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INFLEUNCE OF BRANCHING ANGLES ON THE CROWN SHAPE OF SOME SAVANNAH TREES IN KANO, NIGERIA

***Arzai, A.H. and Aliyu, B.S.**
Department of Biological Sciences, Bayero University, P.M.B. 3011, Kano
*Correspondence author

ABSTRACT
The relationships between height of the first branching, first and second angles of branching and the shape of tree crowns of eight tree species (Parkia biglobosa Jacq. Benth.; Khaya senegalensis (A. Juss); Eucalyptus species, Adansonia digitata Linn.; Cassia siamea Lam.; Azadirachta indica (A. Juss.); Delonix regia (Boj. Ex. Hook) and Acacia nilotica (Linn) growing in Kano were examined. Twenty trees of each species, deemed to be free from obvious ecological disturbances, were selected for the study. The first and second angles of branching are on the average the same for any particular tree species. It was evident that the differences in branching are on the average the same for any particular tree species. It was evident that the differences in branching angles accounted for particular the different shapes shown by the trees. The result also indicated that the effect of first branching angle or canopy width, is very large one (P<0.05). Most of the trees did not show dependence of first angle of branching on height of branching. It was concluded that most of the relationships had a positive adaptive significance in most of the trees (P<0.05; r = 0.4438). These relationships could adequately define the various patterns of branching in trees as well as crown shapes.

Keywords: Savanna Trees, Branching Angles, Crown Shapes, Adaptive significance.

INTRODUCTION

Trees show considerable variation and flexibility in the shape and size of crown. These are governed by an inherited developmental tendency, which may in turn be modified by the environment when the tree grows. For example, if there is no branching from the central trunk and if leaves are borne in a tight terminal spiral or rosette pattern, then only possible shapes are umbrella and lollypop (Givnish, 2002; Kuppers, 1998; http://www.ncbi.nlm.nih.gov/mcm189.pdf. However, most monocotyledonous trees and tree ferns show some variance of this developmental pattern. Nevertheless, most developmental patterns of branching are flexible and can produce virtually any regular shape by varying the angle of branching and degree of terminal dominance (Busgen and Munch, 1929; Pearcy and Yang, 1996; Honda, 1971; Fisher, 1992).

The various postures assumed by trees have adaptation significance that may be obvious in some cases and not in others. The remarkable flat branches of some trees of tropical savannas may be significant in resistance to dry winds. Busgen and Munch (1929) demonstrated that trees with acute branching angles intercept run-off water from rainfall, restricting it near their confined root system due to their narrow crown, whereas in tree with more horizontal branching angles, the water would be channeled further outward to the zone of finer, absorbing roots by their spreading crowns.

Different patterns of branching affect the total amount of timber needed to form a tree of adequate strength. It is therefore reasonable to expect natural selection to favour trees whose pattern of branching reduces the timber required to a minimum, so that growth can be rapid. In fact, work an mathematical models has led to the conclusion that the volume of wood is least when the angle of branching is 90^{o} (Alexander, 1968).

An equally coherent adaptive significance of the branching pattern of trees is the role it plays in their light interception strategy because by determining what shape a tree takes, it indirectly determines the total amount of light that the tree intercepts for photosynthesis and limits the strategies for leaf placement.

The objective of the present study was to examine the relationship between height of the first branching, first and second angles of branching and the shape of tree crowns amongst eight tree species growing in Kano, and to determine the significance of these relationships on adaptation of the tress.

MATERIALS AND METHODS

Twenty specimens each of *Parkia biglobosa* (Jacq-Benth), *Khaya senegalensis* (A. Juss), *Eucalyptus* species, *Adansonia digitata* (Linn), *Cassia siamea* (Lim), *Azadirachta indica* (A. Juss), *Delonix regia* (Boj. Ex Hook) and *Acacia nilotica* (Linn) were considered for the study. It was ensured that all the trees selected had intact parts. They were, in particular, devoid of bark-peeling and obvious signs of branch-cutting in addition, only trees growing in areas free from ecological disturbances (such as over-grazing, anthropogenic factors, bush burning, etc.) were selected.

The following measurements were conducted on each specimen:

Height of First Branching

The height of first branching was measured with a measuring tape. This was considered as the distance from the base of the tree to the position of the first branch on the main trunk.

First and Second Angles of Branching

The angle formed between the first branch and the tree's main trunk was measured with a wooden divider and the angle was read off on a rectangle cardboard paper divided into degrees, from 0 – 180 degrees. This was recorded as the first angle of branching. The angle between the first branch of the main trunk and the first sub-branch was similarly measured and recorded as the second angle of branching.

RESULTS

For each of the eight tree species sampled, the means of the height of first angle of branching and second angle of branching were calculated. The standard error for all the sample means were also computed and the results are given in Table 1. Based on these means, the eight tree species were drawn on a reduced scale (Figures 1 and 2).

Table 1: Means for Height of First Branching, Angle of Branching and Second Angle of Branching of some selected tree species

Tree Species	Height of 1st Branching ± S.E (m)	1st angle of branching (°) ± S.E	2nd angle of branching (°) ± S.E
Parkia biglobosa	1.75 (0.11)	50.48 (4.32)	51.40 (4.41)
Khaya senegalensis	2.10 (0.00)	38.35 (2.29)	39.35 (2.30)
Eucalyptus species	1.30 (0.16)	32.33 (2.10)	29.30 (2.01)
Adansonia digitata	3.13 (0.17)	74.30 (4.76)	73.38 (4.69)
Cassia siamea	0.69 (0.26)	43.93 (5.19)	45.58 (4.95)
Azadirachta indica	1.93 (0.11)	44.48 (3.75)	42.88 (2.99)
Delonix regia	1.24 (0.13)	47.45 (3.20)	46.10 (2.27)

Key: SE = standard error (in parenthesis)

DISCUSSION

Studies on the branching angles of some savanna trees revealed that the first and second angles of branching are on the average more or less the same for any particular species of tree (Table 1). This could explain why trees have perfect radical symmetries and why trees of the same species assume characteristic regular shapes. Irregular branching would lead to branches becoming entangled, leading to the overlapping of the leaves. Uniform branching, therefore, brings about little or no overlap of leaves which minimizes light interception and consequently photosynthesis. Another feature of both angles of branching is that they are all less than 90^o for all the eight tree species studied. Since work on mathematical models has shown that the total amount of timber required to form a tree of adequate strength is least when the branching angle sis 90^o (Alexander, 1968; Fisher, 1992), it therefore follows that all the eight tree species studied contain more wood than is necessary to support their foliage in the following order of decrease in magnitude: *Eucalyptus spp., K. senegalensis, A. nilotica, A. indica, C. siamea, D. regia, P. biglobosa* and *A. digitata.* For mechanical reasons, this is of positive value to a tree because in addition to supporting its weight, a tree must be able to withstand the drag exerted on it by the wind as demonstrated by Fraser (1962); this is so because wind has experimentally been shown to be more important than weight in determining what thickness of trunk is essential (Alexander, 1968). For economic reasons also, tress, with vertical branches are better adapted than those with horizontal branches because the relative cost of lengthening horizontal ones is considerably greater than that of lengthening vertical ones (Greenhill, 1981).

Figures 1 and 2 illustrate the effect of variation of branching angles on the shape of tree crowns. *Eucalyptus spp.* and *K. senegalensis,* which have the most vertical angles are fairly conical in shape. The rest, with their more horizontal branches are flat or ellipsoid. This is, broadly, in agreement with the hypothesis that by varying the angles of branching and the degree of terminal variance, tree could produce virtually any regular shape (Busgen and Munch, 1929; Honda, 1971).

SUMMARY AND CONCLUSION

From the findings of this study, the first and second angles of branching are on the average the same for any particular tree species, although the relationship between the two does not appear to be perfect linear one for individual trees. It is also evident that the differences in branching angles account for the different shapes shown by the trees. The results indicated that the effect of first branching angles on canopy width is a very loose one. In most trees, the first angle of branching is not dependent upon the height of first branching.

In conclusion, most of the relationships studied in this work appear to have positive adaptive significance in most of the trees. These relationships could adequately define the various patterns of branching in trees as well as crown shapes.

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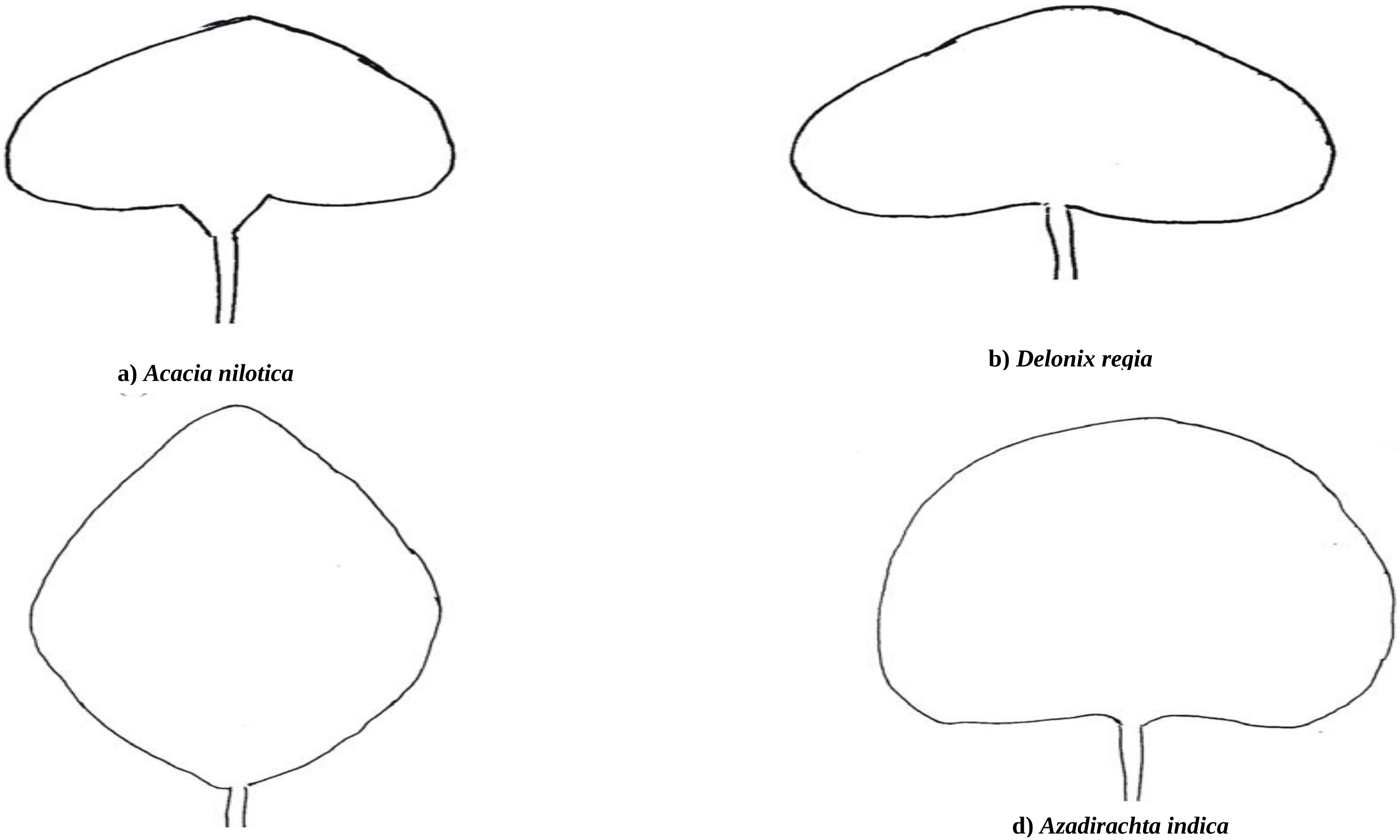

a) *Acacia nilotica*

b) *Delonix regia*

c) *Eucalyptus* sp

d) *Azadirachta indica*

Figure 1: Canopy shapes of some savannah trees

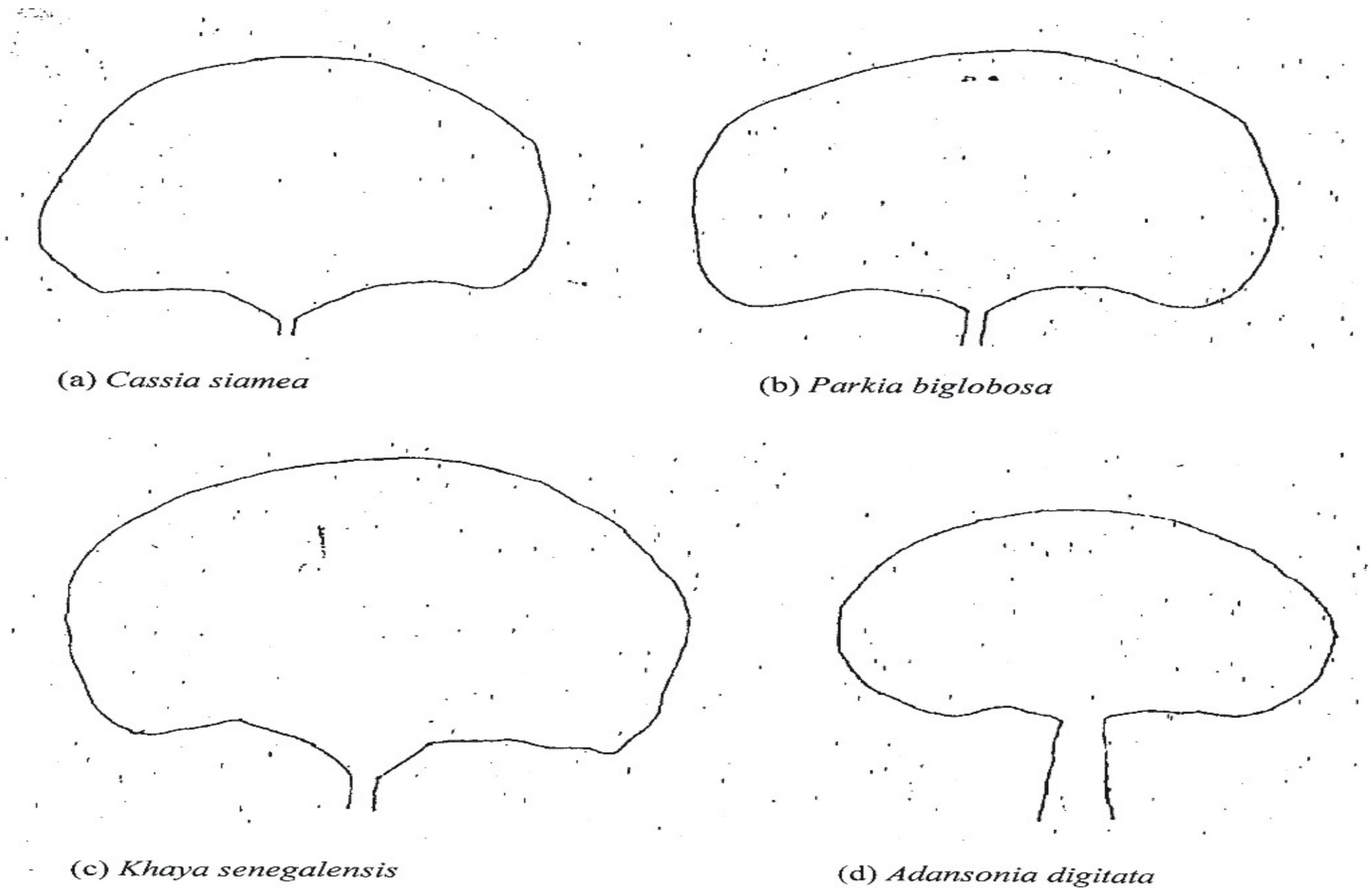

Figure 2: Canopy shapes of some savanna trees