Malvaceae)	R	Dysentery	Decoction given orally
**Pergularia daemia* (Forssk)Chiov. /Juttapaku / (Asclepiadaceae)	L	Dysentery	Paste mixed in curds, given orally
Phyllanthus amarus Schum& Thonn. / NelaUsiri/(Euphorbiaceae)	Sh	Dysentery	Tender tips crushed, paste given orally
Plumbago zeylanica L. / Tella Chitramoolamu/ (Plumbaginaceae)	R	Indigestion	Decoction given orally
Pongamia pinnata (L.) Pierr. / Kanuga / (Fabaceae)	Sb	Dysentery	Decoction mixed in butter milk, given orally
Pterocarpus santalinus L. / Raktachandanamu / (Fabaceae)	Sb	Diarrhoea	Infusion given orally
Rhus mysorensis G.Don/ Sundara/ (Anacardiaceae)	Fr	Dysentery	Extract mixed in curds, given orally
Rynchosia suaveolens (L.f.) Dc. / Adavi kandi / (Fabaceae)	L	Stomach ache	Mixed with ginger and common salt, ground, paste given orally
Tephrosia purpurea (L.) Pers. / Vempali / (Fabaceae)	R	Stomach ache	Extract given orally
Terminalia chebula Retz. / Karakkaya / (Combretaceae)	Fl Fr	Dysentery Indigestion	Paste mixed in jaggery, given orally. Pepper and garlic ground, paste given orally

Fl: flower; Fr: fruit; G: gum; L: leaf; R: root; Sb: stem bark; Sd: seed; Sh: shoot;
Tb: tubers; Wp: whole plant

Table-2: Statistical analysis of crude drugs: Disease wise analysis

S.No.	Disease	No. of species
1	Diarrhoea	12
2	Indigestion	11
3	Dysentery	10
4	Stomach ache	04
5	Diuretic	03

Table-3: Statistical analysis of crude drugs: Family wise analysis

S.No.	Family	No. of species	Species richness (%)
1	Fabaceae	7	19.4
2	Asclepiadaceae	3	8.3
3	Caesalpiniaceae	3	8.3
4	Anacardiaceae	2	5.5
5	Euphorbiaceae	2	5.5
6	Malvaceae	2	5.5
7	Moraceae	2	5.5
8	Tiliaceae	2	5.5
9	Aristolochiaceae	1	2.7
10	Basellaceae	1	2.7
11	Bombacaceae	1	2.7
12	Cannabinaceae	1	2.7
13	Combretaceae	1	2.7
14	Cucurbitaceae	1	2.7
15	Ebenaceae	1	2.7
16	Hypoxidaceae	1	2.7
17	Lamiaceae	1	2.7
18	Menispermaceae	1	2.7
19	Passifloraceae	1	2.7
20	Plumbaginaceae	1	2.7
21	Sapindaceae	1	2.7

Folk medicine for nervous disorders used by local tribes in the forests of Eastern Ghats of Andhra Pradesh

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Abstract

The present paper deals with folk information on therapeutic properties of 44 crude drugs used to cure nervous disorders by the natives of Eastern Ghats of Andhra Pradesh. Among them, 17spp are hitherto not reported and new to the science. The systematic enumeration of the identified crude drugs was appended.

Keywords: *Folk medicine, neurological ailments, taxonomic validation.*

Introduction

Eastern Ghats are a long chain of broken hills and elevated plateaus, running about 1750 km with an average width of about 100 km between Mahanadi and Vaigai rivers along the Indian east coast through Orissa, Andhra Pradesh and Tamilnadu states. In Andhra Pradesh the Ghats are situated between 12° 38' - 22° 00' N latitudes and 78° 50' - 84° 46' E longitudes. The critical review of literature revealed that there are several attempts on ethno botanical studies in the area and majority of them focused on the ailments like rheumatism, birth control, skin diseases and veterinary diseases. But very little attempts were noticed on remedies for nervous disorders, hence present paper gains importance.

Methodology

The folklore information was recorded from the local herbal practitioners and the tribal healers. Based on the recorded information systematic explorations were conducted in different forests of Eastern Ghats to collect the plant specimens with the help of herbal practitioners. The detailed information regarding scientific name, local name, family, part used, purpose, mode of preparation and administration, dosimetry etc., were recorded and systematically analysed. The collected information was cross checked with the information from neighboring herbalists and also with available literature. The specimens were identified with the help of local / regional floras and confirmed by comparing with the authenticated specimens housed at Sri Krishnadevaraya University Herbarium (SKU), Anantapur , Madras Herbarium (MH), Coimbatore and Central National Herbarium (CAL) , Howrah. The voucher specimens were deposited in Sri Krishnadevaraya University Herbarium (SKU), Anantapur.

Results and Discussion

The present survey provides information on therapeutic properties of crude drugs used for nervous disorders. The critical systematic analysis on the collected specimens yielded 44 species belonging to 28 families of flowering plants. The maximum number of crude drugs were represented by Euphorbiaceae (5spp), followed by Fabaceae (4spp), Asclepiadaceae, Verbenaceae and Poaceae (3spp each). The identified crude drugs fall under three pharmaceutical categories and majority of them were used for epilepsy and fits (44spp), paralysis (4spp) and other miscellaneous ailments (3spp). The crude samples were analyzed based on different parts, which revealed leaves (19spp), stem and stem bark, roots and whole plant (7spp each), fruits (3spp), seeds (2sp) and tubers (1sp) used for different ailments. Among all the test samples, the leaf samples were recorded as most common parts involved in crude drug preparations. The information on scientific name, vernacular name, family, part used, purpose of use, mode of preparation and administration was enumerated (table-1). The statistical analysis on different parts of the drug yielding plants used for different ailments (table-2) and Taxonomic richness of different families were analysed (table-3).

The critical analysis of the data in the light of literature resulted 5 spp (*Atalantia correa, A.racemosa, Cardiospermum canescens, Pavetta breviflora, Pluchea tomentos)* are hither to unknown to the science which were indicated with double asterisk. Further the formulation of drugs and mode of administration for 12 drug yielding plants (*Acalypha indica, Bixa orellana, Caralluma umbellata, Catharanthus pusillus, Clerodendron phlomides, Cymbopogon martini, Erythrina stricta, E. variegata, Euphorbia nivulia, E. tirucalli, Ipomoea campanulata, Madhuca longifolia*) were recorded first time, hence indicated with asterisk in the systematic enumeration. The present observations revealed that the crude drug formulations made by the local tribes were performed significantly. However, the active principle involved in therapeutic property has to be isolated and characterized. Attempts are being made in the laboratory to confirm the structural configuration of biodynamic compounds involved in the property.

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Table-1. Systematic enumeration of crude drugs.

Botanical name / Family	Vernacular name	Part used	Disease	Mode of administration
**Acalypha indica* L. - Euphorbiaceae	Pippali	Leaves	Epilepsy and Fits	Ground with that of *Leucas aspera*, garlic and pepper, exract given orally.
Allium sativum L. - Liliaceae	Vellulli	Tuber	Epilepsy and Fits	Extract dropped into nostrils.
Alstonia venenata R.Br. - Apocynaceae	Edakulapala	Fruits	Epilepsy and Fits	Decoction given orally.
Annona squamosa L. - Annonaceae	Sitaphalamu	Leaves	Epilepsy and Fits	Crussed, applied through nostrils.
Aristolochia indica L. - Aristolochiaceae)	Nalla Eswari	Leaves	Epilepsy and Fits	Ground with that of *Argemone mexicana*, pepper and garlic, extract given orally.
***Atalantia correa* Roxb - Rutaceae	Adavinimma	Fruits	Paralysis	Oil extracted from berries applied on joints.
***A. racemosa* Roxb - Rutaceae	Adavinimma	Fruits	Paralysis	Oil applied on affected parts for one month.
Azadirachta indica Juss. - Meliaceae	Yapa	Stem bark	Epilepsy and Fits	Extract filtered and dropped into nostrils.
Bacopa monnieri (L.) Wettst - Scrophulariaceae	Neeli sambarani	Whole plant	Epilepsy and Fits	Extract given orally.
**Bixa orellana* L. - Bixaceae	Jaffra	Fruits	Epilepsy and Fits	Pulp extract given orally.
**Caralluma umbellata* Haw - Asclepiadaceae	Kundeti kommulu	Stem	Epilepsy and Fits	Extract mixed with that of *Butea monosperma*, pepper and garlic given orally.
***Cardiospermum canescens* Wall. -Sapindaceae	Tella budda kakara	Whole plant	Epilepsy and Fits	Extract with lemon water given orally once a day for 10 days.
Cassine glauca (Rottb.) Ktze. Celastraceae	Neridi	Stem bark	Epilepsy and Fits	Extract given orally.
**Catharanthus pusillus* (Murr.) G.Don -Apocynaceae	Konda mirapa	Whole plant	Epilepsy and Fits	Extract given orally.
Citrullus colocynthis (L.) Schrad -Cucurbitaceae	Papara teega	Root	Epilepsy and Fits	Ground with that of *Coccinia grandis*, extract given orally or as eye drops.

Clerodendron inermi Gaertn. - Verbenaceae	Isandaraku	Leaves	Epilepsy and Fits	Mixed with that of *Calotropis gigantea* (5:1) and 2g camphor, ground, extract dropped into nostrils.
**C. phlomides* L. f. - Verbenaceae	Thakkalaku	Root	Epilepsy and Fits	Mixed with stem bark of *Butea monosperma*, pepper, garlic and kasturi, extract given orally.
Cymbopogon flexuosus Wats. - Poaceae	Nimmagaddi	Leaves	Epilepsy and Fits	Extract applied into nostrils.
**C. martini* (Roxb.) Wats. - Poaceae	Kamakshi kasuvu	Leaves	Epilepsy and Fits	Extract applied into nostrils.
Cynodon dactylon Pers. - Poaceae	Garika gaddi	Root	Epilepsy and Fits	Decoction given orally.
**Erythrina stricta* Roxb. - Fabaceae	Mullu moduga	Stem bark	Epilepsy and Fits	Extract applied externally.
**E. variegate* Roxb - Fabaceae	Badisa	Whole plant	Epilepsy and Fits	Extract applied in to nostrils.
**Euphorbia nivulia* Buch-Ham. -Euphorbiaceae	Akujamudu	Leaves	Epilepsy and Fits	Ground with that of *E. tirucalli* and *Ruta chapalense*, extract heated on fire and given orally 3 times daily.
Gmelina arborea Roxb.- Verbenaceae	Gumartek	Shoot	Epilepsy and Fits	Decoction given orally.
Indigofera tinctoria L. - Fabaceae	Nili	Whole plant	Epilepsy and Fits	Extract dropped into nostrils.
**Ipomoea campanulata* L. - Convolvulaceae	Puritititige	Whole plant	Epilepsy, Fits and paralysis	Boiled in oil, applied externally.
**Madhuca longifolia* Gmel. - Sapotaceae	Ippa	Wood	Epilepsy and Fits	Decotion given orally.
Martynia annua L. - Pedaliaceae	Telukondikaya	Leaves	Epilepsy and Fits	Extract dropped into nostrils.
Myrtus communis L. - Myrtaceae	Chittijana	Leaves	Epilepsy and Fits	Juice applied externally.
***Pavetta breviflora* DC. - Rubiaceae	Paccha kommi	Leaves	Epilepsy and Fits	Extract dropped into nostrils.
Pergularia daemia (Forsk.) Choiv. -Asclepiadaceae	Dustapu teega	Leaves	Epilepsy and Fits	Ground with onion, made into paste and given orally for 3 days.
***Pluchea tomentosa* DC. Asteraceae	Gamadaru	Leaves	Epilepsy and Fits	Extract as nosal drops.
Sansevieria roxburghiana Schult. -Agavaceae	Chaga	Leaves	Epilepsy and Fits	Ground with garlic and pepper, extrct given orally.
Sapium insigne Benth. - Euphorbiaceae	Devasurupi	Leaves	Epilepsy and Fits	Ground with *Corum capticum*, given orally.
Sarcostemma acidum (Roxb.) Voigt. -Asclepiadaceae	Pandirijemudu	Fruit	Epilepsy, Fits and Paralysis	Decoction given orally and extract applied externally.
Solanum aguivi Lam.- Solanaceae	Ramamulaka	Roots	Epilepsy and Fits	Ground with fruits of *Coccinia grandis*, extract dropped into nostrils.
S. surattense Burm. f. - Solanaceae	Nallakasi	Roots	Epilepsy and Fits	Ground with gorojanam and saffron, mixed in goat milk, given orally.
Srtychnos nux-vomica L. - Loganiacea	Mushti	Seeds	Epilepsy and Fits	Extract used as tonic.
Tragia involucrata L. - Euphorbiaceae	Teetakanthar aku	Shoot	Epilepsy and Fits	Extract given orally.
Trema orientalis (L.) Bl. - Ulmaceae	Kondajonna	Root bark and Leaves	Epilepsy and Fits	Extract used in epileptic fits.
Tribulus terrestris L. - Zygophyllaceae	Palleru	Leaf	Epilepsy and Fits	Ground with gorojanam, infusion given orally.
Vitex altissima L.f. - Verbenaceae	Nemaliadugu	Leaf and Root	Epilepsy, Fits and Nervous debility.	Extract applied externally and juice dropped into nostrils.

Table 2. Statistical analysis of crude drugs disease – wise

Name of the disease	Fr	L	R	Rb	Sb	Sd	Sh	Sp	Tu	Wd	Wp	Total
Epilepsy & Fits	4	18	4	2	3	2	2	1	1	1	6	44
Paralysis	3	-	-	-	-	-	-	-	-	-	1	4
Nervous debility	-	1	2	-	-	-	-	-	-	-	-	3
Total	7	19	6	2	3	2	2	1	1	1	7	51

Fr = Fruit ; L = Leaf ; R = Root ; Rb = Root bark ; Sb = Stem bark; Sd = Seed ; Sh = Shoot ; Sp = Seed pulp ; Tu = Tuber ; Wd = Wood ; Wp = Whole plant.

Table 3. Taxonomic analysis indicating family wise species richness

Name of the family	*No. of species*	*% of rich ness*
Agavaceae	1	2.27
Annonaceae	1	2.27
Apocynaceae	2	4.54
Aristolochiaceae	1	2.27
Asclepiadaceae	3	6.8
Asteraceae	1	2.27
Bixaceae	1	2.27
Celastraceae	1	2.27
Convolvulaceae	1	2.27
Cucurbitaceae	1	2.27
Euphorbiaceae	5	11.3
Fabaceae	4	9.1
Lamiaceae	1	2.27
Liliaceae	1	2.27
Loganiaceae	1	2.27
Martyniaceae	1	2.27
Meliaceae	1	2.27
Myrtaceae	1	2.27
Poaceae	3	6.8
Rubiaceae	1	2.27
Rutaceae	2	4.54
Sapindaceae	1	2.27
Sapotaceae	1	2.27
Scrophulariaceae	1	2.27
Solanaceae	2	4.54
Ulmaceae	1	2.27
Verbenaceae	3	6.8
Zygophyllaceae	1	2.27