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Research Article

DIVERSITY AND DISTRIBUTION OF ANGIOSPERMIC CLIMBERS IN TROPICAL DRY EVERGREEN FOREST OF TAMILNADU, INDIA

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ABSTRACT
The study of climbers in four different habitats *viz*. the Reserve Forests (RF), Sacred Groves (SG), Hillocks (HL) and Unspecified Vegetation (UV) of the Tropical Dry Evergreen Forest (TDEF) from Chengalpet, Villupuram and Cuddalore districts of Tamilnadu state and Union Territory of Pondicherry was carried out. The scope of the study is to know the diversity and distributional pattern of climbers, in which there are 82, 115, 117 and 103 species each, have recorded from HL, RF, SG and UV respectively. This study revealed a total of 159 species from 37 families and 103 genera. Asclepiadaceae, Convolvulaceae, Cucurbitaceae, Fabaceae and Vitaceae are the dominant families in which the genus *Ipomoea* of Convolvulaceae alone sharing 14 species. The other important species are *Jasminum, Merremia* and *Rhynchosia*. Herbaceous climbers (72) are ranking at top than woody (50). Convolvulaceae and Cucurbitaceae have contributed more herbaceous climbers, while more woody climbers are from Oleaceae and Asclepiadaceae. There are 48 species common in all the four vegetation types among them only 7 are lianas. In the present study the restriction of climber diversity and distribution with respect to the habitat and elevation among the genus/species and the population status are discussed in detail.

Keywords: *Climbers, Tropical Dry Evergreen Forest, Diversity, Distribution, Pondicherry, Tamilnadu*

INTRODUCTION
The Climbers are structural parasites, overcome the constraint of being self-supporting and they have exceed more than 40 m high. The majority of lianas are restricted to tropical forests, where they can contribute up to 35 percent of the total number of woody plant species (Schnitzer *et al.*, 2012) and up to 45 percent of woody stems present (Putz, 1983; Gentry, 1991; DeWalt and Chave, 2004) however, a few species also occur a little north or south of the tropical belt and up to 3280 m ASL in the Himalayas. These have positive effects on forest through animals (Emmons and Gentry, 1987; Odegard, 2000) and contributing to the carbon budget of tropical forest up to 10% of fresh above ground biomass (Putz, 1984).

The Tropical Dry Evergreen Forest (TDEF) is a unique forest type found along the East Coast of Peninsular India from Visakhapatnam, Andhra Pradesh in north and foot hills of Tirunelveli, Tamilnadu in south. This belt harbors several remnants patches of sacred vegetation which are conserved/maintained as 'sacred groves' through faith and belief system. The biodiversity, structure and dynamics of the forest type, especially the groves have been extensively studied (Parthasarathy and Karthikeyan, 1997; King, 1997; Parthasarathy and Sethi, 1997; Ramanujam and Kadamban, 2001; Ramanujam and Praveen, 2003; Parthasarathy *et al.,* 2008; Udayakumar and Parthasarathy, 2010; Praveen, 2011). This vegetation type facing various levels of anthropogenic pressures, disturbance and the impact of cultural changes on the vegetation has studied by Kadamban (1998) and Praveen (2011) in Tamilnadu.

Along the coastal plains Kadamban (1998) recorded 45 climbing species out of 279 species of angiosperms representing 228 genera and 78 families from seven sacred sites from the stretch of Marakkanam-Pondicherry-Cuddalore coastal belt. Reddy and Parthasarathy (2003) reported 39 species representing 34 genera and 24 families in four coastal groves in which the families *viz*. Combretaceae, Asclepiadaceae, Capparaceae and Vitaceae are well-represented. Praveen (2011) invented 18 species of liana and 35 species of herbaceous and woody climbers from four coastal and four inland groves. Reddy and Parthasarathy (2006) stated that the herbaceous and woody climbers contribute substantially to forest

biodiversity and play important role in forest functioning and this was not yet studied in the inland forests of Tamilnadu.

The present study has aimed to know the diversity, distribution pattern, ecology and adaptations of angiospermic climbers from four different habitats *viz*. the Reserve Forests (RF), Sacred Groves (SG), Hillocks (HL) and Unspecified Vegetation (UV) in TDEF of Chengalpet, Villupuram and Cuddalore districts of Tamilnadu and Union territory of Pondicherry, Coromandel Coast of southern India. In addition, the diversity inclination from the coastal plain to up on the hills (towards inland) as well as from north (River Paalar in Kancheepuram district) to south (Chidambaram in Cuddalore district) across different geographical dimensions and elevational gradients are discussed.

Study Area

Extensive botanical survey with an interval of 4-5 months has carried out over a decade in 3 coastal districts *viz*. Chengalpet, Cuddalore and Villupuram out of 13 in Tamilnadu and Union Territory of Pondicherry (Map 1). Generally the terrain is plain with eruption of hillocks and Cuddalore sand stone plateau. Four major habitat (mangrove excluded) such as Hillocks (HL), Reserve Forest (RF), Sacred Groves (SG) and Unclassified Vegetations (UV) were located by using toposheets prepared by GSI, Google map and personal enquiries. The size of the area, anthropogenic disturbances and the plant diversity from the preliminary survey have put in forth as the criteria for the selection of the site. Once the site was selected then it underwent geo-referenced by using Garmin GPS, intensive botanical enumeration, collection of voucher samples and made photography. Herbarium was prepared and deposited in AURO Herbarium. The botanical nomenclature has followed by using 'The Plant List'.

Geography

The long stretch of coastal plains in Tamilnadu extend 40-60 km towards inland (Mani 1974). Generally, the soil along the east coast is sandy loam or red ferralitic and some places covered with alluvial deposits. It becomes clayey in the interiors (Meher-Homji, 1974, 1986). Major parts of the study area lies on Cuddalore sandstone formations of Meiocene period. It is overlain by a thin layer of soil, pebbles and amorphous gravels.

Climate and Soil

A typical maritime tropical climate with a dissymmetric rainfall regime prevails in the study area. The weather is generally humid and hot for most part of the year with only minor variations. North-East monsoon constitute the principal rainy season accounting 60-80 % of the total rain fall and south-west monsoon contributes only 20 %. The mean annual rainfall during 1990-2010 periods was 1428 mm with mean rainy days of 57.5 per year. The minimum temperature is 17.7 °C in January and the maximum was 40.5 °C in May. Dry weather prevails during March-June. The average relative humidity is 74 %. The weather is generally cool during December-February and the late nights are dewy. Wind speed ranges from 5.0 km/hour during June-July and 9 km/hour in August-September but not for the cyclonic days.

RESULTS AND DISCUSSION

Climbing plants are found in all kinds of forest/vegetation and all over the world. They are generally make up 25 % of the plant species diversity, have major functions in the forest ecosystem, have high value for local populations and are seen as a nuisance by many foresters (Gentry 1991, Schnitzer and Bongers 2002). The present study have made in 4 HL, 5 RF, 1 SG and 3 UV in Chenglepet; 2 HL, 4 RF, 7 SG and 5 UV in Villupuram; 19 SG and in Cuddalore; 3 SG and 2 UV in UT of Puducherry. Cuddalore and Puducherry have no HL and RF. The species represented from HL, RF, SG and UV is 82, 115, 117 and 103 species respectively. The diversity from HL has less than RF and SG, while UV is in between. This result tending towards the studies of Homeier *et al.*, (2010), Zhu (2008), Senbeta *et al.*, (2005), Parthasarathy (2004), Leimbak and Balslev (2001) and Balfour and Bond (1993) i.e. the remarkable reduction in the number of individuals and species with increasing altitude. Schnitzer and Bonges (2002) revealed that the species richness of climber was generally higher in the forest types at lower elevation compared with high elevation where as the significant number of liana and climbers is an indication of

disturbance with no relevance in the size of area. This is highly privileged in this work that is discussed below in detail.

Diversity

The lianas (woody vines) and herbaceous vines has evolved many times during the course of plant evolution, with more than 130 plant families including one or more climbing species (Gentry, 1991). This study exposed a total of 159 species from 37 families and 103 genera are provided in the appendix 1. The dominant families and their species representation are given in figure 1. The other major contributors were Oleaceae (8), Menispermaceae (5), Dioscoreaceae and Periplocaceae, had 4 each. Apocynaceae, Celastraceae, Combretaceae and Euphorbiaceae are sharing 3 species each. The remaining seven families have 2 species each and 17 families share each one. The genus *Ipomoea* of Convolvulaceae alone shares 14 species; the other dominant species and their species representation are shown in figure 2. Generally in tropics Letouzey (1969) recorded Convolvulaceae, Cucurbitaceae and Dioscoreaceae have consists completely of climbing plants while Gentry (1991) and Schnitzer and Bongers (2002) studied Rubiaceae, Leguminaceae, Celastraceae and Apocynaceae have each more than 50 species.

The genera such as *Argyreia* of Convolvulaceae, *Ceropegia* and *Sarcostemma* of Asclepiadaceae and *Trichosanthus* of Cucurbitaceae contributed three species each. *Acacia, Ampelocissus, Cardiospermum, Cayratia, Citrullus, Cuscutta, Derris, Grewia, Tetrastigma, Tragia* and *Vigna* were contributing 2 species each. The remaining 82 genera have sharing one species each.

Kokou *et al.*, (2002) have distinguished three categories of climbing plants namely woody climbing plants (liana), herbaceous climbing plants (vines) and climbing shrubs (stragglers). Caballe (1998), Muoghalu and Okeesan (2005) consider the climbing shrubs as lianas. The study of climbers in this work have grouped into six, based on habit, habitat and their climbing nature such as Creeper, Herbaceous, Liana, Succulent, Straggler and Woody climbers; in which herbaceous climbers placing rank one followed by woody and liana. The details of other kinds are given below in figure 3.

Marche-Marchad (1965), Letouzey (1969), Schnell (1970), Mangenot (1951) and Trochain (1980) made a distinction between lianas and climbing plants. But distinctions between the two in actual definitions often blurred by the variety in methods of attachments, ecology and leaning of the plants. In most tropical forests many more small climbers and relatively few large ones are present at forest edges and in forest fragments compared to forest interiors and large sized forests (Schnitzer and Bonger, 2002). Tendril climbers are more suitable to gaps and forest edges, where smaller diameter supports are more common than in forest interiors (Putz and Holbrook, 1991). In this work, there are 72 species of herbaceous climbers were categorized into four sub-types *viz*. twinners (49), tendril climber (17), ramblers (4) and hook climbers (2) based on the mechanism or support of climbing with the host.

The species representation from the five major families and the number of species recorded from each sub-types are given in figure 4, in which Convolvulaceae and Cucurbitaceae are alone sharing 16 and 17 species respectively. In addition, the family Oleaceae (WY – 8) contributes high amount of woody species, followed by Asclepiadaceae (6), Menispermaceae (LA-2, WY-1), Apocynaceae (WY-3), Celastraceae (LA-3), Capparaceae (La-2), Mimosaceae (LA-2) and Tiliaceae (WY-2).

Distribution

The distributions of species are not uniform that they vary from place to place and the uniqueness in diversity is more prevalent with habitat or vegetation types. There are 48 species common out of 159 to all the four vegetation types. A total of 47 species were recorded in liana, straggler and woody categories among them 28 evergreen (EG) and 19 are deciduous. Only seven are lianas *viz*., *Derris ovalifolia, Derris scandens, Pachygone ovata, Reissantia indica, Rivea hypocrateriformis, Strychnos minor* and *Ventilago maderaspatana* recorded in all the vegetation types. In addition to that *Acacia caesia, Acacia torta, Capparis zeylanica, Combretum ovalifolium, Loeseneriella africana, Maerua oblongifolia, Plecospermum spinosum, Symphorema involucratum* and *Tiliacora acuminata* were also recorded (Plate 1).

The present studies from four different habitats have significant record of plant diversity. *Argyreia kleiniana, Cryptostegia grandiflora, Jasminum ritchei, Merremia quinata, Sarcostemma brunonianum.*

Spatholobus roxburghi, Tetrastigma sp. and *Vigna unguiculata* are restricted to the Hillocks. This pattern of distribution is same as in other habitats too. *Basella alba, Cissus heyneana, Ipomoea coptica, Ipomoea indica, Jasminum cuspidatum, Rhynchosia cana* and *Rhynchosia rufescens* in RF; *Heterostemma tanjorense* and *Ipomoea asarifolia* in SG and *Ceropegia juncea* and *Merremia aegyptia* in UV were recorded.

There are 12 species are considered as rare, uncommon and interesting species from this work. They are *Argyreia kleiniana, Ceropegia juncea, Cissus heyneana, Heterostemma tanjorensis, Ipomea asarifolia, Ipomoea coptica, Ipomoea indica, Jasminum cuspidatum, Jasminum ritchei, Merremia quinata, Rhynchosia courtallensis* and *Spatholobus parviflora* (Plate 2). Examples of some common climbers are provided in Plate 3.

The diversity and distribution of species inclination has to be considered significantly with respect to elevation within the family, genus or among the species of any forest type/vegetation. This pattern of distribution was observed earlier in the genus *Toddalia* and *Ochna* (Matthew 1983). This study also revealed such distribution between HL and RF. *Argyreia osyrensis* and *A. cymosa* from RF (in plains) has replaced by *A. kleiniana* on the hillocks; *Rhynchosia cana, R. suaveolens, R. minima* and *R. viscosa* in plains has replaced by *R. courtallensis* in hills; *Jasminum ritchei* occurred on hills while *J. cuspidatum* and *J. angustifolium* in RF and SG; *Merremia gangetica* and *M. hederacea* found only in RF where as *M. quinata* is on the hills; *Dioscorea tomentosa* common on the hills but *D. pentaphylla* noticed only from the plains. Some climbers spread across, without any geographical and habitat boundary. For example *Acacia torta, Ampelocissus latifolia, A. tomentosa, Cajanus scarabeioides, Cissus arnotiana, Dioscorea oppositifolia, Gymnema sylvestre, Mucuna pruriens, Opelia amentacea, Pteralobium hexapetalum* and *Secamone emetica* were recorded in HL, RF and SG. The species such as *Argyreia cymosa, A. osyrensis, Dioscorea tomentosa, Ipomoea eriocarpa, Jasminum flexile* and *Tetrastigma leucostaphylum* are occurred both in HL and RF where as RF and SG have contributed the following species: *Calycopteris floribunda, Cryptolepis grandiflora, Ipomoea cairica, Rhynchosia suaveolens* and *Salacia chinensis*. The occurrence of *Argyreia cymosa, Corallocarpus epigaeus, Hiptage benghalensis, Leptadenia reticulata, Loesneriella africana, Maerua oblongifolia, Mallotus repandus, Merremia aegyptia, M. turphetum* and *Toxocarpus kleinii* from UV has emphasized the occurrence of relics and refugia of rare, uncommon and valuable entities as in SGs by Rao (1996).

Some climbing species are specific to geographical features either in dry or wet conditions *viz*. *Caesalpinia bonduc* and *Olax scandens* are known to alkaline soil; *Ipomoea pes-caprae* on coastal sandy soil (Psamophyte) and *Tragia plukaneti* are restricted to black cotton soil. *Cerpegia* sp, *Cissus quadrangularis* and *Sarcostemma viminale* prefers dry, sandy-alluvial and well draining soils/places; *Calamus rotung, Ipomoea aquatica, I. coptica, Merremia turphetum* and *Oxystelma esculantum* found always on wet soils or bordering water bodies whereas *Cissus arnotiana, Decalepis hamiltoni* and *Rhynchosia courtalensis* grows between the gaps of rocks and boulders.

Discussion

Vascular climbers are either woody or herbaceous and it might be heliophyte or sciophyte. Nearly 60 % of all dicotyledonous plant orders have at least one representative climber (Heywood 1993). The result of present work in TDEF from the habitats *viz*. HL (82), RF (115), SG (117) and UV (103) with a total of 159 species from 37 families and 103 genera are more significant as compare with the study of Kadamban (1998), Reddy and Parthasarathy (2003), Jongkind and Hawthorne (2005), Muthumperumal and Parthasarathy (2009) and Praveen (2011). Asclepiadaceae, Convolvulaceae, Cucurbitaceae, Fabaceae and Vitaceae are the 5 main families and *Ipomoea, Jasminum* and *Rhynchosia* are the 3 main genera in this study lenient to the record of Schnitzer and Bongers (2002), Gentry (1999) and Letouzey (1969) respectively. Contribution of herbaceous climbers from Convolvulaceae, Cucurbitaceae and Fabaceae are at higher side than woody, which has represented from Oleaceae, Vitaceae, Convolvulaceae and Asclepiadaceae.

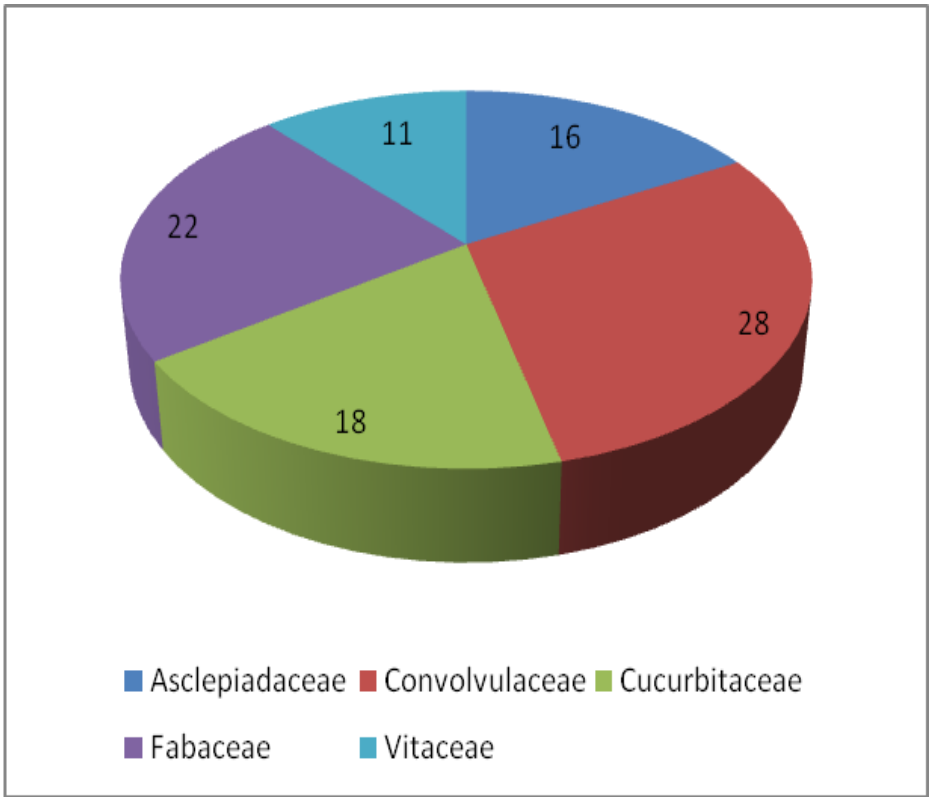

Figure 1: Dominant Families and their Species representation

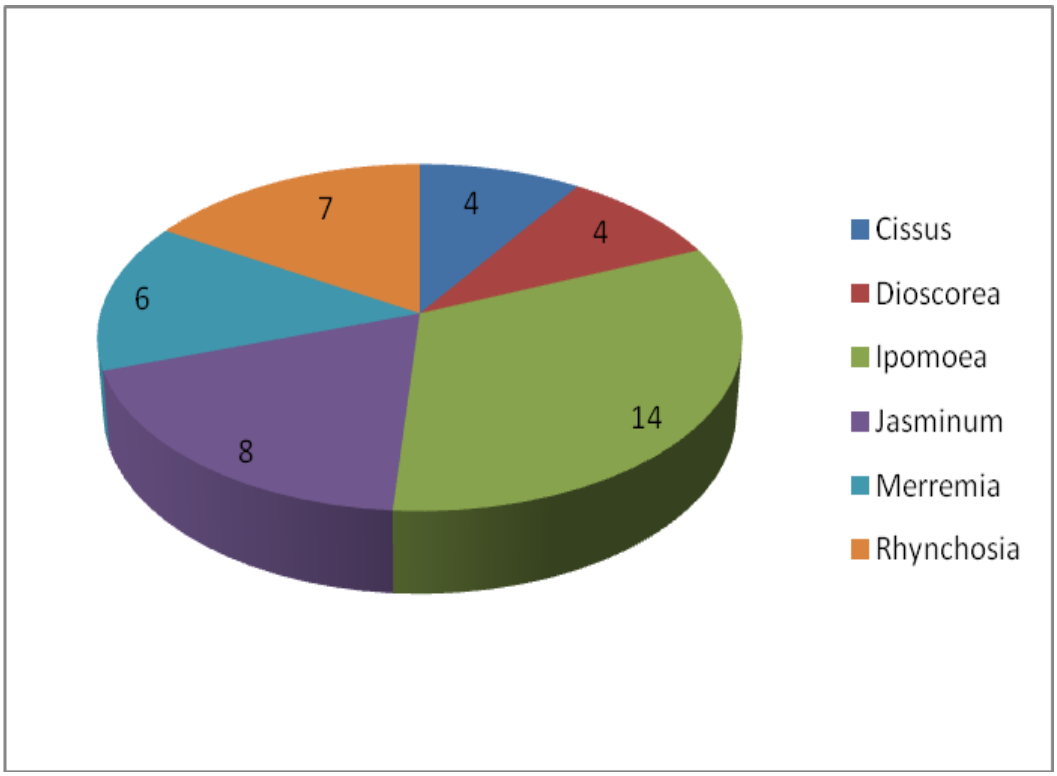

Figure 2: Dominant Genera and the number of Species

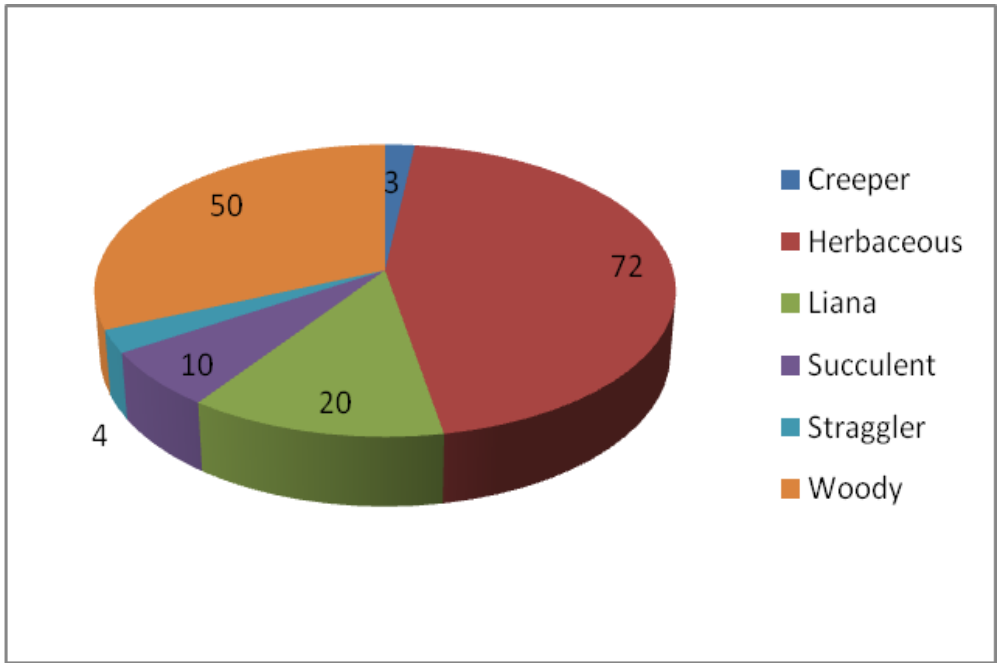

Figure 3: Kinds of climbers and their species representation

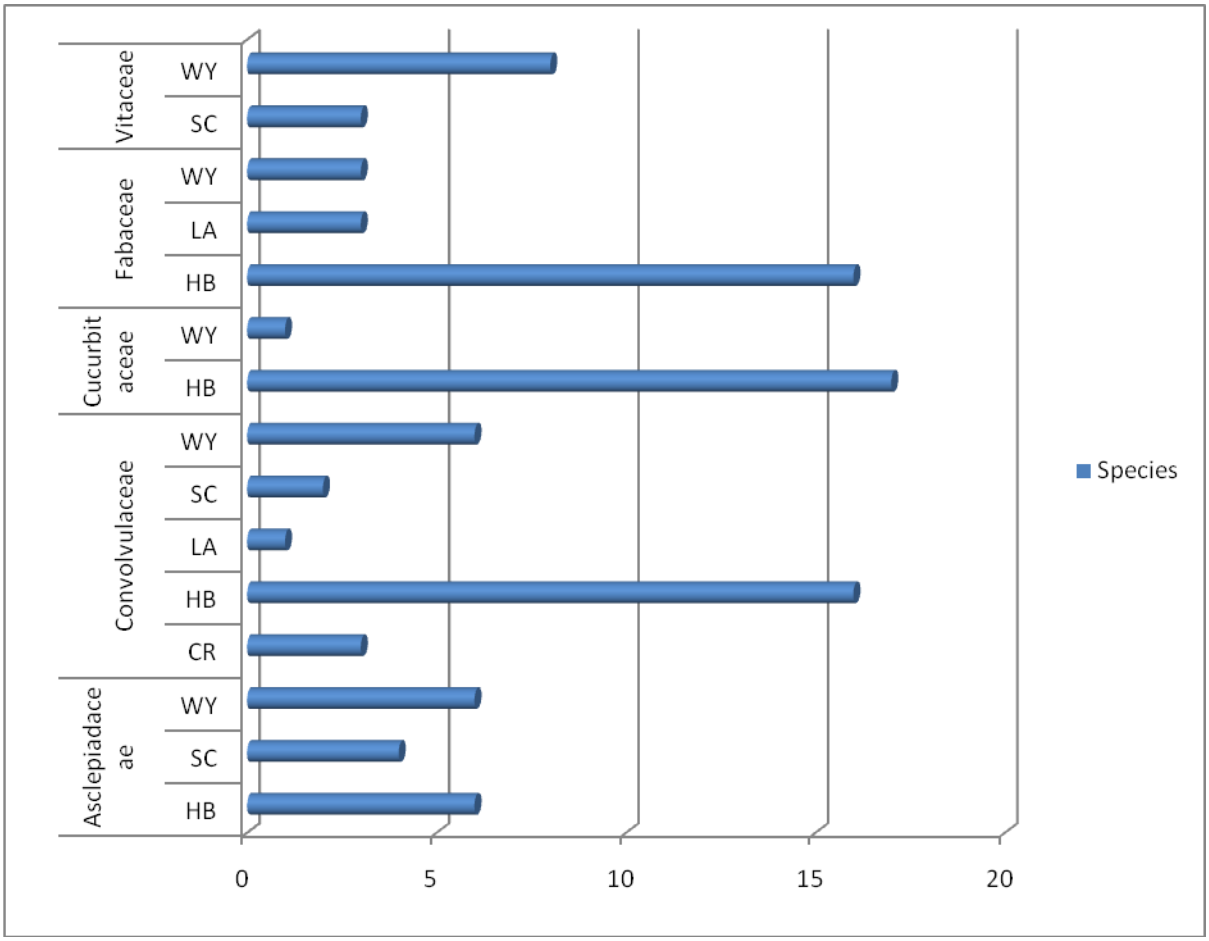

Figure 4: Subtypes and Species of Dominant Families

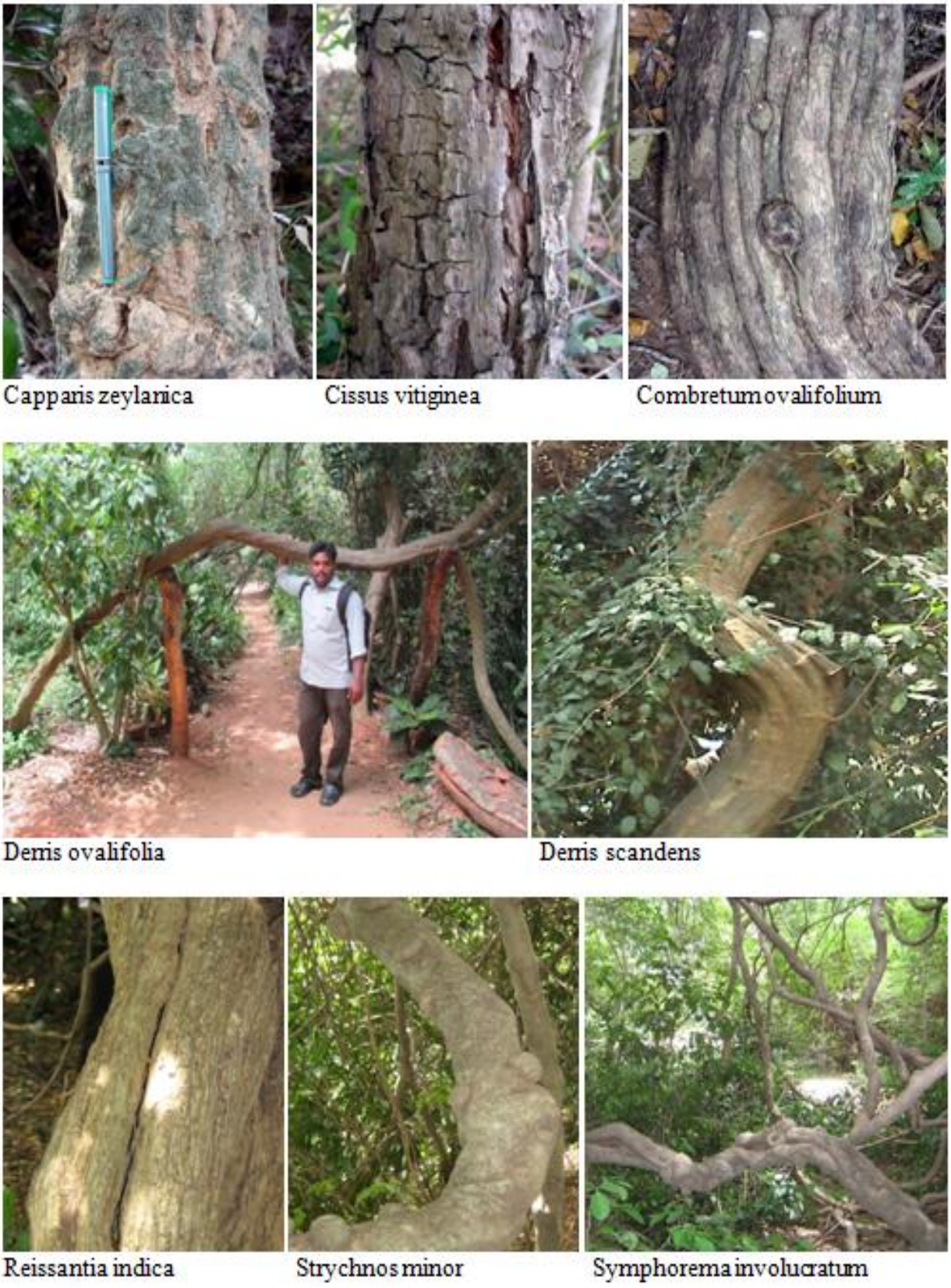

Plate 1: Common lianas recorded in TDEF

Plate 2: Rare climbers from TDEF

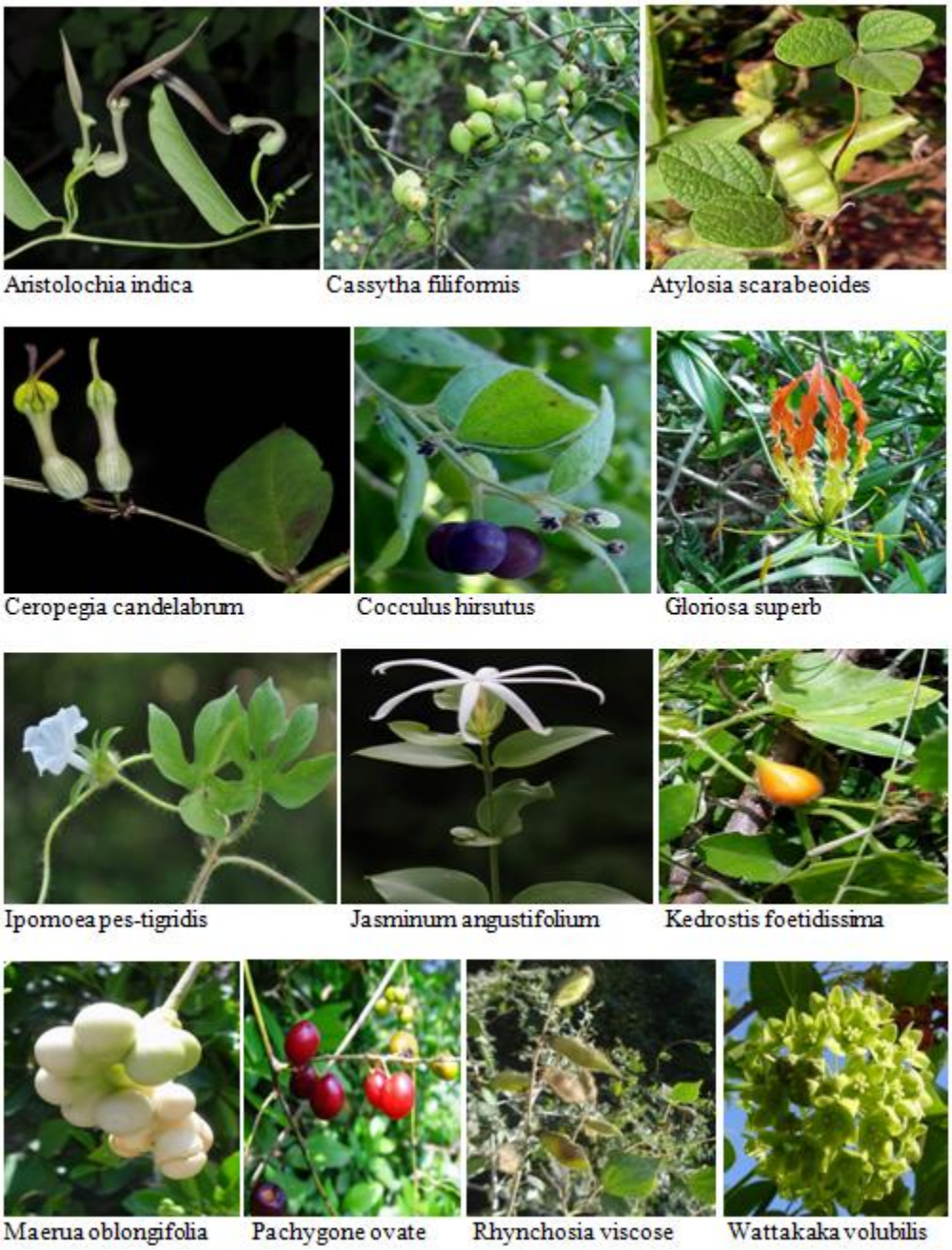

Plate 3: Common Climbers from TDEF

Climbers can colonize gaps very early, growing rapidly in the high light and smothering trees; restricting tree growth and establishment. This physiognomy of this TDEF favors the growth of climbers thus the result of this study has high amount of herbaceous climbers than woody. This supports the "Tree fall gaps have also been hypothesized to be an important mechanism that maintains species diversity in tropical forest" (Denslow, 1987).

The present study shows that the distribution of species with soil, climate and ecology has vary among the vegetation types. It has its own uniqueness, change of diversity from the coast to the hills and also soil specific, habitat specific, rare and common species. Owing to the disturbance as well as the climatic change the record of adaptation mechanism and intra specific variations were privileged here. The study

of diversity and distribution of the climbers from one forest type to other within the country and across the tropics may provide the results for the origin of the high diversity of climbers with repeated independent evolution of the climbing habit. Construction of molecular based phylogenetic study with in the genus and family could explain how climbers have so many different adaptations.

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