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Mistletoe presence on five tree species of Samaru area, Nigeria

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The infestation of trees by mistletoe within Samaru is very high and alarming and there is little or no records on the type of mistletoe species found parasitic on tree species within this area. In order to document and know the species richness of mistletoe within this region, the study was aimed at determining the different species of mistletoe parasitic on *Albizzia lebbeck, Citrus grandis*, *Khaya senegalensis, Terminalia mantaly* and *Terminalia catappa* within Samaru, Nigeria. The study site was divided into four sampling areas based on the presence of the studied species, and the infection of the trees by mistletoes. In each of the sampling areas, the leaves of mistletoes found parasitic on each of these tree species were collected. The study indicated that from all the sampling areas, *A. lebbeck* was infected by six different species of mistletoe: *Tapinanthus dodoneifolius, Tapinanthus globiferus, Globimetula braunii, Globimetula oreophila, Englerina lecardii* and *Tapinanthus belvisii*; *C. grandis, T. catappa* and *T. mantaly* each had four different species found parasitic on them, and *K. senegalensis* had three different mistletoes species parasitic on it. *A. lebbeck* had the highest number of different mistletoe species found parasitic on it while *K. senegalensis* had the lowest. *G. braunii* and *T. globiferus* were the most common mistletoe species found parasitic on all the targeted host trees while *T. dodoneifolius* was found parasitic only on *A. lebbeck* and *T. catappa* and *E. lecardii* was found parasitic only on *A. lebbeck* and *C. grandis* respectively in the study area. In conclusion, among the studied tree species, *A. lebbeck* was the most vulnerable to mistletoe attack in the study area and *G. braunii* and *T. globiferus* were less host specific.

Key words: Distribution, host range, mistletoe, Samaru.

INTRODUCTION

Mistletoe, which consists of about 1400 species around the world, belongs to the kingdom Plantae, subkingdom Tracheobionta, super-division Spermatophyte, division Magnoliophyta, class Magnoliopsida, subclass Rosidae, order Santales (Judd et al., 2002). Recent phylogenetic studies confirm that mistletoes belong to five distinct

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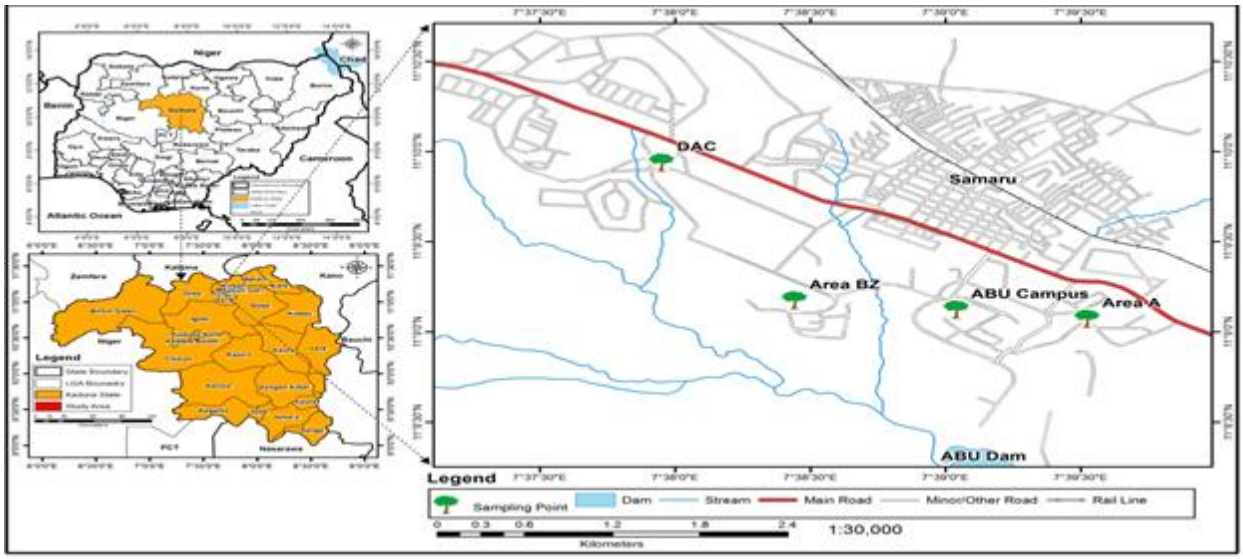

Figure 1. Map of Samaru with the location of sampling areas.

families: Misodendronaceae, Eremolepidaceae, Santalaceae, Viscaceae and Loranthaceae (Der and Nickrent, 2008, Malecot and Nickrent, 2008, Vidal-Russell and Nickrent, 2008). The largest family of this mistletoe is Loranthaceae which has 75 genera and over 900 species (Judd et al., 2002). Among them, six major genera are found in Nigeria, namely: *Tapinanthus*, *Agelanthus*, *Loranthus*, *Globimetula*, *Phragmanthera* and *Englerina*. *Tapinanthus* is far more widespread in the Nigeria savanna (Johri and Bhatnagar, 1972; Omolaja and Gamaye, 1998). Mistletoe, in Yoruba speaking area in Nigeria, it is called 'afomo', in Igbo 'apari' while in Hausa it is called 'kauci' and 'children's matches' in Eastern Cameroon presumably due to the match-like shape of the flower (Oluwole et al., 2013).

All mistletoes are hemi-parasites, bearing evergreen leaves that photosynthesize but depend on their host mainly for water and mineral nutrients (Milius, 2000). These mistletoes grow on a wide range of host trees, and it may reduce their growth and eventually they can kill the trees with heavy infestation.

Seeds of most mistletoe are spread by birds that eat the fruits (Cowles, 1964) or by the wind. The mistletoe seed germinates on the branch of a host tree or shrub and in its early stages of development it is independent of its host. Later it forms a haustorium that penetrates the host tissue and takes water and nutrients from the host plant (Milius, 2000).

Many of these parasitic plants (mistletoes) can simultaneously parasitize many host species. Since different host species may supply a parasite with different resources, a mixture of host species may be superior to a single host alone. Boussium et al. (2004) reported that mistletoe (*T. globiferus*) parasitized 126 species, and believed that it is less specific compared to other mistletoe species. Despite the large host range of the majority of parasitic plants, many also show high levels of host preference. In mistletoe plants, host choice can be considerably influenced with relatively abundant hosts (Norton and Carpenter, 1998; Norton and De Lange, 1999), host characteristics such as branch size, age and height and the duration of association between the host and the parasite (Didier et al., 2009).

It has been observed that in Samaru, the infestation of trees by mistletoe is very high and generates great concern in the local people as these mistletoes result in the reduction of vegetation and fruit production of trees in the region. Also, there is little or no records on the type of mistletoe species found parasitic on tree species within this area. As such, in order to document the number of mistletoe species and record the rate of infestation of trees in this region, this study is aimed at determining the presence of different mistletoe species on some selected trees with medicinal importance within Samaru (Zaria, Nigeria).

MATERIALS AND METHODS

Study area

The study area is Samaru, Zaria, Kaduna State (Nigeria) which falls within the Guinea Savannah zone (07°37'22" to 7°40'36" EL, 11°09'14" to 11°10'09" NL). It has a size of 23.46 km^2. The area was divided into four sampling areas which includes: Areas A, BZ, DAC and ABU main campus with estimated sizes of 0.90, 0.74, 1.15 and 0.56 km^2 respectively based on the presence of *Albizzia lebbeck, Citrus grandis*, *Khaya senegalensis, Terminalia mantaly* and *Terminalia catappa* and with the presence of infestation of trees by mistletoes (Figure 1).

Collection of mistletoes

In each of the sampling areas, three separate plants of each of *A. lebbeck, C. grandis*, *K. senegalensis, T. mantaly* and *T. catappa* were randomly chosen based on the heavy infestation of their branches with different species of mistletoe and fresh leaves of the mistletoes found parasitic on it were collected. The samples were taken to the herbarium unit of the Department of Biological Sciences, Ahmadu Bello University (Zaria) for further identification.

Counting of host plants

Each of the sampling areas was according to its size divided into clusters. Sampling areas A, BZ, DAC and ABU main campus were divided into 34, 27, 20 and 40 clusters respectively and each cluster was 200 m in size. And the number of *A. lebbeck, C. grandis*, *K. senegalensis, T. mantaly* and *T. catappa* within each of the clusters was noted, taking note of those infected and uninfected by mistletoes.

RESULTS

Infestation of trees by mistletoe

The results revealed that, all the selected tree species were infected in virtually all the sampling areas and there was significant relationship between the infected and uninfected tree species in all areas except *T. catappa* which had insignificant relationship between its infected and uninfected trees in all the sampling areas at $P<0.05$ (Table 1). *A. lebbeck* in sampling area A was the highest in number of trees compared to other areas. However, the *A. lebbeck* in area BZ had the highest percent (77.27%) of infection whereas the ones in ABU main campus had the least (45.80%) (Table 1).

K. senegalensis and *C. grandis* in area A, were the highest in number of trees, however, it had the least percent (29.48 and 56.41% respectively) of infection by mistletoes while those in sampling area BZ had the highest percent (57.71 and 80.00% respectively) compared to those in other areas (Table 1).

ABU main campus had the highest number of *T. mantaly* as well as the percentage of those infected by mistletoes (61.33%) whereas in area BZ none of the *T. mantaly* there was infected (Table 1).

Also, ABU main campus had the highest number of *T. catappa*, however, area A had the least percent (25.00%) of those infected by mistletoes whereas those in area BZ had the highest percent (66.67%) of infection (Table 1). All the tree species except *T. catappa*, had significant relationship between the infected and uninfected in each of the sampling areas (Table 1).

Level of infestation of tree species by mistletoe

In comparison of each tree species from all sampling areas, *A. lebbeck* had the highest level of infestation by mistletoes (58.26%) than other tree species. However, the level of the infestation was significantly similar to those of other tree species (Table 1).

Species of mistletoe identified on the targeted host trees in area A

On *A. lebbeck*, four different species of mistletoe were identified, include: *G. oreophila, G. braunii, T. globiferus* and *T. dodoneifolius*. And on *T. catappa* were found two species of mistletoe: *T. dodoneifolius* and *G. braunii*. However, on *C. grandis, K. senegalensis* and *T. mantaly* was only found one species of mistletoe in each tree species (*G. braunii, T. globiferus* and *G. oreophila,* respectively).

Species of mistletoe identified on the targeted host trees in area BZ

In area BZ (Figure 1), two species of mistletoe were identified on *A. lebbeck*, known as *T. belvisii* and *T. dodoneifolius,* and on *C. grandis* and *K. senegalensis*, only *G. oreophila* was identified, where on *T. catappa,* only *G. braunii* was identified. *T. mantaly* was part of the targeted host tree before which was not found in the area (Table 2).

Mistletoe species identified on the targeted host trees in DAC

From the sampling area DAC (Figure 1), three species of mistletoe identified on *A. lebbeck* were *E. lecardii, T. dodoneifolius* and *G. oreophila*. However, *C. grandis* and *T. mantaly* had two species of mistletoe each (*T. globiferus, E. lecardii, T. belvisii* and *T. globiferus,* respectively). *T. catappa* and *K. senegalensis* had one species of mistletoe each, which was identified as: *T. belvisii* and *G. oreophila,* respectively (Table 2).

Mistletoe species identified on the targeted host trees in ABU main campus

In the sampling area ABU (Figure 1), three species of mistletoe (*G. oreophila, T. dodoneifolius* and *T. belvisii*) were found parasitic on *A. lebbeck*. On *T. catappa* and *K. senegalensis*, two species of mistletoe were found on each tree species (*T. globiferus, G. braunii* and *G. braunii* and *T. globiferus* respectively). *Citrus grandis* which was one of the targeted host tree was not found in the area (Table 2).

The summary of the observasions from all the

Table 1. Selected host tree species in each of the sampling areas indicating number of those infected and those uninfected by mistletoes.

Sampling area	Host tree	No. of tree	Infected (%)	Uninfected (%)	X^2	Df	P- value	Level of infestation of each tree sp from all areas (%)
Area A		837	456 (54.55)	381 (45.57)				
ABU main campus	*A. lebbeck*	262	120 (45.80)	142 (54.19)	48.24	3	0.00	58.26[a]
Area BZ		198	153 (77.27)	45 (22.73)				
DAC		92	51 (55.43)	41 (44.57)				
Total		1389	780 (233.05)	609 (167.06)				
Area A		631	186 (29.48)	445 (70.52)				
ABU main campus	*K. senegalensis*	457	242 (52.95)	215 (47.05)	105.36	3	0.00	48.20[a]
Area BZ		454	262 (57.71)	192 (42.29)				
DAC		134	70 (52.24)	64 (47.76)				
Total		1676	760 (192.38)	916 (207.62)				
Area A		39	22 (56.41)	17 (43.59)				
ABU main campus	*C. grandis*	3	0 (0.00)	3 (100.00)	8.09	3	0.04	49.10[a]
Area BZ		20	16 (80.00)	4 (20.00)				
DAC		10	6 (60.00)	4 (40.00)				
Total		72	44 (196.41)	28 (203.59)				
Area A		13	4 (30.77)	9 (69.23)				
ABU main campus	*T. mantaly*	150	92 (61.33)	58 (38.67)	34.13	3	0.00	28.86[a]
Area BZ		16	0 (0.00)	16 (100.00)				
DAC		30	7 (23.33)	23 (76.67)				
Total		209	103 (115.43)	106 (284.57)				
Area A		8	2 (25.00)	6 (75.00)				
ABU main campus	*T. catappa*	267	86 (32.21)	181 (67.79)				
Area BZ		6	4 (66.67)	2 (33.33)	4.06	3	0.26	38.24[a]
DAC		65	18 (27.69)	47 (72.31)				
Total		346	110 (151.57)	236 (248.43)				

X^2: Chi-square; Df: Degree of freedom; %: Percentage; sp: species; DAC: Division of Agricultural College; ABU: Ahmadu Bello University. Mean with the same letter along the column are not significantly different at P<0.05. See sampling areas in Figure 1.

sampling sites showed that, *G. braunii* and *T. globiferus* were the most common mistletoe species found parasitic on all the targeted host

Table 2. Mistletoe species identified on the targeted host trees in each of the sampling areas.

Host Tree	Mistletoe species				
	Sampling areas				
	Area A	**Area BZ**	**DAC**	**ABU main campus**	**All areas**
Albizzia lebbeck	*G. oreophila*	*T. belvisii*	*E. lecardii*	*G. oreophila*	*T. dodoneifolius*
	G. braunii	*T. dodoneifolius*	*T. dodoneifolius*	*T. dodoneifolius*	*T. globiferus**
	T. globiferus	-	*G. oreophila*	*T. belvisii*	*G. braunii**
	T. dodoneifolius	-	-	-	*G. oreophila*
	-	-	-	-	*E. lecardii*
	-	-	-	-	*T. belvisii*
Citrus grandis	*G. braunii*	*G. oreophila*	*T. globiferus*	-	*T. globiferus**
	-	-	*E. lecardii*	-	*G. oreophila*
	-	-	-	-	*G. braunii**
	-	-	-	-	*E. lecardii*
Khaya senegalensis	*T. globiferus*	*G. oreophila*	*G. oreophila*	*G. braunii*	*T. globiferus**
	-	-	-	*T. globiferus*	*G. oreophila*
	-	-	-	-	*G. braunii**
Terminalia mantaly	*G. oreophila*	-	*T. belvisii*	*G. braunii*	*T. globiferus**
	-	-	*T. globiferus*	-	*T. belvisii*
	-	-	-	-	*T. dodoneifolius*
	-	-	-	-	*G. braunii**
Terminalia catappa	*T. dodoneifolius*	*G. braunii*	*T. belvisii*	*T. globiferus*	*T. belvisii*
	G. braunii	-	-	*G. braunii*	*T. globiferus**
	-	-	-	-	*G. oreophila*
	-	-	-	-	*G. braunii**

DAC: Division of Agricultural College; ABU: Ahmadu Bello University; * Mistletoe species found common on all the targeted host trees. *Globimetula braunii, Globimetula oreophila, Tapinanthus dodoneifolius, Tapinanthus belvisii, Englerina lecardii, Tapinanthus globiferus.* See sampling areas in Figure 1.

trees (*T. catappa, T. mantaly, K. senegalensis, A. lebbeck* and *C. grandis*).

G. oreophila was found parasitic on four of the host trees (*A. lebbeck, K. senegalensis, T. mantaly* and *C. grandis*) and *T. belvisii* on three host trees (*A. lebbeck, T. mantaly* and *T. catappa*). *Englerina lecardii* was found parasitic only on two hosts (*A. lebbeck* and *C. grandis*) and *T. dodoneifolius* was found parasitic only on *A.*

lebbeck (Table 2).

A. lebbeck had six different species of mistletoe found parasitic on it (*T. dodoneifolius, T. globiferus, G. braunii, G. oreophila, E. lecardii* and *T. belvisii*) which was the highest. *C. grandis, T. catappa and T. mantaly* each had four different species found parasitic on them whereas *K. senegalensis* had three different mistletoes species parasitic on it (Table 2).

DISCUSSION

All the selected tree species used in this study were exotic to the region. They were planted forthe provision of shade and wind break in residential areas of the region. However, the infestation of these trees by mistletoes is very high and alarming in the study area as infected trees usually have reduced vegetative growth and fruit production especially as infestation increases and are killed with time. As such, with the passage of time, if no measures are taken to curtail the rate of infestations of these trees by mistletoes, especially on *A. lebbeck*, these trees will be lost. For example, two stands of *A. lebbeck* in one of the sampling areas, Division for Agricultural College (DAC), were dead as a result of heavy infestation by mistletoes.

The tree species of area A were mostly *A. lebbeck*. This explains why it had the highest number of mistletoe species and level of infestation (although, not significantly different from those of the other tree species) as abundance of host tree in an area could influence parasitization by mistletoe as reported by (Norton and Carpenter, 1998; Norton and De Lange, 1999). Tree species like *C. grandis, T. catappa* and *T. mantaly* were sparsely planted in the study locations except in ABU main campus where most of it were planted. However, *C. grandis* was next to *A. lebbeck* in the level of infestation with 49.10%, although not significantly different from that of the other tree species. This result was in agreement with Asare-Bediako et al. (2013) who reported high level of infestation and very high severity indices ranging between 20 and 90% in *Citrus* trees in orchard in Ghana.

The collection of mistletoes from all the four sampling areas revealed that the host plant, *A. lebbeck* had the highest infestation (of 58.26%) of different species of mistletoes, followed by *C. grandis* and *T. mantaly* compared to the other host trees. This incidence could be attributed to the relative abundance and susceptibility of *A. lebbeck* to mistletoes more than the other host trees (except *K. senegalensis* as shown in Table 1), host choices of the mistletoes, the host plant characteristics (such as the height of the plant, branch size, susceptibility of the plant to mistletoe attack, etc) and the movement patterns of dispersal agents. Similar report was published by Aukema and Martinez (2002) and Norton and Carpenter (1998) who reported that the relatively abundance of citruses and guava in the study area influenced the host choice of mistletoe. Overton (1994) also similarly reported that the characteristics such as branch size, age, and height of a host plant can have a strong effect on mistletoe attachment resulting in size related mistletoe infection patterns. It was also observed that, out of the several species of mistletoe obtained from these five different host trees, *T. globiferus* and *G. braunii* were the most common and found parasitic on all the five host trees. This could be due to their seeds being very sticky in nature than other mistletoe seeds, thus enhances their distribution by birds and other animals (Del Rio *et al.*, 1996; Aukema, 2004). It can also be as a result of their being less host specific compared to the other mistletoe species (Boussim et al., 2004).

Conclusions

These findings revealed that mistletoes could parasitize a variety of tree species with few of them having special preference to certain type of host plants. Factors like abundance of host plant and vulnerability (host characteristics) of the host plant could influence the parasitization of plant by mistletoe. Among the five studied tree species, *A. lebbeck* was the most parasitized and vulnerable to mistletoe attack in Samaru and *G. braunii* and *T. globiferus* were the most common species of mistletoe on the five host tree species.

Therefore, percentage rate of infestation of *A. lebbeck* in the study area demands the attention of authority in that region for quick measures so as to curtail the infestation, thus, preventing it from being endangered or threatened to extinction. Further studies on mistletoe species richness and the rate of infestation of other tree species within Samaru should be encouraged so as to know the presence of other species of mistletoe not identified in this study and the tree species that could be endangered or threatened by mistletoes.

Conflict of interests

The authors have not declared any conflict of interest.

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