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Population structure and natural regeneration of *Allanblackia floribunda* oliv. (Clusiaceae) in a forest concession of East Cameroon

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Abstract

Allanblackia floribunda Oliv. a plant known for its nutritional, economic, industrial and therapeutic qualities is less studied in research centres. Apart from primary studies already carried out, the population structure and natural regeneration arouse much questioning. The follow up of species into FMU 10 044 and on the farmland was realized with the aim of bringing out an in-depth knowledge on the diameter structure, phenology of defoliation, flowering and fructification as well as the dissemination of the diasporas. This study was carried out in a natural forest and cultivated area revealed that *A. floribunda* is an evergreen species, its foliage is always present independent of the climatic seasons; the size of fruits does not restrain the species to barochory; other chorology types such as zoochory and anthropochory were observed; blossom and fructification take place once a year; flower and fruit outgrowth is different at the level of the branches, trees and population; the distribution of trees by diameter classes revealed that the species regenerates easily under the wood but the follow up of the individuals is weak.

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Introduction

Allanblackia are medium-sized tree species of humid forest zone of Africa producing berry-like fruits that are suspended on long pedicels, and seeds of the genus are recalcitrant (germination success less than 5%, Vivien and Faure 1996). Nine species in the genus have been recorded (Bamps 1969), namely *Allanblackia floribunda* Oliver or tallow-tree, *Allanblackia gabonensis* (Pellegr.) P. Bamps, *Allanblackia kimbiliensis* Spirlet, *Allanblackia kisonghi* Vermoesen, *Allanblackia marienii* Staner, *Allanblackia parviflora* A. Chev., *Allanblackia stanerana* Exell & Mendonça, *Allanblackia stuhlmanii* (Engl.) Engl. and *Allanblackia ulugurensis* Engl. *A. parviflora* is distributed in Upper Guinea domain of the Guineo-Congolian region of Africa (Denys, 1980), from Sierra Leone and Guinea to Ivory Coast and Ghana (Bamps, 1969) and is very similar to *A. floribunda*, which is distributed in the lower Guinea Domain and the Congo Basin (Bamps, 1969) and (Denys, 1980) from Benin to Democratic Republic of Congo (DRC) and North Angola. *A. kisonghi* and *A. marienii* are found in DRC, mainly in Bas-Congo and District Forestier Central, the former being also found in Kasai, whereas *A. kimbiliensis* is found in DRC and Bwindi forests in Uganda (Bamps, 1969) and (Cunningham, 1992). *A. ulugurensis* and *A. stuhlmannii* occur in the Eastern Arc mountains of Tanzania. *A. gabonensis* is distributed from Cameroon to Democratic Republic of Congo, from 500 to 1750 m elevation above sea level, while *A. stanerana* is found from Cameroon to Angola and Democratic Republic of Congo in evergreen littoral forests (Vivien & Faure, 1996).

Allanblackia floribunda Oliv. is a fruit tree of Clusiaceae family or Guttiferae. It is a plant which is in abundance in the forests of Central Africa and West Africa (Anonyme, 2004). The seeds of this species are full of enormous potential nutritional and therapeutic: (i) they are consumed by humans in times of starvation and by rodents (Anonyme, 2005), (ii) they produce a butter that is 67.6 to 73% by weight of a seed (Foma & Abdala, 1985), (iii) stearic acid (52-58%) and oleic acid (39-45%) (Hilditch, 1958) contained in the seeds contribute lower cholesterol in the blood and limit cardiovascular events, these acids are popular in cosmetics and food (Bonanome & Grundy, 1988). The bark is used in Cameroon for its therapeutic virtues, is involved in the treatment of cough, dysentery, diarrhea and toothache (Laird, 1996) and (Raponda-Walker & Sillans, 1961) and as an aphrodisiac and pain reliever. Consequently, the species is one of the most commonly used medicinal plants in Cameroon (Laird, 1996) and possibly has even greater potential. For example, Guttiferone F, an HIV-inhibitor (Fuller *et al.*, 1999) was found in the extracts of the heartwood from *A. floribunda* (Locksley & Murray 1971). The active compounds of its bark contain prenylated xanthone, a natural product acting against human epidermoid carcinoma of the nasopharynx cancer line (Nkengfack *et al.*, 2002).

Despite the potentials of this plant is full, it remains untapped because the last fifty years it has been abandoned for other oils which are easier to produce. For this reason, the commercial potential of *A. floribunda* is underestimated. Recently, the Dutch group Unilever is committed to value this oil which according to him, has the ability to solidify at a temperature of 30°C, and can therefore be used in the manufacture of margarine. It was concluded that the production of this oil requires little energy, with the added advantage that the chemical waste products do not have a significant impact on environmental pollution as is the case with palm oil (Anonyme, 2005). According to tests conducted by World Agroforestry Centre (ICRAF), the germination of *A. floribunda* remains a big problem to solve, because it takes a minimum of 15 months to observe the first lifted in natural conditions. As a result, although apparently undeniable economic importance, this plant is not subject to an industrial culture. It stayed away from the research programs. The main objective of this work is to describe the structure of the population and the level of natural regeneration of *A. floribunda* in FMU 10044. More specifically, it is to

determine the structure of the diameters of trees to know the phenology of defoliation, flowering and fruiting; determine the type of dissemination; inventory seedlings in situ.

Materials and methods

Study site

FMU 10044 (Fig. 1) is located in East of Abong-Mbang Lomié, and is bounded on the north by the FMU 10043 and 10045, to the east by the FMU 10,040 and an area of exclusive mining, south and west by agroforestry zone encompassing nearly 41 villages along the roads Abong Mbang Mindourou, Lomié Kongo. The geographical coordinates of the study site are between 3° 10' and 3° 44' North latitude and between 13° 20' and 13° 52' East longitude (Hubert *et al*., 2004). The average temperature in the region oscillates around 24°C. The lowest monthly temperatures are recorded in July (22.8°C) and the highest in April (24.6°C) (Hubert *et al.,* 2004). Data collected between 1999 and 2003 suggest that the average annual rainfall is around 1902 mm. Relatively uniform relief of the FMU 10044 can be described as moderately hilly. It presents a series of hills generally mild slopes interspersed with small streams or swampy depressions usually traversed by perennial streams. Steep slopes can be observed but they are much localized and their height difference rarely exceeds 20 to 35 m. The altitude varies from 500 to 600 m; the highest point is located in the North-eastern part. From geological point of view, most of the FMU based on the complex Precambrian lower base, the main rocks are dark gray mica silver and to a lesser extent quartzites, mica schists and compact gray biotite. The North-East is covered by a complex Precambrian means (series Ayos) characterized by rocks of mica muscovite quartzites and gray inter-stratified (Hubert *et al.,* 2004). The hydrographic network consists of three permanent watercourses, especially rivers Ndjoo, Ossananga and Dja. Dja remains the most important watershed in the area; it covers the entire northern half of the FMU.

Field observations

An area of 6.4 ha belonging to the FMU 10 044 and cultivated area near the village Mindourou with the same surface were explored in order to appreciate the behavior of individuals into the two environments (forest and field). The choice of this FMU can be explained by their proximity with the village. The studies were conducted on 59 trees identified across the two environments. Particular attention has been made on individuals flowering and fruiting. Diameter measurements were done, the type of dissemination has been studied, flowering and fruiting were followed, the level of natural regeneration and population structure of the species were observed.

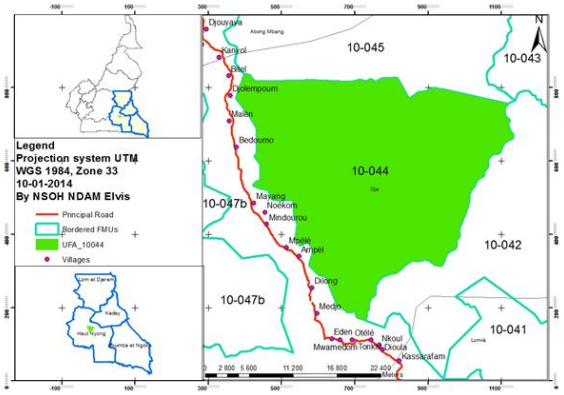

Fig. 1. Location map of the FMU 10 044 and surrounding FMU.

Population structure

The structure of the population can appreciate the equilibrium level of a settlement. It also helps to understand whether the species is represented only by adults or if you encounter the seedling too. For the study of this structure, the diameters were used, the diameter measurements are more reliable than the height of trees especially in closed forest.

Structure tree diameter

The structure described here is the diameter of the same species showing the distribution of stems by diameter class. To accomplish this work, red paint was used to mark the stems of *A. floribunda*. A diameter tape was used to measure tree diameter at 1.30 m above the ground. A botanist and two trackers respectively contributed to the identification of the

species and to reopening transects bushy in certain places.

Natural regeneration

Natural regeneration takes into account several factors in this phenology (leaf, leaf fall, flowering, fructification), dissemination of diasporas on seedling development in situ.

Phenology

Phenology is the study of the effects of weather and climate on plant life stages, including flowering, fruiting, leafing and defoliation (Parent, 1991). Phenology of a species is determined by examining the seasons of the influence of local climatic conditions on the behavior of a species in its natural habitat, knowledge of seasonal manifestation of a biological phenomenon of leafing, flowering and fruiting can contribute effectively to the development of strategies for the use and sustainable management of this species.

Defoliation phenology

For this study the density of leaves depending on the habitat, the frequency of the falling leaves, the variations in shape and size of leaves and branches and the color of young leaves and mature leaves were studied**.**

Flowering phenology

This work was used to study the behavior of flowers (eg opening or closing of the petals at certain times of the day), to estimate the time required for the passage of flower buds and flowers to the formation of the first fruits.

Fruiting phenology

The minimum time for the fruit completes its maturation, the rate of fall of the fruit, size and shape of fruit dehiscence (explosion, rot) of the fruit were determined.

Inventory of seedlings in situ

This study was conducted in forests and cultivated land for a comparison of the potential in the two environments. The level of *A. floribunda* regeneration was determined by counting all seedlings less than one meter in height within a radius of 10 meters from the adult stem. A diameter tape was used to measure the distances from the young stem to the bear's seed.

Dissemination

The study of the dissemination was to determine the mode of dispersal of seeds and fruits as well as officials of the dissemination. For this purpose the traces and clues found around the area enclosed within the framework of this work have been reviewed by the responsible fauna of the host structure.

Results

Diameter structures

Diameter measurements obtained from 59 trees of *A. floribunda* were divided into class of diameter of amplitude 5 cm. All classes are represented in the surface explored in the forest. In the open area (cultivated surface), the classes of diameter below 15-20 cm were not found during data collection (Table 1).

Table 1. Diameter classes in the environment.

Diameter classes	Number of tree in forest area	Number of tree in farmland
05-10	20	0
10-15	9	0
15-20	6	1
20-25	7	1
25-30	4	2
30-35	2	3
35-40	2	1
40-45	1	0
Mean density	6,4	1
Standard deviation	6,16	1,07

The distribution of the trees in forest in classes of diameter presents a reversed J curve, with many trees of small diameters (or young trees). This great number falls quickly at the beginning, then more slowly, while the diameter of the trees increases. The shape of the curve indicates that although there are many young trees and seedlings capable of growing in the forest, a majority of them die quickly, leaving some trees of average size, and even less the average size (Fig. 2).

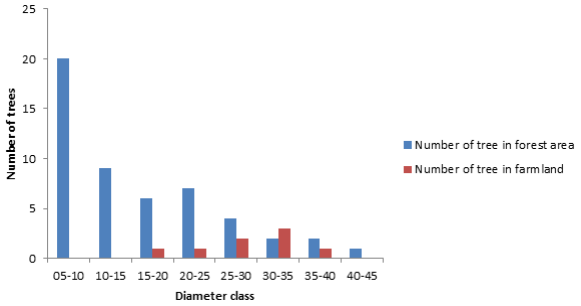

Fig. 2. Distribution of trees in forest area and farmland by diameter class.

Trees densities

Figure 3 shows that, considering their trees with 05 cm ≤DBH ≥45 cm, the mean densities of trees in two types of environment are different. But then, at 95% confidence interval of the student test, the difference in the two environments is not significant. This is explained by the implementation of reduced impact logging techniques (RIL) in this forest concession.

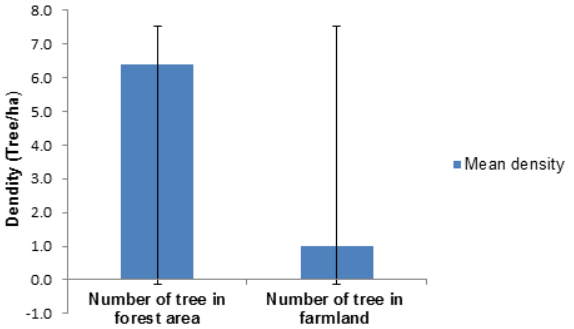

Fig. 3. Tree density in forest area and farmland.

Natural Regeneration

Phenology of Defoliation

The observations made in the two habitats (forest and cultivated surface) revealed that, one does not observe a precise period of defoliation and leaf regeneration. The fall of the old leaves occurs without a particular rate. The leaves fall as they aged. During the dry season, however, the fall of the old leaves is more significant, with variations from one tree to another.

Phenology of Flowering

A.floribunda flowering starts from November 15 which is the beginning of the grand dry season (Fig. 4). It is regular and continuous all through the year. This flowering is axial for the young and leaflet twigs. One does not distinguish the inflorescences on the trunk. Most frequently, they can observe on the same tree, and even on the same branch, inflorescences at various stages of evolution. Certain axes carry at the same time floral buttons and/or opened out flowers. The flowers being of large sizes and flowering most often generalized for all branches of the same tree, the biomass produced generally represents a good part of the canopy.

Fig. 4. Inflorescences of *A. floribunda*: A, flower buds B, with flowers blooming starts fruiting.

The results obtained from the 59 trees listed on the two habitats present 9 flowering individuals. These include 4 out of 51 identified in forest and 5 out of 8 found on cultivated surfaces.

The various stages of evolution of the inflorescences observed show that each individual and each branch seems to have its own periodicity. Thus, indicating an absence of synchronization at the level of only one tree as well as for the population.

Phenology of Fructification

Fructification starts in the beginning of december and is spread out over several months. Fructification like

the flowering is axial on the young and leaflet twigs. One does not observe fruit formation on the trunk. The simultaneous presence of fruits on the same branch or the same tree with various phases of maturation (young fruit and mature fruit) was very often observed. In addition, this fructification in term of diaspores and biomass is less abundant. Fructification is also characterized by a specific periodicity of each individual (Fig. 5).

Fig. 5. Mature fruits and mature seeds of *A. floribunda*: A, mature fruit B, mature seeds.

Fructification is equally spread out like flowering. As for the rate of individuals having fructified on the two habitats under study, 1.98% that is to say 1/51 trees carried fruits in forest against 62.5% that is to say 5/8 trees on cultivated surface. This variation in terms of individuals having fructified after flowering in the two environments could be also explained by an insufficiency of light in forest.

Fruits maturity is effective as from July (Fig.5). Therefore, fruits fall almost every day, they can harvest about one to two fruits per tree. The amount of seeds produced by a fruit gave a proportion varying from 9 to 52 seeds.

Dissemination

The observation of traces of rodents or frugivores such as rat or porcupine shows that the seeds of this species are eaten by animals directly under the seed holder, or by carrying over shorter or longer distances. Several seeds carrying the prints of incisors or half consumed and moved from several meters away from the seed-bearing were frequently observed at the entry of certain burrows. In the same way, humans accidentally disperse seeds between the place of harvest and the village.

Inventory of Young plants in situ

The characteristics of *A. floribunda* fruit should quite naturally for several reasons constitute a barrier to the natural regeneration of this specie. The fruit being a fleshy berry is very appreciated by the animals such as the rodents. They attack not only the epicarp which is fleshy on all its thickness but also the seed itself which is strongly rich in lipids. The counting of the seedlings around seed-bearer made it possible to count a total of 29 young plants of height varying between 50 cm to 1 m and diameter lower than 5 cm (Fig. 6). Certain seedlings were found sporadically in the forest far from seed-bearer following transportation of diasporas by dissemination agents (Humans and Animals).

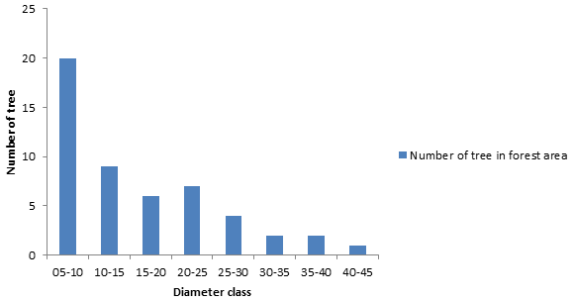

Fig. 6. Natural regeneration of *A. floribunda*.

Discussion

Diameter Structures

The absence 5-10 and 10-15 cm diameter class on cultivated field is due to the cuts made by farmers during creation of farms. The diametric structure of the forest stand is the result of the dynamics of all species and their interactions. These structures which decrease in an exponential way of the smallest classes to the greatest classes of diameter, testify to the stability of this specie, characterized by a regular and sufficient regeneration. However, this is not necessarily the case for other species from the forest habitats such as cultivated land.

On tree height, the results obtained during the data collection corroborate those obtained by Bamps (1969); the species rarely exceeds the size of 30 m. On

the other hand, a single tree was 70 cm in diameter throughout the FMU; contrary to the results obtained by Vivien and Faure (1996), stating that *A. floribunda* reached 80 cm in diameter.

Phenology

The foliage of A. floribunda is always provided regardless of the climatic seasons means that the species is evergreen, because bears leaves that are renewed continuously. Similarly, observations revealed that the canopy of trees found was more radiant than those found in forest trees. Observations on leaf color can be concluded that the young leaves are dark red color while mature leaves are dark green color.

In forest, only 7.84% of the trees have blossomed against 62.5% of cultivated land. These percentages suggest that light is an important factor in triggering the process of flowering. Observations on the opening times of the parts of the perianth reveal that the flowers open shortly before 6 am and close at dusk. This phenomenon would mean that the moisture influence on the opening of the floral parts.

Passages of buds to open flowers and flowers to the formation of the first fruits are respectively two weeks and three weeks. Contrary to the results obtained by Vivien and Faure (1996) showing that *A. floribunda* flowers twice a year, all individuals bloom once during the same year.

All the individuals flower once during the same year. In the same way, the number of seeds obtained in the fruits of the species is contrary with those obtained by Vivien and Faure in 1996, results according to which *A. floribunda* produce between 40 and 100 seeds per fruit. Fruits carrying nine 09 seeds were found. This phenomenon could be explained either by a bad season of production or by the type of ground where these plants were met.

Morphology and fruit weight should naturally compel the barochory species, but whereas the action of rodents and possibly humans contributes inevitably to some extent, to seed dispersal of this plant. Chorology types such as zoochory and anthropochory respectively seem more justified.

Inventory of young plants in situ

Despite the fact that the seeds are consumed and carried by rodents in this case rats, porcupines, germination of A. floribunda is not affected. Histogram obtained on the diametric structure of plantings has good natural regeneration in the undergrowth (Fig. 6). This histogram shows many seedlings in class between 0-5 cm, which means that the species regenerates easily, but the survival of individuals is low. However, this does not translate into good regeneration easy germination because the young plants from seed found may have been introduced after several years. However artificial germination tests initiated by the World Agroforestry Centre (ICRAF) Yaoundé revealed that the seeds of A. floribunda difficult to germinate, it takes about 15 months to observe the first lifted. Similarly it was found that the seeds remain viable even after spending two years underground. This obstacle to germination could be explained by a non integumentary inhibition (as the epicarp is thin enough that no resistance to break through the radicle) but an internal inhibition in the plant.

Conclusion

A. floribunda is a plant whose small diameter individuals are more numerous at the starting stage, and then this number is decreasing gradually as the trees grow older. The species is evergreen; foliage remains green regardless of the climatic seasons. The species recruits among species average stratum of the forest. Heliophilous plant, *A. floribunda* flowers and fruits once during the same year. These phenomena are important in an open environment. In the forest, only the trees exposed to light following the opening of the canopy produce flowers and fruit. The species regenerates well in the undergrowth despite the attack of seeds by humans and animals.

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