CHAPTER 3

SPATIAL DENSITY AND POPULATION SIZE OF *ADANSONIA DIGITATA* AND *STERCULIA ROGERSII* IN THE KRUGER NATIONAL PARK

INTRODUCTION

Density is by definition, numbers per unit area, per unit volume or per unit of habitat (Krebs 1994). Trees can occur in many different types of spatial arrangement, from single isolated trees to dense clumps with a closed or almost closed canopy (Wilson 1988). Baobabs occur in all such arrangements and have even been planted in the form of avenues in some places. Although common star-chestnuts usually occur in an isolated arrangement on rocky outcrops, they are sometimes found in dense groups.

The use of quadrats is the most common method for sampling plants, but for samples of density, relies on three factors (Krebs 1994):

- The population of each quadrat examined must be determined exactly,
- The area of each quadrat must be known,
- The quadrats counted must be representative of the whole area.

Elephants have differing effects on the numbers and density of different plant species. Density of baobabs has been related to elephant densities in some places, but in other situations, increases in elephant density have not affected the size of the baobab population (Barnes *et al.* 1994).

In this study, quadrats in the form of belt transects were used to determine the density of *Sterculia rogersii* and *Adansonia digitata* in the study area. Estimates were then made of the population size of each of these two species in the area.

METHODS

Density data were obtained using a belt transect method (Tchamba 1995; Tchamba & Mahamat 1992; Viljoen 1995). A random stratified sampling technique was used in which transects were laid out according to Gertenbach's (1983) landscape system. Transects were located proportionally both north and south of the Luvuvhu River in order for comparisons to be made between these two sections. Transects were randomly located in all nine of the landscapes which occur in the study area. The location of transects did, however, have to take into account the accessibility of each area which was dependant on the road network. The location of each transect was determined from a map before entering the area so that bias could be avoided. Transects were set up at right angles to roads and were parallel to each other in each area. Transects started 30 m from roads to avoid disturbed veld conditions next to roads.

Data were gathered by two observers walking along the predetermined transect line. All *Sterculia rogersii* and *Adansonia digitata* trees, within a predetermined distance from the centre line of the transect, were located. This distance was dependent on the visibility at the site of the transect. The horizontal visibility was determined for each transect. Ten visibility estimates were made for each kilometre walked, and the lowest of these was taken as the single visibility estimate for that transect. Transects were preferred to total counts to minimise the possibility of smaller trees being missed and thus giving rise to erroneous data. Swanepoel and Swanepoel (1986), recorded damage to baobab trees, while travelling in a vehicle in the Zambezi Valley. Weyerhaeuser (1985) assessed elephant induced bark damage to baobabs in Tanzania. Both admit to overlooking smaller trees while conducting these total area counts. It was felt, that for this survey, sampling methods would result in a more complete representation of all size classes and hence more accurate data. The location of each baobab and star-chestnut relative to the centre line of the transect was recorded.

The density of trees was calculated separately for each landscape, using the following equation:

$$d = [(t \div s) \times n] \div t$$

where: d = density

t = total area

s = area sampled

n = number of trees sampled

The population size for each of the species was calculated by determining the product of the overall density and the size of the study area. The overall density was determined by adding the products of the density of each landscape and the size of the particular landscape in the study area.

Comparisons were made between the tree density of both *Adansonia digitata* and *Sterculia rogersii* in the northern and southern sections of the study area.

RESULTS

Adansonia digitata

The baobab population in the study area consists of around 15 216 trees which occur at an average density of approximately 11.14 trees/km^2 ($s^2 = 90.07$). The densities for individual landscapes are shown in Table 1.

The baobab density north of the Luvuvhu River is 21.8 trees/km^2, considerably higher than the density of 7.0 trees/km^2 south of the river. The difference in density is highly significant (difference of proportions on the density, $z = 7.75$; $P < 0.001$)

Table 1

Density of trees in each landscape (Fig. 6)

LANDSCAPE	SIZE (km^2)	*A. DIGITATA* (per km^2)	*S. ROGERSII* (per km^2)
15. *Colophospermum mopane* Forest	157	10.813	10.813
16. Punda Maria Sandveld on Cave Sandstone	166	17.532	5.844
23. *Colophospermum mopane* Shrubveld on Basalt	156	0.316	0.000
25. *Adansonia digitata* / *Colophospermum mopane* Rugged Veld	313	11.436	80.550
26. *Colophospermum mopane* Shrubveld on Calcrete	166	2.397	73.108
27. Mixed *Combretum* spp. / *Colophospermum mopane* Woodland	155	8.222	1.370
28. Limpopo / Luvuvhu Floodplains	128	32.174	22.274
32. Nwambia Sandveld	100	12.029	10.614
34. Punda Maria Sandveld on Waterberg Sandstone	199	5.297	5.959

Sterculia rogersii

The average density of the *Sterculia rogersii* population in the study area is approximately 23.39 trees/km^2 (s^2 = 963.18). There are an estimated 45 849 trees which occur in this area. The densities of trees in the various landscapes are also given in Table 1.

The common star-chestnut density north of the Luvuvhu River is 61.42 trees/km^2, almost three times higher than the density of 22.06 trees/km^2 south of the river. The difference in density is highly significant (difference of proportions on the density, $z = 13.44$; $P < 0.001$)

DISCUSSION

Although many studies have been conducted on baobabs, and much has been written about these unusual trees, not many authors have bothered to include any information on their spatial density or the size of the populations. Barnes (1980), however, has calculated the density of baobabs in 15 transects and arrived at figures as dissimilar as 3 trees/km^2 and 723 trees/km^2. He calculated a median density of 69 trees/km^2 for the 15 transects in Ruaha National Park, Tanzania. No relationship between vegetation type or soil could be found. The transects with the highest and lowest baobab densities occurred on the same soil type. In a later study, Barnes *et al.* (1994) calculated densities which varied from 15 trees/km^2 to 1025 trees/km^2 in the same reserve. The mean densities of baobabs in Ruaha in 1976, 1982, and 1989 were 51, 28, and 35 trees/km^2 respectively (Barnes *et al.* 1994). Densities of baobabs in parts of Sudan and Mali have also been calculated (Wilson 1988). The densities for these regions were 11.2 trees/km^2 and 10.7 trees/km^2, respectively.

Ben-Shahar (1996) found that tree densities in three woodland types in northern Botswana were regulated by factors other than elephant, such as soil nutrients, water drainage and fire.

The density of baobabs in the Kruger National Park of 11.14 trees/km^2 is much lower than the densities of trees in Ruaha, Tanzania, but is similar to the density of trees in Sudan and especially Mali. The density of baobabs in the north of the Kruger National Park is, however, much greater, although still not as high as in Ruaha. With the exception of the occasional straggler, baobabs are only found in the north of the Kruger National Park. They are at the southernmost part of their range in this region as a consequence of the less suitable climate further south, with frost being the limiting factor. Both altitude and climate varies considerably in the study area and is probably more suitable for baobabs in the north. It is therefore, expected that the density of trees in the northern study section would be higher due to the more suitable climate. Parts of the southern section can also be regarded as unsuitable for baobab growth. These trees show an affinity for deep, well drained soils, but much of this section consists of vertic soils with a high clay content (*Colophospermum mopane* Shrubveld on Basalt) (Gertenbach 1983). The unsuitability of this region for baobabs is demonstrated by the near absence of these trees there, probably as a result of poor drainage. The density of baobabs does not show any other trends related to soil type. Deep sandy soils have densities ranging from 5.2 trees/km^2 (Punda Maria Sandveld on Waterberg Sandstone) to 17.5 trees/km^2 (Punda Maria Sandveld on Cave Sandstone). While the baobab density on the shallow soil of landscape 26 (*Colophospermum mopane* Shrubveld on Calcrete) is very low, the shallow soils of the *Adansonia digitata* / *Colophospermum mopane* Rugged Veld support a high density of baobabs.

Density of *Sterculia rogersii* is higher in the northern than in the southern section, but as with baobabs, this is most likely due to the more suitable habitat in the north rather than as a result of the overutilisation by herbivores. This species prefers dry conditions and does not tolerate cold (Van Wyk 1974). The soil of the *Adansonia digitata* / *Colophospermum mopane* Rugged Veld is shallow, calcareous and has a poorly developed topsoil layer (Gertenbach 1983). The soil of the *Colophospermum mopane* Shrubveld on Calcrete is also shallow and calcareous (Gertenbach 1983). The density of star chestnuts in the study area is highest in these two landscapes. The common soil properties of these areas suggests that *Sterculia rogersii* has an affinity for this particular type of soil. These trees are absent from the *Colophospermum mopane* Shrubveld on Basalt, again probably due to this landscape lying on vertic clay soils. The densities of *Sterculia rogersii* is low in all landscapes with deep sandy soils, but as with baobabs, these trees are fairly common on the alluvial floodplains.

The spatial distribution of *Sterculia rogersii* may also be affected by fire. This species occurs in highest density in rocky places and on ridges where the fire intensity is lower due to a sparse field layer and hence a poor fuel load. Gertenbach (1983) describes the field layer of landscapes 25 (*Adansonia digitata* / *Colophospermum mopane* Rugged Veld) and 28 (Limpopo / Luvuvhu Floodplains) as sparse and that of landscapes 27 (Mixed *Combretum* spp. / *Colophospermum mopane* Woodland) and 34 (Punda Maria Sandveld on Waterberg Sandstone) as moderate to dense. The latter two landscapes support low densities of *Sterculia rogersii*, while the former two support relatively high densities. These densities may be influenced by fire frequency or intensity, although more research is required in this regard before any conclusions can be made.