

DIVERSITY AND SPATIAL DISTRIBUTION OF EPIPHYTIC FLORA ASSOCIATED WITH FOUR TREE SPECIES OF PARTIALLY DISTURBED ECOSYSTEM IN TROPICAL RAINFOREST ZONE

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ABSTRACT

As components of forest communities, epiphytes influence litter and nutrient cycling while providing shelter, nesting materials and food for arboreal animals, thereby promoting diversity. Their preference for certain tree species (phorophytes) influences biodiversity and distribution, but this association is poorly understood in the tropics. We assessed the diversity and spatial distribution of epiphytes associated with four phorophytes (Alstonia booneii, Peltophorum pterocarpum, Mangifera indica and Terminalia catappa) in southern Nigeria, with number of trees sampled as 4, 29, 32 and 44, respectively. The epiphytes were delineated, sampled and identified. Soil samples were collected from tree pockets for textural and pH analyses. On the four phorophytes, 265 epiphytes under seven species (Platyserium elephantotis, Microgamma owariensis, Nephrolepis biserrata, Funaria hygrometrica, Axonopus compressus, Commelina benghalensis and Ficus spp.) and five families (Polypodiaceae, Funariaceae, Poaceae, Commelinaceae and Moraceae) were recorded. The three most abundant were Funaria hygrometrica (109), Platyserium elephantotis (102) and Microgamma owariensis (44), being present on all four phorophytes. Funaria hygrometrica and Platyserium elephantotis were the most abundant on M. indica (32 each) and T. catappa (44 and 39, respectively). Nephrolepis biserrata appeared only once on T. catappa; so too did Axonopus compressus and Commelina benghalensis on P. pterocarpum. Altogether, A. booneii, P. pterocarpum, M. indica and T. catappa had 11, 62, 89 and 103 epiphytes, respectively. Funaria hygrometrica traversed three tree strata, while others were restricted to two or even one stratum. Canopy layer, middle stratum and lower portion hosted four, five and three epiphytic species, respectively out of the seven recorded, pointing to the relative importance of light, spaciousness and moisture, respectively in epiphyte abundance on trees. Epiphytes distribution on phorophytes was not influenced by texture of the arboreal soils, but was inversely related to their pH. This study has provided useful information on epiphyte-phorophyte association in tropical environments and deserves repetition with more tree species in more natural forests.

Key words: forest tree species, tree spatial strata, epiphyte distribution, species abundance, Nigeria

INTRODUCTION

Epiphytes refer to plants that have true roots but grow on other plants or objects upon which they depend for mechanical support but not for nutrients, thus, they are not parasitic. They derive their nutrients and moisture from air, precipitation, debris and photosynthesis (Benzing, 2008). They are also called aerophytes or air plants. When epiphytes grow on other plants, such supporting plants are called phorophytes. The name epiphyte is coined from the Greek word *epi* (meaning 'upon') and *phyton* (meaning 'plant').

As climbing plants, epiphytes live on branches of tall trees and vines where they are able to access sunlight for photosynthesis which plants on lower levels cannot due to dense forest canopy with foliage. Due to adverse environmental conditions,

scarcity of resources and eminent competition, epiphytes exhibit ecophysiological, morphological and anatomical adaptations to survive under harsh canopy conditions (Lorenzo *et al.*, 2010). For instance, they have strong yet succulent roots and stems that not only allow them to grow on almost anything, but are extremely efficient in absorbing water from mist, rain and moisture from humidity (Akinsoji, 1990). Species such as bromeliads have stiff, upturned leaves that allow large amounts of water to be stored, while the Staghorn fern (*Platyserium madagascariense*) has very thick and waxy leaves to retain moisture. Epiphytes produce beautiful and attractive blooms, fruit, perfume and nectar to lure pollinators and produce mass numbers of small seeds that can be transported by wind (Ng and Hew, 2000; Glime, 2007).

Epiphytic plants play functional roles in forest communities; they influence carbon uptake and biomass production and nutrient cycling as well as provide shelter, nesting materials and food for especially aboreal animals (Ellwood *et al.*, 2002; Bartels and Chen, 2012). Despite their role, this group of plants is understudied compared to their terrestrial counterparts. According to Zotz (2013), there are over 27,614 species of vascular epiphytes worldwide, which is about 9% of all vascular plant species. Many others have not been identified or catalogued. This situation has been attributed to limited accessibility as well as difficulty in sampling and identification (Kreft *et al.*, 2004; Burns and Zotz, 2010; Zhao *et al.*, 2015). Also, the ecology of many epiphytic species is not well understood especially in the tropics.

Microclimate influences local distribution of vascular epiphytes as vertical stratification of species shows that their occurrence is often restricted to certain microhabitats or microsites (Akinsoji, 1990; Castejon-Silvo and Terrados, 2012). Such stratification is closely related to the vertical variation in ecological factors (biotic and abiotic) found from the forest floor to the canopy (Zhang *et al.*, 2010; Köster *et al.*, 2011). Major factors include phorophyte species, age, shape, size, bark morphology (texture and trunk thickness), branching pattern, height, leaf size, canopy density, moisture retention and chemical composition (Flores-Palacios and Garcia-Franco, 2006; Zhang *et al.*, 2010; Wyse and Burns, 2011; Rosell *et al.*, 2014; Zhao *et al.*, 2015). In Nigeria, the growth of two exotic tree species was reported to depend on physicochemical properties of a plantation forest soil (Watanabe *et al.*, 2009), just as the distribution of weed species follows local differences in soils (Udoh *et al.*, 2007). The extent to which this kind of association could hold true between epiphytic species and arboreal soils captured and retained in hollows of supporting tree species is not clear.

This study was, therefore, carried out in Benin in southern Nigeria, typifying a tropical rainforest zone. The objectives were to (i) identify epiphytic species associated with selected tree species, (ii) establish their relative abundance and distribution on the trees, and (iii) relate such distribution to soil texture and pH of arboreal soils on the tree species.

MATERIALS AND METHODS

Study Area

The study was carried out at the University of Benin, Ugbowo Campus, in southern part of Edo State, Nigeria between Nov. 2015 and Feb. 2016. The area is situated at 06° 23' N and 005° 37' E, and is on elevation of 96-130 m asl. It has a humid tropical climate and lies within a heavy rainfall zone with two distinct seasons; the dry season between Oct. and Jan. and the rainy season that is usually from Feb. to Sep., having two rainfall peaks

in Jun. and Sep. There is a short dry period around Aug. commonly referred to as the "August break". The range of annual rainfall is 1500-2500 mm. The area experiences marked variations in diurnal temperature throughout the year. There are two temperature ranges; the high range that occurs during the four dry months and the low range in the eight months of rainfall due to the cooling effect of the rain. Relative humidity is usually lowest in Dec. and Jan. which are the peaks of the dry season.

The soil type here is the low-fertility coarse-textured soil. The vegetation is mainly rainforest with areas of secondary growth (Okhakhu, 2016). The site for the present study represents a partially disturbed ecosystem in this tropical rainforest zone in that, being a university campus housing the Faculty of Agriculture among other faculties, many trees have been felled such that the original tree contiguity has been apparently interfered with but not epiphyte growth on the remaining trees.

Sampling and Data Collection

The study utilised four tree species; *Alstonia boonei* (God's tree), *Peltophorum pterocarpum* (yellow flametree), *Mangifera indica* (mango tree) and *Terminalia catappa* (tropical-almond) selected using the random method of sampling. *Alstonia boonei* de Wild is a very large, deciduous, tropical forest tree in the dogbane family of Apocynaceae. The tree is native to West Africa. *Peltophorum pterocarpum* (D.C.) K. Heyne is a deciduous ornamental tree growing to 15-25 m and rarely up to 50 m tall, with a trunk of up to 1 m wide. It belongs to family Fabaceae/Leguminosae. It is native to tropical Southeast Asia. *Mangifera indica* Linn., commonly called mango, is a species of flowering plants in the Anacardiaceae family. The tree is erect, 9-30 m high, with a broad, rounded canopy which, with age, attains 30-38 m wide or a more upright, oval, fairly slender crown. It is native to India. *Terminalia catappa* Linn. is a large tropical tree in the leadwood tree family, Combretaceae. It grows to 35 m tall, with an upright, symmetrical crown and horizontal branches. Besides serving as an ornamental and shade tree, the tree produces corky light edible fruits dispersed by water.

A quadrat of 900 cm² was used to mark out an area round each tree for sampling. Synthetic characters assessed of the epiphytic species were presence and occurrence. Presence was inferred from visual observation. Occurrence, the degree of presence of a given species in the sampled trees, was calculated as the percentage ratio of the number of trees on which the epiphyte appeared to the total number of trees sampled.

Analytical characters estimated for each epiphytic species were cover, density and frequency. To do the estimation, the quadrat was placed on various parts of the trees. Cover was estimated as the area of the quadrat covered by

individual epiphytes. The cover was then evaluated by the Dansereau's (1951) coverage scale, whereby 5, 4, 3, 2, 1 and + represent 100-75, 75-50, 50-25, 25-5, 5-1 and < 1% coverage, respectively. Density was estimated as the number of individual epiphytic species per unit sampled area. Frequency was estimated as the fraction of sampled area containing the given species. The proportional representation of each epiphytic species among all species on a phorophyte was determined as relative cover/density/frequency (Gradstein *et al.*, 2003):

$$\text{Relative cover or relative density or relative frequency} = \frac{x}{y} \times 100\%$$

where *x* is cover, density or frequency for an epiphytic species and *y* is the sum of corresponding parameter for all species on a phorophyte. For each tree species data collected from all quadrats on these analytical characters were averaged.

Two qualitative characters, those based on some permanent features and not according to spatial importance within the quadrat, including sociability and stratification/layering, were assessed of the epiphytic species. Sociability was graded 5, 4, 3, 2 and 1 for plants growing in thick or large colonies, plants growing in thin or small colonies, plants that are few or sparsely populated, plants growing in two groups or turfs, and plants growing as isolated individuals, respectively. For stratification/layering, the quadrats were carefully examined for superimposition or overlapping of the epiphytic flora in strata or layers. These layers were then graded accordingly on a scale of L-1 to L-4; with L-1, L-2, L-3 and L-4 representing basal stratum, lower portion, middle layer, and top layer (canopy) of the tree, respectively.

To identify the epiphytes, those at the base and trunk level were collected after close observation, while those at the canopy layer were collected with the aid of an adjustable ladder. Some of the epiphytes were identified *in-situ* using the works of Hutchison and Dalziel (1972) and Aigbokhan (2014). Others that could not be identified in the field were pressed and deposited at the herbarium of the University of Benin for identification. Also, soil samples were collected from the pockets of sampled phorophytes. These arboreal soil samples were taken to the laboratory and analysed for particle size distribution and soil pH.

RESULTS AND DISCUSSION

A total of 265 epiphytes were recorded on the four 'host' tree species (phorophytes) selected including *Alstonia booneii*, *Peltophorum pterocarpum*, *Mangifera indica* and *Terminalia catappa*. The 265 epiphytes belong to seven epiphytic species which in turn belong to five families. The epiphytic species included *Platyserium elephantotis* (elephant ear staghorn), *Microgamma owariensis* (snakeferns) and *Nephrolepis biserrata* (giant sword fern) which are all pteridophytes in the Polypodiaceae family. Other epiphytic species were *Funaria hygrometrica* (bonfire moss), *Axonopus compressus* (carpet grass), *Commelina benghalensis* (dayflower) and *Ficus* spp. (figs) in the Funariaceae, Poaceae, Commelinaceae and Moraceae families, respectively. *Microgamma owariensis* is believed to originate from West Africa. *Funaria hygrometrica*, the most abundant moss currently recognised in the southern part of Africa, is a bryophyte. Both *Axonopus compressus* and *Commelina benghalensis* are monocotyledonous angiosperms. *Ficus* spp. is a dicotyledonous angiosperm that is native throughout the tropics.

The most abundant epiphytic species was *Funaria hygrometrica*, followed by *Platyserium elephantotis* and *Microgamma owariensis* (Table 1). These three species were not selective as they were found on all four phorophytes studied (Plates 1-4). Notably, *Funaria hygrometrica* was present in every sampled tree. The distribution of epiphytic species on the phorophytes was uneven, and this is attributed to differences in traits of the epiphytes and phorophytes alike and to microclimatic variations (Brown, 1990; Mezaka *et al.*, 2012). For instance, *Platyserium elephantotis* and *Funaria hygrometrica* were observed growing in clusters. *Platyserium elephantotis* is highly diverse and variable between individual plants (Desalegn and Lekelefac, 2005), and together with *Funaria hygrometrica*, requires little soil and shady, humid environments that favour reproduction by spores (Mucunguzi, 2007), hence their abundance and presence in all the four phorophytes. Also, Mucunguzi (2007) recorded high occurrence of epiphytic species in the family of Polypodiaceae. This is the family to which *Platyserium elephantotis* and *Microgamma owariensis* found to be among the abundant species in the present study belong. It could be, therefore, that species in this family are ubiquitous.

Table 1: Summary of the epiphyte abundance as indexed by presence (PRS) and percent occurrence (OCC) on the four tree species

Tree species	No. of trees sampled	<i>Platyserium elephantotis</i>		<i>Microgamma owariensis</i>		<i>Nephrolepis biserrata</i>		<i>Funaria hygrometrica</i>		<i>Axonopus compressus</i>		<i>Commelina benghalensis</i>		<i>Ficus</i> spp.		Total No. of epiphytes
		PRS	OCC	PRS	OCC	PRS	OCC	PRS	OCC	PRS	OCC	PRS	OCC	PRS	OCC	
<i>Alstonia booneii</i>	4	4	100.00	3	75.00	0	0.00	4	100.00	0	0.00	0	0.00	0	0.00	11
<i>Peltophorum pterocarpum</i>	29	27	86.21	4	13.79	0	0.00	29	100.00	1	3.45	1	3.45	0	0.00	62
<i>Mangifera indica</i>	32	32	100.00	25	78.13	0	0.00	32	100.00	0	0.00	0	0.00	0	0.00	89
<i>Terminalia catappa</i>	44	39	88.64	12	27.27	1	2.27	44	100.00	2	4.55	2	4.55	3	6.82	103
Total No. of epiphytes		102		44		1		109		3		3		3		265



Plate 1: Pictorial view of *Alstonia boonei* with epiphytes associated with it at the study site



Plate 2: Pictorial view of *Peltophorum pterocarpum* with epiphytes associated with it at the study site



Plate 3: Pictorial view of *Mangifera indica* with epiphytes associated with it at the study site

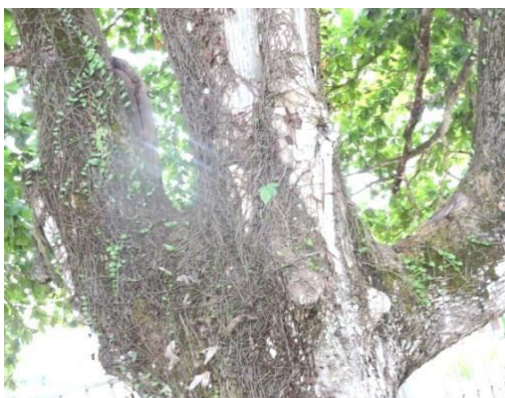


Plate 4: Pictorial view of *Terminalia catappa* with epiphytes associated with it at the study site

For the phorophytes, the one with the lowest number of epiphytes was *Alstonia booneii* (11), followed by *Peltophorum pterocarpum* (62). *Alstonia booneii* produces white latex which may explain the poor diversity of epiphytes on it. *Peltophorum pterocarpum* with the second lowest number has a dense and spreading crown, but a smooth bark which does not support epiphyte establishment (Akinsoji, 1990). The remaining two tree species, *Mangifera indica* and *Terminalia catappa*, with higher number of epiphytes have features such as rough bark, tall height, large trunk and large canopy that support abundance and high occurrence of epiphytes (Akinsoji, 1990; Andama *et al.*, 2003; Oloyede *et al.*, 2014; Zhao *et al.*, 2015).

The epiphytic species *Funaria hygrometrica* and *Platyserium elephantotis* appeared the most per stand not only on *Mangifera indica* (32 each), but also on *Terminalia catappa* (44 and 39, respectively). By contrast, *Axonopus compressus*, *Commelina benghalensis* and *Nephrolepis biserrata* appeared the least at the study site, as each of these epiphytic species was found just once on *Peltophorum pterocarpum*, *Peltophorum pterocarpum* and *Nephrolepis biserrata*, respectively. The observation for *Nephrolepis biserrata* is rather contrary to Oloyede *et al.* (2014) who reported it as one of the most common species in Obafemi Awolowo University Estate in southwestern Nigeria. According to this author, *Nephrolepis biserrata* is host-specific and is associated with *Elaeis guineensis* (palm tree) whose characteristics are different from those of the tree species of the present study.

Mean analytical characters of the epiphytic species found on each of the four phorophytes are shown (Table 2). *Microgamma owariensis* generally showed the highest values for cover, density and frequency; the only exceptions to this trend were for cover and frequency on *Mangifera indica* and *Terminalia catappa* where *Funaria hygrometrica* showed the highest values. Values of relative cover, relative density and relative frequency generally increased with a decrease in number of observations, *n*, made of the epiphytes on a given phorophyte which, in this study, represents presence of the epiphytic species on the said phorophyte.

Further, anthropogenic activities such as clearing of under-storey, pruning of tree branches or felling of whole trees often take place at the study site. These activities which alter the natural environment and disturb the natural habitat play a major role in changing the diversity and distribution of vascular epiphytes, and so may have influenced the data attained (Flores-Palacios and Garcia-Franco, 2004; Hietz *et al.*, 2006; Kromer and Gradstein, 2007). Such activities lead to species isolation, reduced cover, increased exposure to solar radiation and associated increase in evapotranspiration rate, all of which modify the microclimate.

Table 2: Mean analytic characters of epiphytes on selected tree species

Tree Species	Epiphytic Species	Species cover	Relative cover	Species density	Relative density	Species frequency	Relative frequency
<i>Alstonia booneii</i>	<i>Platyserium elephantotis</i> (n = 4)	4.00	25.00	0.003	25.00	0.67	25.00
	<i>Microgamma owariensis</i> (n = 3)	5.00	33.30	0.021	33.33	0.83	33.33
	<i>Funaria hygrometrica</i> (n = 4)	4.00	25.00	0.014	25.00	0.67	25.00
<i>Peltophorum pterocarpum</i>	<i>Platyserium elephantotis</i> (n = 27)	3.41	3.70	0.005	3.70	0.57	3.71
	<i>Microgamma owariensis</i> (n = 4)	4.50	25.00	0.030	25.00	0.75	25.00
	<i>Funaria hygrometrica</i> (n = 29)	3.48	3.45	0.015	3.45	0.58	3.46
	<i>Axonopus compressus</i> (n = 1)	1.00	100.00	0.001	100.00	0.17	100.00
	<i>Commelina benghalensis</i> (n = 1)	1.00	100.00	0.001	100.00	0.07	100.00
<i>Mangifera indica</i>	<i>Platyserium elephantotis</i> (n = 32)	3.06	3.13	0.004	3.13	0.51	3.13
	<i>Microgamma owariensis</i> (n = 25)	2.72	4.00	0.011	4.00	0.45	4.01
	<i>Funaria hygrometrica</i> (n = 32)	3.78	3.13	0.009	3.13	0.63	3.12
<i>Terminalia catappa</i>	<i>Platyserium elephantotis</i> (n = 39)	2.67	2.56	0.002	1.89	0.44	2.56
	<i>Microgamma owariensis</i> (n = 12)	2.92	8.33	0.009	8.33	0.49	8.33
	<i>Nephrolepis biserrata</i> (n = 1)	1.00	100.00	0.001	100.00	0.17	100.00
	<i>Funaria hygrometrica</i> (n = 44)	3.57	2.27	0.009	2.27	0.60	2.27
	<i>Axonopus compressus</i> (n = 2)	ND	ND	ND	ND	ND	ND
	<i>Commelina benghalensis</i> (n = 2)	ND	ND	ND	ND	ND	ND
	<i>Ficus</i> spp. (n = 3)	1.00	33.33	0.001	33.33	0.17	33.33

ND, Not determined

The epiphytes exhibited sociability (Table 3). Also, the middle stratum (sub-canopy level) registered the highest number of epiphytic species, 5 out of 7 (Table 3). Kersten *et al.* (2009) and Zhao *et al.* (2015) made similar observations in coastal Atlantic rainforest at Ilha do Mel Island of Brazil and tropical montane forest in SW China, respectively. In the present study, the middle stratum was followed by the canopy layer with four species and the lower portion with three species; just as an examination of the quadrats for superimposition showed a certain level of stratification (Table 3). Two species were found at the lower portion and only one species at the basal stratum. This observation could be due to limited amount of light reaching the base of the phorophytes. *Funaria hygrometrica* was identified in three tree strata; *Platyserium elephantotis*, *Microgamma owariensis* and *Axonopus compressus* were found in two strata; while *Nephrolepis biserrata*, *Commelina benghalensis* and *Ficus* spp. were restricted to one stratum being L-4, L-1 and L-3, respectively.

Overall, the data in Table 3 show that most of the epiphytic species preferred the last two layers upwards (middle layer and top layer or canopy of the tree) to the first two layers upwards (basal stratum and lower portion). These results suggest that light availability and intensity are major factors in epiphyte location within the microhabitat. Similar results have been reported by Akinsoji (1990), Oloyede *et al.* (2014) and Zhao *et al.* (2015). According to Richter (1991), epiphytes are very sensitive to direct solar radiation and changes in climatic conditions. However, such radiation is often not possible as leaves on tree canopy cast

shade on the trunk while allowing light to penetrate. This situation modifies the entire environment of the tree and specifically the microclimate of the trunk where the epiphytes grow. Many epiphytic species occur at the intermediate canopy of trees due not only to large surface area and substrate found on the main forks or axils, but also to the intermediate light and moisture (Flores-Palacios and Garcia-Franco, 2006; Krömer *et al.*, 2007; Köster *et al.*, 2011; Zhao *et al.*, 2015). Occurrence at the basal stratum and lower portion could be an adaptation strategy to minimize water loss via evapotranspiration, and this explains the uneven distribution and composition of epiphytic species across the different strata on the phorophytes.

Table 3: Sociability and layering of the epiphytes on the sampled trees

Taxa	Sociability	Layering
<i>Platyserium elephantotis</i>	SOC 5	L-3, L-4
<i>Microgamma owariensis</i>	SOC 4	L-3, L-4.
<i>Nephrolepis biserrata</i>	SOC 1	L-4
<i>Funaria hygrometrica</i>	SOC 5	L-2, L-3, L-4
<i>Axonopus compressus</i>	SOC 1	L-2, L-3
<i>Commelina benghalensis</i>	SOC 1	L-1
<i>Ficus</i> spp.	SOC 1	L-3

SOC - Sociability, L - Layering; SOC 5, 4, 3, 2 and 1 represent plants growing in thick or large colonies, plants growing in thin or small colonies, plants that are few or sparsely populated, plants growing in two groups or turfs, and plants growing as isolated individuals, respectively; L-1, L-2, L-3 and L-4 represent basal stratum, lower portion, middle layer, and top layer (canopy) of the tree, respectively

The soils collected from the pockets of the four phorophytes all had well above 90% sand (Figure 1); hence they are not just sandy but belong specifically to the textural class of sand. This sandiness of the arboreal soil could be reflecting loss of fine particles to regular washing by rainfall, throughfall and post-rain trunk-dripping water. Sand is chemically inert and so contributes little or nothing to both water retention and cation exchange in highly weathered tropical soils (Obalum and Obi, 2013; Obalum *et al.*, 2013). With this situation, therefore, the soil component of the microhabitats provided by the phorophytes would be expected to be of low water holding capacity and fertility status, implying that water and nutrients due to it were not sufficient to support the epiphytes. For their nutrition, the epiphytes must rely more on rainfall/throughfall and litterfall as well as materials brought by wind and animals.

Availability and physico-chemical properties of substrates vary among environments and tree species (Cardelús *et al.*, 2007), such that adaptation of epiphytic species is also a factor. For instance, under harsh environmental conditions, many of *Platycerium elephantotis* are adapted to store water in their leaves and to root with little substrate (Mucunguzi, 2007). Therefore, the abundance of this species in the present study is not surprising.

The pH of the soils in all investigated microhabitats is shown (Figure 2). The results show that the arboreal soils were generally acidic. Gill and Onyibe (1986) obtained similar results in their phytosociological studies of epiphytic flora on *Elaeis guineensis*. The highest pH of 6.5 was obtained for the soils collected on *Alstonia booneii*, the tree species with 11 epiphytes, which was the lowest number of epiphytes recorded in this study. Intermediate pH values of 5.5 were obtained for the soil samples collected on *Peltophorum pterocarpum*

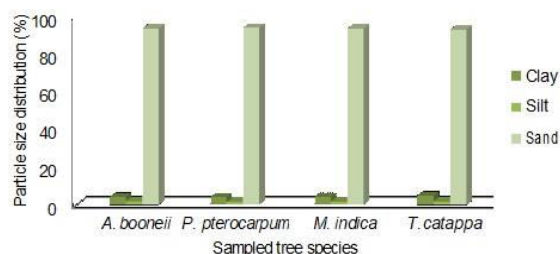


Figure 1: Particle size distribution of the arboreal soils collected from hollows in the four sampled tree species

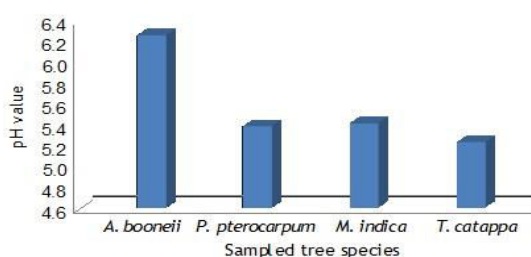


Figure 2: Soil pH values of the arboreal soils collected from hollows in the four sampled tree species

and *Mangifera indica*, with 62 and 89 epiphytes, respectively. Further, the lowest pH of 5.0 was obtained for the soils collected on *Terminalia catappa* with the overall highest number of epiphytes of 103. This trend suggests that epiphytes prefer acid environments to near-neutral ones.

Based on the above observations, it could be inferred that the pH of arboreal soils inversely related with epiphyte distribution, with a high correlation coefficient, r , of -0.83 . These results not only contradict the notion that soil pH is not a factor in epiphyte distribution and abundance (Pessin, 1925), but also challenge the notion that host effect is modulated by nutrient inputs from the atmosphere (Flores-Palacios and Garcia-Franco, 2004). As opined by Callaway *et al.* (2002) and Hsu *et al.* (2006), changes in microclimatic factors in the environment and some specific species adaptation/tolerance traits influence epiphyte distribution and abundance. The present results show the underlying role of the pH of soils adhering to phorophytes in such changes and adaptation/tolerance in tropical environments.

One perceived shortcoming of the data reported here is that the study was executed with only four tree species in a campus environment where the forest ecology had been partially disturbed, with the trees mostly isolated from one another. Since the population of epiphytes is typically higher in natural than disturbed forests (Andama *et al.*, 2003), our data need validation through more robust studies involving more tree species that could offer even wider contrasts of phorophytic features in natural forests of representative tropical ecosystems.

CONCLUSIONS

The study has identified seven epiphytic species that could thrive on such trees as *Alstonia booneii*, *Peltophorum pterocarpum*, *Mangifera indica* and *Terminalia catappa* in humid tropical environments. These species include *Platycerium elephantotis*, *Microgammma owariensis* and *Nephrolepis biserrata* all in the family of Polypodiaceae as well as *Funaria hygrometrica*, *Axonopus compressus*, *Commelina benghalensis* and *Ficus* spp. in the Funariaceae, Poaceae, Commelinaceae and Moraceae families, respectively. Abundance and distribution of *Funaria hygrometrica* was spectacular, as it was found on all four tree species, traversing three strata. *Platycerium elephantotis* and *Microgammma owariensis* were the next two most abundant and widely distributed species on these trees, but not without showing preference for the middle and canopy layers. It seems that the number of epiphytes to be found on a given 'host' tree species linearly varies with the latter's size (tree height, trunk size and canopy cover). Also, epiphyte distribution on trees does not depend on texture of the soils in their pockets; instead, it depends on pH of such arboreal soils, with wider distribution as their pH tends towards acidity.

In our perception, the carrying out of this study with only four tree species in a partially disturbed ecosystem where some of the phorophytes were found in isolation such that tree-canopy cross-cover effects were apparently lacking poses a limitation to the conclusions and inferences drawn. The study, nevertheless, has contributed to our understanding of the association of epiphytes with forest trees in tropical environments. A repeat of the study with more tree species in natural forest environments is, however, needed to add to our understanding of the observations made and interpretation of same.

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