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Assessment of Epiphyte Diversity in Avenue Trees of National and State Highways of Udupi District, India

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Keywords : *Epiphyte, Highways, Diversity.*

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Assessment of Epiphyte Diversity in Avenue Trees of National and State Highways of Udupi District, India

Poornima Jyothi D'cunha [α], P. Venkatramana Gowda [σ] & Rajeshwari.H.S [ρ]

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I. Introduction

The diversity of epiphytic flora may provide an indication of ecosystem health as they are considered as an important component of plant life which constitutes about 10% of flora present worldwide. The epiphytic diversity and its abundance is depends on the forest structure, tree species composition and atmospheric humidity. Tree species composition affects epiphytic vegetation through substratum characteristics provided by each tree species, giving rise to host-epiphyte specificity (Went, 1940). The vertical distribution of epiphytes is mostly determined by patterns in photon flux density (PFD) and humidity in subsequent forest strata. The specific humidity level is also an important factor for diversity and composition of epiphyte (Sanford 1968). The presence of individual species, including crustose lichens and bryophytes, in seven habitats representing different canopy positions, based on a sample of twenty trees in an old conifer forest. Many authors have contrasted epiphytes on various species of trees. The studies demonstrated some important patterns of variation in epiphytes. These are 1) quantification of the relative strength of these various patterns, 2) consideration of dead trees as habitat for epiphytes, and 3) synthesis and reconciliation of seemingly disparate results from various regions (Pike *et al.*, 1975).

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The epiphytes are important with relation to the biological diversity maintaining a balance in nature. Due to manual activities, pollution is on all the time rises and therefore epiphytes are declining in number. Due to the shrinkage of forest areas and need for timber and firewood, the avenue trees are also being destroyed day by day, cheating epiphytes of their natural habitat.

Objective of the study:

1. Study of nature of the epiphytes.
2. Study of occurrence of the epiphytes.
3. Study of abundance of epiphytes.

II. Review of Literature

Schimper (1888) studied the taxonomic diversity of epiphytes and listed 33 families and 232 genera of epiphytes.

Went, 1940 documented different epiphyte vegetations found in different lowland rain forests. This is related to forest structure, tree species composition and atmospheric humidity. Tree species composition affects epiphytic vegetation through substratum characteristics provided by each tree species, giving rise to host-epiphyte specificity. Distibution of hemiparasites and hemiepiphytes can vary in at least two ways: horizontally, they can differentiate between host species and forest types, and vertically, they vary from the tree base to its top.

The following substratum factors are relevant, like texture (roughness) and porosity of bark (water interception and storage) pH and nutrient contents of bark; cover and characteristics of litter and bryophyte mats; bark toxins; bark turn-over rate etc. The vertical distribution of epiphytes is mostly determined by patterns in photon flux density (PFD) and humidity in subsequent forest strata. For instance, many epiphytic Bromeliaceae members show specific humidity demands. (Sanford 1968).

Pike *et al.*, (1975), Studied the presence of individual species, including crustose lichens and bryophytes, in seven habitats representing different canopy positions, based on a sample of twenty trees in an old conifer forest. Many authors have contrasted epiphytes on various species of trees. The studies demonstrated some important patterns of variation in

epiphytes. These are 1) quantification of the relative strength of these various patterns, 2) consideration of dead trees as habitat for epiphytes, and 3) synthesis and reconciliation of seemingly disparate results from various regions.

High canopy dwellers must be able to withstand frequent periodic droughts. All orchid species among them are small-sized and succulent, and some of them have terete leaves. The water-absorbing capacity of the trichomes of *Tillandsia* has been demonstrated by Benzing, 1776.

Relatively a few lineages have been able to enter the epiphytic niche, presumably because of the complex suite of adaptations needed. Thus even though it is true that the evolution of an epiphytic habit has been a relatively common feature of vascular plant evolution, it is equally true that very few of the taxa that have evolved an epiphytic habit have radiated successfully to produce other epiphytic species. In most of the epiphyte-containing families, epiphytism is a rather insignificant anomaly. Indeed, eliminating a mere 85 such "oddball" species from the roster of the world's epiphytes removes 3 1 families from the epiphytic ranks. Only 32 seed plant families have as many as five or more epiphytic species, 26 of these with epiphytes in the Neotropics. It is on the 42 families that contain epiphytes in the Neotropics. Even though this analysis of epiphyte diversity and distribution is largely focused on the Neotropics, a few comparisons with the Paleotropics are instructive. There are actually slightly more families with epiphytes in the Paleotropics (43) than in the Neotropics (42), with all of the paleotropical epiphytic families having epiphytic representatives in Australia but only 15 in Africa and Madagascar. If only the 32 seed plant families with five or more epiphytic species are considered, there are also roughly equal representations of epiphyte-containing families in the Neotropics (26) and Australia (25), but only about half as many in Africa (14). At the species level the story is very different. There are many more epiphytes in the Neotropics, at least half again as many as in Australasia and six times as many as in Africa. Although similar numbers of genera and families evolved epiphytism in the different regions, subsequent speciation as epiphytes was dramatically greater in the Neotropics. (Burger, 1977)

The diversity in epiphyte communities might be maintained by disturbance in forest canopies, bark exfoliation, detaching branches and new growth that prevents competitive exclusion within the community. (Benzing ,1981).

Differences in the distributions of Tillandsias and orchids may not reflect past competition as much as phylogenetic differences in mechanisms of seed dispersal and seedling establishment (Chesson and Warner, 1981).

Plant families belonging to different habit groups have fundamentally different distributional patterns. Families composed mostly of canopy trees or lianas have their greatest diversity in Amazonia whereas families made up mostly of epiphytes, shrubs, or palmetto-type herbs are largely extra- Amazonian and are especially concentrated along the lower slopes of the northern Andes and to a lesser extent in southern Central America. For epiphytes, this concentration of species diversity could have been predicted from the trends outlined above.(Gentry, 1982).

The open forests are generally short in stature and possess a limited number of potential epiphytic host species (phorophytes). A dominant tree in areas of these forests is the logwood, *Haemotoxylon campechianum*, a species of tree utilized in olden times to produce fabric dyes. (Dachary & Arnaiz,1983).

A hemiepiphyte, apparently needs the accumulations of organic debris to germinate and establish. It starts its luxuriant growth through the forest from the lower canopy. As indicated above, "moss epiphytes" are found mainly on large more or less horizontally positioned branches. Apart from the species mentioned before, *Maxillaria superf, Dichaea picta*, and *Xiphopteris nana* prefer the lower canopy.(Kelly, 1985).

Forest associations dominated by *H. campechianum* are referred to as tintales. Vascular epiphytes in tintales are abundant and the epiphyte community is relatively diverse. There recorded 183 individuals representing 17 species of vascular epiphytes in an 800 m^2 sample of tintal in the Sian Ka'an Biosphere Reserve in the state of Quintana Roo, Mexico. The abundance of epiphytes in these forests may be due to high humidity maintained by standing water which can persist in the dry season.(Olmsted and Durang, 1986).

The long and fine roots of orchids and tillandsioids also seem adaptive to this special habitat, since they may curl around the smallest twigs and provide solid attachment. (Chase 1987).

Tree tops represent a tiny proportion of the total habitat in the forest. Some species were most frequent on dead tree tops while others were more abundant in the living tops. We hypothesize that treetops develop a distinctive epiphyte community because they are so frequently visited by birds and others. Birds influence epiphyte communities by bringing propagules on their feet and increasing local nutrient availability through deposition of feces. (Kantvilas and Minchin,1989).

Ryan, (1991) studied in detail the factors responsible for the pronounced differences in epiphytes between the upper and lower sides of leaning trunks.

Light is rapidly attenuated between 13 and 37 m high in the canopy, the "light transition zone." Biomass of epiphytic macrolichens at the crane site is about 1.3 metric tonsha, composed of approximately 42%

cyanolichens, 28% alectorioid lichens, and 30% other lichens (McCune *et al*., 1993).

In western British Columbia, found that the lean of trunks influences epiphytes mainly through the interception of precipitation, as opposed to differential stem flow or light. This contrasting environment produces the well-known contrast in lichen communities: the sheltered side with a thin community rich in *Caliciales* and *leprose* lichens, with the upper side often heavy with macroepiphytes. At our study site, *Chaenotheca brunneola* and *Lepraria spp*. had the strongest association with the lower sheltered side, with a similar but weaker tendency shown by *Hypocenomyce friesii* and *Lopadium discifone*. Many other species occur in this habitat but were too infrequent to demonstrate their association statistically. Associated with the upper side of leaning trunks were *Cladonia squamosa* var. *subsquamosa, C. transcendens*, *Ochrolechia oregonensis, Cephalozia lunulifolia, Dicranum fuscescens,* and *Scapania bolanderi*. More species of epiphytes showed a distinct association with the very tops of trees (within two m of the top) than any other single habitat in the forest.(Sillett and Rambo, 2000).

III. Material and Methods

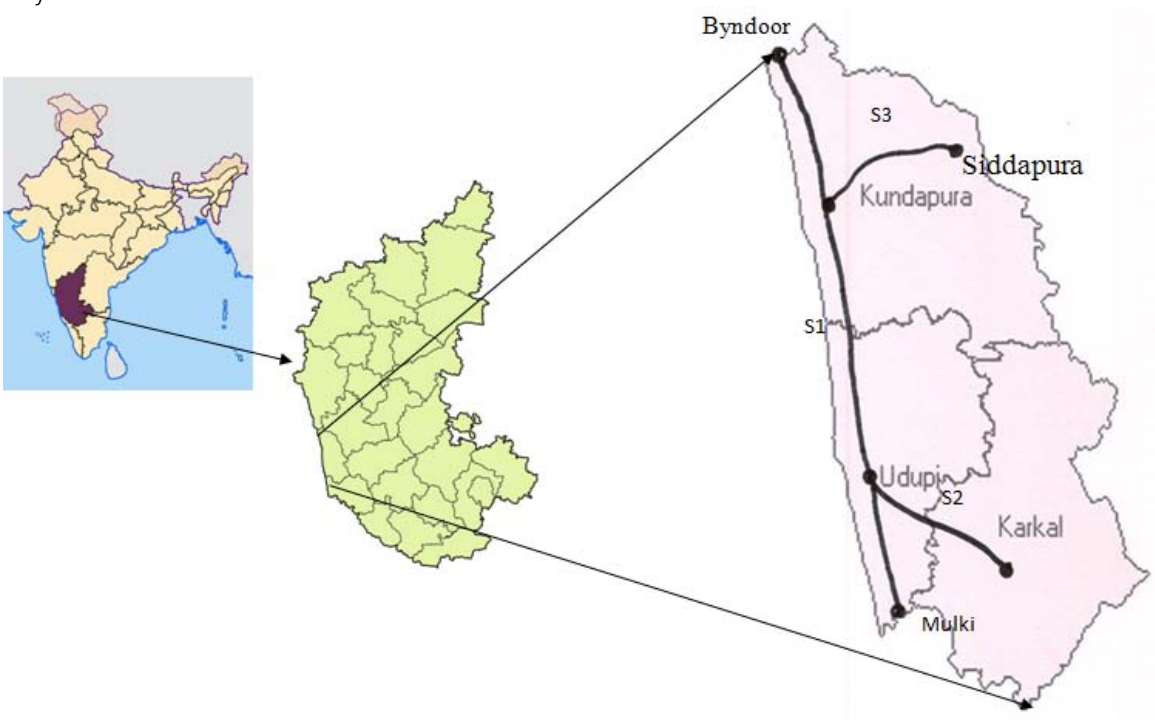
Study area: The present study is carried out in one national highway (NH) and two state highways (SH), 13°06' 20.86''N to 13 ° 12.52''N and 74° 47' 13.12'' to 74° 37' 43.31''E. 50x20 m Belt transacts was used for the epiphytic sampling. Transacts were laid randomly just next to the footpath on either sides. 90 and 60 transacts were laid in NH and SH respectively. Girth at breast height (GBH) ≥ 30cm and the height of all trees in transact was recorded. Their occurrence and height were noted. The epiphytes present in transacts were identified using standard key books. Dried specimens are then mounted on herbarium sheets of standard size 29x42 cm using synthetic glue and the woody part of the specimen is stitched using white coloured thread. The specimens like patches of mosses and the orchids are preserved using the 70% alcohol.

Shannon-Wiener's diversity was used to calculate the variation in phytoplankton species diversity of the study area along the national and state highways using the formula

$$H' = {}^{s}\sum_{i} Pi \log_e (Pi)$$

Where *s is* the number of species, and P*i* is the proportion of the total number of individuals consisting of the i^{th} species.

The study area:



The study area was represented as follows.

Table 1 : Study area

Study area		Site no.
National Highway(NH)	Mulki to Byndoor	S1
State Highway (SH)	Udupi to Karkala	S2
State Highway (SH)	Kundapura to Siddapura	S3

IV. Results and Discussion

The avenue trees found on the study area are represented in the table.

Table 2 : Avenue trees found on the study area.

Botanical name of the avenue tree	S1	S2	S3
Acacia auriculiformis	+	+	+
Acacia sinuate	+	+	+
Albizia lebbeck	+	+	+
Alstonia scholaris	+	+	+
Artocarpus heterophyllus	+	+	+
Artocarpus hirsutus	+	+	+
Borassus flabellifer	-	+	+
Casuarina equisetifolia	+	+	+
Calophyllum inophyllum	-	+	+
Caryota urens	-	+	+
Dalbergia sissoides	-	+	+
Erythrina variegata	+	+	+
Eucalyptus tereticornis	+	+	+
Ficus benghalensis	+	+	+
Ficus religiosa	+	+	+
Hopea parviflora	+	+	+
Hopea ponga	-	+	+
Mammea suriga	-	+	+
Mangifera indica	+	+	+
Mimusops elengi	+	+	+
Morinda citrifolia	-	+	+
Olea dioica	-	-	+
Pongamia pinnata	-	+	+
Pterocarpus marsupium	-	+	+
Samanea saman	+	+	+
Syzygium cumini	-	+	+
Tectona grandis	-	+	+
Vatica chinensis	-	+	+
Vateria indica	+	+	+

The above table reveals more avenue trees are in state highways than national Highway 17.

The epiphytes present on the avenue trees are represented in the table.

Table 3 : The epiphytes present on the avenue trees of study area.

S. No.	Name of the plant	Type of the plant	Family
1	*Calymperes tenerum* C. Muell.	Bryophyte	Calymperaceae
2	*Sematophyllum caespitosum*(Hedw.)Mitt.	Bryophyte	Sematophyllaceae
3	*Taxithelium nepalense*(Schwaerg.) Broth.	Bryophyte	Sematophyllaceae
4	*Drynaria quercifolia* (L.)J.Sm.	Pteridophyte	Polypodiaceae
5	*Acampe praemosa*(Roxb.) Blatt. & McCann.	An orchid	Orchidaceae
6	*Bulbophyllum neilgherrense* Wight.	An orchid	Orchidaceae
7	*Cleisostoma tenuifolium* (L.) Garay	An orchid	Orchidaceae
8	*Dendrobium ovatum*(Willd.)	An orchid	Orchidaceae
9	*Rhynchostylis retusa* Blume	An orchid	Orchidaceae
10	*Vanda testacea*(Lindl.)Reichb.	An orchid	Orchidaceae

From the current study it is observed that *Acacia auriculiformis, Artocarpus heterophyllus, Casuarina equisetifolia, Eucalyptus tereticornis, Samanea saman, Mangifera indica,* and *Tectona grandis* are more common. The epiphytes and the parasites are absent on *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus tereticornis* and *Vateria indica*. The epiphytes are commonly found on *Artocarpus heterophyllus, Artocarpus hirsutus, Dalbergia sissoides, Ficus religiosa, Ficus benghalensis, Mammea suriga, Mangifera indica, Pongamia pinnata, Samanea saman*.

The epiphytes which are common in the Udupi district are *Calymperes tenerum, Sematophyllum caespitosum, Taxithelium nepalense, Drynaria quercifolia, Acampe praemosa, Bulbophyllum neilgherrence, Cleisostoma tenuifolium, Dendrobium ovatum, Rhynchostylis retusa, Vanda testacea*. Shannon's diversity index of epiphytic species was higher in SH (0.907) compared to NH (0.846).

The distribution of epiphytes in National and state highways are represented below.

Table 4 : The distribution of epiphytes in National and state highways.

Avenue tree species	*Cal*	*Sem*	*Tax*	*Dry*	*Aca*	*Bul*	*Cle*	*Den*	*Rhy*	*Van*
Acacia auriculiformis	-	-	-	-	-	-	-	-	-	-
Acacia sinuate	-	-	-	-	-	-	-	-	-	-
Albizia lebbeck	+	+	+	+	-	-	-	-	-	-
Alstonia scholaris	-	-	-	-	-	-	-	-	-	-
Artocarpus heterophyllus	+	+	+	+	+	+	+	+	+	+
Artocarpus hirsutus	+	+	+	+	+	+	+	+	+	+
Borassus flabellifer	+	+	+	+	-	-	-	-	-	-
Calophyllum inophyllum	-	-	-	-	-	-	-	-	-	-
Caryota urens	-	-	-	+	-	-	-	-	-	-
Casuarina equisetifolia	-	-	-	-	-	-	-	-	-	-
Dalbergia sissoides	+	+	+	+	+	-	-	-	-	+
Erythrina variegata	+	+	+	+	+	-	-	-	-	-
Eucalyptus tereticornis	-	-	-	-	-	-	-	-	-	-
Ficus benghalensis	+	+	+	+	+	-	-	-	-	+
Ficus religiosa	+	+	+	+	+	-	-	-	-	+
Hopea parviflora	+	-	+	-	-	-	-	-	-	-
Hopea ponga	+	+	+	-	+	+	-	-	-	-
Mammea suriga	+	+	+	+	+	+	+	+	+	+
Mangifera indica	+	+	+	+	+	+	+	+	+	+
Mimusops elengi	+	+	+	+	+	-	-	-	-	-
Morinda citrifolia	-	-	-	-	-	-	-	-	-	-
Olea dioica	+	+	+	+	+	+	-	-	-	-
Pongamia pinnata	+	+	+	+	+	+	+	+	+	+
Pterocarpus marsupium	+	+	+	+	+	-	-	-	-	-
Samanea saman	+	+	+	+	+	-	-	-	-	-
Syzygium cumini	+	+	+	+	+	-	-	-	-	-
Tectona grandis	-	-	-	+	-	-	-	-	-	-
Vateria indica	-	-	-	-	-	-	-	-	-	-
Vatica chinensis	-	-	-	-	-	-	-	-	-	-

Herbaceous vascular epiphyte species numbers are less and within the range of six in study area. Since the study area receives only moderate to heavy rainfall with a dry period of 4–5 months, epiphyte diversity is less.Epiphytes mostly occurred on trees located along the state highways S2 and S3 (figure 1), than the national highway S1 (figure2). Moisture seems to be the most important ecoclimatic variable (Benzing 1981) mainly to the cryptogamic types i.e. three genera from bryophytes, one genus from pteridophyta and six genera from angiosperms belonging to family Orchidaceae are epiphytes.

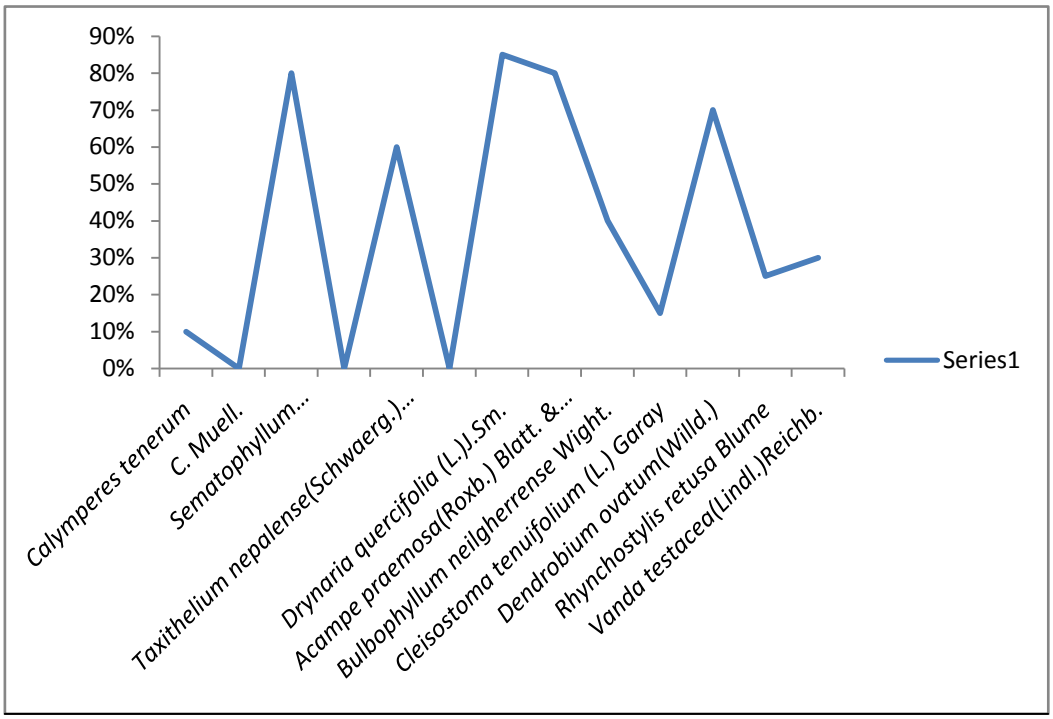


Figure 1 : Distribution of epiphytes along the study area S2 and S3

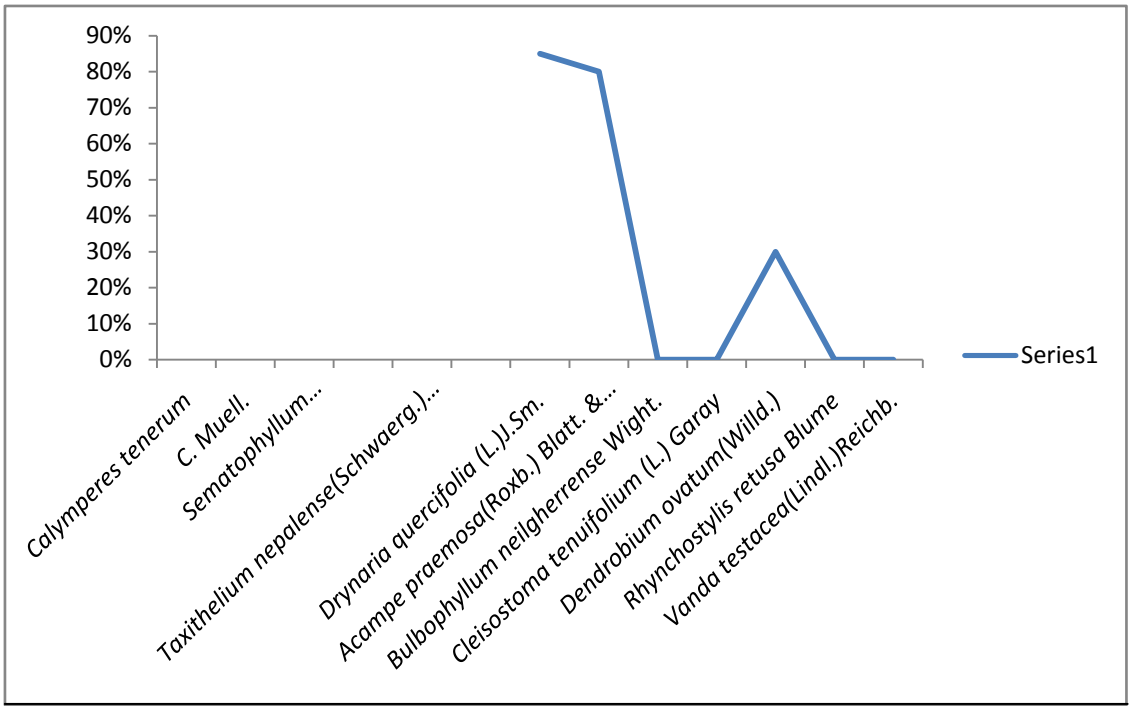


Figure 2 : Distribution of epiphytes along the study area S1

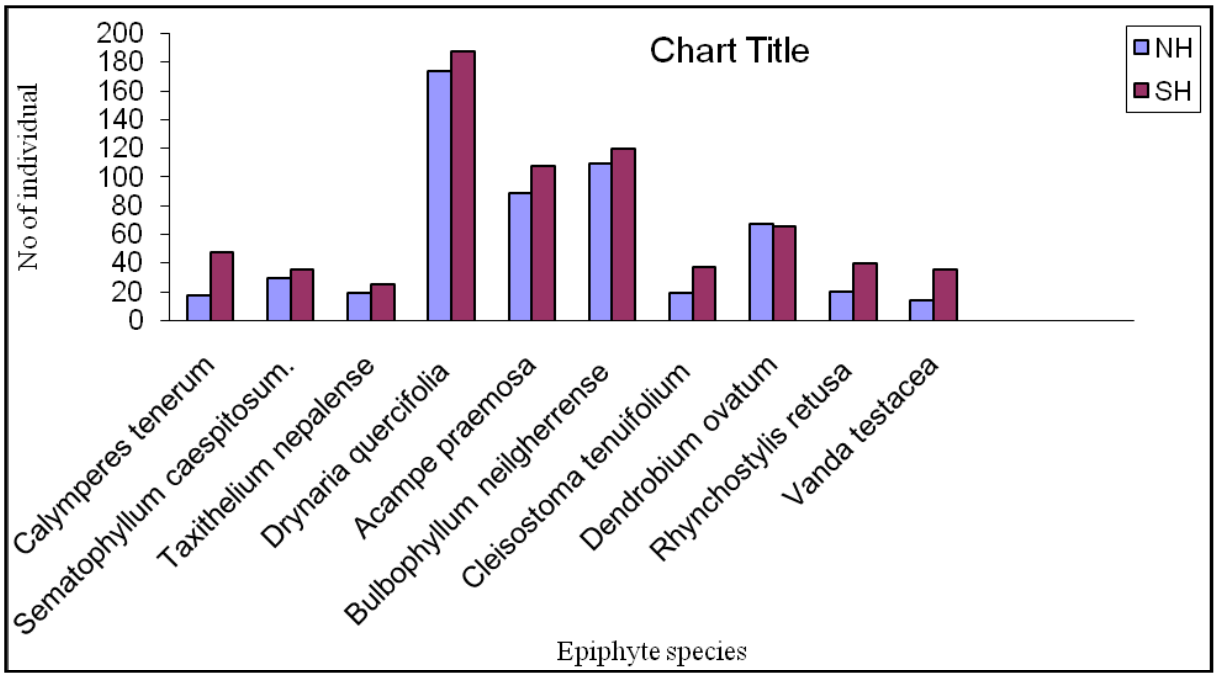


Figure 3 : Distribution of epiphytes along the study area S1, S2 and S3

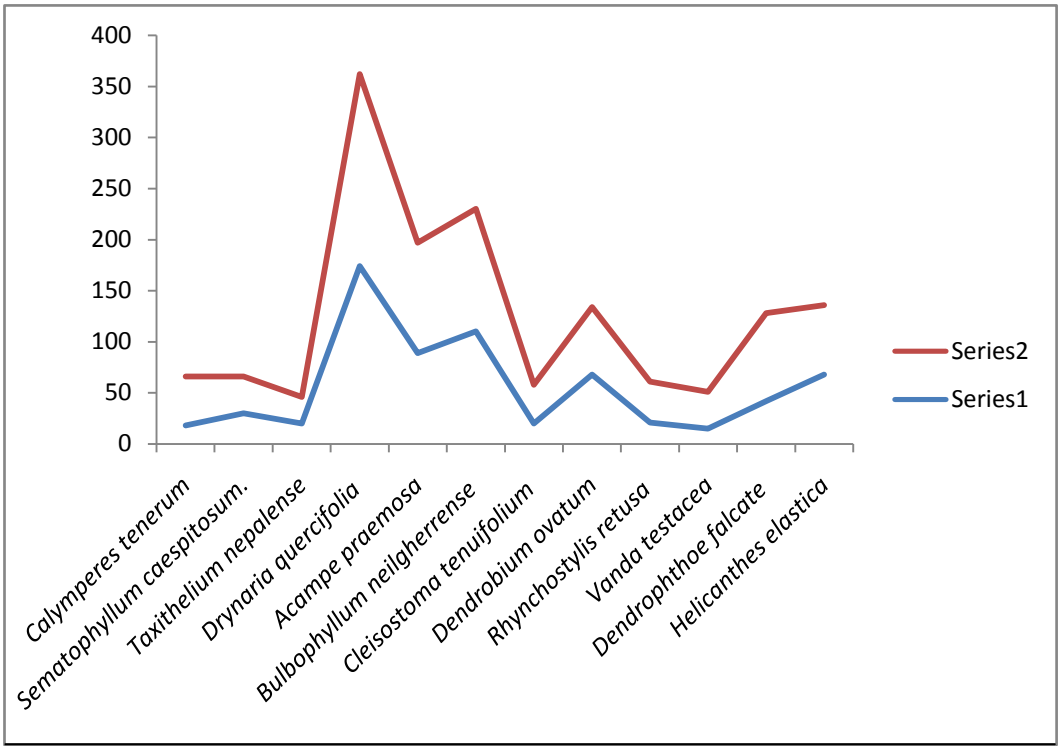


Figure 4 : Distribution of epiphytes along the study area S1, S2 and S3.

According to Went (1940), the different epiphyte vegetations may be found in different lowland rain forest types. This is related to forest structure, tree species composition, and atmospheric humidity. Tree species composition affects epiphytic vegetation through substratum characteristics provided by each tree species, giving rise to host-epiphyte specificity. But in Udupi district the epiphytes which are present on the avenue trees do not show host specificity but it has been observed that in *Mangifera indica* and *Samanea saman* supports more number of epiphytes because in these plants the presence of very thick bark helps in the accumulation of moisture and organic matter. Limited epiphytes were observed on the plants like *Dalbergia*

sissoides, Elaeocarpus tuberculatus, Mammea suriga and *Pongamia pinnata*. Because of the thin bark which is unable to support organic matter and moisture. The epiphytes were totally absent in *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus tereticornis* and *Vateria indica* because of peeling of bark reduces the moisture and organic matter to almost nil (table no.4).

According to Benzing (1776), the high canopy dwellers must be able to withstand frequent periodic droughts. All the orchid species among them are small-sized and succulent and some of them have terete leaves. The water-absorbing capacity of the trichomes of *Tillandsia* has been demonstrated. During the current study it has been also observed in Udupi district. The epiphytes mainly the orchids show various modifications like the presence of thick elongated roots along with the velamen tissue, presence of pseudobulbils, and thick succulent leaves which helps the plants to absorb moisture from the environment and conserve water. In *Drynaria quercifolia* the presence of pocket leaves is an additional feature which helps in the collection of organic matter.

According to Sanford (1968), distibution of hemiparasites and hemiepiphytes can vary in at least two ways: horizontally, they can differentiate between host species and forest types, and vertically, they vary from the tree base to its top. The following substratum factors are relevant: texture (roughness) and porosity of bark (water interception and storage, grip for diaspores); pH and nutrient contents of bark, cover and characteristics of litter and bryophyte mats, bark toxins and bark turn-over rate. The vertical distribution of epiphytes is mostly determined by patterns in photon flux density (PFD) and humidity in subsequent forest strata. For instance, many epiphytic Bromeliaceae members show specific humidity demands. In Udupi district distribution of the epiphytes and parasites varies in the given study area. On the national highways thenumber of epiphytes are less compared to the state highways and the moss mats are common on the state highways on the avenue trees. On the national highway, N.H.17 *Acacia auriculiformis, Artocarpus heterophyllus, Casuarina equisetifolia, Eucalyptus tereticornis, Samanea saman, Mangifera indica,* and *Tectona grandis* are more common. The epiphytes are commonly found on *Artocarpus heterophyllus, Artocarpus hirsutus, Ficus religiosa, Ficus benghalensis, Mangifera indica,* and *Samanea saman*. The epiphytes are absent on *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus tereticornis* and *Vateria indica*, where the bark is thin or absent because of peeling. On the state highway *Samanea saman, Artocarpus heterophyllus, Tectona grandis* and *Mangifera indica* are more common. The epiphytes are commonly found on *Artocarpus heterophyllus, Artocarpus hirsutus, Dalbergia sissoides, Elaeocarpus tuberculatus, Ficus religiosa, Ficus benghalensis, Mammea suriga, Mangifera indica, Pongamia pinnata, Samanea saman* and *Tectona grandis*. On the state highway, the most of the trees have a thick bark. This stores water and organic matter. The national highway N.H.17 is proximity to the Arabian Sea there by increasing the humidity but rain fall is comparatively less because of deforestration. In the areas of state highway there are wild life conservation parks like Kudremukh national park nearer to Udupi to Karkala state highway and Mookambika reserve forest in Kundapura to Siddapura state highway which have rich vegetation, thereby increasing the moisture and organic matter. Hence epiphytes are more common in state highways. In the present study, it is observed that *Drynaria quercifolia* is more common and present on most of the avenue trees of study area. The present study also indicates that *Acampe praemosa* was more commonly present on *Mangifera indica*. The rest of the orchids present on most of the avenue trees.

Among the mosses *Sematophyllum caespitosum* was more common. The three types of the mosses (*Calymperes tenerum, Sematophyllum caespitosum, Taxithelium nepalense*) were more commonly present on *Mangifera indica* and *Samanea saman*.

Epiphytes grow very well on old avenue trees. In most of the young trees the epiphytes were absent. As the plant becomes older the number of epiphytes and parasites increases. In young trees only one type of moss was found where as in old trees all the three types of mosses were found. When the tree grows older, woody the variety of epiphytes and parasites go on increasing.

V. Summary and Conclusion

In the present study, it is observed that the epiphytes are commonly found on *Acacia auriculiformis, Artocarpus heterophyllus, Casuarina equisetifolia, Eucalyptus tereticornis, Samanea saman, Mangifera indica,* and *Tectona grandis* are more common. The epiphytes and the parasites are absent on *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus tereticornis* and *Vateria indica*. The epiphytes are commonly found on *Artocarpus heterophyllus, Artocarpus hirsutus, Dalbergia sissoides, Elaeocarpus tuberculatus, Ficus religiosa, Ficus benghalensis, Mammea suriga, Mangifera indica, Pongamia pinnata, Samanea saman* and *Tectona grandis*. In most of the trees, mosses and *Dynaria quercifolia* are more common and occur in large quantities. The epiphytes which are common in Udupi district are *Drynaria quercifolia, Calymperes tenerum, Sematophyllum caespitosum, Taxithelium nepalense, Acampe praemosa, Bulbophyllum neilgherrence, Cleisostoma tenuifolium, Dendrobium ovatum, Rhynchostylis retusa, Vanda testacea,*

On the national highway due to dust, pollution, heavy traffic and lesser rain fall, the epiphytes were

fewer in number and variety. Many were found on older trees having thicker bark and hence had more organic material and moisture. Younger trees do not support much epiphytes growth.

On the state highway, owing to less traffic and heavier rain fall, the varieties of epiphytes were much greater than on the National Highways.

In the study areas the National Highway, (S1) lot of trees being cut for the purpose of broadening of the road in order to allow more traffic and also for the use as timber. Because of this, epiphytes have lost their natural habitat and in the process some rare epiphytes belonging to the family Orchidaceae are on the verge of extinction. Afforestration is taking place on a large scale but the trees used for afforestration are *Acacia auriculiformis, Casuarina equisetifolia, Eucalyptus tereticornis, Vateria indica*. These trees are fast growing but have a very thin or no bark due to peeling. Hence they cannot support epiphytes, thus leading to a reduction in their number.

In the study area on the state highways, (Udupi to Karkala and Kundapura to Siddapura) however avenue trees are naturally growing and have epiphyte supporting characteristics and hence here the growth of epiphytes is much more than on the National Highway. But due to lack of awareness the avenue trees are also being cut for house hold uses. Hence trees show the risk factor for the survival of the epiphytes on them.

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