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Leaf Venation and Morphometric Studies in Some Members of Family Loranthaceae

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ABSTRACT

In the present study, leaf venation & morphometrically analysed in nine species belonging to the five genera of the Loranthaceae family in the Northern Karnataka region. Venation studies revealed that, in primary veins arrangement Acrodromus (suprabasal) type observed in *Helicanthes elasticus*, the remaining 8 species have shown pinnate primary venation. Leaf morphometrical studies with the help of PCA, cluster analysis and CD. It was observed that the quantitative characters *viz.,* leaf length, leaf breadth, ratio of leaf length to leaf breadth, leaf base nerve number, petiole length, leaf lamina length and ratio of leaf lamina length to petiole lengths, have a great contribution in the separation of the taxa.

KEYWORDS: *Mistletoes; Parasitic plants; Venation; Morphometrics; Karnataka*

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INTRODUCTION

Parasitic Angiosperms are classified into two categories, root parasites and stem parasites. Approximately 60% are root parasites and 40% are shoot or stem parasites. Root parasites belong to the families Apodanthaceae, Olaceae, Opiliaceae, Orbanchaceae, Santalaceae and Schropulariaceae. The stem parasites belong to Loranthaceae, Viscaceae, Convolvulaceae and Lauraceae. Apart from the damaging agents, some parasitic plants have provided an invitation to man to make use of them (Parker and Riches, 1993).

The Loranthaceae family is also known as Mistletoe, this name was derived from the old German '*Mist*', which means dung and '*Tan*' means twig, which describes the observable origin of these plants from the droppings of birds that have been feeding on mistletoe fruits (Clader, 1983). It is the largest mistletoe family with 78 genera and more than 1074 species (POWO, 2024). The members of Loranthaceae are utilized globally in conventional medicine to cure a variety of ailments (Guimares *et al.* 2007).

Venation is the arrangement of the veins of a leaf for ease of reference divided into primary midrib/mail vein, secondary veins and tertiary venation (Beentje, 2010). Leaves typically have 4-7 orders of veins, with the first three being primary, secondary and tertiary. Primary veins are the widest and most structural, running from the base to the margin. Secondary veins are smaller, branching from the base or primary veins to the margin. Tertiary veins are even narrower, connecting primary and secondary veins and forming a network across the leaf. While primary and tertiary veins are usually easy to identify, secondary veins can have varying widths and courses but are still considered secondary. (Amanda *et al.,* 1999). The Leaf Venation Studies are important for the proper

identification of a plant in the absence of the flowering season.

Similar studies have been reported in the family Sapandiaceae (Mohd *et al.,* 2017), and in some genera like *Saxifraga* Tourn. Ex L. (Zhuoxin *et al.* 2015), *Nervilia* Comm. Ex Gaudich. (Betageri & Kotresha, 2023). Leaf morphometric study is a Statistical method. The proper identification of Loranthaceae species is essential because it is medicinally valuable. So, Morphometric studies involve numerical analysis and comparison of closely related taxa, enabling distinct separation and grouping of plant species. Techniques such as Cluster Analysis (CA) and Principal Component Analysis (PCA) facilitate the differentiation and classification of closely related species. Such type of studies has been performed in the genus *Terminalia* L (Deshmukh *et al.,* 2013). *Salvia* L. (Kharazian, 2012), *Clerodendrum* L. (Deshmukh *et al.* 2012), *Cassia* L. (Deshmukh 2011), *Ficus* L. (Jangam *et al.* 2017).

MATERIAL & METHODS

During this study, we have collected 9 species belonging to 5 genera, namely *Dendrophthoe*, *Helicanthes*, *Helixanthera*, *Macrosolen, Scurrula*. The collected and dried leaves were kept in sodium hypochlorite for 24 hours to degrade the leaf tissues other than the venations and veinlets (Amanda *et al*. 1999). After that, the leaves have been meticulously studied under a stereo-microscope with the help of light at the ventral side. The leaves were drawn using a Rotring pen with various sizes as per primary, secondary and tertiary veins. Type of ventilation and arrangements were tabulated in the table along with their botanical name.

Nine species of the Loranthaceae family were included in this study based on their common leaf shape and patterns. The samples were collected from different locations. Approximately 25 mature leaves were collected per species, but only 25 leaves per species (n = 25) were recorded. Although there might be differences in leaf sizes among the species within the family, focus on leaf shapes that have identifiable homologous landmarks and noticeable differences in outlines (Oso & Jayeola, 2021). Measurements of leaf characters *viz.* leaf length, leaf width, petiole length, and lateral nerve number were taken with the help of thread and line ruler. The obtained mean values of each quantitative character were processed for cluster analysis and principal component analysis (Kovach, 2013).

RESULT & DISCUSSION:

In leaf venation studies of 9 species belonging to 5 genera of Loranthaceae family. Along with the Botanical name, primary veins, secondary veins, secondary vein spacing, secondary vein angle and tertiary veins were tabulated in **Table 1.** In primary veins arrangement, the Acrodromus (suprabasal) arrangement was observed in *Helicanthes elasticus*, the remaining 8 species have shown the pinnate primary venation.

In secondary vein arrangements Brochidodromus type was observed in *Dendrophthoe falcata* var *pubescenes*, *Dendrophthoe falcata* var *coccinea* and *Helixanthera obtusata* and Festooned brochidodromus type was seen in *Helicanthes elasticus, Macrosolen capitellatus, Macrosolen trigonus,* and *Scurrula parasitica.* In case of *Dendrophthoe falcata var falcata* both the Brochidodromus and Festooned brochidodromus types were observed. Secondary vein spacing is decreasing towards the base in *Dendrophthoe falcata* var *pubescenes* and *Macrosolen trigonus*. Secondary vein spacing is irregular in remaining all species. The secondary vein angle is smoothly decreasing towards the base. Tertiary veins were randomly reticulated in all the species.

Table 1: Leaf Venation Studies in the family Loranthaceae

Sl. No	Botanical name	Primary veins	Secondary veins	Secondary vein spacing	Secondary vein angle	Tertiary veins
01	*Dendrophthoe falcata* var *pubescenes*	Pinnate	Brochidodromus	Decreasing towards base	Smoothly increasing toward base	Random reticulate
02	*Dendrophthoe falcata* var *falcata*	Pinnate	Brochidodromu, Festooned brochidodromus	Irregular	Smoothly decreasing towards base	Random reticulate
03	*Dendrophthoe falcata* var *coccinea*	Pinnate	Brochidodromus	Irregular	Smoothly decreasing towards base	Random reticulate
04	*Helicanthes elasticus*	Acrodromus (suprabasal)	Festooned brochidodromus	Irregular	Smoothly increasing towards base	Random reticulate
05	*Helixanthera obtusata*	Pinnate	Brochidodromus	Irregular	Smoothly decreasing towards base	Random reticulate
06	*Macrosolen capitellatus*	Pinnate	Festooned brochidodromus	Irregular	Smoothly increasing toward base	Random reticulate
07	*Macrosolen trigonus*	Pinnate	Festooned brochidodromus	Decreasing towards base	Smoothly decreasing towards base	Random reticulate
08	*Scurrula parasitica*	Pinnate	Festooned brochidodromus	Irregular	Smoothly increasing toward base	Random reticulate
09	*Helixanthera wallichiana*	Pinnate	Brochidodromus	Irregular	Smoothly increasing toward base	Random reticulate

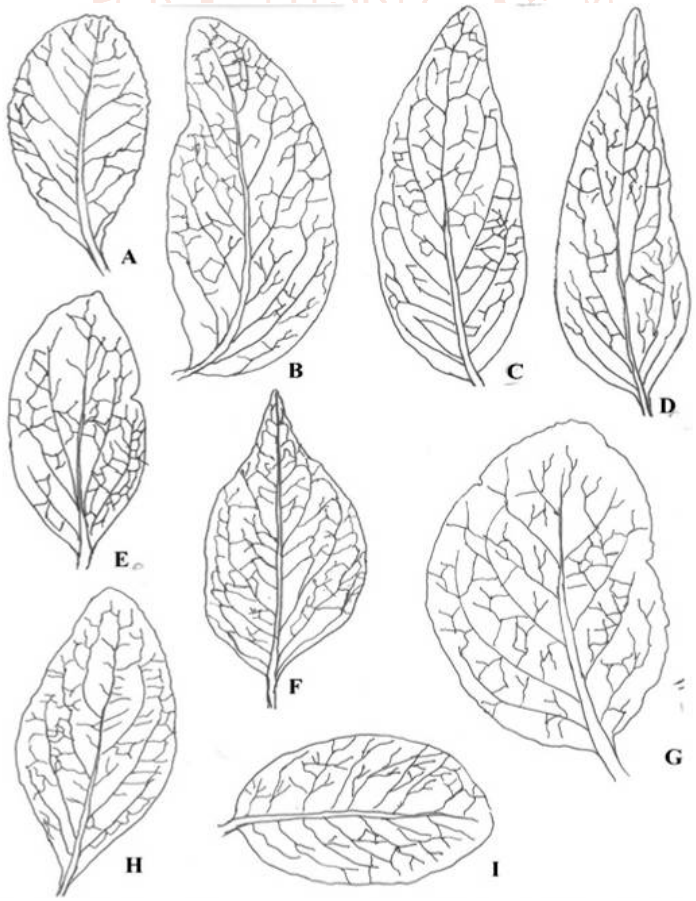

Figure 1. A. *Dendrophthoe falcata* var *coccinea* (Talbot) Santpau, B. *Dendrophthoe falcata* var *falcata*, C. *Dendrophthoe falcata* var *pubescens* (Hook. F.) V. Chandras, D. *Macrosolen capitellatus* (Wight & Am.) Danser, E. *Helicanthes elastica* (Desr.) Danser, F. *Helixanthera wallichiana* (Schlutes) Danser, G. *Macrosolen trigona* (Wight &Am.) Tiegh, H. *Helixanthera obtusata* (Schultes) Danser, I. *Scurrula parasitica* L.

The current study related to nine species of Loranthaceae family and leaf quantitative characters **(Table 2)** based on PCA and CA. The PCA studies revealed a significant correlation between leaf length, leaf breadth, petiole length, and lamina length while the leaf base nerve number serves for distinct segregation of the species within the same genus. It has also been analyzed that, the ratios of leaf length to leaf breadth and leaf lamina length to petiole length also segregate the taxa within the family. Cluster analysis and dendrogram **Figure 2** based on farthest neighbor and constrained clustering strategy among *Dendrophthoe falcata var coccinea; Helicanthes elastica; Dendrophthoe falcata var falcata; Helixanthera obtusata; Dendrophthoe falcata var pubescens; Helixanthera wallichiana; Macrosolen capitellatus; Scurrula parasitica* and *Macrosolen trigona.*

Based on the **Figure 2** Dendrogram based on cluster analysis, farthest neighbour mean character difference and constrained strategy in studies show that *Dendrophthoe falcata var coccinea* and *Helicanthes elastica* species form one distinct node which is related to the other species. *Dendrophthoe falcata var falcata, Helixanthera obtusata* and *Dendrophthoe falcata var pubescens* form one distinct node which is related to the other species. The remaining 4 species from different distinct node are related to each other. *Helixanthera wallichiana and Macrosolen capitellatus* form one distinct node which is related to the other species *Scurrula parasitica* and *Macrosolen trigona* form different distinct nodes which is not much related to the other species.

Table 02: Leaf Qualitative Characters of Some Species of Loranthaceae (Median values in cm)

	L1	L2	L3	L4	L5	L6	L7	L8	L9
LL	9.7	6.3	11.6	9.5	11.2	10.1	10.6	6.7	13.5
LB	4.3	3.3	5.1	2.6	2.8	3.7	3.8	3.6	7.2
LL/LB	2.3	1.8	2.2	3.7	4	2.7	2.7	1.8	1.9
LBNN	3	3	2	3	2	3	3	3	3
PL	0.8	0.1	0.7	0.9	0.2	1	0.6	0.6	1
LLL	8.7	6.2	10.8	8.6	11	9.1	10	6	12.5
LLL/PL	10.85	62	15.4	9.5	55	9.1	17.4	10	12.5

Abbreviations: LL- Leaf length; LB- Leaf breadth; LL/LB-Ratio of leaf length to leaf breadth; LBNN- Leaf base nerve number; PL- Petiole length; LLL- Leaf lamina length; LLL/PL- Ratio of leaf lamina length to petiole length.; L1- *Dendrophthoe falcata var coccinea;* L2- *Helicanthes elastica;* L3- *Dendrophthoe falcata var falcata;* L4- *Helixanthera obtusata;* L5- *Dendrophthoe falcata var pubescens;* L6- *Helixanthera wallichiana;* L7- *Macrosolen capitellatus;* L8- *Scurrula parasitica;* L9- *Macrosolen trigona;*

Table 03: Principal Component Analysis of 9 species of the Loranthaceae family.

Similarity matrix	LL	LB	LL/LB	LBNN	PL	LLL	LLL/PL
LL	1.000						
LB	0.624	1.000					
LL/LB	0.257	-0.570	1.000				
LBNN	-0.371	0.038	-0.375	1.000			
PL	0.475	0.472	-0.073	0.359	1.000		
LLL	0.990	0.583	0.294	-0.444	0.346	1.000	
LLL/PL	-0.283	-0.352	0.158	-0.350	-0.911	-0.150	1.000

Abbreviations: LL- Leaf length; LB- Leaf breadth; LL/LB-Ratio of leaf length to leaf breadth; LBNN- Leaf base nerve number; PL- Petiole length; LLL- Leaf lamina length; LLL/PL- Ratio of leaf lamina length to petiole length.

Table 04: Cluster Analysis Revealing Relationship between the 9 species of Loranthaceae family.

Distance matrix	L1	L2	L3	L4	L5	L6	L7	L8	L9
L1	0.000								
L2	5.512	0.000							
L3	44.309	39.713	0.000						
L4	51.341	47.176	10.107	0.000					
L5	2.595	7.321	45.613	52.697	0.000				
L6	1.986	6.938	45.997	53.132	1.729	0.000			
L7	6.771	2.931	37.669	44.982	8.253	8.374	0.000		
L8	6.341	4.528	42.886	50.575	8.039	6.897	7.144	0.000	
L9	4.218	8.924	45.573	52.005	4.422	4.792	9.318	10.386	0.000

Abbreviations: L1- *Dendrophthoe falcata var coccinea;* L2- *Helicanthes elastica;* L3- *Dendrophthoe falcata var falcata;* L4- *Helixanthera obtusata;* L5- *Dendrophthoe falcata var pubescens;* L6- *Helixanthera wallichiana;* L7- *Macrosolen capitellatus;* L8- *Scurrula parasitica;* L9- *Macrosolen trigona;*

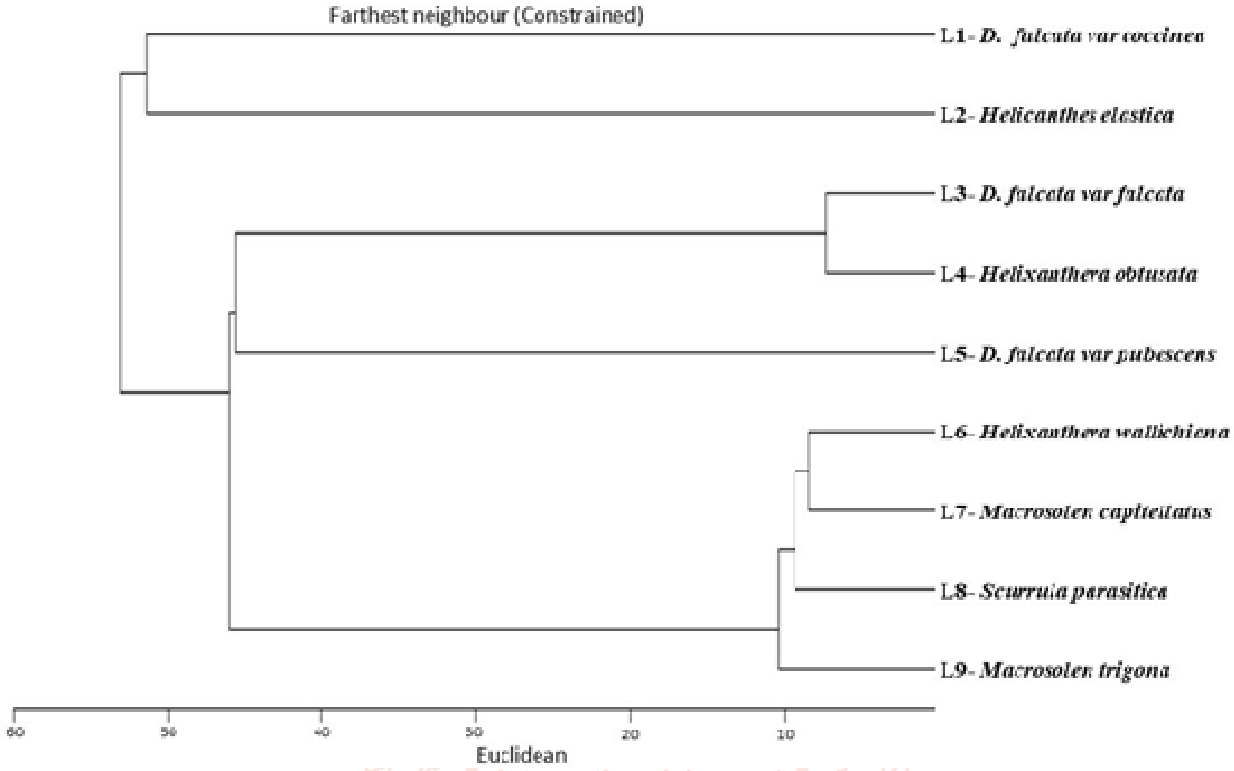

Figure 2: Dendrogram on the basis of Cluster Analysis, Farthest Neighbor, Mean Character difference and constrained clustering strategy in studies some species of Loranthaceae

CONCLUSION:

In Loranthaceae family we have collected 9 species belongs to 5 genera. In leaf venation studies, variations in venation were observed in the primary veins, secondary veins, secondary vein spacing, secondary vein angle, and tertiary veins. In primary veins arrangement, the Acrodromus (suprabasal) arrangement was observed in *Helicanthes elasticus*, the remaining 8 species have shown the pinnate primary venation. Brochidodromus and Festooned brochidodromus type of secondary veins arrangement. Tertiary veins were randomly reticulated in all the species.

The current study related to nine species of Loranthaceae family and leaf quantitative characters based on PCA and CA. The PCA studies revealed a significant correlation between leaf length, leaf breadth, petiole length, and lamina length while the leaf base nerve number serves for distinct segregation of the species within the same genus. Cluster analysis and dendrogram based on farthest neighbour and constrained clustering strategy among *Dendrophthoe falcata var coccinea* and *Helicanthes elastica* species form one distinct node which is related to the other species. *Dendrophthoe falcata var falcata, Helixanthera obtusata* and *Dendrophthoe falcata var pubescens* form one distinct node, which is related to the other species. The remaining 4 species from different distinct nodes are related to each other. *Helixanthera wallichiana and Macrosolen capitellatus* form one distinct node which is related to the other species *Scurrula parasitica* and *Macrosolen trigona* form different distinct nodes, which are not much related to the other species.

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