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RATE OF BURYING AND CACHING OF *CARAPA GRANDIFLORIA* SEEDS BY RODENTS WITHIN NGEL- NYAKI, MONTANE FOREST, TARABA STATE, NIGERIA

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ABSTRACT

The rate of burying and caching, depth and distance interval of burying *Carapa grandiflora* seeds within the main forest and grassland habitats of Ngel-Nyaki montane forest by rodents was determined. Seeds of *Carapa* were collected under the parent trees or plucked, checked to avoid spoilt ones and their caps cover removed before selection into big (≥ 20g) and small (< 20g) sizes. Each habitat was allocated 540 seeds and each transects carried 180 seeds each. 1m long steel wire was passed through each seed using drilling needle and a flagging tape indicating the size attached. Five (5) seeds were dropped in each transect (A, B and C) and data collected after observation for 5 days. This was replicated 12 times until 180 seeds were exhausted in transacts. The treatments carried out in Martins plots were also carried out in Peter's plot. Following established methods. Cameras and harmless traps to the rodents were set to monitor the mammals that visited the habitats. Failures to locate any seed within 30m were considered missing seeds. Any flagging tape seen within the 30m radius was checked either buried/cache. Results showed that more seeds were buried within 0-4m depth in both habitats, with the forest habitat having more buried seeds (425 seeds) than the grassland (344 seeds) habitat. Buried seeds serve as agent for dispersal of *Carapa* trees. More seeds were dispersed within 0-10m interval than above 10m intervals. Rodents implicated in burying/caching of *Carapa* seeds were Giant African rats (*Cricetomys gambiamus*), Striped field mouse (*Apodemus agrarius*) and House mouse (*Mus musculus*). Surrounding dwellers of the forest reserve should be educated on the negative impact associated with poaching of seed disperser such as Giant African rat.

Keywords: Burying, Caching, *Carapa*, Rodents, Forest, Grassland

INTRODUCTION

Seed dispersal is a critical step in a plant's life cycle, with important consequences for seedling establishment, population genetics, demography, spatial distribution, conservation and evolution. Seed dispersal by animals for animal species and dispersal services for plants (Vander Wall & Beck 2012). Animals that ingest fruits and defecate or regurgitate seeds (hoarders) can inadvertently disperse some seeds, contributing to the natural plant regeneration cycle (Vander Wall & Beck 2012). Seed dispersal is an important determinant of plant reproductive success; it allows seeds to escape distance and density dependent mortality and increases a plants chance of having seeds in suitable establishment sites (Hamilton and May 1977). Reduced disperser abundances might indirectly reduce seedling recruitment and may ultimately reduce species (Asquith, Terborgh, Arnold and Riveros, 1999).

Rodents species act as prominent seed dispersers by moving and cycling seed that may not be recovered and thus germinate. This process may have strong effects on seed dispersal patterns and the recruitment dynamics of many plant species (Jansen and Den 2005; Xiao, Zhang & Wang 2005). Hence, the study of foraging decisions by rodents is fundamental to understanding seed dispersal and plant regeneration dynamics (Forget, Munoz, and Leigh, (1994)).The foraging decision of seed-caching rodents consist of a set of sequential choices that determine seed fate: basically, whether the seed is consumed immediately or transported and cached at a certain distance in a given microhabitat structure (Brewer, 2001).That rodents are capable of dispersal over longer distances is demonstrated by the

occasional observance of seeds dispersed >100 m. Additionally, although most studies of seed dispersal only consider "primary" movement, the initial movement of seeds from the parent tree, some have shown that seeds recovered from caches are sometimes re-cached rather than eaten and that sequences of multiple secondary movements occur.

In the afromontane forest, cattle ranching and agriculture are destroying the last natural forest habitat that occur at high altitudes, Forget *et al*. (2007) says, that in fragmented forests the giant rats may actually be hurting overall tree diversity, since they prey on some seeds and not others. He added that, when forest is disturbed, the giant rats are also disturbed. But it's more than just forest loss and fragmentation that is threatening the continent's giant rats. He stressed further that bush meat hunting has also become a problem and soon may worsen.

Seed dispersal of *Carapa* is exclusively by two scatter hoarding rodents, the red a couch (*Myoproc taacouchy*) and the red-rumped-agouti (*Dasyprocta Leporina*) (Jansen & Den, 2005). Both are important game species (Curran and Leighton, 2000). Both rodents disperse *Carapa* by removing seeds one by one from below parent trees and burying these as food reserves in shallow caches at distances up to 125m from the tree, each seed at a different spot. Although cached seeds are heavily drawn on during the dry season (Vander Wall, 2002), some are never recovered and may establish into seedling (Forget, Wenny, 2005) seeds left below parent trees, in contrast, are subjected to heavy infestation by Hypsipila moths (Becker 1973) and in protected areas to predation by Peccaries (Pecaritajacu and Tayassupecari), which prohibits seedling establishment. Most if not all *Carapa* seedlings emerge from seeds scatter-hoarded by a couchies and agoutis (Forget 1996; Jansen *et al*. 2004). It is important for *Carapa* that seeds be removed before they germinate or get infested by insects. Insect-infested seeds may still be viable but are discriminated against by the rodents (Jansen *et al*. 2012).

In African forests, contemporary autropogenic pressures such as hunting, forest degradation and fragmentation are contributing toward major declines in large frugivores (Mangan *et al.* 2010), yet the potential for scatter hoarding to mitigate this loss is largely unknown (Forget and Vander Wall 2001, Nyiramana *et al.* 2011).

That is why this study was focused on investigating the rate of burying and caching of seed dispersers of a mega faunal tree species by scatter-hoarding rodents. Our study species will focus on *Carapa grandiflora* (*Meliaceae*) that produces hard endocarps with large seeds, enclosed, oversized fleshy fruits with many extremely large seeds. It has been hypothesized that such fruits evolved to attract megafaunal seed dispersers that are now extinct, such as elephant-like *gomphotheres*, which would have ingested the fruits without cracking the hard stones and defecated the seeds intact, as is still seen today in African elephants. Today, *Astrocaryumstandleyanum* palm is primarily dispersed by Central American agoutis (*Dasyproctapunctata*) that scatter-hoard the seeds across their 2- to 3-ha home ranges as food reserves for the low-fruit season. Thus, the objective of the study was to determine the distance interval and depth of buried/caching seeds from the point of treatment.

METHOD AND MATERIALS

This research was conducted at the Nigeria Montane forest project Ngel-Nyaki forest reserve (7^0 05'N, 11^0 03'E) on the Mambilla plateau in Taraba State North-east Nigeria. Ngel-Nyaki Forest Reserve is about $46km^2$ in area including $7.5km^2$ of continuous forest, the largest area of forest on the Mambilla plateau (Chapman and Chapman, 2001). It can be reached on foot from Yelwa village past the Mayo Jigawal, from where it is less than half an hour walk to the upper edge of the forest. The altitude ranges from 1400 (4593ft) up to 1600 meters (5249ft) (Chapman and Chapman, 2001).

. The seeds of *Carapa* were collected from the forest of Ngel-Nyaki under the parent trees or plucked from the parent tree; a thorough check was applied to avoid the spoilt ones, the cover caps of seeds were removed and the seeds selected based on their sizes. A steel wire of 1m long was passed through each seed using drilling needle, at the edge of the steel wire; flagging tape was attached indicating either big (≥ 20g) or small size (< 20g).

Two main locations were considered; Martins plot location and

Peters plot location. At each of these locations; main forest habitat and grassland habitat were founded. These habitats were categorized into transects; transect A, B and C. A total of 2160 *Carapa* seeds were used for the research. Each habitat was allocated 540 seeds of *Carapa grandiflora*, with each transects carrying 180 seeds each. Five (5) seeds were dropped in each transect (A, B and C) and data collected after observation for 5 days. This was replicated 12 times until 180 seeds were exhausted in transacts. The treatments carried out in Martins plots were also carried out in Peter's plot. Following Nyiramans *et al.* (2011), and Aliyu Babale *et al.*, (2013) methods.

The transects were mark 30m horizontal and vertical away from the central treatment point and 30m interval apart from the next transect, and seeds of *Carapa* was placed at every transect treatment point. Immediately after the placement, the days start counting. The time for collecting data record was in the morning 7:30 am and 4:30pm of the day of collection. Using data observation techniques; predated seeds were identified by having been partially or fully consumed and retrieve by the presence of flagging tapes and measuring tape (100 by 100 meters) apart. This was used to measure the distance from the transect (plot collecting point) to where the seeds were buried/cache; 30 m search was applied in both forest and grassland. Failure to locate any seed within the estimated meter was termed missing. Following Yadok *et al.* (2015) methods, some limited 10m forest and 5m grassland, some 20m to 10m forest and grassland respectively.

RESULTS AND DISCUSSION

Buried or Cached Seeds

Data collected showed that more seeds were buried within 0-4m in both forest and grassland habitats. There was no buried seed found within the 5-8m grassland. Coincidentally, the same frequency of seeds were found buried within 0-4m of transects A, B and C in forest habitat; while in the grassland habitat, the highest rate of buried seeds was found in transects A and C also within 0-4m depth. Buried seeds at 5-8m depth were found in transects A and C in forest habitat, where none was recorded in grassland habitat (Table 1 and Fig. 1). The frequencies of buried seeds in grassland were higher than in the forest habitat. Comparatively, it is clear from the chart that within 0-4m depth, the grassland habitat had more buried seeds than the forest habitat, (114 in transect A, 114 in transect B and 115 in transect C, giving a total of 344 seeds buried). While the forest recorded (114 in transect A, 114 in transect B and 114 in C, giving a total of 343 seeds buried). However, data collected from depth ranges of 0-4 and 5-8m depth showed that the forest had the highest number of seeds buried (114 + 114 + 114 + 10 + 7 + 10 =369 seeds) while the grassland recorded zero buried seeds at 5-8m depth. Table: 1 and Fig.1.

Table 1: Frequency of Depth of Buried Seeds

Depth	FOREST						GRASSLAND					
	A		B		C		A		B		C	
	F	%	F	%F	%	F	%	F	%	F	%	
0-4M	114	76.0	114	76.0	114	76.9	114	76.6	114	76.9	115	76.6
5-8M	10	6.9	7	4.9	10	6.8	0	0.0	0	0.0	0	0.0

Source: Fields data, 2021

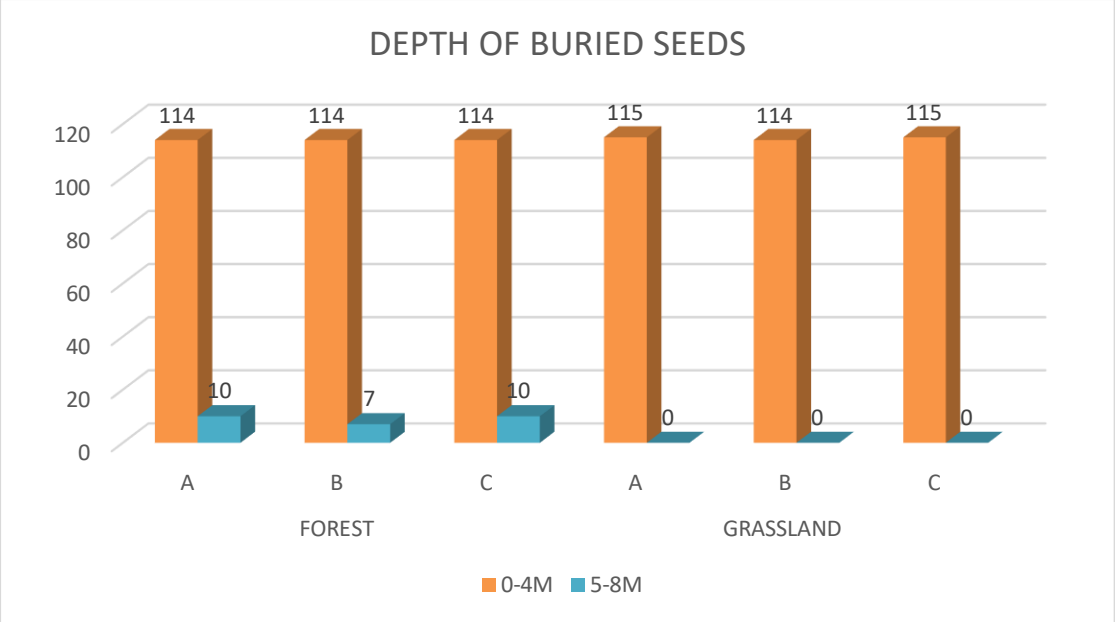

Figure 1

Distance Interval of buried/cached seeds

The result from search for buried seeds interval went as far as 30m, categorized into 0-10m, 10-20m and 20m-30m. Data collected showed that more seeds were dispersed within 0-10m distance in all the transects both forest and grassland habitat (Fig: 2). Distance interval of 10-20m recorded buried seeds only in transects A and C in forest habitat, while no buried seeds within this interval in grassland. Within 20-30m interval, only transect A in forest habitat recorded buried seeds Fig. 2.

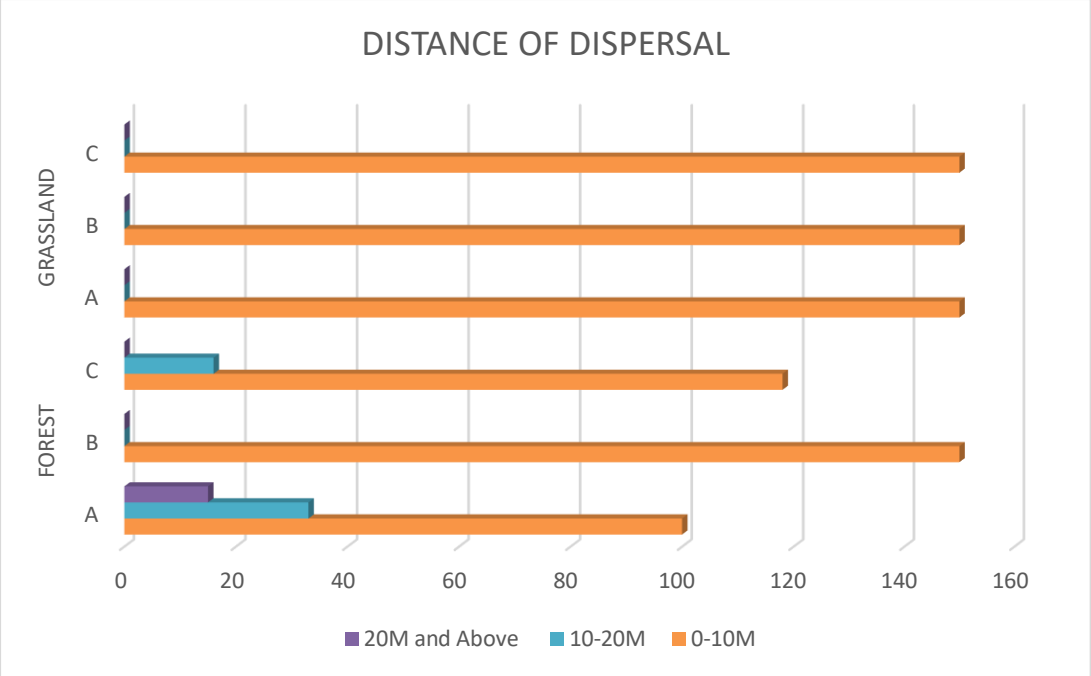

Figure: 2 Horizontal bar chart showing the distance of seed dispersal

Buried or Cached Seeds

Buried seeds are more likely to establish new plants than unburied seeds. Data collected showed that more seeds were buried within 0-4m and 0-8m depth in both forest and grassland habitat. The shallow buried of 0-4m depth could be attributed to fear of their predators, or it could equally be that they are hiding them for easy collection later. Linzhang *et al* 2007; who reported on germination depth of seed sown showed 0-4.43m to 6m depth enhances germination of seeds. Rodents of Ngel-Nyaki forest hid/buried seeds contributed massively to forest within this range, thereby contributing to the reforestation of the *Carapa* trees in the reserve.

Table 1 revealed that more seeds were buried within 0-4m in both the forest and grassland habitats. There was no record of buried seeds at 5-8m depth in grassland habitat. Contemporaneously, the same frequency of seeds was found buried within 0-4m of transects A, B and C of the forest habitat, while in the grassland habitat, the highest rate of buried seeds was found in transects A and C. Only in forest habitat that seeds buried of 5-8m depth were found. This could be attributed to the porosity of forest soil. In the 5-8m category, transects A and C had the same number of buried seeds, while there was none found in the grassland habitat.

Distance Interval Of Buried/Cached Seeds

Evidence from the figure 3 showed that more seeds were dispersed within 0-10m than in 10-20m and 20-30m. Furthermore from the table, rodents in transects B in the forest habitat and transects A, B and C in the grassland habitat dispersed 100% of the seeds within the 0-10m range. This means that in the 10-20m and 20-30m range had 0.0% dispersal in the above transects. It can also be gleaned from the figure that rodents in the grassland habitat didn't disperse seeds at all beyond 10m while forest rodents this may be due to the fact that rodents in the grassland habitat close burrows to the point of treatment, or that they could not run farther with the *Carapa* seeds. While other hand, rodents in the forest habitat dispersed more seeds within 10-20m and 20-30m ranges. This is beautifully depicted by the horizontal bar chart in figure 2. This may be due to the open nature of the lower strata of the forest reserve. The dispersal of seeds away from the parent tree is thought to be

a critical factor in the maintenance of tree diversity in tropical forests (Vander Wall *et al.* 2005). Most large-seeded plant species rely upon large-bodied frugivores (41 kg) for seed dispersal (Forget *et al.* 2007) and seedling establishment (Terborgh *et al*. 2008). The relative importance of rodents as seed predators or dispersers depends on temporal variability in crop size, and may therefore change with seasons (Nyiramana, Mendoza, Kaplin and Forget, 2011). The dispersal of *Carapa* seeds at longer distances in the forest is responsible for the distribution of *Carapa* trees within the forest reserve and the grassland. Ecological studies with *C. procera*, a closely related species, have shown short average seed dispersal distances by scatter hoarding rodents (mean/SD = 18.5/0.9 m) (Jansen *et al.*, 2004). According to Martins *et al.* (2012), the shorter seed dispersal distance in the occasionally inundated plot may be partly a consequence of both the higher plant density and the experimental design. According to Jansen *et al.* (2012), rodents may disperse seeds over much longer distances than was ever anticipated, and with much higher seed survivorship. This statement was borne of out their finding of average distance of dispersal of >100M. The study by Li and Zhang (2007) revealed that all released seeds were found at distances from 1.0m up to 20.0m from the seed source stations (or point of treatment).

CONCLUSION

The study revealed the different buried and caching locations in Ngel-Nyaki at their various habitats. It was found that more seeds were buried between 0-4 m in both habitats, while most of the *Carapa* seed were found to be dispersed between 0-10m in both habitats. The research revealed that *Cricetomys gambianus* (Giant African rat) was the most abundant specie in both forest and grassland habitats, while *Mus musculus* (House mouse) was the least abundant specie in both habitats. Thus, it was recommended that government should collaborate with reserve centers and parks, to sensitize surrounding dwellers of the negative impact associated with the poaching of seed dispersers such as *Cricetomys gambianus* (Giant African rat).

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