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Review article

A comprehensive review on *Dendrophthoe falcata* (L.f.) Ettingsh. (Loranthaceae)

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Abstract: The plant species belong to the family Loranthaceae (mistletoe family) are hemi parasites. *Dendrophthoe falcata* is a large bushy evergreen stem hemiparasite. It can capture food from the host trees by means of penetrating roots called the haustoria. This epiphytic parasite found generally on various host plants in large amounts worldwide and causes much damage to economical cultivated plants and also grown on different host plants throughout India. As hemiparasite it is associated with tropical trees specifically the mango trees and rarely few timbers yielding trees. It has been reported to have increased its host range and found growing on varieties of trees. The species of *Dendrophthoe falcata* commonly known as *Loranthus* are common parasitic flowering plants occur all over India and cause severe damage to the field crops. However, comprehensive reports on the occurrence of this parasite, host range, effect on crop production, management practices are not available in the country. Under these circumstances the present study was undertaken to identify the species of *Loranthus* attacking a fruit yielding crop mango (*Mangifera indica*) cultivated in and around Vizianagram District, Andhra Pradesh to observe their parasitic relationship with their host plants.
Keywords: *Dendrophthoe falcata* - *Mangifera indica* - Hemiparasite - Bird pollination.

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INTRODUCTION

Phanerogamic plant parasites are destructive pests of several economically important fruit trees such as mango and of several field crops such as mustard, legumes, tobacco, berseeem, lucerne etc. Among important families containing parasitic species are Loranthaceae, Orobanchaceae, Convolvulaceae, Scrophulariaceae, Lauraceae, Santalaceae and Balanophoraceae. These parasites damage the plants through exhaustion of nutrients and sometimes through restriction of growth of the plant. Some of them produce toxins also. The parasitic angiosperms produce seeds that are dispersed by wind, bird and other animals and also through soil. The parasitic flowering plants can be halo or partial parasites of stem and roots. *Cuscuta* is a halo - parasite of stem while *Orobanche* is halo-parasite of roots. *Striga* is a semi-parasite of roots while *Dendrophthoe falcata* (L.f.) Ettingsh. (Loranthaceae) is a semi-parasite of stems. The semi-parasites possess leaves and synthesize the carbohydrate portion of their food. These parasites establish relationship with host vascular elements to draw nutrients (Singh 2002). *Dendrophthoe falcata* (Loranthaceae) is a hemiparasite associated with tropical trees specifically the mango tree and rarely few timbers yielding trees. Loranthaceae is the largest family of Santalales with 73 genera and 900 species. It is also called the "Showy Mistletoes" due to the often specular bright red and yellow flowers which can be more than 20 cm long. The evergreen parasitic species of various families such as Loranthaceae, Eremolepidaceae and Viscaceae are commonly called as "Mistletoes". Loranthaceae family is the well-known family of the parasitic plants that included genus like *Viscum* and *Dendrophthoe* (*Loranthus*).

TAXONOMICAL DESCRIPTION

The plant is a partial stem-parasite (hemiparasite). Taxonomically, it is a large bushy shrub, dichotomously

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branched, perennial, partial stem parasite, glabrous with grey-smooth bark, having twiggy and woody branches. Leaves thick, sub-sessile, coriaceous, elliptic ovate to oblanceolate, mostly opposite, obtuse, sometimes acute, entire, slightly shining, variable in size and shape, midrib prominent, usually red with attenuated base; Flowers whitish-yellow, red, orange-red or yellowish red and sometimes pink, 5–15 cm. long, axillary to supra-axillary, unilateral spikes with persistent bract. Calyculus 4 mm. long, glabrous and persistent with 4–5 lobes, stamens 5, filament approximately 3–5 mm. long or even upto corolla and epipetalous, glabrous; Style 2.5–3.5 cm. long with capitate stigma; Fruit berries 7–11 mm. long, bright red, globose to ovoid-oblong; seeds minute and oblong (Cooke 1908, Shah 1978, Bole & Pathak 1988, Shetty & Singh 1991).

Classification

Kingdom : Plantae
Phylum : Tracheophyta
Class : Magnoliopsida
Order : Santalales
Family : Loranthaceae
Genus : *Dendrophthoe*
Species : *falcata*

Botanical name : *Dendrophthoe falcata* (L.f.) Etting.
Common names : Honey Suckle Mistletoe, Showy Mistletoe, Giant Mistletoe
Vernacular Names : Banda, Banda Patha (Hindi); Vrksadani, Vriksharohini, Vrikshabhak, Bandaka, Vanda (Sanskrit); Vanda, Bandgul (Marathi); Pulluri, Pulluruvi, Uchi (Tamil); Ittikkanni (Malayalam); Maduk, Badanike (Kannada); Bemdram (Konkani); Vando (Gujarati); Raghumala (Assamese); Jiddu, Yelinga, Badanika, Bajinika, Vajinika, Velagabadanika (Telugu).

DISTRIBUTION

Loranthaceae as a family of Santalales comprises about 73 genera and 900 species (Russell & Nickrent 2008, APG III 2009). Once upon a time there are 450–500 species *Loranthus* existed; but most of the historic species have been transferred to other genera and only 10 species of Loranthus are currently available (Nickrent *et al.* 2010). *D. falcata* also known as *Loranthus longiflorus* Desr., is a perennial climbing woody parasitic plant. It is indigenous to tropical regions especially in India, Srilanka, Thailand, China, Australia, Bangladesh, Malayasia and Myanmar. *Loranthus* species are serious parasites of a large variety of economic plants, both angiosperms and gymnosperms. At present *Loranthus* spp., are destructive to economic plants in many parts of the world. *D. falcata* is a large bushy parasitic plant that grows on a variety of host plants in deciduous forests throughout India. The worldwide distribution of Loranthaceae was divided into seven geographical areas: Africa, South America, Asia, Malaysia east of Wallace's line (New Guinea), Malaysia west of Wallace's line, Australia and New Zealand (Russell & Nickrent 2007).

Dendrophthoe falcata in India

Dendrophthoe falcata is known as 'Vanda' in the Indian Ayurvedic System of Medicine. There are about thirty species of *Dendrophthoe* and seven species are found in India (Sampathkumar & Selvaraj 1981). It has been used in traditional medicine and found to have antimicrobial, antidiabetic, antioxidant, anticancer, antilithiatic, hypertensive and antiviral properties (Daud *et al.* 2005). Among different species, *D. falcata* is largely studied and is used to control a wide variety of diseases such as skin disorder, pulmonary tuberculosis, psychic disorders, asthma, paralysis, ulcers, menstrual disorders and wounds. They are used as health food for enhancing immunity and used as a pain reliever, aphrodisiac, narcotic and diuretic (Sastry 1952, Pattanayak & Sunita 2008, Pattanayak *et al.* 2008). Since time immemorial, many species of *Loranthus* have been used medicinally by the Brazilians. The leaves of *Loranthus rotundifolius* Engl. cooked in milk have been used to cure chest diseases (Maout *et al.* 1876). A total of 20 different species of the genus *Dendrophthoe* found all over the world, among them seven species are widely spread in India. The hemiparasite *Dendrophthoe falcata* (L.f.) Etting. var. *falcate* (Loranthaceae) is one of the seven species present in India (Fig 1). Hemiparasites have the parasitic relationship with more than 300 host plants (Sampathkumar & Selvaraj 1981).They are also known as potential pests, due to the severe damage which they cause to many economically important plants.

POLLINATION

The plant species *D. falcata* are typically Ornithophilous (pollinated by birds). The seed dispersal is by birds,

mainly "Flowerpeckers". The seeds in the bird faecal matter get attached to the branches with the help of non digestive gummy mucilage around the seed. Thus it gets the attachment on the host branches and germinates in the bark. The plant is a partial parasite and cannot be grown in soil. Mostly *D. falcata* prefers to grow only on top of the canopy of host.

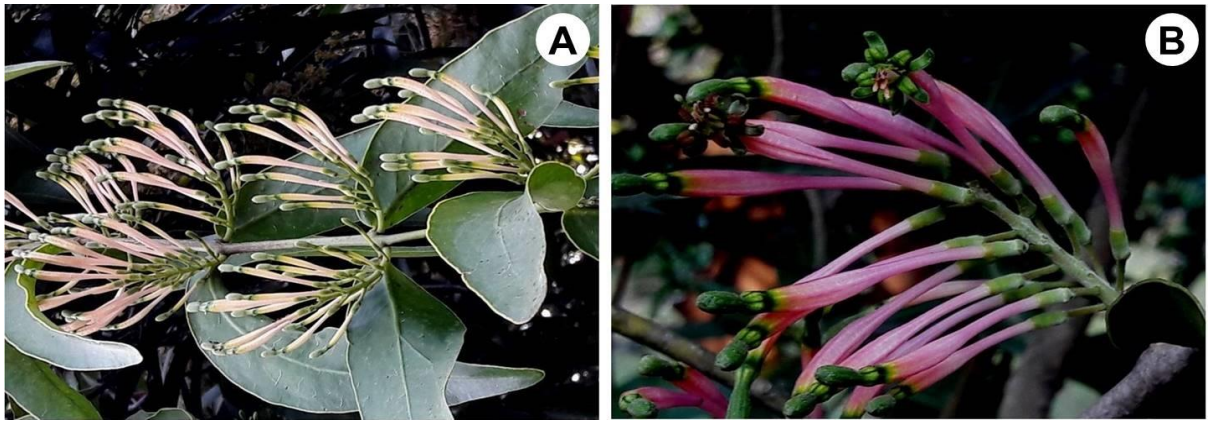

Figure 1. Two varieties of hemiparasite *Dendrophthoe falcata* (L.f.) Ettingsh. infecting *Mangifera indica* L.: **A**, *Dendrophthoe falcata* var. *falcate*; B, *Dendrophthoe falcata* var. *coccinea*.

HOST RANGE

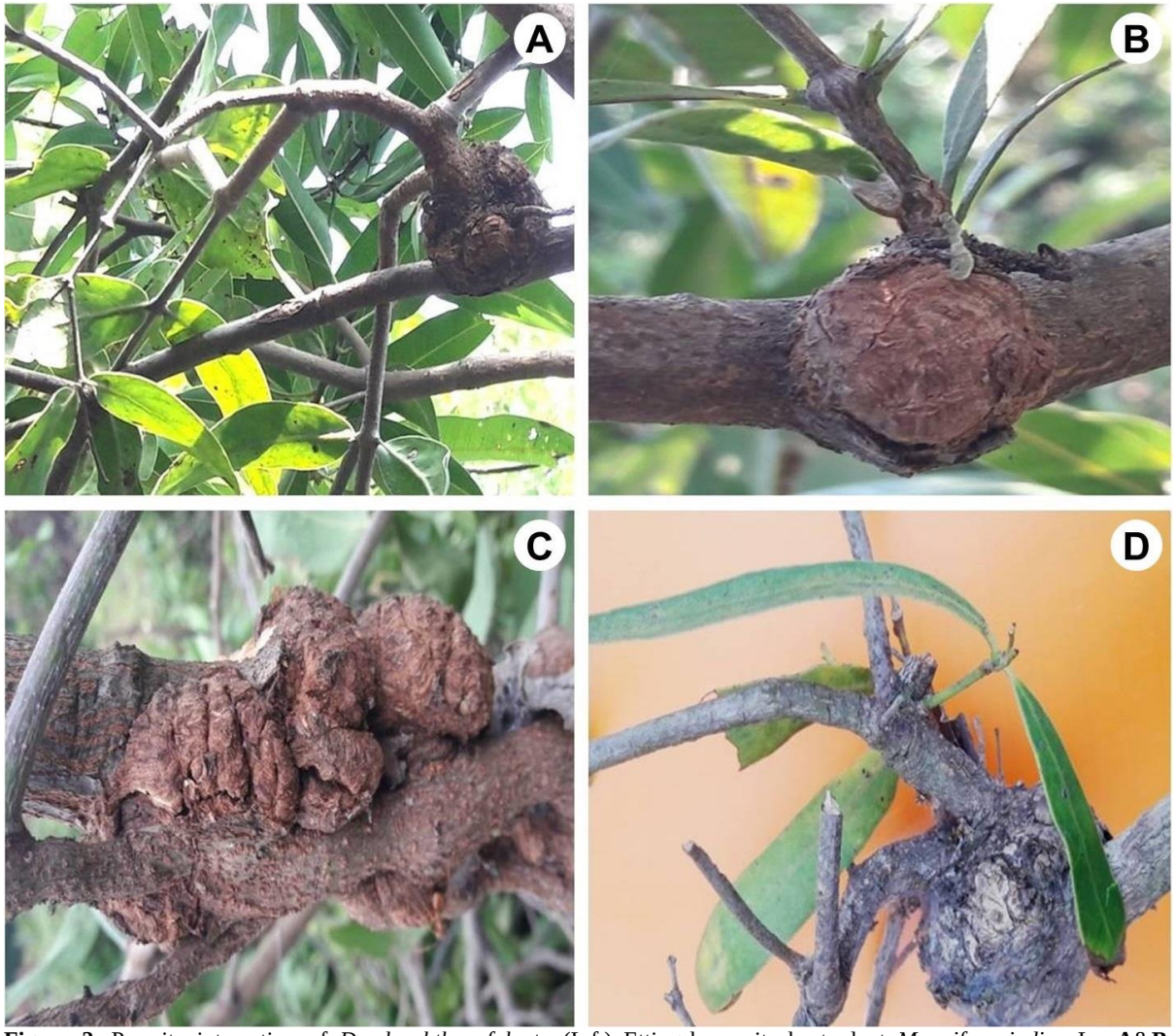

Figure 2. Parasite interaction of *Dendrophthoe falcata* (L.f.) Ettingsh. on its host plant *Mangifera indica* L.: **A**&**B**, Development of woody, round abnormal structures on host; **C**, Interaction between haustorial roots and host tissue; **D**, Development of new branches of *Loranthus* on woodrose.

The parasitic plants *Loranthus* can grow abundantly on the branches of woody trees such as mango (Fig 2). It belongs to the family Loranthaceae (Watson & Dallwitz 1992). Its common name in English is "Loranths" or

"Giant Mistletoe", in Hindi "Banda" (Singh 1996). *Loranthus* plant is hemiparasite. It is parasitic under natural conditions and is also photosynthetic. The parasite obtains water and mineral nutrients from the host plant. It is a common angiosperm parasite of fruit and forest trees (Phanerogamic plant parasite). The most common host is the mango tree, and in northern India 60–90% of the mango trees are infected by the parasite. As many as 343 hosts have been listed in India, which included all the common horticultural and forest trees (Table 1). In the central part of India the most common host is *Madhuca latifolia* L. The parasite can be easily spotted on the branches of host trees as a dense cluster of small twigs bearing smooth broad leaves and long, tubular, orange coloured flowers with red berries (Johri & Bhatnagar 1972, Watson & Dallwitz 1992, Mehrotra & Aggarwal 2004). There are two common varieties of *D. falcata*, the plant with red flowers used to be called *D. falcata* var. *coccinea* and the plant with greenish white flowers used to be called *D. falcata* var. *falcata***.**

Table 1. Different host plants parasitized by *Dendrophthoe falcata* (L.f.) Ettingsh. in India and their economic importance.

Scientific name	Common name	Family	Economic value
Acacia auriculiformis A.Cunn.ex Benth.	Northern Black Wattle	Fabaceae	Ornamental plant
Acacia chundra (Rottler) Willd.	Red kutch	Fabaceae	Medicinal plant
Acacia concinna (Willd.) DC.	Shikakai, Soap-pod	Fabaceae	Medicinal plant
Aegle marmelos (L.) Correa	Bale tree, Indian bael, stone apple	Rutaceae	Fruit tree
Ailanthus excelsa Roxb.	Indian Tree of Heaven	Simaroubaceae	Medicinal plant
Albizia amara (Roxb.) B.Boivin	Krishna Siris, Oil cake tree	Fabaceae	Medicinal plant
Albizia lebbeck (L.) Benth.	Siris tree, Woman's tongue	Fabaceae	Forage, medicine, wood
Albizia procera (Roxb.) Benth.	White siris	Fabaceae	Medicinal plant
Anogeissus latifolia (DC.) Wallich ex Guill. & Perr.	Axle wood	Combretaceae	Tanning and firewood.
Artocarpus integrifolia L.f.	Jack fruit	Moraceae	Fruit tree
Azadirachta indica A.Juss.	Neem, Indian lilac	Meliaceae	Medicinal plant
Bauhinia purpurea L.	Butterfly tree, Pink butterfly tree	Fabaceae	Ornamental plant
Bauhinia recemosa Lam.	Bidi leaf tree, The Sonpatta Tree	Fabaceae	Medicinal plant
Bauhinia variegate L.	Kachnar, Orchid tree	Fabaceae	Medicinal plant
Bombax ceiba L.	Silk Cotton Tree, Kapok Tree	Bombacaceae	fodder, fuel, fiber and medicine
Bridelia scandens (Roxb.) Willd.	Climbing bridelia	Phyllanthaceae	Medicinal plant
Canthium dicoccum (Gaertn.) Merr.	Ceylon boxwood	Rubiaceae	Medicinal plant
Careya arborea L.	Wild Guava, Ceylon Oak, Patina Oak	Lecythidaceae	Medicinal plant
Cassia fistula L.	Golden Shower, Indian Laburnum	Fabaceae	Medicinal plant
Cassia montana Heyne ex Roth.	Mountain cassia	Fabaceae	Medicinal plant
Cassia siamea Lam.	Kassod tree	Fabaceae	Ornamental and wood
Casuarina equsetifolia L.	Australian pine tree	Casuarinaceae	Ornamental and wood
Catunaregam spinosa (Thunb.) Tirveng.	Emetic nut	Rubiaceae	Fruit tree
Cedrela toona Roxb.ex Rottl. & Willd.	Indian mahogany, Red cedar	Meliaceae	Soft wood
Ceiba pentandra (L.) Gaertn.	Kapok, ceiba, white silk-cotton tree	Malvaceae	Fibre and Medicine
Citrus medica L.	Citron	Rutaceae	Fruit tree
Cordia dichotoma G.Forst.	Indian cherry, clammy cherry	Boraginaceae	Fruit tree
Dalbergia latifolia Roxb.	Black Rosewood, Indian rosewood	Fabaceae	Wood
Dalbergia paniculata Roxb.	Takoli	Fabaceae	Ornamental and medicinal
Dalbergia sissoo Roxb.	North Indian rosewood	Fabaceae	Timber/Wood
Delonix regia (Boj. ex Hook.) Raf.	Flame of the forest	Fabaceae	Ornamental and medicinal
Derris indica (Lam.) Benn.	Indian beech	Fabaceae	Ornamental and

			medicinal
Elaeodendron glaucum (Rottb.) Pers.	Ceylon Tea	Celastraceae	Medicinal plant
Enterolobium sama (Jacq.) Prain	Rain tree, coco tamarind	Fabaceae	Ornamental and wood
Ervatamia coronaria (Jacq.) Stapf	Pinwheel flower	Apocynaceae	Ornamental plant
Eucalyptus globules Labill.	Southern Blue Gum	Myrtaceae	Oil and timber
Eucalyptus globules Labill.	Southern Blue Gum	Myrtaceae	Oil and timber
Eugenia jambolana Lam.	Black Plum, Jamun	Myrtaceae	Fruit tree
Ficus carica L.	Fig Tree	Moraceae	Fruit and ornamental
Ficus hispida L.f.	Hairy Fig, Devil Fig	Moraceae	Medicinal Plant
Ficus microcarpa L.f.	Chinese Banyan, Malayan Banyan, Indian Laurel,	Moraceae	Medicinal Plant
Ficus religiosa L.	Sacred Fig, Bodhi Tree, Peepul Tree	Moraceae	Medicinal Plant
Gravillea robusta A.Cunn. ex R.Br.	Southern Silky Oak, Australian Silver Oak	Proteaceae	Ornamental plant
Hardwickia binata Roxb.	Anjan	Fabaceae	Medicinal Plant
Holoptelea integrifolia (Roxb.) Planch	Indian Elm	Ulmaceae	Medicinal Plant
Jacaranda mimosifolia D.Don	Jacaranda, Blue Jacaranda	Bignoniaceae	Ornamental plant
Kigelia pinnata (Lam.) Benth.	Sausage tree	Bignoniaceae	Medicinal Plant
Kydia calycina Roxb.	Kydia	Malvaceae	Ornamental plant
Lagerstroemia speciosa (L.) Pers.	Pride of India, Queen Crape Myrtle	Lythraceae	Ornamental plant
Lagestroemea indica (L.) Pers.	Crape Myrtle, Crepe Myrtle	Lythraceae	Ornamental plant
Lagestroemea lanceolata Wall.	Nandi Tree	Lythraceae	Timber
Mangifera indica L.	Cuckoo's Joy, Mango	Anacardiaceae	Fruit and Timber
Manilkara zapota (L.) P.Royen	Chiku, Sapodilla,	Sapotaceae	Fruit tree
Manilkara hexandra (Roxb.) Dubard	Ceylon Iron Wood, Milk tree	Sapotaceae	Fruit tree
Melia azedirach L.	Chinaberry tree, Persian lilac	Meliaceae	Medicinal Plant
Millingtonia hortensis L.f.	Tree Jasmine, Indian Cork Tree	Bignoniaceae	Ornamental and medicinal plant
Mitragyna parviflora (Roxb.) Korth	Kaim, True Kadamb	Rubiaceae	Medicinal Plant
Moringa oeifera Lam.	Drumstick Tree	Moringaceae	Medicine and Food
Muntingia calabuta L.	Jamaica Cherry	Muntingiaceae	Medicinal Plant
Nerium odorum L.	Rosebay	Apocynaceae	Medicinal Plant
Nyctanthus arbortristis L.	Night jasmine	Oleaceae	Medicinal Plant
Peltophorum pterocarpum (DC.) K.Heyne	copperpod, yellow-flame	Fabaceae	Ornamental and medicinal
Phyllanthus acidus (L.) Skeels	Malay gooseberry, star gooseberry	Euphorbiaceae	Medicinal Plant
Pithecolobium duice (Roxb.) Benth	Monkeypod	Fabaceae	Food and medicinal plant
Prosopis cineraria (L.) Druce	Jammi, Khejri Tree	Fabaceae	Timber
Psidium guajava L.	yellow guava, or lemon guava	Myrtaceae	Fruit tree
Pterospermum acerifolium (L.) Willd.	Maple-leaved Bayur tree	Sterculiaceae	Ornamental and timber
Punica granatum L.	Pomegranate	Lythraceae	Fruit and medicine
Salix tetrasperma (Roxb.)	Indian willow	Salicaceae	Medicinal Plant
Samanea saman F.Muell.	Rain Tree and Monkeypod	Fabaceae	Ornamental and timber
Stereospermum suaveolens (Roxb.) DC.	Rose Flower Fragrant	Bignoniaceae	Medicinal Plant
Stereospermum suaveolens (Roxb.) DC.	Rose Flower Fragrant	Bignoniaceae	Medicinal Plant
Tecoma stans (L.) Juss. ex Kunth	Yellow bells	Bignoniaceae	Ornamental plant
Tamarindus indica L.	Indian date, Tamarind tree	Fabaceae	Timber and fruit
Tecoma argentea Bureau & K.Schum	Yellow Tabebuia, Golden	Bignoniaceae	Ornamental plant

	Bell		
Tectona grandis L.f.	Teak	Lamiaceae	Timber
Terminalia arjuna (Roxb.) Wight & Arn.	Arjun tree	Combretaceae	Timber and medicinal plant
Terminalia catappa	Indian almond, Malabar almond	Combretaceae,	Ornamental, Food and medicinal plant
Vitex altisima L.f.	Peacock chaste tree	Lamiaceae.	Wood
Ziziphus jujuba Mill.	Chinese date	Rhamnaceae	Fruit and timber

HEMIPARASITE

This genus is chiefly hemiparasitic shrub with opposite or subopposite and pinnately veined leaves, and axillary or terminal inflorescences with sessile spikes. The flowers are bisexual or unisexual (dioecious plants), 5- or 6-merous, actinomorphic. Calyx is usually persistent. Corolla is greenish, yellowish, or white, petals free, small, shorter than 10 mm. Stamens only are inserted on the petals. Berry is ovoid or subglobose. Each berry contains the embryo, the endosperm and a mucilaginous viscin, that consists of cellulose in a mixture of acidic and neutral polysaccharides (Sallé 1983, Gedalovich *et al.* 1988). *Dendrophthoe falcata* robust shrubby epiphytic-parasite, usually on trees; Leaves often sub-opposite; Inflorescence an axillary or sometimes terminal raceme or spike; Calyx tubular or flask-shaped; Corolla 5; tube more less dilated; Stamens 5; Anthers basifixed; Ovary 1-locular; Style without articulation; Stigma capitates; Fruit a berry, usually ovate (Alam 1986). Chromosome number 2n=18 (Fedorov 1969).

Loranthus does not have a root system of its own but develops root-like absorbing organs called haustoria, which penetrate deep into the tissues of the host. Morphologically the haustorium is of root origin which acts as a primary root to infect host plant. Through these organs, water and minerals flow from the conducting system of the host to the parasite. There is a continuous drain of nourishment from the host to the parasite and in course of time the attached branch withers as a result of the interference in the flow of the sap to its leaves, beyond the point of attack. In many cases the branches of the host are killed by the parasite, owing to the tapping of most of the vascular bundles (Singh 1996, Mehrotra & Aggarwal 2004). The green leaves of the parasite manufacture sugar and starch and thus it is not completely dependent on the host plant. Sometimes a parasite produces a creeping branch that grows closely along the host stem and forms haustoria at intervals.

Species of *Loranthus* are very destructive to tea plantations, citrus groves and park trees in Africa; many broad-leaved trees in the Indian Subcontinent; rubber and kapok plantations in Indonesia; *Citrus*, *Castanea*, *Camphora*, *Diospyros*, *Liquidambar*, *Psidium* and *Pyrus* in China and Philippines; *Lansium domesticum* Jack and *Bombycidendron vidalianum* Merrill & Rolff plantations in the Philippines; *Citrus* in Mexico and South America; fruit, forage, ornamental trees, and commercial timber, especially *Eucalyptus* species in Australia (Gill & Hawksworth 1961); rubber in Malaysia; and limes in the West Indies (Baloch & Mohyuddin 1969). However, as the family Loranthaceae originated in the tropics and the subfamily Loranthoideae is native to Africa and Indo-Malaysia (Gill & Hawksworth 1961), and as at present *Loranthus* spp. are destructive to economic plants in many parts of the world.

BIRD POLLINATION AND SEED DISPERSAL

The parasite is disseminated mainly through its seeds, carried by birds. The birds are attracted by the brilliant colour of the berries, the pulp is sticky and viscous and so birds easily carry the seeds. The parasite causes damage by preventing the growth of the host (Singh 1996, Mehrotra & Aggarwal 2004). Dissemination of the parasite occurs due to dispersal of its seeds mostly through birds and in some cases by other animals. The fruit is comparatively succulent, brilliantly coloured and is attractive to birds. The pulps of the seeds are sticky and thus seeds are easily carried by the birds. Although the birds eat way the pulp of fruits and get rid of the seeds by wiping or striking their beaks against branches or other objects, occasionally some of them are swallowed. Out of these few pass unharmed through the gut and germinate quite well while others are destroyed by the digestive juices in the gut (Mehrotra & Aggarwal 2004).

WEED CONTROL

There is a lack of knowledge in control of a weed or phanerogamic stem parasite *Loranthus*, commonly found in several areas of Andhra Pradesh and also other fruit cultivated states in India. Only mechanical weeding by cutting (pruning) of Loranthus branches on host trees is a common practice in mango cultivation. Chemical weeding by Ethephon (20 ml L^{-1}), Metrubuzin (1%) and 2, 4-D powder is not effective and familiar among farmers. The biological control was not reported successfully perhaps it is in the infant stage in India.

Therefore, the study can enlightens the awareness of farmers, agronomists and researchers concerning to phanerogamic plant parasites, particularly *Dendrophthoe falcata*, in the areas of morphology, pollination biology and seed dispersal, and host-parasite interaction, to take further effective control methods in mango cultivation. Finally, Authors recommended some agricultural practices in mango orchards to control bird pollination, pollen development and seed dispersal of *Dendrophthoe falcata.* They are: 1). Cultivation of some alternative crops/ fencing crops to attract birds 2). The use of some concentrations of chemicals or plant growth regulators to cause male sterility of Loranthus, and 3). The degradation of viscin tissue (bird glue) to control seed adhesion and seed dispersal of *Loranthus.*

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