Innovations

First report on seed biology of Mango Mistletoe *Dendrophthoe Falcata* (L.f) Ettingsh

Subhashini Kuramana[1], Gaddeyya Gandipilli[2], and P. K. Ratna Kumar[3]

[1,2,3] Centre for Advanced Study, Department of Botany,
Andhra University, Visakhapatnam-530003, Andhra Pradesh, India

Corresponding author: **Subhashini Kuramana**

Abstract

Dendrophthoe falcata (L.f) Ettingsh., a mango mistletoe, is a parasitic flowering plant in the order Santalales. Even though it is a native flora of the Indian subcontinent, there is no sufficient data on the seed germination and seed dispersal of D. falcata in India. Because of the unusual mode of existence, unique physiological characteristics, haustorial system, parasitic characteristics, floral characteristics, seed dispersion mechanism, plant-parasite interactions, mutual interactions with frugivorous birds, and the wide host range of D. falcata has attracted the curiosity of botanists, agronomists, gardeners, and researchers. Considering the importance of mistletoe management in horticulture, the first comprehensive study on the seed biology of D. falcata was attempted in coastal Andhra Pradesh, especially in Vizianagaram District, where the fruit market loses its returns due to this parasitic weed.

Keywords: 1.*Dendrophthoe falcata,2.Mangifera indica, 3.Mistletoe, 4.Seed dispersion*

Introduction

Mistletoes, a group of parasitic flowering plants in the order Santalales, successfully parasitize the aerial parts of a wide range of host plants (Nickrent, 2011). As true perennial parasitic plants, they can survive on various plants over a wide range of habitats and environmental conditions (Ornelas *et al*., 2016). *Dendrophthoe falcata* (L.f) Ettingsh. is a hemiparasitic plant of the Loranthaceae(Mistletoe family). It is firmly parasitic on *Mangifera indica* L., a horticultural crop widely cultivated in India, and this parasite is known as mango mistletoe. *D. falcata* is an evergreen hemiparisitc plant with beautiful flowers and colourful berries. The plant is native to the Indian subcontinent and has been reported both in the northern and western parts of India. As an epiphyte, the profuse growth and infestation of *D. flacata* are found on the tops of the canopies of the host plants. Apart from its parasitic nature, the mistletoe *D.falcata* is widely used in folk medicine and some pharmacological studies have revealed the importance of *D. falcata* for health care.

Materials and methods

The study was attempted with multipurpose significance, primarily in relation to seed biology and the spatial distribution of parasitic plant species *D. falcata*.A systematic field survey was conducted in Vizianagaram, one of the coastal districts of the Andhra Pradesh state in south India. The tools and techniques related to ecological studies were adopted for the present study. The study area was divided into plots and the data related to seed biology was recorded carefully.The abundant growth of *D. falcata* on its host plant, *Mangifera indica* (mango), a member of the Anacardiaceae, was recorded in field sites. Two varieties of *D. falcata* are reported widely in the field with different colours of inflorescence. In contrast, the species was identified as *D.falcata* (L.f) Etting.

var. *falcata* with white coloured flowering and*D. falcata* var. coccinea (Tail.) Sant. with pink coloured flowering. A systematic field survey was conducted in the study area during the months of January to June, 2022 and, further, small branches of the parasite, stems, leaves, inflorescence, and bulbs that indicate parasitic infection on the host were collected. Plant specimens were identified authentically with the help of relevant literature and the flora of Andhra Pradesh (Gamble and Fisher, 1957; Pullaiah and Chennaiah, 1997).Voucher Specimens of *D. falcata* were deposited in Andhra University Herbarium (AUH) maintained by some eminent taxonomists and the faculty of Department of Botany, Andhra University. *In-situ* and *in-vitro* seed germination studies of *D.falcata* were conducted to estimate the germination percent of the matured seeds.

Results:

An abundant growth of *D. falcata* was observed in the fields of mango orchards of the Vizianagaram District of Andhra Pradesh state. Two distinct varieties of *D.falcata* were identified on *Mangifera* and infested many species with seed dispersal mechanisms by frugivorous birds. Both varieties of *D.falcata*, namely white-cream coloured species *D.falcata* var. *falcata* and, on the other hand *D.falcata* var. *coccinea* with attractive pink-coloured flowering, occupied the top of the canopies of mango plants and established their parasitic relationship with the help of a haustorial system. Two species of *D. falcata* were authentically identified in the presence of taxonomists by the use of native flora and other relevant literature. Voucher specimens collected from the field sites were deposited in the Andhra University Department Herbarium (AUH) in Visakhapatnam with access numbers 23324, 23325, 23326, 23327, and 23328 for future reference and taxonomical studies.

Systematic observations were made on the morphological, anatomical, eco-physiological aspects of the mistletoe seed in both *in situ* and *in vitro* conditions (Figure 1). Various stages of seed germination, the development of disc-shaped holdfast, growth of seedlings, the role of gelatinous viscin, and other eco-physiological aspects such as seed dispersion by frugivorous birds were recorded with standard photographs (Figure 2).The present study exposed the seed germination of *D.falcata*, determined during the field visits as well as in the plant pathology laboratory. Furthermore, an average of 70.8 percent seed germination was observed in the field, whereas only 27.8% germination was observed in laboratory culture(Figure 3&4). The data revealed that the host plant *M. indica* washighly favourable to the stem parasite *D.falcata*, and on the other hand, very low germination was recorded in laboratory conditions up to a few days, and later the seeds remain in stagnant condition. The study highlighted that parasitic flowering plants, either root parasites or stem parasites, depend on their host for their survival and their seeds establish parasitic relationships with their host in a favourable environment. Hence, the study concerning the seed biology of mistletoe plants has a significant demand to understand the parasitic nature of mistletoe like *D. falcata*.

Morphology of fruit and seed

The matured, brightly-coloured fruits (single seeded-berries) were born in groups at each joint of an axillary spike. Some fruits ripened early in the month of January, and the mature fruits ripened between the months of February to March. Within the fruit, the chlorophyllous embryo and the endosperm surrounded the seed as a seed coat were observed. A mucilaginous substance called viscin closed the seed as an outer layer. The upper part of the seed coat was extended into a beak-shaped structure, which was a distinguishing feature of mango mistletoe *D. falcata*. At the stage of maturity, the embryo slightly emerges from the massive nutrient tissue, the endosperm (pulp). The carbohydrate-rich residue of the fruit pulp was cream in colour and was used for the feast of the passerine birds. At the stage of establishment, the elongating radical of the seedling usually comes in contact with the host substrateand responds with the formation of an attachment disk, the holdfast.

Seed Dispersal

Avian species, mainly frugivorous (fruit-eating birds), played an important role in the seed dispersion of *D. falcata*. The feeding behaviour of frugivores can influence the seed dispersal and new invasions of this parasitic plant. The small flowerpecker, *Dicaeum erythrorhynchos,* contributed to both pollination and seed dispersal of

D. falcata. Aside from*D. erythrorhynchos,* the Purple-rumped sunbird *Nectarinia zeylonica* also involved in*D. falcata* seed dispersal.

Discussion

Mistletoes, commonly known as hemiparasites, do not affect their hosts seriously but play an important role in forest ecosystems. Some species impact the host fitness, productivity, and economic value (Rist *et al.*, 2011). An account of ecology, including the spatial distribution of the infection, its underlying mechanisms, seed morphology and physiology, and the process of seed dispersion, is required to understand the complete life cycle of these specialised plant parasites in addition to weed control. Mistletoes have been found in a variety of habitats, including temperate forests, tropical forests, mangrove forests, and arid shrublands (Shaw *et al.*, 2004). A sound understanding of the factors that affect the occurrence and spread of mistletoes has been attempted by some ecologists and researchers (Reid *et al.*, 1995; Overton, 1996; Aukema and Martinez del Rio, 2002a; Bowie and Ward, 2004; *Shaw et al*., 2004).

As mistletoe, *D. falcata* has a significant management concern in Andhra Pradesh, where the mango orchards are highly infested with this stem parasite. This mistletoe affects the productivity of several horticultural crops, most significantly *M. indica*,which is a favourable host of*D. falcata*. It causes a loss of yield and the destruction of the host plant after a long time of infection. Comprehensive knowledge of seed biology may be beneficial for low-cost weed management practises in the mango crop. The distribution and population dynamics of the plant parasite are important in the plant community. The study on mistletoe seed biology provides sufficient information on the ecological dynamics of a unique relationship, i.e., host-parasite interaction.Even though a few studies have highlighted some features of mistletoe seeds, such as in the case of *Viscum*, there is no sufficient information on the mango mistletoe*Dendrophthoe*. Therefore, a systematic study attempted to fill the research gap and to attract the attention of botanists towards thisflowering plant parasite*D. falcata*. Enthusiastic research on the seed morphology, ecology, and seed dispersal mechanisms of the mistletoe plant parasites leads to new inventories in weed management and ecosystem resilience.

Acknowledgements:
Authors are very thankful to local farmers and mango cultivars for their support during field survey

Conflict of interest of authors
There are no conflicts of interest

Financial support
There is no financial support to authors for the present research

References

1. *Aukema, J.E. and Martinez Del Rio, C. (2002a). Variation in mistletoe seed deposition: Effects of intra and inter-specific host characteristics. Ecography 25: 139-144.*
2. *Bowie, M. and Ward, D. (2004).Water and nutrient status of the mistletoe Plicosepalus acacia parasitic on isolated Negev Desert populations of Acacia raddiana differing in level of mortality. J.Arid Environ56:487-508.*
3. *Gamble, J.S. and Fischer, C.E.C. (1957). Flora of the Presidency of Madras. London. (Rep. ed. 1957. BSI, Calcutta).*
4. *Rist, L., Uma Shaanker,R. and Ghazoul, J. (2011). The Spatial Distribution of Mistletoe in a Southern Indian Tropical Forest at Multiple Scales. Biotropica 43(1): 50-57.*
5. *Nickrent, D.L. (2011) Santalales (Including Mistletoes). In : Encyclopedia of Life Sciences (ELS), Wiley, Chichester.*
6. *Ornelas, J.F., Gandara, E., Vasquez-Aguilar, A.A., Ramirez-Barahona, S., Ortiz-Rodriguez, A.E., Gonzalez, C., Mejia-Saules, M.T., Ruiz-Sanchez, E. (2016). A mistletoe tale: postglacial invasion of*

Psittacanthus Schiedeanus (Loranthaceae) to Mesoamerican cloud forests revealed by molecular data and species distribution modeling. BMC Evol Biol16:78

7. *Overton, J.M. (1996).Spatial autocorrelation and dispersal in mistletoes: Field and simulation results. Vegetatio. 125:83-98.*
8. *Pullaiah, T. and Chennaiah, E. (1997) Flora of Andhra Pradesh, Vol-I. Scientific Publishers, Jodhpur.*
9. *Reid, N., Smith,M.S. and Yan, Z. (1995). Forest canopies. In: M.D.Lowman, and N.M.Nadkarni(Eds.).Ecology and population biology of mistletoes. Academic Press, San Diego, California. Pp.285-310.*
10. *Sha, D.C., Watson, D.M. and Mathiasen, R.L. (2004) Comparision of dwarf mistletoes (Arceuthobium spp., Viscaceae) in the western United States with mistletoes (Amyema spp., Loranthaceae) in Australia-Ecological analogs and reciprocal models for ecosystem management. Aust.J.Bot.52:481-498.*

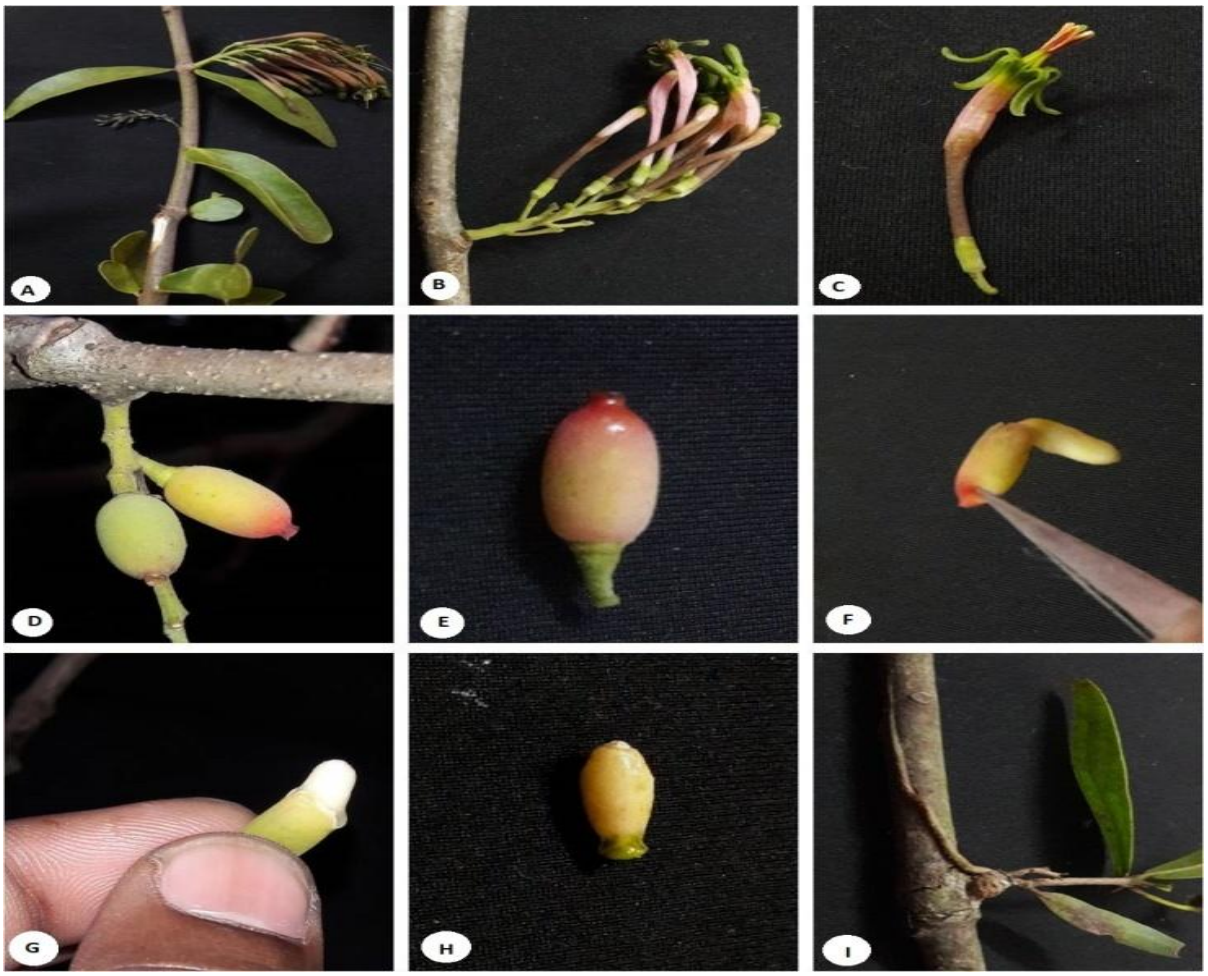

Figure 1. Morphological characteristics of *Dendrophthoefalcata*

(A). A small twig of *D.falcata* (B).Inflorescence (C). Individual Flower (D) Fruits in the early stage of ripening (E). Ripened Fruit (F). The expulsion of the seed along with the pulp (G). Mucilaginous viscin in liquid form (H).Matured Seed (I).Haustorium

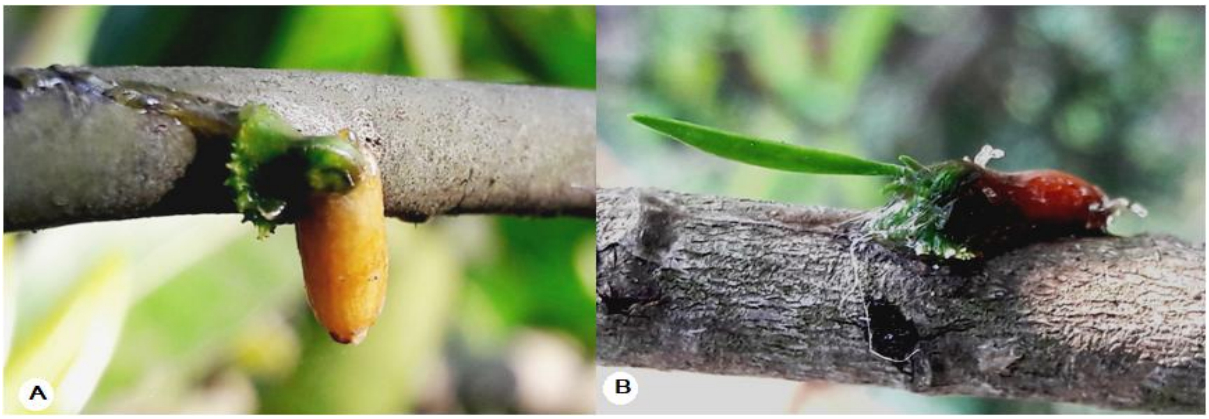

Figure2. **Establishment and germination of mango mistletoe (*D.falcata*) seed on its host. (A). Mistletoe seed with disk-shaped holdfast and Viscin (B). Seedling with early foliage**

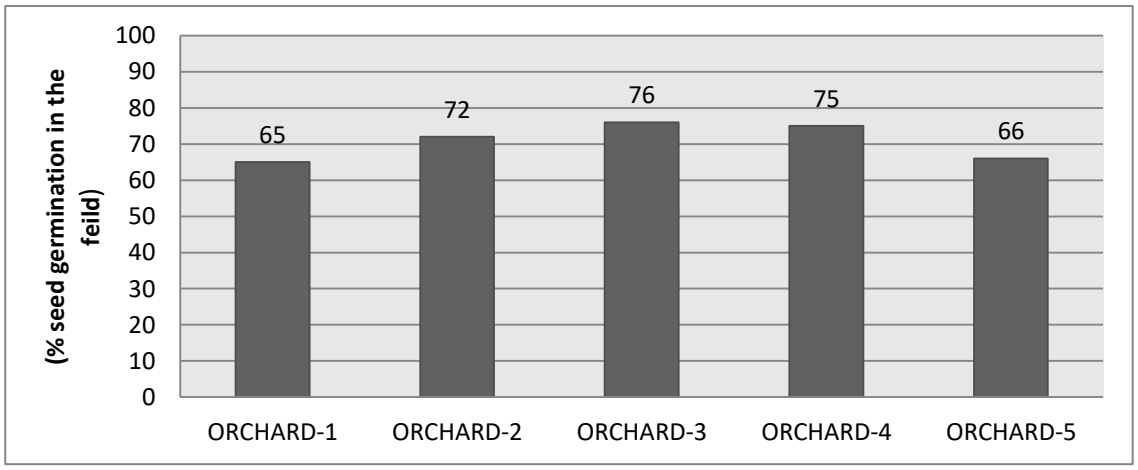

Figure 3. Percent seed germination of *Dendrophthoe falcata* in the field of mango orchards

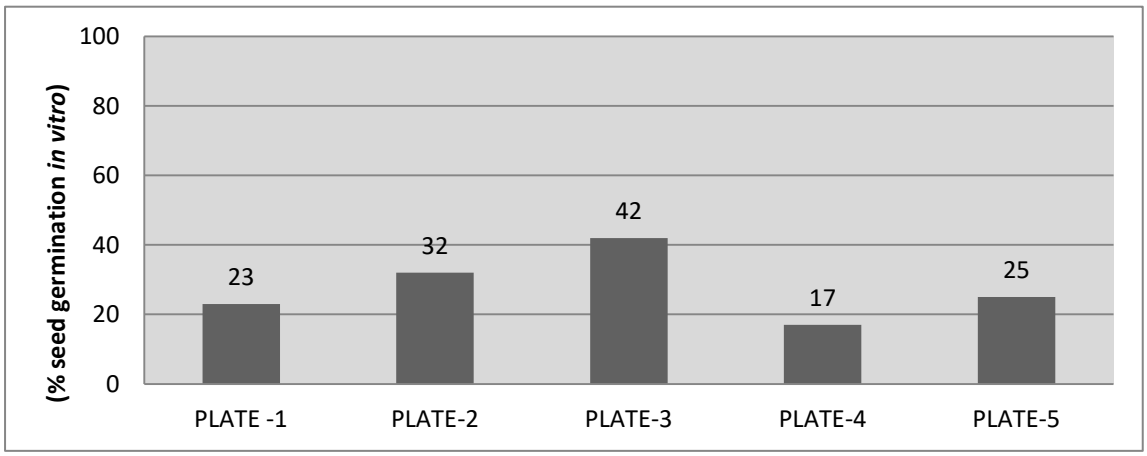

Figure 4. Percent seed germination of *Dendrophthoe falcatainvitro*

Corresponding author's E-mail: ***subha.au22@gmail.com***