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ORIGINAL ARTICLE

Parasitism of host trees by the *Loranthaceae* in the region of Sitheri Hills (Eastern Ghats), Tamil Nadu, India

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ABSTRACT
Mistletoes, as perennial flowering plants and aerial parasites of trees, face several interesting physiological challenges. Mistletoe seeds must firmly attach to a host branch and the seedlings must overcome host defenses and secure access to organic and inorganic resources of the host. Hemiparasitic plants withdraw resources from the vascular system of their hosts through a specialized transfer organ called haustorium. Hemiparasites attack the host's xylem, in contrast to the holoparasites that infect both phloem and xylem, and as a consequence, hemiparasitic plants have access to water and mineral nutrients but little carbon. Sitheri hill station in Dharmapuri district located in Tamil Nadu, India. Sitheri Hills are one of the segments of Eastern Ghats of Tamil Nadu. Which, this comes under Pappireddipatti taluk. It is situated at an altitude of 1097.3metres (3600 ft)The area comprises various vegetation types such as the evergreen, semi-evergreen, riparian, dry deciduous scrub and southern thorn scrub forests. Among them, hemi-parasitic plant on stem received a considerable attention among phanerogamic parasite due to its prolific effect on host plants. Keeping in mind, a methodical survey of six consecutive months (June-December) during the year 2010 -2014 was conducted to establish a correlation between parasite and its host plants. The information on phenology and height of the plant, total number of affected plants, and number of affected branches of particular plant species was documented. Besides, number of dead plants was also recorded.
Key words: *Host and parasite interactions, Mistletoes, Parasite, Sitheri hills.*

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INTRODUCTION

Mistletoes, According to most recent tallies, there are ~4100 species of angiosperms that are parasites on other plant species [1]. Parasitic angiosperms are spread across 19 families and 227 genera and encompass a wide range of morphologies, life strategies and growth forms. In the angiosperm group, parasitism has evolved independently on a number of occasions, possibly up to 11 times [2]. For example, the mistletoe habit is thought to have arisen five times in the Order Santalales [3-4] and holoparasitism has evolved along eight independent lineages. Two broad types of parasitic angiosperm are distributed globally—those that parasitize stems (or aerial parasites, 40% of species) and those that parasitize roots (root parasites, 60% of species [5-6]. Hemiparasites may grow to maturity without a host (facultative parasite) or may require a host to reach maturity (obligate parasite). Parasitic plants can be further distinguished according to whether they are xylem- or phloem-feeders [7-8]. Host plants of parasitic angiosperms are extraordinarily diverse and encompass much of the plant kingdom ranging from herbaceous annuals and perennials to trees and shrubs [9].

Mistletoes, as perennial flowering plants and aerial parasites of trees, face several interesting physiological challenges. Mistletoe seeds must firmly attach to a host branch and the seedlings must overcome host defenses and secure access to organic and inorganic resources of the host. Hemiparasitic plants withdraw resources from the vascular system of their hosts through a specialized transfer organ called haustorium. Hemiparasites attack the host's xylem, in contrast to the holo-parasites that infect both phloem and xylem, and as a consequence, hemiparasitic plants have access to water and mineral nutrients but little carbon. Due to their reduced or non existing root networks, hemiparasitic plants acquire virtually all mineral nutrients and water from the host while organic carbon is provided, at least in part, by their own photosynthetic activity [10-11]. This is in contrast to holoparasitic plants which rely on the host for the supply of both organic and inorganic nutrients. The locations of the attachment to the host and the

degree of host dependency represent the most important characters defining the three basic functional types within hemiparasitic plants [12-13].

Woody angiospermic parasitic plants, commonly known as mistletoes infest trees throughout the world. In India some of the vernacular names for these parasites on various tree species are *Banda* or *Bandba, Panda* (Hindi), *lthikanni* (Malayalam), *Manda* (Bengali), *Banje, Banduka* (Kannada), *Othu* (Tamil), *Bajinike* (Telugu). According to Webster's Third International Dictionary, mistletoes are hemiparasitic evergreen shrubs that have dichotomously branching stems, thick persistent leathery leaves; including numerous species of the family Loranthaceae- Good (1974) defined mistletoe as any aerial parasite belonging to the families - Viscaceae, Loranthaceae, Santalaceae and Myzodendraceae [14]. Most of the species are distributed in tropical and subtropical regions and occasionally in temperate regions.

In the aim at elaborating the strategies to fight against the parasitism of the Loranthaceae, the specific objectives of this research are: To take an inventory of the Loranthaceae species and their host trees in the region; To determine the ecological factors that influence the spatial distribution of the parasitic species met and To identify the specific relations between hosts and parasites.

METHODOLOGY

Study area

Sitheri (Sitteri) is a hill station in Dharmapuri district located in Tamil Nadu, India. Sitheri Hills are one of the segments of Eastern Ghats of Tamil Nadu. Which, this comes under Pappireddipatti taluk. It is situated at an altitude of 1097.3metres (3600 ft)The area comprises various vegetation types such as the evergreen, semi-evergreen, riparian, dry deciduous scrub and southern thorn scrub forests. The minimum and maximum temperature is 19°C in winter and 40°C in summer respectively. The average annual rainfall is 900 mm attained from both northeast and southwest monsoons. Topographically, the area is undulating with an altitude varying from 240 to 1266 m. The total area of Sitheri village is found to be 400 km^2.

Throughout Sitheri hills forest region were given for natural stands and forest cultures older than 150 years, in a diagonal survey for 1year, put data about infested and non infested trees, as well as the number of mistletoe shrubs on infested trees. Data about the presence of mistletoe outside the forest were put in another form. The determination of hosts was checked in the field or on the basis of the collected herbarium materials.

RESULTS

Distribution: Mistletoe (*Loranthus europaeus*, and *Dendrophthoe falcata* Ettingsh) was distributed in the Sitheri region of Dharmapuri District mostly in natural forests. Sitheri hills covered with many villages viz., Mullerikadu (angiosperm host: 7species; 2 parasites), Kalnadu (5:1), Mamparai (6:1), Nochikuttai (4:1), Azhakur (7:2), Kundalmadu (10:2) *etc*.,

Hosts:

In mistletoe occurred on 67 species. Most of the hosts were oaks. Yet another two host species also belong to the Anacardiaceae and Punicaceae family, and these were: Bauhinia species (Caesalpiniaceae), Azadirachta indica (Meliaceae), and Samanea saman (Mimosaceae), out of two species were infected with mistletoe: *D. falcata* occurred on the cultivar (*Table* 1).

Table 1: Information on Host and Parasite Plant Species in Sitheri hills, Dharmapuri District, Tamil Nadu

Host	Family	No. of affected individuals	No. of Dead plants	No. of parasite plants	Affected plant parts		Phenophase of host plant		
					I	II	Veg.	Fl.	Frut.
Aegle marmelos, Corr.	Rutaceae	3	2	4	0	10	1	4	0
Albizzia lebbeck, Benth.	Mimosaceae	5	1	3	0	8	0	3	0
Anogeissus latifolia, Wall	Combetaceae	4	3	3	0	2	0	3	0
Artocarpus integrifolia, L.	Moraceae	5	4	3	0	3	0	3	2
Azhadirachta indica A. Juss.	Meliaceae	2	5	2	20	4	4	2	6
Bauhinia purpurea L.	Caesalpiniaceae	2	2	5	2	9	0	5	0
Bauhinia recemosa Lam.	Caesalpiniaceae	3	2	6	0	4	0	6	0
Bauhinia variegate L.	Caesalpiniaceae	2	2	3	0	5	0	3	0

Bombax ceiba L.	Bombacaceae	2	1	7	2	2	0	7	0
Bombax malabaricum DC	Malvaceae	2	1	7	0		0	7	0
Bridelia scandens R.Br.	Euphorbiaceae	2	1	7	0	35	0	7	0
Canthium dicoccum Teys. & Binn.	Rubiaceae	2	2	3	0	4	0	3	0
Careya arborea, Roxb.	Lecythidaceae	3	3	2	0	6	0	2	0
Cassia fistula, l.	Caesalpiniaceae	8	4	4	6	8	5	4	2
Cassia Montana, Heyne	Caesalpiniaceae	8	6	7	2	2	4	7	3
Cassia siamea, Lam.	Caesalpiniaceae	8	5	4	1	3	0	4	0
Cassia sp.	Caesalpiniaceae	3	7	2	2	5	0	2	0
Catunaregam spinosa, Triv.	Rubiaceae	4	3	3	0	7	0	3	0
Cedrela toona, Roxb.	Meliaceae	4	2	8	0	2	0	8	0
Ceiba pentandra, (L.) Gaetrn.	Bombacaceae	7	2	1	0	1	0	1	0
Citrus medica, L.	Rutaceae	9	7	2	0	6	0	2	0
Dalbergia latifolia, Roxb.	Palilionaceae	6	4	3	0	6	0	3	0
Dalbergia paniculata, Roxb.	Palilionaceae	7	4	5	0	6	0	5	0
Dalbergia sissoo, Roxb.	Palilionaceae	9	3	6	0	3	0	6	0
Delonix regia Raf.	Caesalpiniaceae	5	2	7	5	3	0	7	0
Elaeodendron glaucum, Pers.	Celastraceae	4	5	4	2	3	0	4	0
Endrerolobium saman, Prain	Mimosaceae	3	4	2	0	3	0	2	0
Ervatamia coronaria, Staf.	Apocynaceae	3	2	4	0	3	0	4	0
Eucalyptus globules Labill.	Myrtaceae	2	3	6	0	3	0	6	0
Ficus microcarpa	Moraceae	10	1	8	5	4	3	8	3
Ficus religiosa L.	Moraceae	13	1	3	2	4	2	3	1
Millingtonia hortensis L.f	Bignoniaceae	12	1	2	2	4	0	2	0
Manikara hexandra	sapotaceae	4	1	1	2	4	0	1	0
Mnagifera indica	Anacardiaceae	3	9	6	2	245	2	6	4
Syzygium jambolamum, DC.	Myrtaceae	5	9	7	1	2	0	7	0
Tamarindus indica L.	Caesalpiniaceae	15	5	10	29	29	0	10	0
Tecoma stans, Don.	Bignoniaceae	10	3	13	4	2	0	13	0
Tecoma argentia, Britt.	Bignoniaceae	4	1	2	6	2	0	2	0
Terminalia chebula, Retz.	Combretaceae	3	2	2	4	5	0	2	0
Terminalia crenulata, Roth.	Combretaceae	9	1	4	4	5	0	4	0
Terminalia tomentosa, Wt. Arn.	Combretaceae	7	1	5	1	5	0	5	0
Thevetia nerifolia, Juss.	Apocynaceae	6	2	3	1	2	0	3	0
Acacia chundra (Rottl.). Willd.	Mimosaceae	5	2	1	1	2	0	1	0
Acacia concinna (Willd.) Dc.	Mimosaceae	4	2	1	1	2	0	1	0
Eucalyptus sp.	Myrtaceae	6	3	3	1	20	0	3	1
Ficus carica L	Moraceae	8	1	5	1	45	0	5	1
Ficus hispida L.f	Moraceae	7	3	7	0	42	0	7	0
Ficus religiosa L.	Moraceae	6	3	8	0	34	0	8	0
Gravillea robusta A. Cunn.	Proteaceae	4	2	3	0	9	0	3	0
Grewia sp.	Proteaceae	4	4	2	0	9	0	4	0
Hardwickia binata Roxb.	Papilionaceae	3	7	4	0	9	0	3	0

Holopielea integriflia Pl.	Ulmaceae	2	10	6	0	5	0	3	0
Jacaranda mimosifolia, D.Don.	Bignoniaceae	3	13	3	0	7	0	3	0
Kydia calycina, Roxb.	Malvaceae	7	2	4	0	8	0	2	0
Lagestroemea lanceolata Wall.	Lythraceae	6	2	1	0	2	0	5	0
Lagestroemea indica L.	Lythraceae	5	4	2	0	2	1	6	1
Lagestroemea speciosa L.	Lythraceae	8	5	4	0	2	1	3	0
Magaranga peltata M. Arg.	Euphorbiaceae	7	3	5	0	23	0	7	0
Melia dubia L.	Meliaceae	9	1	3	0	4	0	7	0
Melia composia, Willd.	Meliaceae	5	1	2	0	41	0	7	0
Mitragyna parvifolia Korth.	Rubiaceae	6	3	5	0	2	0	3	0
Moringa oeifera Lam.	Moringaceae	4	5	6	0	3	2	2	0
Muntingia calabuta L.	Tiliaceae	4	7	2	2	22	0	4	0
Murraya konigi Spr.	Rutaceae	3	8	3	2	33	0	7	0
Nerium odorum Ait.	Apocynaceae	2	7	5	3	3	0	4	0
Nyctanthes arbor-tristis L.	Nyctaginaceae	2	10	6	2	23	0	2	0
Phyllanthus acidus L.	Euphorbiaceae	6	13	7	3	23	0	3	0
Pithecolobium duice Benth.	Mimosaceae	6	2	1	2	31	0	8	0
Pithecolobium saman L.	Mimosaceae	5	2	3	3	3	0	1	0
Psidium guajava L.	Myrtaceae	4	4	18	2	3	2	2	2
Punica granatum Vent.	Punicaceae	7	5	12	3	3	0	3	0
Salix tetrasperma Roxb.	Saliacaceae	8	3	3	3	4	0	5	0
Samanea saman (Jacq.) Merr.	Mimosaceae	8	1	19	2	60	2	6	1
Stereospermum suaveolens DC	Bignoniaceae	6	1	23	2	21	0	7	0
Tectona grandis L.f	Verbinaceae	4	3	45	2	2	0	4	0
Terminalia arjuna Wt. & Arn.	Combretaceae	3	5	6	2	2	0	2	0
Terminalia paniculata Roth.	Combretaceae	2	7	4	3	2	0	4	0
Terminalia catappa L.	Combretaceae	6	8	3	3	2	0	6	8
Trema orientalis Bl.	Ulmaceae	8	6	6	2	2	0	8	2
Vitex altisima L.f	Verbenaceae	4	7	7	2	3	0	3	1
Zizyphus jujube Lam.	Rhamnaceae	2	3	10	2	40	0	2	2
Prosopis cineraria (L.) Duce	Leguminasae	8	3	12	2		0	1	1

I = Primary Branch; II = Secondary branch; Vg = Vegetative; Fl = Flowering; Fr = Fruiting; Gradient of Effect: 1 – 10 (Light); 11 – 50 (Moderate); > 50 (Severe)

DISCUSSION AND CONCLUSION

The host-parasite interrelations are of great importance. Louis Pasteur was of opinion that the susceptibility of a host is increased as the result of stress caused by effect of low environmental temperature. However recent studies have revealed that other environmental factors are also involved in maintaining the host-parasite relationship.

The study of macro and micro ecology reveals that the presence or absence of a number of physical and biological factors in the environment directly or indirectly affects the densities and distribution of parasite. Parasite population is greatly influenced by the vegetation that serve as food and shelter for hosts, both definitive and intermediate.

The proliferation of the *Loranthaceae* is probably owed to a disruption of the host-parasitic balance, but also to changes in the land use and other ecological factors. The rate of *Loranthaceae* is higher in the parcelled forests. If there are a large number of mistletoe shrubs on a tree, they exhaust the host. However, generally speaking, this mistletoe species present a considerable economic problem in Sitheri hills a considerable parasite on the Silver Oaks (*Grevillea robusta* A.Cunn.ex.R.Br.) and pomegranate (*Punica granatum* L.) and Dendrophthoe falcata general 40 host observed in Tiruchirappalli city areas[6] .

Fig1

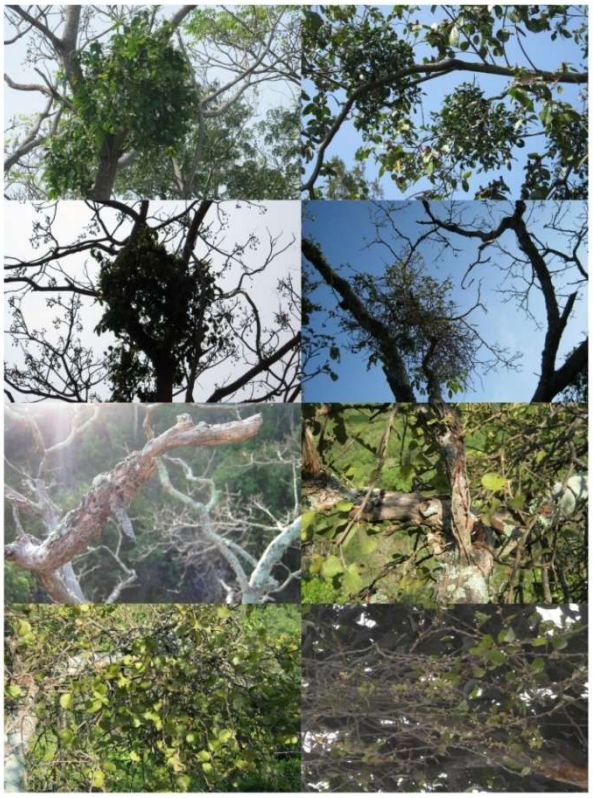

Fig 2

Fig 3

The nature of infection (Light, Moderate, Severe) by a parasite plants and distribution of host plants (Common, Rare) was recorded during the study period. Monocotyledons did not have such parasite infection. Moreover, parasite plants were found to prefer trees rather than shrubs or herbs (among 28 hosts plants, 27 were trees). The reason for such selective preference for host plants (trees) being that Loranthus seeds are distributed chiefly by birds, and trees are more likely to receive them than shrubs or herbs[15]. Till date, only few control measures with application of crude methodical approach have been documented for an absolute eradication of Dendrophthoe falcata. Diesel or Powerine oil (30-50 ppm) is sprayed on host plants affected by Dendrophthoe falcata to prevent its growth further[16].

The average number of mistletoe shrubs on the infested trees was from 1 for the silver oak (*Grevillea robusta* A.Cunn.ex.R.Br.) and the largest number of observed shrubs on pomegranate (*Punica granatum* L.). In the same research a positive co-relation was established between the host age and the yellow mistletoe infestation, and a negative correlation between the mean elevation and mistletoe infestation of the sessile oak.

The hosts of Oaks in Croatia have already been recorded in other European countries. The deciduous autochthonous oaks were the most common hosts of this mistletoe species. The research showed that it was very widespread in Croatia. Apart from following the distribution range of its host, its distribution depends on the movement of birds as the main vectors, as well as local ecological conditions. Genus *Loranthus* (*Dendrophthoe falcata* Ettingsh.) were species which were hosts to both mistletoe and common mango the infestation with both mistletoe species on the same tree has been observed.

Silver Oaks is the most abundant and most frequent species, but also the most dreaded by the populations for theirs morphogenetical, technological, ecological and socioeconomic consequences. These numerous and damaging effects make some parasitic angiosperms true agronomic threats, especially in developing countries. The leakage by manual destruction of the tufts appears like an efficient method of fighting even though it asks for some complements of information, notably the cutting point for completely eradication of the parasite from the trees.

However, *Loranthaceae* have higher rate of therapeutic properties. Moreover, the objective pursued at the present time by the researchers is not more the eradication of the parasites in general, but to maintain them to a compatible level with their environment. This explains the necessity of integrated struggle proposed and important training of smallholders in developing countries.

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