

An Account on Diversity, Distribution and Host Range of Mistletoes in Bandipur Tiger Reserve, Karnataka, India

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ABSTRACT: Mistletoes are a unique group of plants named for their sticky fruits. As part of the floristic study of Angiosperm diversity in Bandipur Tiger Reserve, Karnataka, a total of 22 taxa of mistletoes belonging to two families were documented. Out of which 2 species endemic to India, 8 species endemic to Southern India and 3 were restricted to Karnataka state. The study reports *Dendrophthoe gamblei* L.J. Singh, Ranjan, Rasingam & J. Swamy, a recently discovered species as an addition to the state flora of Karnataka. The present study provides an additional distributional location to *Viscum malurianum* Sanjai & N.P. Balakr. and also reports new host ranges for *Taxillus heyneanus* (Schult. & Schult.f.) Danser, *Viscum ramosissimum* Roxb. ex DC. and *Viscum heyneanum* DC.

Keywords: Mistletoes, *Dendrophthoe gamblei*, *Viscum malurianum*, Host range.

INTRODUCTION

Mistletoes are the shoot or stem hemiparasites that depend on various host species to complete their lifecycle. Although they are often considered damaging the economically valuable trees (Rist *et al.*, 2011), they throw interest among many plant taxonomists due to their attractive flowers and camouflaging habits. Additionally, they serve as a food source for many forest birds (Muche *et al.*, 2022). Efforts by many taxonomists, starting from Miers in 1851, resolved the confusion in the delimitation of Viscaceae from Loranthaceae as a separate family. The major reasons for the separation include the type of embryosac development and the characteristics and sexuality of the flowers. The recent Angiosperm Phylogeny Group (APG IV 2016) classification merges Viscaceae under Santalaceae as the tribe Visceae, and the present study follows the same.

The initial works by Danser (1941); Rao (1957) enlighten the diversity of *Viscum* in British India and Indomalaya regions. The family Loranthaceae consist of 8 genera and 52 taxa in India (Sanjai and Balakrishnan 2012; Singh and Ranjan 2013; Singh, 2020; Sivaramakrishna, 2021), while the tribe Visceae includes four genera with 21 species (Sanjai and Balakrishnan 2006; Thriveni *et al.*, 2010; Sanjai and Balakrishnan 2012; Sardesai, 2019). This indicates that the present-day mistletoes of India constitute only 73 taxa. Some of the studies on the diversity of stem hemiparasites in Karnataka of the 20th century include Gamble (1967); Saldanha (1996) documented only a limited number of species. A revisionary work on Loranthaceae and Viscaceae by Thriveni (2016)

documented 24 taxa, providing details on their host ranges. Ravi *et al.* (2021), while compiling the seed plant diversity of Karnataka, listed 38 taxa of this group from the state.

Mistletoes parasitize a wide range of woody plants, particularly in forests and woodlands (Kuijt 1969) and also in cultivated fruit crops. They inhabit diverse biomes, including boreal forests, deserts, and also parasitize on monocotyledons and ferns. Both root and shoot parasites exhibit broad host ranges, with some species like *Castilleja* spp. and *Cuscuta* sp. parasitizing a greater number of hosts (Thriveni, 2016). The present study collectively documents the diversity of all stem hemiparasites, known as mistletoes, of Bandipur Tiger Reserve. The challenge of removal and conservation of both the parasite and host fascinates biodiversity conservationists, and the study of host preference and new host ranges plays a vital role in that. Thus, this study provides an updated list of mistletoes and their host ranges in Bandipur Tiger Reserve, Karnataka.

MATERIAL AND METHODS

Bandipur Tiger Reserve (BTR), one of the oldest tiger reserves in India, is located between 75° 12'17" E - 76° 51' 32" E and 11° 35'34" N - 11° 57'02" N, covering an area of 1036.05 km² in the central Western Ghats (Fig. 1). The reserve is situated at the trijunction of three southern states, extending from Mysore to Chamaraajanagara districts. The average elevation ranges from 388 m to 1450 m, with Himavad Gopalaswamy Betta as the highest peak (1454 m). Extensive field surveys were conducted from November 2022 to June 2024 throughout Bandipur Tiger Reserve, covering all seasons. The collected

specimens were identified using the available literature (Gamble 1925; Saldanha 1996; Saldanha and Nicolson 1976; Sanjai and Balakrishnan 2006; Balakrishnan *et al.*, 2012 and Thriveni 2016). The specimens were

processed using standard techniques (Jain and Rao 1977) and were deposited in the Madras Herbarium (MH), Southern Regional Centre, Botanical Survey of India.

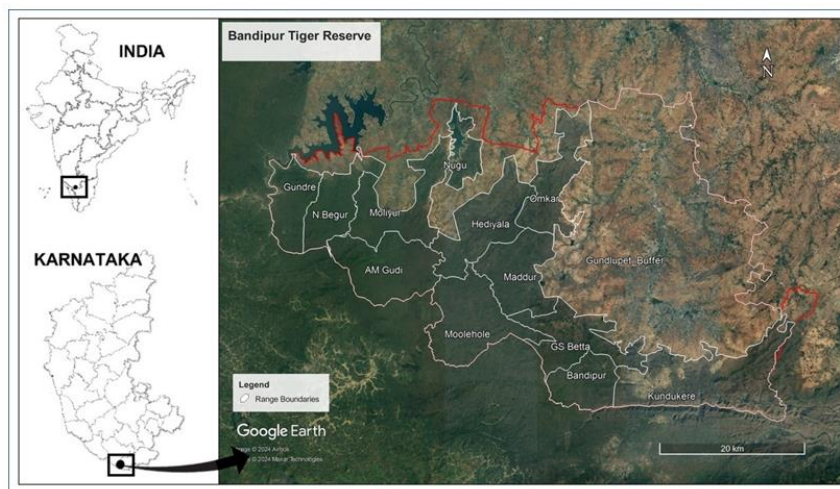


Fig. 1. Map of Bandipur Tiger Reserve.

RESULTS AND DISCUSSION

Taxonomic diversity of mistletoes: Around 12 genera and 73 taxa of mistletoes are distributed throughout India. Among these, 6 genera and 22 taxa are found in BTR, this constitutes 55% of mistletoes diversity of Karnataka (Table 1). Karnataka has the largest number of *Viscum* species among all Indian states (Sanjai and Balakrishnan 2006). The genus *Viscum* dominates with 10 species in the reserve, except *Viscum monoicum*, *V. acacia*, a recently collected species from Bangalore and *Viscum mysorensis* which is so far known only by its type collection, all the species are distributed in the reserve. This makes the reserve a hotspot for the genus *Viscum* in Karnataka. The recently discovered species *Dendrophthoe gamblei*, collected from the dry deciduous habitat of BTR at an altitude of 800-1000 m, is reported here as an additional distribution record for Karnataka state. Some of the photographs of mistletoes are given in (Fig. 2).

Distribution of Indian Endemics: A total of 31 endemic mistletoe species are found in India (Balakrishnan *et al.*, 2012). Among the 22 mistletoes documented in BTR, 10 are endemic to India, including 3 steno endemic species namely *Viscum bandipurense*, *V. malurianum* and *V. subracemosum*. These constitute 29% of the Indian endemic mistletoe species and 55% of the Karnataka endemic mistletoe species. Around four species show a restricted distribution to South India and Sri Lanka. *Viscum malurianum*, collected and described from Malur railway station, Kolar district, Eastern Karnataka (Sanjai and Balakrishnan 2001), was previously known only from the type locality (Sanjai and Balakrishnan 2006). The present study identifies an additional distribution location for this species in BTR, particularly on *Ficus benghalensis* from Gundlupet city to Melukamanahalli village along NH 766.

Distribution in BTR: The distribution of mistletoes depends on long-term habitat disturbance, climatic factors, and the availability of dispersers and host

species (Devkota *et al.*, 2011). The forests of BTR, with regard to mistletoe distribution, are broadly classified into dry deciduous, scrub forest, moist deciduous, and semi-evergreen forest types. The distribution pattern of mistletoes in BTR shows that the dry deciduous forest supports the highest diversity, followed by scrub forest. However, species such as *Taxillus recurvus* and *Macrosolen parasiticus* were found to occur on a greater number of hosts in all forest types. Marginal and fragmented forests promote invasion and provide habitat support to these groups (Bach *et al.*, 2005). Habitat destruction, particularly road construction, is the major cause of mistletoe diversity. Along highways and jeep roads, the population is higher, around 80% of mistletoe diversity in BTR observed along the two major highways. The species *Taxillus recurvus*, found irrespective of altitude and forest type, should be considered a major concern for conservation efforts, as its continuous spread may cause damage to native trees. The rapid spread and increasing host ranges in BTR: These perennial semi-parasitic plants are identified into two groups: those that can grow on diverse host species and those that specifically grow on a single or narrow range of hosts (Glatzel and Geils 2009; Okubamichael *et al.*, 2016). The former type of plants can be observed to greater extents and have a higher chance of survival (Nickrent and Musselman 2004). *Dendrophthoe falcata* is an example from Karnataka known to grow on 411 species of woody plants (Thriveni and Shivamurthy 2010). Most of the species in BTR prefers grow in diverse host ranges, but the number of colonies per host varies greatly. Some species observed with higher number of colonies in specified host such as *Scurrula cordifolia* on *Ficus bengalensis* and *Cordia dichotoma*, *Taxillus recurvus* on *Phyllanthus emblica*, *Macrosolen parasiticus* on *Terminalia tomentosa*. While *Viscum heyneanum* and *V. malurianum* prefers to grow specifically on *Atalantia racemosa* and *Ficus benghalensis* respectively. The present study also

documented the spread of endemic mistletoe on endemic trees, especially *Taxillus heyneanus* on *Deccania pubescence* and *Dendrophthoe gamblei* on *Hardwickia binnata*. Although the number of colonies observed was only 1–5 per individual host and it is not affecting the survival of the host species.

The characteristic berries of mistletoes, which contain mucilaginous substances, promote the adherence of seeds to their host species. Despite the problems caused by mistletoes, they are a major food source for birds. The low nutritional value of mistletoe makes the birds to consume large quantities of fruits to meet their caloric needs which are a vital strategy for the survival and spread of mistletoes (Szmidla *et al.*, 2019). This dependency on birds for seed dispersal highlights the high degree of coevolution between mistletoes and birds (Medel *et al.*, 2004) and plays a significant role in their pollination and dispersal (Devkota, 2005). Bird species that feeds on mistletoe berries in BTR include Purple sunbird, Bee-eaters, Asian Koel, Pale billed flower peckers and Leaf birds.

Mistletoe embryos are capable of germinating from the fruit, but they cannot break the exocarp without the assistance of birds (Ko *et al.*, 2014). However, during the study, it was observed that mature fruits of *Viscum articulatum* in herbarium specimens exhibited good germination and haustoria formation even after repeated

exposure to alcohol. The growth of mistletoes on a specific host depends on factors such as the host's nitrogen content, compatibility, chemical interactions between the parasite and host, and the role of birds in depositing mistletoe seeds on the aerial parts of plants (Muche *et al.*, 2022). Despite this, mistletoes can grow on a wide range of taxonomically unrelated hosts (Docteres Van Leeuwen 1954; Kuijt, 1964). Healthy parasites on healthy hosts can spread from one colony to as many as 4-5 colonies within two years. The infected plants have more chance of further spread of mistletoes than the uninfected plants. During the study period, the infection of *Taxillus recurvus* on *Phyllanthus emblica* increased from 1 colony to 5 colonies in Bandipur Tiger Reserve. *Taxillus* species produce epicortical roots that allow them to infest quickly within the same host species. Thriveni and Shivamurthy (2010) listed the host ranges and host specificity of most mistletoe in Karnataka, showing that only a few species rely on a limited number of hosts. However, the host range and host preference of mistletoes still need further study, as host ranges tend to increase over time in India. The present study also recorded additional host species for *Dendrophthoe gamblei*, *Helicanthes elastica*, *Taxillus cuneatus*, and *Taxillus heyneanus* (Table 1).

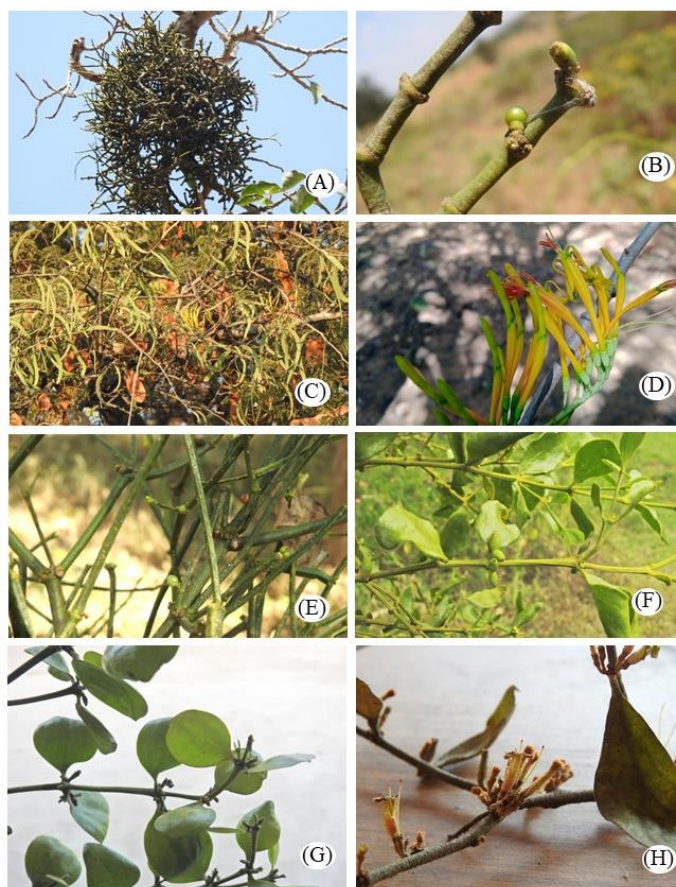


Figure 2: A & B, *Viscum malurianum* Sanjai & N.P.Balakr.; C & D, *Dendrophthoe gamblei* L.J.Singh, Ranjan, Rasingam & J. Swamy; E, *Viscum angulatum* B.Heyne ex DC.; F, *Viscum heyneanus* DC.; G, *Viscum bandipurense* Thriveni, Shivam., Amruthesh, Vijay & Sadanand.; H, *Taxillus tomentosus* (B.Heyne ex Roth) Tiegh.

Table 1: List of species documented in BTR.

Species name	Distribution	Distribution in BTR	Notes	Specimen examined
<i>Dendrophthoe falcata</i> (L.f.) Ettingsh	Indian Subcontinent, E. Queensland (India, Nepal, Bangladesh, Queensland, Sri Lanka, West Himalaya)	Throughout BTR	This species has various leaf shapes and is found to occur in more number of host especially on <i>Terminalia</i> spp.	Rekha & Sujana 153127
<i>Dendrophthoe falcata</i> var. <i>coccinea</i> (Talbot) Santapau	Southern India Endemic	Bandipur range particularly from Kekkanella check post to Bandipur forest range office	These woody shrubs parasitize on <i>Terminalia anogeissiana</i> , identified with the ovate-oblong orange coloured tuberculate berries.	Rekha & Sujana 153077
<i>Dendrophthoe gamblei</i> L.J.Singh, Ranjan, Rasingam & J.Swamy.	Southern India Endemic	Dry deciduous forest of G.S. Betta and Kundukere ranges	Singh <i>et al.</i> (2020) described this as a new species from Anantpur District and stated its distribution only from Andhra Pradesh and Tamil Nadu This species is rarely found in the dry deciduous forest of Moyar Valley, Kudukere range and the dry deciduous forest of G.S. Betta range of BTR, Karnataka. Additional host species: <i>Dalbergia sissoo</i> , <i>Hardwickia binata</i> and <i>Senegalia catechu</i>	Rekha & Sujana 152846
<i>Helicanthes elastica</i> (Desr.) Danser.	Southern India Endemic	Near Hosagundihalla of G.S. Betta and near Sulakette APC camp of Hediya range.	Much branched parasitic herb, these plants exhibit comparatively stunted growth. Additional host species: <i>Madhuca longifolia</i> var. <i>latifolia</i> and <i>Stereospermum personatum</i>	Rekha & Sujana 162038
<i>Macrosolen parasiticus</i> (L.) Danser	India, Sri Lanka & Tibet	Throughout BTR	It is found to occur in a greater number of hosts especially on <i>Terminalia</i> spp. identified with their bright red flowers	Rekha & Sujana 152996
<i>Macrosolen trigonus</i> (Wight & Arn.) Tiegh.	India Endemic	Throughout BTR	Large leaved mistletoe of the tiger reserve, mostly observed on <i>Ficus benghalensis</i>	Rekha & Sujana 162039
<i>Scurrula parasitica</i> L.	Tropical & Subtropical Asia	Bandipura range	Especially on <i>Terminalia tomentosa</i>	Rekha & Sujana 162044
<i>Scurrula cordifolia</i> (Wall.) G.Don.	Indian Subcontinent to Indo-China	Throughout BTR	Orbicular white leaves observed on <i>Cordia</i> spp. and <i>Dalbergia lanceolaria</i>	Rekha & Sujana 153026
<i>Taxillus cuneatus</i> (B.Heyne ex Roth) Danser.	India and Sri Lanka	Nugu, Bandipur & Kundukere ranges	Rare in the reserve on <i>Diospyros</i> sp., <i>Vitex altissima</i> . Additional host species: <i>Naringi crenulata</i>	Rekha & Sujana 152787, 153013
<i>Taxillus heyneanus</i> (Schult. & Schult.f.) Danser.	Southern India Endemic	Bandipur range office to G.S. Betta checkpoint & Kundukere range	Common in the reserve on <i>Terminalia anogeissiana</i> and <i>Ixora pavetta</i> , Additional host species: <i>Deccania pubescens</i> , <i>Vitex altissima</i>	Rekha & Sujana 153033
<i>Taxillus recurvus</i> (Wall. ex DC.) Tiegh.	Southern India Endemic	Throughout BTR	Common in the reserve especially on <i>Phyllanthus emblica</i>	Rekha & Sujana 152843
<i>Taxillus tomentosus</i> (B.Heyne ex Roth) Tiegh.	Southern India, Sri Lanka & Thailand	A.M. Gudi, Bandipura, G.S. Betta & Moolehole ranges	Common in the reserve resembles <i>T. recurvus</i> , but identified with 2 flowered fascicles at their nodes observed on <i>Phyllanthus emblica</i>	Rekha & Sujana 162028
<i>Viscum angulatum</i> B.Heyne ex DC.	India Endemic	Kekkanahalla boarder to Mudumalai TR and Gundlupet to Moolehole check post	Rare, observed especially on <i>Schrebra swietenoides</i>	Rekha & Sujana 153128
<i>Viscum articulatum</i> Burm.f.	Tropical & Subtropical Asia to	Throughout BTR	Common on <i>Grewia tiliifolia</i>	Rekha & Sujana

	S. Pacific.			152841, 153023
<i>Viscum bandipurense</i> Thriveni, Shivam., Amruthesh, Vijay & Sadanand.	India (Karnataka) Endemic	Bandipur CAMPUS, Maddur range office campus and G.S. Betta range	Rare, observed as an epiparasite on <i>Macrosolen trigona</i> which in turn parasitizes on <i>Ficus benghalensis</i>	Rekha & Sujana 153027
<i>Viscum capitellatum</i> Sm.	India, Sri Lanka	Bandipur range office to Check post & in Chikbarki APC camp	Rare, observed as epiparasite on <i>Dendrophthoe falcate</i> which in turn parasitize on <i>Stereospermum</i> <i>personatum</i>	Rekha & Sujana 162047
<i>Viscum heyneanum</i> DC.	S. India, N. Sri Lanka, Indo-China.	Rare in Bandipura range	Rare on <i>Atalantia racemosa</i> , difficult to differentiate because of the resemblance in leaf size and shape. Thriveni (2016) did not recorded this species from Karnataka	Rekha & Sujana 153022
<i>Viscum malurianum</i> Sanjai & N.P.Balacr.	India (Karnataka) Endemic	Rare from Gundlupet to Mellukamanahalli	Rare on the <i>Ficus benghalensis</i> . It is the additional distribution location of this species from Karnataka (Channmrajanagara district). Thriveni (2016) did not recorded this species from Karnataka	Rekha & Sujana 162004
<i>Viscum orientale</i> Willd.	Afghanistan to Indian Subcontinent (Afghanistan, Bangladesh, India, Nepal, Pakistan, Sri Lanka)	Bandipura and Gundlupet ranges	Commonly found on <i>Albizia amara</i> resembles <i>Viscum subracemosum</i> identified with ovate shortly petiolated leaves	Rekha & Sujana 162052
<i>Viscum ramosissimum</i> Roxb. ex DC.	Southern India, Sri Lanka	Throughout BTR	Commonly observed on <i>Ixora</i> <i>pavetta</i> and <i>Phyllanthus emblica</i> . Additional host species: <i>Flacourtia</i> <i>indica</i>	Rekha & Sujana 152638, 152786, 153179
<i>Viscum trilobatum</i> Talbot.	Southern India Endemic	A.M. Gudi near Waynaad Border	Rare found as epiparasite on <i>Macrosolan parasiticus</i> . resembles <i>Viscum bandipurense</i> but differentiated with their truncate apex of leaves.	Rekha & Sujana 162036
<i>Viscum subracemosum</i> Sanjai & N.P.Balacr.	India (Karnataka) Endemic	Rare in G.S. Betta & Gundlupet ranges	Rare, observed on <i>Pongamia</i> <i>pinnata</i> . Thriveni (2016) did not recorded this species from Karnataka	Rekha & Sujana 162003

CONCLUSIONS

The diversity of mistletoes in Bandipur Tiger Reserve is high due to its location in the shaded area of the continuous Western Ghats mountains and the presence of over 300 bird species, particularly Pale-billed flower peckers and Sunbirds, which spread these berries throughout the reserve. However, not all mistletoes pose a threat to their hosts, and as long as their presence does not endanger the host's life, they can be allowed to grow. While not all mistletoes cause significant damage to their hosts in Bandipur Tiger Reserve, their presence can become problematic if they threaten endemic plant diversity. Long-term monitoring is necessary to ascertain if the host trees are dying. In such cases, if long-term monitoring proves the death of a host, it may be beneficial to remove the parasites. This can be followed even if the parasite is endemic. Mechanical removal of mistletoes can be an effective strategy for conserving native biodiversity to manage the impact on endemic host species.

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Conflict of Interest. None.

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