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ECOLOGICAL ADAPTATION AND CLIMBING MECHANISM 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 ecological assemblage, adaptation and mechanism of climbers found in this forest type. There are 82, 115, 117 and 103 species recorded from HL, RF, SG and UV respectively. A total of 159 species recorded from 37 families and 103 genera, in which herbaceous climbers (72) are ranking at top than woody (50). The present study is mainly focused on active and passive mechanism of climbing and its adaptational features such as recurved prickles, stipular thorns and abrupted branch ends; ecological adaptations against hot and drought by means of tubers and tuberous roots and heteromorphism found in leaf, flower, fruit or seed.

KEY WORDS: Climbers, Tropical Dry Evergreen Forest, Ecology, Adaptation, Tubers, Tamilnadu.

INTRODUCTION

The climbers are structural parasites that have overcome the constraint of being self-supporting even exceeding 40 m. 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 Chave, 2004). However, a few species also occur a little north or south of the tropical belt and up to 3280 masl (metres above sea level) in the Himalayas. These have positive effects on forest through animals (Emmons and Gentry, 1987; Odegard, 2000) and contribute up to 10% to the carbon budget of tropical forest in the form 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, Selwyn and Udayakumar, 2008, Udayakumar and Parthasarathy, 2010, Praveen, 2011). Various levels of anthropogenic pressures, disturbances and the impact of cultural changes on this vegetation type were studied by Kadamban (1998) and Praveen (2011) in Tamilnadu.

MATERIALS & METHODS

Study Area

Extensive botanical survey with an interval of 4-5 months was carried out over a decade in 3 coastal districts *viz*. Chengalpet, Cuddalore and Villupuram out of 13 in Tamilnadu and Union Territory of Pondicherry (Plate 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 are the criteria for the selection of the site. The study area was geo-referred by using Garmin GPS followed by intensive botanical enumeration, collection of voucher samples and photography. Herbarium was prepared and deposited in AURO Herbarium, Auroville, India. The botanical nomenclature was followed 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 which becomes clayey in the interiors (Meher-Homji, 1974). Major parts of the study area lies on Cuddalore sandstone formations of Meiocene period. It is overlaid by a thin layer of soil, pebbles and amorphous gravels.

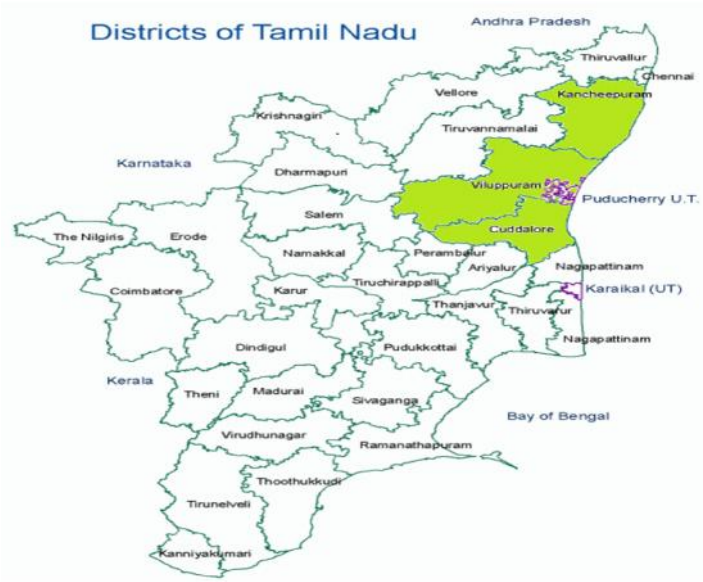


PLATE 1. Political map of Tamilnadu State, India
The study area consisting of three districts are shaded with green colour

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

Climbing plants are found in all kinds of forest/ vegetation all over the world generally making up to 25 % of the plant species diversity. They play 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 was 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 number of species representing HL, RF, SG and UV are 82, 115, 117 and 103 species respectively. The species reported from HL is less than RF and SG, while in UV it is average. This result is in accordance with the studies of Homeier *et al.* (2010), Zhu (2008), Senbeta *et al.* (2005), Parthasarathy (2004), Leimbak (2001) and Balfour and Bond (1993) who have reported a remarkable reduction in the number of individuals and species with increasing altitude. Schnitzer and Bonges (2002) revealed that the richness of climber was at lower elevation compared to high elevation in the forest types.

Ecology and adaptations

Climbing mechanisms of liana often determine the height which was divided into active or passive types (Hegarty and Caballe, 1991). Scramblers and lianas climbing with thorns are passive, while root attachments, hooks, tendrils and twiners are active mechanisms. Lianas with passive mechanisms usually do not climb high up to the forest canopy as they easily fall down, while “active” lianas reach higher up (Nabe-Nielsen, 2001). Generally the tropical evergreen forest favours the active mechanism of climbing and the deciduous forest supports the thorn and hook climbing mechanism. In TDEF 72 species are herbaceous following active mechanisms which climb by means of twining, hooks and tendrils (Plate 2). This ground truthing strongly favours the drought and disturbance of past and present status of the forest type / species.

Occurrence of thorns, prickles and abrupted branch ends are found among the climbers as in trees, shrubs and herbs. *Artabotrys hexapetalus*, *Cansjera rheedei*, *Mallotus rependus* and *Olax scandens* (Plate 3) has thick woody thorns which is the modification of abrupted branch ends at base of the trunk. *Acacia caesia*, *A. torta*, *Caesalpinia bonduc*, *Calamus rotung*, *Pteralobium hexapetalum*, *Solanum trilobatum* and *Toddalia asiatica* (Plate 4) have recurved prickles in all parts of the plant. *Asparagus racemosus* and *Capparis zeylanica* has only recurved stipular thorns. Generally it is known that these thorns and prickles used to protect against their pest, whereas ecologically it is adapted to claim with the host. It is one of the forwarding physiological phenomena during stress and the development of secondary anatomical features for self protection and sometimes helps to reproduce. Underground stems such as bulb, tuber, rhizome and corm are additional ecological adaptation found among the plants. Climbers also have such features to store water and food material and serve to produce young generation (Table 1, Plate 5, 6). Most of them have medicinal values due to the presence of active principal compounds which

are scientifically proved. Climbers play an important ecological role in the forest ecosystem, dynamics and functioning (Nobe-Nielson, 2001; Bonges *et al*., 2002). They contribute substantially to canopy closure after tree fall and help to stabilize the microclimate underneath (Schnitzer and Bonges, 2002). The involvements of biotic and climatic factors are mainly responsible for the evolution of plants and animals. The micro habitat, intensity of light, new sprout and elevation difference induce a plant into morphological variations or heteromorphic changes. Variations in the leaves of *Ampelocissus latifolia, A. tomentosa, Coccinia grandis* and *Trichosanthus cucumarina* are recorded. *Clitorea ternatea* exhibits colour variations and rows of petals in the flower. The variations in *Hemidesmus indicus* are size, shape and blotches on the leaf; flower colours, striations and size. There are at least seven different colour combinations noticed in the seed coat of *Abrus precatorius* of Fabaceae, the famous 'pillaiyar eye' (Tamil name), the flower colour ranging between the shades of blue - pale yellow - white (Plate 7).

TABLE 1. List of species recorded with underground stems and tubers.

Botanical Name	Family Name
Adenia wightiana	Passifloraceae
Aganosma cymosa	Convolvulaceae
Asparagus racemosus	Asparagaceae
Cayratia pedata	Vitaceae
Ceropegia candelabrum ssp. tuberosa	Asclepiadaceae
Ceropegia juncea	Asclepiadaceae
Cissus arnotiana	Vitaceae
Coccinea grandis	Cucurbitaceae
Corallocarpus epigaeus	Cucurbitaceae
Cryptolepis grandiflora	Periplocaceae
Ctenolepis garcinii	Cucurbitaceae
Cyphostemma setosum	Vitaceae
Decalepis hamiltonii	Periplocaceae
Dioscorea bulbifera	Dioscoreaceae
Dioscorea oppositifolia	Dioscoreaceae
Dioscorea pentaphylla	Dioscoreaceae
Dioscorea tomentosa	Dioscoreaceae
Gloriosa superba	Colchicaceae
Heterostemma tanjorense	Asclepiadaceae
Kedrostis foetidissima	Cucurbitacae
Solena amplexicaulis	Cucurbitaceae
Tetrastigma leucostaphylum	Vitaceae
Trichosanthus cucmerina	Cucurbitaceae

Cayratia trifolia - Climbing with roots

Galactia tenuiflora - A twinner

Reissantia indica - Coiling of side branches

Strychnos minor - Hook climber

PLATE 2. Representation of active mechanism of climbers from TDEF

Artabotrys hexapetalous

Cansjera rheedei

Hugonia serrata

Mallotus repandus

Plecospermum spinosum

Olax scandens

PLATE 3. Passive mechanisms example 1 representing woody climbers /stragglers showing abrupted branch ends

Acacia caesia

Asparagus racemosus

Caesalpinia bonduc

Calamus rotang

Hibiscus surattensis

Pterolobium hexapetalum

Mimosa intsia

Solanum trilobatum

Toddalia asiatica

PLATE 4. Passive mechanisms example 2 showing woody climbers /stragglers with recurved priclkes

Adenia wightiana

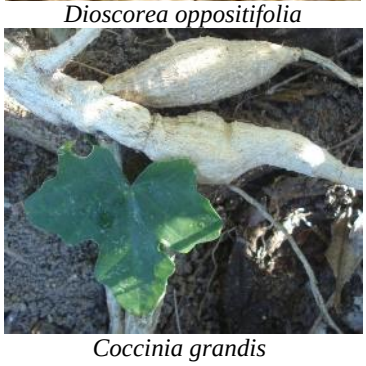
Asparagus racemosus

Ceropegia candelabrum

Dioscorea oppositifolia

Dioscorea pentaphylla

Dioscorea tomentosa



Coccinia grandis

Cayratia pedata

PLATE 5. Ecology-root adaptations against hot and drought to store water and food materials with underground tubers

Basella alba

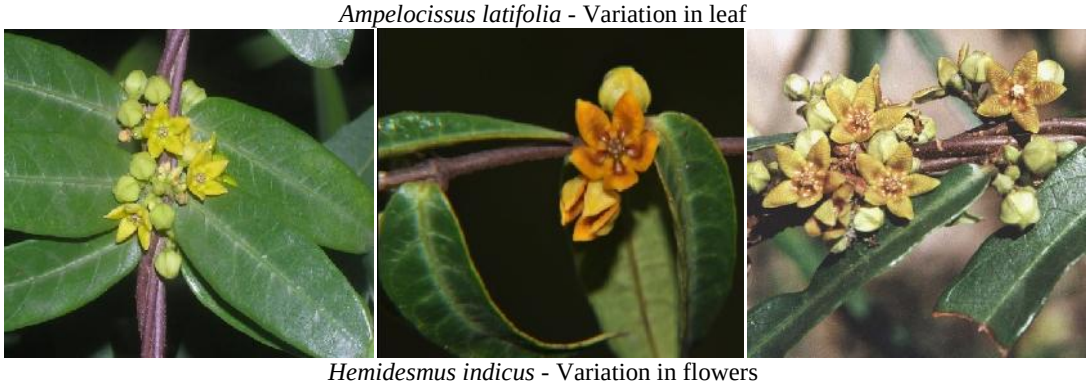
Cissus quadrangularis

Cyphostema setosum

Sarcostemma viminale

PLATE 6. Ecology-stem adaptations forming (sub) succulent stem and leaves

Ampelocissus latifolia - Variation in leaf



Hemidesmus indicus - Variation in flowers

Abrus precatorius - Variation in seeds and flowers
PLATE 7. Heteromorphism found in TDEF climber

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). A total of 159 species was recorded from 37 families and 103 genera in the four different habitats *viz*. HL (82), RF (115), SG (117) and UV (103). Climbers can colonize gaps very easily, growing rapidly in the high light and smothering trees; restricting tree growth and establishment. This TDEF favours the growth of climbers of which many are herbaceous climbers than woody. This supports the view of Denslow (1987) who reported that tree fall gaps have also been hypothesized to be an important mechanism that maintains species diversity in tropical forest. The work also revealed the diversity and distribution of species with regards to soil, climate and elevation among the four vegetation types studied. The plant community among the four habitats has its own uniqueness; diversity inclination from the coast to the hills, soil and habitat specific, represented by rare and common species. Owing to the disturbance as well as 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 within the genus and family could explain further how the climbers have acquired so many different adaptations.

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