

Beyond protective status; what next? Current knowledge  
on *Talbotiella*  
*gentii* (Hutch & Greenway), an endemic species in Ghana



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## Abstract

The study investigated current threats to survival and growth of *Talbotiella gentii*, an endemic species in Ghana. To be able to conserve the species effectively, it is necessary to understand the viability (density and altitudinal distribution) of current populations as well as the level of awareness of fringe communities on the global significance of the species.

The study was carried out in the Yongwa, Sapawusu and Bandai Hill forest reserves and fringes communities. Mature tree (DBH>5cm) density, diameter at breast height as well as regeneration densities were determined within twenty five (25) plots covering 2,500m<sup>2</sup> of area and laid through stratified random procedure in the study areas. Through a two-phase and stratified purposive sampling procedure, eighty two (82) individuals from eight (8) fringe communities were interviewed. An educational campaign was initiated also through field trips organized for school kids.

Results show that most people know the species and its relevance to their community in terms of medicinal uses, charcoal production use etc; they however do not have any idea on the global significance of the species. Among the three study sites, while regeneration density was highest (1284.80/100m<sup>2</sup>: STD 2723.84) in the Bandai Hill forest reserve, mature tree density (2.4/100m<sup>2</sup>; STD 1.45) was lowest. Extraction of stem and branches for fuel wood and charcoal production as well as wildfire were identified as the major threats to species. The educational campaign initiated was quite successful which saw the participation of about a hundred and eighty (180) school pupils.

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## Table of Content

List of Figures	4
List of Tables	5
List of Plates	5
1.0 Introduction	6
1.1 Objective	7
1.2 Structure of Report	7
2.0 Materials and Methods	7
2.1 Study Site	7
2.1.1 Bandai Hills Forest Reserve	7
2.1.2 Sapawsu Forest Reserve	8
2.1.3 Yongwa Forest Reserve	8
2.2 Data Collection	8
2.2.1 Reconnaissance Survey	8
2.2.2 Research and Sampling Design	9
2.3 Analysis of Data	10
3.0 Results	11
3.1 Interviews	11
3.1.1 Knowledge on <i>Talbotiella gentii</i>	12
3.1.2 Use of the species	12
3.1.3 Abundance and distribution of species	12
3.2 Results – Inventory	13
3.2.1 Species Density	13
3.2.2 Species Distribution	14
3.3 Results – Educational Campaign	15
4.0 Discussion	18
5.0 Conclusion	20
Reference	21

## List of Figures

Figure 1: showing the plot layout given the elevation of the area	8
Figure 2: Depth of Respondents' Knowledge on <i>Talbotiella gentii</i>	12
Figure 3: Altitudinal distribution of DBH (cm) of species in the three reserves	15
Figure 5: Density of mature trees along altitudinal gradient	15
Figure 4: Altitudinal distribution of the regeneration in the three reserves	15

## List of Tables

Table 1: Characteristics of respondents	11
Table 2: Summary Parameters of Population	13

## List of Plates

Plate I: Researcher together with the District Director of the National Commission on Civic Education explaining the importance of <i>Talbotiella gentii</i>	15
Plate II: A section of the school pupils from Adjenador nor L/A primary school	15
Plate III: Teacher making notes during the outreach so as to pass on to their pupils (they were all in RUFFORD T' shirts)	15
Plate IV: A section of the school pupils from Yongwasi L/A primary and J.S.S	16
Plate V: Group photograph with Head teachers, teachers and Director of the National Commission on Civic Education (everyone in RUFFORD T-shirt)	18
Plate VI: Group Photograph with the teachers and school pupils from Yongwasi L/A school	18

## 1.0 Introduction

'The accelerating and potentially catastrophic loss of biotic diversity is unlike other environmental threats because it is irreversible' Mittermeier *et al* (1998). Loss of biological diversity is worldwide (MES, 2002) but biodiversity is by no means evenly distributed (as some areas are far richer than others in overall diversity and endemism), concerted local effort is needed therefore to address this issue at various local scales. Further to this and as pointed out by Mittermeier *et al* (1998), many of the richest areas also happen to be under the most severe of threat as is the case in many tropical regions of the world. West Africa was reported to have the highest rate of forest loss on the continent of Africa with the most rapid forest clearance of between 1.3% and 1.5% occurring in countries including Ghana (FAO 1997; WRI 1994). Habitat and forest loss has quite serious implications for biodiversity (Barbier *et al.* 1995). As a recognized global threat, several conventions notably the Convention on Biological Diversity (CBM) have been signed as a first step in reversing loss of biological diversity (Amissah, 2005). As Ghana is a signatory to especially the CBM, it is enjoined to undertake local actions aimed at addressing local biodiversity loss issues.

In September 1999, together with development partners, the Forestry Commission of Ghana launched the natural resources management programme which is "a three-phase ten-year investment programme" (Forestry Commission of Ghana, 2007). The programme among others was to undertake enhanced conservation of globally significant biodiversity in forest reserves and national parks through some protection strategy. One of the components of this project was therefore the biodiversity project which focuses on areas of high floral diversity determined through index of concentration of rare plants (Genetic heat index) in an area. These areas were excluded from timber exploitation and designated as Special Biological Protection Areas referred to as Globally Significant Biodiversity Areas, GSBA's. Some of these areas included places where *Talbotiella gentii* Hutch & Greenway occurs.

According to IUCN (2008), *Talbotiella gentii* is a critically endangered (A1c, B1+2c, ver 2.3) gregarious living perennial legume based on investigations by Hawthorne (1998). Hall and Swaine (2004) referred to the species as one with the highest conservation priority in Ghana. Even though there were some reports on the species from Cameroon, 'Records from Cameroon appear to be erroneous' according to Hawthorne (1998). The species therefore has limited geographical distribution and is endemic to Ghana. In Ghana, this evergreen tree is known to occur in tiny stands in rocky areas of three dry forests including Sapawusu, Yongwa and Bandai Hill forest reserves. Use is made of the wood for timber, fuel wood and charcoal production for many fringe communities.

About ten (10) years into the implementation of protection measures for the species (Globally Significant Biodiversity Area, GSBA), data on species recovery, growth, abundance and distribution is unavailable. It is not known what the current threats to species survival, growth and propagation are and whether much more needs to be done to save the critically endangered species. Data is very scanty

on the level of local awareness on the global significance of the species and the need for local communities to protect the species.

## **1.1 Objectives**

This study therefore investigated and documented current status of the species, including density, threats to species survival and also local level of awareness on the global significance of the species.

Specifically the study;

- determined local knowledge on the global significance of the species
- investigated the density and altitudinal distribution of the species in the study areas
- identified the threats to species survival and growth
- initiated educational and awareness creation programme for school pupils in fringe communities

## **1.2 Structure of Report**

The report has the following components

- A background and an introduction to the project leading into the objectives of the study
- Methodology employed in addressing research objectives
- Results section which states the findings of the project
- A discussion section interpreting the results and making relevant deductions from observations
- A conclusion of the discussion and recommendations for future research and activities regarding the species and study sites

## **2.0 Materials and methods**

### **2.1 Study Site**

The study was carried out in the Somanya and Juaso forest districts in Ghana. Within the Somanya forest district, Yongwa and Sapawsu forest reserves and fringe communities were the study sites while within the Juaso forest district, the study was carried out in the Bandai Hills forest reserve and the Abiriwapon community.

#### **2.1.1 Bandai Hills Forest Reserve**

The Bandai hills forest reserve (within the Juaso forest district) is within the dry semi deciduous forest zone of Ghana, located by the co-ordinates 06° 48.00' North and 000° 55.00' West. It covers an area of 16,080ha and as part of the biodiversity component of the natural resources management programme embarked upon by the Ghanaian forestry commission, 1,403ha of the reserved area was designated as globally significant biodiversity area (GSBA) in 1999 (FC, 2007).

### 2.1.2 Sapawsu Forest Reserve

This reserved area is located in the Somanya forest district within Latitude 06° 16' 0 North and longitude 00° 1' 0 East and covers an area of 1,550ha in the Southern Marginal Zone. More recent personal communication from M. D. Swaine (2006) however puts the area under the south-east outlier forest type. *Talbotiella gentii* has being reported to cover 37.8ha of the main block of the reserve area and a further 19ha in the extension area (Nose *et al.*, 1992) but the study was restricted to the main block.

### 2.1.3 Yongwa Forest Reserve

Also located in the Somanya forest district between latitudes 06° 10" North and longitude 00° 03' West, the reserve covers an area of 780ha in the south-east outlier type of forest. Amissah (2005) however reported that the reserve belongs to the southern marginal forest type based on personal communications from M. D. Swaine (2006). Stands of *Talbotiella gentii* are mainly located in the western side of the reserve and cover an area of 134ha (Nose *et al.*, 1992).

## 2.2 Data Collection

### 2.2.1 Reconnaissance Survey

The study started with a reconnaissance survey aimed at obtaining first hand information on the structure of the forest which will aid in the finalization of the inventory methodology and also meant to meet with and establish rapport with community members. The selected site for this pre-survey was the Sapawsu forest reserve and its fringe communities. During this period, tree diameter at breast height (DBH) and total height were determined for all species with DBH above 5cm within six (6) plots each of size 10m x 10m. Plots were laid randomly along the elevation strata such that they reflected the gradient of the reserve as illustrated in figure 1 below.

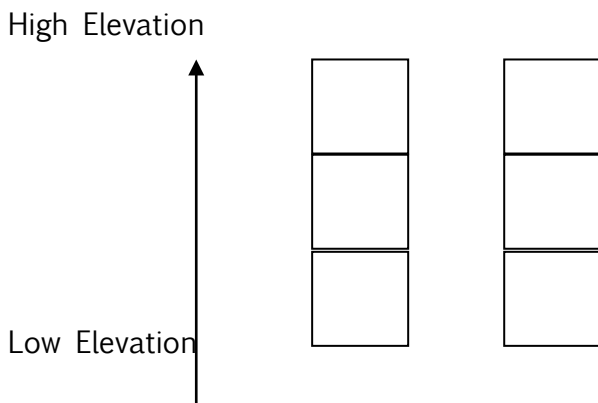


Figure 1: showing the plot layout given the elevation of the area

Besides height and diameter measurements, trees with DBH below 5cm were considered regeneration and counted within the demarcated plots. The density of both mature and regeneration was determined using the equation (1) below

$$\text{Density (d)} = \frac{\sum n_i}{A_i} \dots\dots\dots(1)$$

Where  $n_i$  is the number of observations in the  $i$ th plot



And  $A_i$  is the area in square meter of the  $i$ th plot

Some of the observations made during the reconnaissance survey which informed and shaped the main study include:

- *Talbotiella gentii* occurred largely as a mono crop and in determining the viability of the stand, plots each of size 100m<sup>2</sup> well distributed along the elevation gradient was enough to secure an idea of the viability of the population
- Height measurement was quite difficult as it was challenging locating the exact tip of the tree given that there is profuse branching besides the seemingly closed canopy. This was therefore abandoned in the main study
- Identification of Trawa and Yongwasi as fringe communities of the Yongwa forest reserve and Kokono, Pupuni, Sapaw, Adjenadonor and Tawtibo for the Sapawsu forest reserve. Abiriwapon community was also identified for the Bandai hill forest reserve.
- Identification of fringe communities members and other persons who had previously assisted with similar projects

The main study proceeded after the completion of the reconnaissance survey

### 2.2.2 Research and Sampling Design

The main study was undertaken in three phases; an *interview phase* to determine local knowledge on species abundance and distribution, threats to survival from local people's perspective and also the level of local knowledge on the global significance of the species. This was followed by an *inventory phase* aimed at determining the structure and viability of *T. gentii* populations. Finally an *educational awareness campaign* was embarked upon to introduce school children and teachers to the global significance of the species and the need to protect it.

#### *Interview Phase*

Through a two-stage and stratified purposive sampling procedure, selected individuals from identified and selected fringe communities of the studied reserves were interviewed. For each reserve, communities were selected due to their proximity to the reserve and from selected communities, individuals were interviewed based on geographical location within selected communities such that a representative sample of the community can be obtained as far as selection of respondents is concerned. Twenty five (25) individuals were interviewed from Trawa and Yongwasi; both communities in the fringe of Yongwa reserve. Another twenty five (25) individuals were interviewed in the Abiriwapon community close to the Bandai Hills Forest Reserve. From five (5) fringe communities of the Sapawsu forest reserve including Kokono, Pupuni, Sapaw, Adjenadonor and Tawtibo, thirty two (32) individuals were interviewed. Table 1 has details on the characteristics of respondents in this study.

#### *Inventory Phase*

Stratified random sampling procedure was employed in laying twenty five (25) plots in the study area; four (4) plots within the Sapawsu forest reserve, six (6) plots within the Yongwa forest reserve and fifteen (15) within the Juaso forest

reserve. Since the stands were purely natural and monocropic and variations were low as was observed during the reconnaissance survey, plot sizes were 10m x 10m. Within each plot, the GPS coordinates of the plot centre, elevation of plot determined at the plot centre as well as tree diameter at breast height (DBH) for all individuals with DBH of 5cm and above. Diameter was measured using diameter tape while the elevation and co-ordinates of plot centre taken using GPS Garmin II. Individuals with DBH below 5cm were recorded as regeneration and their density determined.

### *Educational Campaign Phase*

During this phase, schools were selected purposively within the selected communities and in each school particular classes/stage of students were selected for the field trip in consultation with the Heads of school and the District Director of the National Commission on Civic Education. School pupils in the upper primary i.e. classes 4, 5 and 6 together with their senior colleagues in the Junior high schools were selected for the field trip.

Adjenadonor and Sapaw L/A primary schools were selected for the educational trip to the Sapawsu forest reserve. A total of about a hundred and fifty (150) school pupils, four (4) teachers and two (2) heads of schools together with the District head of National Commission on Civic Education (NCCE) and a staff from the local forestry office participated in the programme.

In the Yongwa reserve area, about thirty (30) school pupils from Yongwasi L/A primary school took part in the educational campaign. The Head of school and a teacher accompanied the pupils up the hill into the forest. Also present were staff of the local forestry office, District Director of NCCE and some members of the community.

## **2.3 Analysis of Data**

The characteristics of the respondents were described in terms of percentage of response and results tabulated. Characteristics of respondents e.g. gender, family size etc were summarized and grouped based on the reserve which the communities were close to. Responses to the species-related questions e.g. knowledge on *T. gentii* were analyzed as a single data and not along reserve lines. Data from inventory was considered and analyzed at plot levels and therefore mean values were determined for each plot and then used as single values for stand graphs and correlation tests. For instance at the Bandai hill forest reserve, 25 plots were laid, therefore 25 mean values for tree DBH, regeneration density, elevation, GPS co-ordinates were used for further analysis at the Bandai Hill stand level.

Density of the regeneration and mature tree populations within all three reserves were determined using the equation (1) above. Linear correlation and simple regression tests from MS Excel were determined between various parameters including: altitude and mature tree densities, altitude and regeneration densities

and also between regeneration density and mature tree density. Correlations tests were conducted on reserve/stand level data as well as for all three reserves data pooled together. Educational campaign is presented in narrative with photographs taken during the process.

### 3.0 Results

#### 3.1 Interviews

This section presents the results from the interviews conducted. The objective of the interview was to determine the level of knowledge of fringe community members on species significance, changes in abundance and perceived threats to species survival

**Table 1: Characteristics of respondents**

Parameter	Categories	Percentage (Respondents)		
		Yongwa	Sapawusu	Juaso
Sex	Male	64.00	43.75	68.00
	Female	36.00	56.25	32.00
Age (years)	Young ( $\leq 18$ )	16.00	0.00	0.00
	Young Adult (19-35)	32.00	41.94	44.00
	Adult (36-55)	36.00	22.58	32.00
	Aged ( $\geq 55$ )	16.00	35.48	24.00
Educational levels	no	28.00	50.00	32.00
	basic	44.00	34.38	40.00
	secondary	20.00	12.50	28.00
	tertiary	8.00	3.13	0.00
	vocational	0.00	0.00	0.00
Occupation	farmer	68.00	71.88	100.00
	fisherman	4.00	0.00	0.00
	labourer	0.00	0.00	0.00
	teacher	16.00	3.13	0.00
	unemployed	4.00	0.00	0.00
	trader	8.00	31.25	0.00
	retired	0.00	6.25	0.00
	Other (seamstress, student & weaver)	8.00	3.13	0.00
Civil Status	married	79.17	93.75	92.00
	single	20.83	6.25	8.00
family size	$\leq 3$	28.57	3.13	26.09
	4 to 5	23.81	43.75	60.87
	$\geq 6$	47.62	53.13	13.04

Much more males were interviewed in the Yongwa and Bandai Hill fringe communities compared to the Sapawsu fringe communities where the male to female ratio of respondents were almost one (1). While there was almost an even distribution in the age of respondents within the Yongwa fringe community, there was no respondent in the 'young' category within the Sapawsu and Bandai Hills fringe community. It can also be observed from the table 1 above that 50% of all respondents in the Sapawsu fringe community had no formal education. Most of the respondents are farmers who are married and this is common to all fringe communities of the three reserves.

### 3.1.1 Knowledge on *Talbotiella gentii*

About 69% of respondents indicated and demonstrated that they have an extensive knowledge of the species implying they knew that the species existed and some of its uses. As shown in figure 2 below, it was however interesting to realize that only 7% of respondents knew something about the global relevance of the species in terms of its endemism (intensive knowledge).

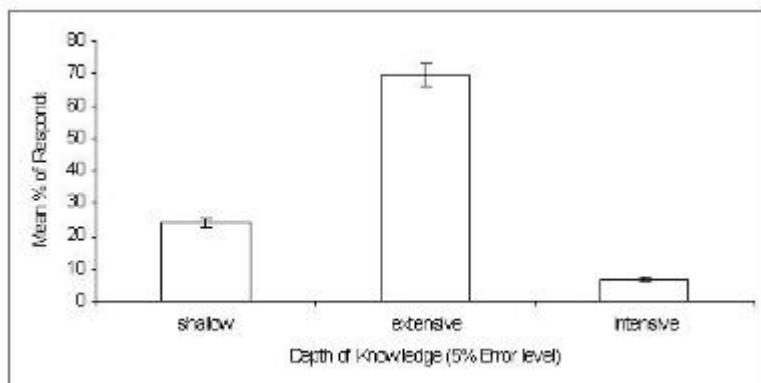


Figure 2: Depth of Respondents' Knowledge on *Talbotiella gentii*

### 3.1.2 Use of the species

About 85% (STD: 16.8) of the respondents who demonstrated an extensive knowledge on the species indicated they find the species useful in some regards. While 26% (STD: 19.5) used the species only in the past, 74% (STD: 19.5) of the respondents still actively use it mainly (63%, STD:17) for fuelwood and charcoal. Other substantial uses included timber (10%, STD: 8.6), medicinal purposes (13%, STD: 7.8) and for mortar and pestle (14%, STD: 21). Stems (52%, STD: 31) and branches (53%, STD: 22) are mainly used for the stated purposes extracted at monthly (75%) time intervals within the fringes of Yongwa reserve. Within the fringe communities of Sapawsu reserve however, extraction was carried out occasionally (70%) while within the fringe community in Bandai Hills, it was on weekly (41%) basis as well as occasionally (36%).

### 3.1.3 Abundance and distribution of species

Most (85.5%, STD: 15) of the respondents have recognized a decrease in the abundance and distribution of the species. Fire was mentioned as the major cause (97%, STD: 3.6) of the reduction while some respondents (35.6%, STD: 22.7)

attributed it to harvesting (for charcoal and fuelwood) and yet others say it's due to removal during land preparation (9.8%, STD: 9) for cultivation and also the need for pestle and mortar (5.5%, STD: 3.9). In proposing measures to deal with the problem, there was a high push for research and awareness creation (44%, STD: 30.8) and also an increased punishment (65%, STD: 21.7) for culprits found violating the conservation laws. The idea of supplementary planting was also mentioned by a section of the respondents (17.5%, STD: 15.8) while others advocated for better protection measures against fires (20%, STD: 31).

### 3.2 Results – Inventory

The section involves the inventory component of the study and attempts to answer the question, what is the density and altitudinal distribution of current populations?

#### 3.2.1 Species Density

It can be observed from table 2 as well as from figure 4 and figure 5 that mean density of regeneration was highest in the Juaso district compared with those of the Sapawusu and Yongwa forest reserves. Mean density of regeneration was lowest in the Yongwa forest reserve. It must be added that much more variation exists in the Bandai Hills regeneration among plots than was the case for the other reserves.

Mature tree (DBH>5cm) densities was observed to be lowest in the Bandai Hill forest reserve with about 240trees/ha compared to about 1,083trees/ha in the Yongwa forest reserve. Highest within stand variation in tree population was observed in the Sapawusu forest reserve.

**Table 2: Summary Parameters of Population**

		Mean	Standard Deviation (STD)
Mature Tree Density/100m <sup>2</sup>	Yongwa FR	10.83	2.99
	Sapawusu FR	10.25	6.13
	Bandai Hill FR	2.40	1.45
Density of Regeneration/100m <sup>2</sup>	Yongwa FR	62.67	127.34
	Sapawusu FR	104.75	163.72
	Bandai Hill FR	1284.80	2723.84
Diameter at Breast Height (DBH)	Yongwa FR	16.14	2.70
	Sapawusu FR	19.05	7.71
	Bandai Hill FR	26.73	14.25

Trees within the Bandai Hill forest reserve had the highest mean DBH but with the highest within stand variations (STD: 14.25) as can be inferred from table 2. Within

the Yongwa forest reserve, mean DBH of 16.14cm (STD: 2.7) was lowest observed among the three studied reserves.

Linear correlation test to verify if mature tree population densities was a reflection of the density of regeneration showed that within the Sapawusu reserve there was a significant negative correlation ( $r=-0.99$ ) between densities of regeneration and mature trees. This relationship was however negatively weak ( $r=-0.15$ ) within the Yongwa reserve and positively weak ( $r= 0.35$ ) within the Bandai Hills reserve.

### 3.2.2 Species Distribution

The distribution of *T. gentii* along the altitudinal gradient of the reserves is illustrated in figure 3, 4 and 5. While species within the Sapawusu and Bandai Hill reserves occur below 800ft, it was observed that in the Yongwa forest reserve, species occurred at over 1000ft. As indicated also earlier, the largest trees at breast height were found at the Bandai Hills reserve and were located at about 600ft above sea level. The plot with the least mean DBH of 12.41cm was found at 1160ft above sea level in the Yongwa forest reserve. There was a plot with no tree in the Bandai Hill reserve which appears as an outlier in the graphs below.

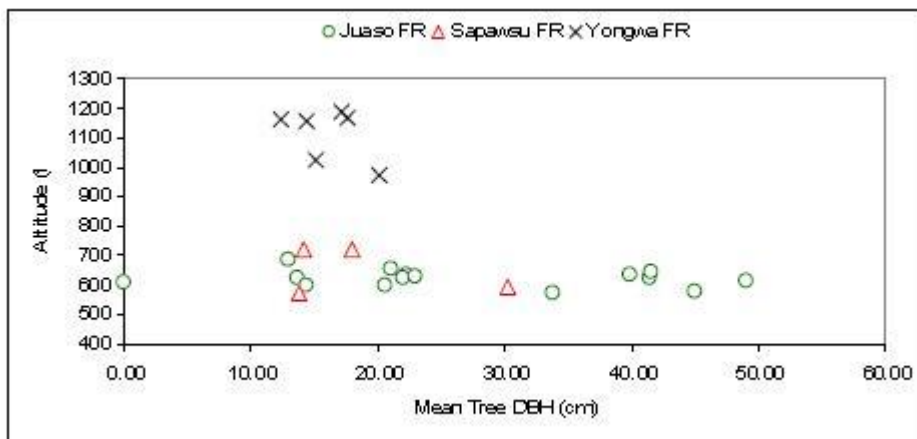


Figure 3: Altitudinal distribution of DBH (cm) of species in the three reserves

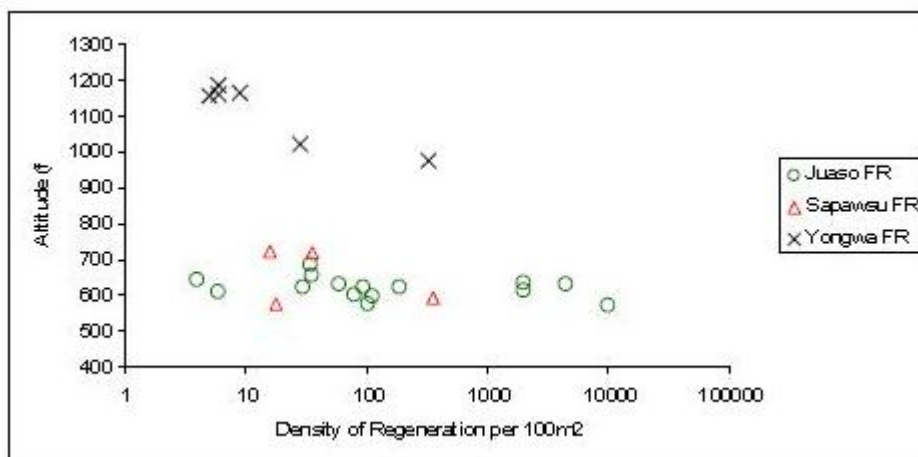


Figure 4: Altitudinal distribution of the regeneration in the three reserves

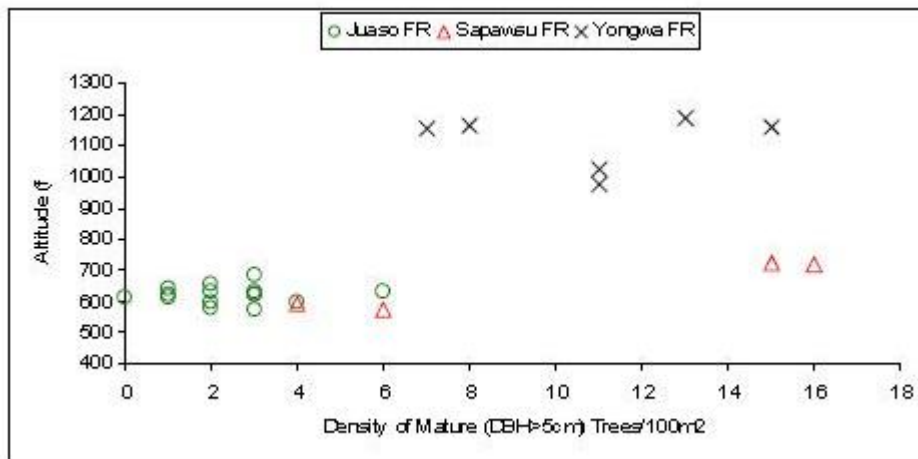


Figure 5: Density of mature trees along altitudinal gradient

The density distribution of mature tree species as can be inferred from figure 5 shows that the Yongwa stand was quite highly populated among the three reserves with all the trees occurring between 975ft and 1188ft above sea level. Bandai Hills reserve had the least variation in altitude of about 113ft between the lowest end and the highest ends where plots were laid.

Correlation tests performed revealed that within the Yongwa reserve, altitude was significantly ( $p < 0.05$ ) and negatively ( $r = -0.79$ ) correlated with regeneration density indicating that the further higher one goes, the lesser the tendencies for high regeneration. This was observed for all two other reserves except that the relationship was significant ( $\alpha = 5\%$ ) only within the Yongwa reserve. Within the Sapawusu reserve, mature tree density had a significant ( $p < 0.05$ ) positive correlation ( $r = 0.97$ ) with altitude illustrating that as one moves higher up the hill, tendencies of finding more mature trees per unit area is higher compared to lower elevations. This finding was true also for Yongwa and Bandai Hill reserves except the linear relationship was weak (insignificant).

### 3.3 Results – Educational Campaign

The aim was to initiate education and awareness creation on the species within fringe communities through field trips for school pupils.



Plate 1: Researcher together with the District Director of the National Commission on Civic Education explaining the importance of *Talbotiella gentii*

School pupils were taken to the forest to see the tree species in question and to be able to identify by themselves. Before the section of lecture each time, there was always an initial brain storming period, with the aim to identify what the kids knew about the tree so as to know where to begin the awareness from. It was always interesting to find that many of the kids knew the local name of the tree and could tell some uses of the tree.

Medicinal use was the most commonly mentioned by kids.



Plate II: A section of the school pupils from Adjenadornor L/A primary school

After the brain storming exercises, pupils were taught the different parts of the tree including roots, stem, leaves with the aim to help them identify the tree with those parts. The local as well as global significance of the species was explained so as to get across the message of the species status as endemic. They were informed on the consequences, if all the species was lost completely such as rock fall which could kill them as they live right in the valley of those hills, complete list of the species from the globe as it is known to be endemic to Ghana etc.



Plate III: Teacher making notes during the outreach so as to pass on to their pupils (they were all in RUFFORD T' shirts)





Plate IV: A section of the school pupils from Yongwasi L/A primary and J.S.S

The school pupils were asked to carry the message to their friends and parents and to inform them of what they have learnt. There were periods of questions and discussions after each lecture and it was interesting some of the issues discussed with the kids and their teachers. Below were some of the issues that came up.

- *“if we tell our parents they will ask, we have been using this tree for long before your birth and you think you know better than we do telling us to conserve it, so it would be necessary to engage them in an awareness creation as well”*
- *“whether extracting roots for medicinal purposes wouldn’t lead to reduced stability hence reduced ability to check rock fall”*
- *“since the tree has medicinal values, strictly protecting it would mean depriving communities of health care”*
- *“plant more seedlings to expand the reserve size given its global importance”*
- *“whether planting of seedlings in lower elevations would be successful since it occurs only at on hills”*
- *“which soil is best for the propagation of the seedlings”*
- *“why the agricultural services is not encouraging farmers to grow *Talbotiella gentii* but rather *cassia/Leucaenia* etc”*

After the discussions, school kids were asked what they have learnt so as to obtain some immediate feedback on the campaign exercise. The kids were quite excited about the lecture and demonstrated some level of new knowledge acquisition. Pencils, Books and bar soaps (to help wash off the dirt in their uniform after the trip) were distributed to participants (school kids and teachers) at the end of each field trip.



Plate V: Group photograph with head teachers, teachers and Director of the National Commission on Civic Education (everyone in RUFFORD T-shirt)



Plate VI: Group Photograph with the teachers and school pupils from Yongwasi L/A school

#### 4.0 Discussion

Species decline has been largely an open knowledge and respondents in this study have confirmed their observation of this decline. Indeed, overwhelming majority (85.5%, STD: 15) of fringe community members interviewed alluded to this fact as also reported in earlier study (92.5%) by Amissah (2005). The importance of the designation of the study areas as globally significant biodiversity areas with the aim of protecting the species and reversing further decline can therefore not be overemphasized. The major cause of this decline as stated by respondents (97%, STD: 3.6) was wild fire as reported in earlier section of this report. But while the major cause of decline was identified as fire (as was also reported in earlier study by Amissah (2005), it was interesting to find out that 74% (STD: 19.5) of respondents who know some uses of the species still actively exploit the species. The question that comes to mind is therefore would be what is obtained from the reserves and to what extent do they extract these products or services? And what was the frequency of extraction?

The study observed that a good number (63%, STD: 17) of respondents with knowledge on species usefulness extract the species for fuel wood and charcoal while a few others (13%, STD: 7.8) use it for medicinal purposes and also for mortar and pestle (14%, STD: 21). As also stated earlier in this report, tree stems (52%, STD: 31) and branches (53%, STD: 22) were mainly extracted for these uses. Even though many respondents couldn't provide tentative figures on amount

extracted each time, it was observed that frequency of extraction varied among fringe communities of the three study reserves. Frequency of extraction was largely weekly (41%) among fringe community members of Bandai Hills, monthly in Yongwa (75%) while occasionally (70%) among the fringes of Sapawsu reserve. With this background knowledge, one could slowly hasten to deduce that extraction of stems and branches for charcoal and firewood etc could be a major cause of decline. A further cautious deduction could be that given the relative high extraction rate within the Bandai Hills reserve, it should present the worst of scenarios as far as state of the resource was concerned comparing all three reserves under study.

The study therefore carried out an inventory of the three reserves with the objective to verify the abundance and distribution pattern of species. Inventory results show that even though Bandai hills recorded the highest regeneration intensity per unit area (Table 2) among the three studied sites, it recorded the lowest mature tree population of 240trees/ha compared to about 1,083trees/ha in the Yongwa forest reserve and 1,025tree/ha in the Sapawsu reserve. Probably due to the relative paucity of trees within the Bandai reserve, mean DBH was highest compared to the other sites.

One can therefore cautiously say that given the relative high extraction frequency within the Bandai fringe community and the low density of mature trees relative to the high regeneration intensity, anthropogenic influences cannot be placed on a low key as far as species decline in this reserve is concerned. While wild fires and human extraction remain serious threats to species status, it can be clearly observed the severity in Bandai Hills is higher compared to those of Sapawsu and Yongwa reserves and generalizations might prevent identification of particular threat factors at play at particular site. Knowledge on the tree extraction quantities at various fringe communities and also on fire frequency would be useful in understanding their relative importance as far as species decline is concerned.

*Talbotiella gentii* is known to occur in elevated areas and on rocky slopes. This was true for all the three study sites but the question of whether altitude has any significant influence on species distribution and or abundance is not known. The study has observed that the further higher up the hill one goes, the lesser the tendencies for regeneration (Figure 4). This was true for all the three reserves demonstrating that regeneration was influenced by altitude. This observation could be attributed the increased rockiness of the reserves up the hill. As one moves up the reserve it can be observed that rocks are more abundant and much larger compared to those at lower elevations and these might have reduced or impeded regeneration as available soil area reduces.

Mature tree population density variation with altitude was an interesting observation also. Significant ( $p < 0.05$ ) positive correlation observed within the Sapawsu reserve and similar but weak linear correlation in the other reserves studied imply that as one moves higher up the hill, tendencies of finding more mature trees per unit area was higher compared to lower elevations (figure 5).

This could be due to the fact that at lower elevations, extraction of trees was easier and therefore more frequently and or intensively carried out compared to higher elevations. Given the earlier observation that regeneration intensity was higher at lower elevations where mature tree population was relatively less dense, one could say that light might be an important factor for regeneration of the species. Since at lower elevations, canopies might be relatively open compared to higher elevations where denser populations of mature species occur and therefore canopies would be relatively closed.

When asked what could be done to improve the current status of the reserves, a good number of the respondents (65%, STD: 21.7) called for an increased punishment for culprits found violating the conservation laws while 44% (STD: 30.8) thought research and awareness creation might help deal with the species decline. It must be stated that earlier study carried out by Amissah (2005) made similar observations. While law enforcement lies solely with the forestry commission, educational campaigns could be organized to supplement any regular plans the commission might have in this direction. Indeed education was quite necessary as only 7% of respondents knew something about the global relevance of the species in terms of its endemism (figure 2). The educational campaign component of this study was fashioned in a bottom-up approach, so school kids who represent future residents of those communities would transfer the awareness message to their parents. As pointed out earlier, Bandai Hills seemed to be in a relatively dire situation as current population of mature trees do not reflect the quantum of regeneration and woefully compares with tree densities in the other two reserves. An intensified educational campaign in the fringe communities of Bandai Hills reserve would therefore be crucial to improve the situation as law enforcement activities are also improved.

## **5.0 Conclusion**

While wild fire and extraction by humans for charcoal and fuel wood were responsible for species decline at stand level, altitude influenced species densities and distribution within stands. It would be interesting to know the level of tree extraction in fringe communities and also the frequency of fires as this would help understand their relative importance and therefore address the threat factor more effectively. Regeneration is quite satisfactory in all three reserves but retention rate is woefully low within the Bandai Hill reserve. Knowledge on the global significance of the species is extremely low even though most people could tell some uses of the tree at the community level. While embarking on an intensified educational campaign within fringe communities, improved law enforcement might help in species protection.

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