

Research Article

Prevalence of Seed-dispersers in a Semi-deciduous Forest of Ghana

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Abstract: Seed dispersal is a necessary process for plant reproduction. The research seeks to give an overview of mammals and birds that exist and utilize a plantation in the semi-deciduous forest. The questions asked in this regard are: (1) which native mammalian fauna and or birds utilize the plantation area (2) what ecological roles do the mammals/bird play (3) Do different bird species inhabit the various vegetation types within the plantation. The study was carried out on a private plantation (7°3' N and 1°34' W) 42 km north of Kumasi, the Ashanti region, Ghana. An indirect questionnaire method was used to estimate the distribution of mammalian species that are good seed dispersers. Interviews were conducted with a total of 9 hunters in two near-by villages bordering the plantation area. The point count method was used for the bird survey, because it was easy to gather large amounts of data within a short period of time. A total of 45 counting stations were located in the plantation for the point count survey. Based on the evaluation of the questionnaire, eleven of the mammals were found in or around the plantation. A total of 32 bird species were sighted in the general bird survey and the point count sampling. The similarity of bird species in the remnant natural forest compared to the agro forestry area was 0.21, while that for the remnant natural forest compared to the actual plantation area was 0.18 using the Jaccards index. However the Shannon diversity index for birds calculated for the remnant natural forest was 1.682 while that of the actual plantation area and agro forestry areas are 1.693 and 2.074, respectively. It was concluded that seed-dispersal mammals and birds occurred on the plantation.

Keywords: Birds, mammals, natural forest, plantation, seed-dispersers

INTRODUCTION

Dispersal is a crucial process for plants at several scales, because it connects end of the reproduction cycle of adult plants with the establishment of their offsprings (Lorts *et al.*, 2008). Seed dispersers therefore play an important role in not only regeneration but also plant species diversity. There will be negative consequences for plant populations if the dispersal process is absent or impaired (Cordeiro and Howe, 2003; Guimaraes *et al.*, 2008). Seed dispersal generally involves the removal and deposition of seeds away from parent plants (Terborgh *et al.*, 2008). Success of flowering plants is greatly dependent on effective seed dispersal though specific fruit types support different mechanisms of seed dispersal (Lorts *et al.*, 2008). Despite the fact that tropical trees vary in their ability to disperse seeds, theories of tropical tree diversity emphasize dispersal limitation as a potential mechanism for separating species in space and reducing competitive exclusion (Seidler and Plotkin, 2006).

Mammals are excellent indicators of biodiversity and state of a habitat and represent an important

biological and functional component of tropical forest ecosystems (Hunter, 1996; Davies and Hoffmann, 2002). Large seeds have been found to co-evolve with particular animal dispersers (Harrington *et al.*, 1997) since plant-mammal interactions are inevitable in ecosystems. Mammals are also important vectors of seed dispersal; the elephant a typical example (Sayer *et al.*, 1992). They play a crucial role in the ecology of tropical forests, especially in the reproductive biology of flowering plants through activities such as pollination, seed dispersal and predation (Harrington *et al.*, 1997). Auffret (2011) reported grazing animals as important propagule dispersers. Local extinction of a fruit-eating bird, bat or primate might, for instance diminish recruitment of fruiting trees dependent upon it for reproduction and therefore increases the chance of local extinction of the focal trees, of other animals that eat their fruits and eventually of other trees dispersed by members of the initial assemblage (Howe, 1984).

Birds are important indicator species that exhibit characteristics that give insights into a local environment without having to study the local environment itself. The suitability of a habitat for birds

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is a good indicator of the ecosystem condition and its functioning. Indicator species are species whose abundance can predict some characteristic of the ecosystem (Johns, 1997). Birds also play an important role in seed dispersal. Furthermore they can easily be detected as they are often brightly colored, relatively easy to see and highly vocal. Sutherland (1996) argues that birds are perhaps the easiest of animals to census as a result of which they are the most frequently censused of all taxa. This has therefore led to reliable data bases for birds in the form of field guides. There are also many professionals with high level of identification skills. Rappole *et al.* (1993) remark that birds indicate their presence vocally and therefore many bird species are best detected in this way. Seed dispersal may assist seeds to escape predation (Howe, 1984; Sekercioglu *et al.*, 2004) and hence control plant reproductive success and spatial distribution (Terborgh *et al.*, 2002; Jansen *et al.*, 2004).

Germination and growth away from a mother plant as a result of dispersal, allows opportunities to find advantageous areas to inhabit, in addition to avoiding unfavorable conditions around the mother plant such as inbreeding and sibling competition (Willson and Traveset, 2000). This research seeks to give an overview of the existence of mammals and birds on a plantation site. The questions asked in this regard are:

- Which native mammalian fauna and or birds utilize the plantation site?
- What ecological roles these mammals/birds play in the plantation site?
- Do different bird species inhabit the various vegetation types within the plantation?

These are very essential given the ecological role of birds and mammals to forest regeneration and plant species diversity.

MATERIALS AND METHODS

Study area: The study was carried out on a privately owned plantation (7°3' N and 1°34' W) 42 km north of Kumasi, the Ashanti regional capital of Ghana. The region is located in the semi-deciduous forest zone (Hall and Swaine, 1981) with soils that are comparatively rich in nutrients and ideal for the cultivation of cocoa and other cash crops. The identified soils in the plantation area are predominantly sandy and the cation exchange capacity indicates that the nutrient supply from the clay fraction and organic matter is adequate and appropriate for the cultivation of trees (Küster, 2003). The annual rainfall varies between 1200 and 1800 mm, respectively.

The plantation site covers a total area of 164 ha, which is grouped into four vegetation areas: the tree

Plantation Area (APA), grassland area, farmlands/Agro Forestry Area (AFA) and Remnants of Natural Forest (RNF). The grassland area was burnt by fires in previous years. The tree plantation area was afforested mainly with teak, to a lesser extent with pine (*Pinus oocarpa* Schiede ex Schltdl, *Pinus caribaea* var. *hondurensis* Morelet, *Pinus taeda* L. and *Cedrela odorata* L.). This area is divided in different planting blocks with planting periods from 1995 to 2003 (Ackermann and Küster, 2004).

Mammal species survey: An indirect questionnaire method was used to estimate the distribution of various mammalian species that are good seed dispersers of tree seeds. Interviews were conducted with a total of 9 hunters in two near-by villages bordering the plantation area. Colored pictures of mammals expected in the area were taken from Haltenorth and Diller (1985) and Kingdom (1997). These were shown to the hunters for identification in order to have a general idea of the variety of mammals that occur not only in the plantation area but in the whole region surrounding the plantation. All the 20 mammals selected were seed dispersers. The vernacular names of the mammals were asked to verify that the hunter knew the animal they were being questioned about. The place where the mammal was sighted was included in the questionnaire to estimate how close that is to the plantation. The time lapse from the date when the mammal was sighted was included in the questionnaire to get an idea whether the mammal still existed in the area or whether it was probably extinct. The ecological roles played by these animals were taken from literature (Kingdom, 1997; Grubb *et al.*, 1998; Hofmann *et al.*, 1999).

For the purposes of interpretation, the answer 'a few days' on the questionnaire implied the time period one day to one month. 'A few months' implied one month to one year and a few years implied one year to ten years. These time periods give an indication of the fact that a species still exists in and around the plantation or is extinct. The distance from the plantation where the mammal was sighted was interpreted as follows: Very close is a distance of up to 1.6 km radius around the plantation. Not too far implies a distance of 3.2 km radius around the plantation site and Very far implied a distance of 8.0 km radius around the plantation site. These distances were estimated by the author.

Bird survey: The point count method was appropriate, because it was easy to gather large amounts of data within a short period of time. Sutherland (1996) suggests this method as the most recommended in patchy habitats. This method can also be used outside the breeding season and the counting stations are relatively easy to allocate randomly. Birds were identified with the help of a native ornithologist and in

cases of doubt verified using the descriptions in Borrow and Demei (2010) and Fry *et al.* (1997, 2000). The study was carried out in only three vegetation strata namely: actual plantation stratum, agro forestry stratum and the remnants of natural forest.

Counting stations were located 100 m apart and fixed time periods of five minutes was spent at each counting station. Each point-count was used once. All birds located within 30 m diameter of the counting station were recorded. A total of 45 counting stations were located in the plantation which means 225 min was spent on the point count survey. The total distance covered in this survey was approximately 4.5 km. The survey was carried out during the early hours of 6:00 am to 9:00 am in the mornings and 4:00 pm to 6:00 pm in the evenings. Additionally a general bird survey was carried out during the other hours of the day in all the vegetation strata. During these time periods good observation posts were set up to observe any species of birds that passes. One to two hours was spent at these posts, noting the bird species that occur in the area.

Data analysis: To assess the relationship between bird communities in the sample areas, the Jaccards Similarity Index (Magurran, 1988) was calculated:

$$\text{Jaccards Index} = C/N1 + N2 - C \quad (1)$$

- N1 = The number of bird species in area one
- N2 = The number of bird species in area two
- C = The number of birds common to both sites

To assess the diversity of the various areas, the Shannon diversity index was used since the two populations were selected randomly from a larger population (Magurran, 1988):

$$H' = - \sum p_i \ln p_i \quad (2)$$

p_i = Is the proportional abundance of the i^{th} species = n_i/N

n_i = Number of individual bird species

N = Total number of birds

RESULTS

Mammal survey: The results from the questionnaire indicate at least 78% of all hunters interviewed (Table 1) have seen or killed all of the 20 mammals. Out of the 20 mammals, 5 have never been sighted near the area indicating that they are not in or around the plantation area. These are *Cercopithecus pestaurista* (Lesser white-nosed monkey), *Cercopithecus atys lunulatus* (White-naped mangabey), *Hystrix cristata* (African crested porcupine), *Gorilla gorilla* (Gorilla) and *Loxondonta africana* (African elephant). Based on the evaluation of the questionnaire, it can be said with 70% certainty that eleven of the mammals are found in or around the plantation. These are *Eidolon helvum* (straw colored fruit bat), *Hypsignathus monstrosus* (hammerheaded fruit bat), *Cephalophus niger* (black duiker), *Cephalophus maxwelli* (Maxwell's duiker), *Cephalophus dorsalis* (bay duiker), *Cephalophus sylvicultor* (yellow-backed duiker), *Genetta tigrina* (large-spotted genet), *Civettictis civetta* (African civet), *Tragelaphus scriptus* (bushbuck), *Epixerus ebi* (Palm squirrel) and *Atherurus africanus* (African brush-tailed porcupine). Table 2 illustrates the ecology of the selected mammals found in this research with reference to Kingdom (1997), Grubb *et al.* (1998) and Hofmann *et al.* (1999).

Table 1: The total of all the answered questions by the 9 hunters interviewed. 5 mammals have never been sighted in or around the plantation

Species	Have ever seen or killed this animal?		Where did you kill it?			When did you kill it?		
	Yes	No	Very close	Not too far	Very far	A few days	A few months	A few years
<i>Eidolon helvum</i>	9		8		1	6	3	
<i>Hypsignathus monstrosus</i>	8	1	7		1	4	2	2
<i>Lissonycteris angolensis</i>	4	5	4			2	1	1
<i>Cercopithecus lowei</i>	7	2			7		3	4
<i>Cercopithecus petaurista</i>	5	4						
<i>Cercopithecus atys lunulatus</i>	7	2						
<i>Gorilla gorilla</i>	8	1						
<i>Cephalophus Niger</i>	9		8	1		3	4	2
<i>Cephalophus maxwelli</i>	9		9			2	6	1
<i>Cephalophus dorsalis</i>	9		8	1		2	5	2
<i>Cephalophus sylvicultor</i>	7	2	6		1		5	2
<i>Loxondonta Africana</i>	9							
<i>Tragelaphus scriptus</i>	7	2	6	1	1	4	2	1
<i>Tragelaphus euryceros</i>	7	2	2	2	3			7
<i>Genetta tigrina</i>	9		9			3	5	1
<i>Civettictis civetta</i>	9		9				7	2
<i>Nandinia binotata</i>	6	3	5	1		1	3	2
<i>Hystrix cristata</i>	8	1						
<i>Epixerus ebi</i>	8	1	8			5	2	1
<i>Atherurus africanus</i>	9		9			1	7	1

Table 2: Ecology of mammals dispersers found to be in or around the survey area (Kingdom, 1997; Grubb *et al.*, 1998; Hofmann *et al.*, 1999)

Common name	Scientific name	Habitat	Diet/food
Straw-colored fruit bat	<i>Eidolon helvum</i>	Forest and savannah zones	Juices of various fruits are the preferred food, though this bat also feeds on the blossoms and perhaps young shoots of the silk-cotton tree (ceiba). It will eat directly into the fruit of the borassus palm and has the unusual habit of chewing soft wood, apparently to obtain moisture
Hammer bat	<i>Hypsignathus monstrosus</i>	Forest, common in swamps, mangroves and palms along rivers	Figs make up most of its diet, but this bat may also include the juice and soft pulp of mangos, bananas and guavas
Angola fruit bat	<i>Lissonycteris angolensis</i>	Tropical African lowland and highland forest	Fruits and flowers
Lowe's monkey	<i>Cercopithecus lowei</i>	Primary secondary and gallery forests	Mainly fruits; pulp of oil-palm seeds, figs, cola, baphia and garden fruits
Black duiker	<i>Cephalophus niger</i>	Prefer primary forest but adapts to secondary forests	Fallen fruits and flowers, leaves and herbs, buds, young shoots, grasses, herbs and berries.
Maxwell's duiker	<i>Cephalophus maxwelli</i>	Lowland and montane rainforest	Mostly fruits, but also foliage with traces of flowers. Preferred fruits are small berries. It also eats dry fallen leaves
Bay duiker	<i>Cephalophus dorsalis</i>	Lowland rainforest	Hard fibrous fruits, such as wild mango, kleinedoxa, treculia, chrysophyllum, strychnos and myrianthus
Yellow-backed duiker	<i>Cephalophus sylvicultor</i>	Rainforest, montane forest and the forest-savannah mosaics	Fallen seeds, fruits, berries and the bark of shrubs. Favored fruits include: waterberry, dog plum, yellow wood, forest stem fruits, African mangosteen, the duiker tree, raisin tree and the snake beans
Large-spotted genet	<i>Genetta tigrina</i>	Associated with riverine habitats	Eat a broad variety of food items including small rodents, birds, reptiles, fruits, and invertebrates
African civet	<i>Civettictis civetta</i>	Forested or partly forested areas	It consumes mainly wild fruit, carrion, rodents and insects
African palm civet	<i>Nandinia binotata</i>	Rainforest	They are omnivorous and highly opportunistic: they feed on the following fruits: musanga, uapaca, myrianthus and wild figs
Bushbuck	<i>Tragelaphus scriptus</i>	Forest edges or brushy cover associated with rivers and streams	Largely shrubs, leguminous herbs and growing grass. Also pods and fruits of many species
Bongo	<i>Tragelaphus euryceros</i>	Disturbed forest mosaics	Bongos are grazers and browsers. They typically eat leaves, flowers, twigs, thistles, garden produce and cereals. Additionally, bongos favor younger leaves, suggesting that high protein and low fibre content influence their plant choice
Giant squirrel	<i>Epixerus ebi</i>	Forest but largely terrestrial	Feeds mainly on plam fruits but also eats insects
African brush-tailed porcupine	<i>Atherurus africanus</i>	Rainforest	Fallen fruits, root tubers and stems, oil-palm, crab wood and ginger fruit preferably

Table 3: Ecology of potential seed dispersing birds encountered in the survey area (Borrow and Demey, 2010; Fry *et al.*, 1997, 2000)

Common name	Scientific name	Family	Food sources
Double spurred francolin	<i>Francolinus bicalcaratus</i>	Phasianidae	They are opportunistic feeders; predominantly vegetable material including: fruits, roots, green leaves, seeds, millet, corn, rice and peanuts
Splendid glossy starling	<i>Lamprotornis splendidus</i>	Sturnidae	Fruit eater
Common garden bulbul	<i>Pycnonotus barbatus</i>	Pycnonotidae	Wild and cultivated fruits; also flowers, nectar, insects and some seeds. They eat any fruit available including figs, guava, mango, trema, banana, apple, morida, macaranga and acacia spp
Grey hornbill	<i>Tockus nasutus</i>	Bucerotidae	Feeds mainly on fruits and insects, they are also plantain eaters
Black-and-white-tailed hornbill	<i>Tockus fasciatus</i>	Bucerotidae	Feeds mainly on fruits and insects, they are also plantain eaters
Green fruit-pigeon	<i>Treron australis</i>	Columbidae	Cultivated fruits including prunus, morus, raisins, banana and pawpaw. they also eat cereals and wild grass
Red-eyed dove	<i>Streptopelia semitorquata</i>	Columbidae	They eat seeds; also berries (<i>Lantana camara</i> etc.), rhizomes (<i>Cyperus esculentus</i>) and flowers (<i>Cedrella toona</i>)
Red-billed wood-dove	<i>Turtur afer</i>	Columbidae	They eat seeds of grasses and also castor-oil racinus seeds

Bird survey: A total of 32 different bird species were sighted in both the general bird survey and the point count sampling. Out of these, 23 were sighted during the point count sampling. There were a higher number of individual birds recorded in the point count survey on the Agro Forestry Area (AFA) than in the other two areas, with the agro forestry area recording a total of 62% of all birds while the Remnant Natural Forest (RNF) and the actual plantation area recorded 31 and 7% birds respectively. The agro forestry area also recorded the highest number of different bird species,

with a total of 16 species as compared to 7 and 6 by the remnant natural forest and the actual plantation area respectively. The Bishops, which were in eclipse at the time of this research, recorded the highest number of individuals as compared to all the other species recorded. It was also realized that most of the bird species recorded were savannah species with 59% being strictly savannah species. Thirty four percent of birds were forest/savannah species with no recorded species being a strictly forest species, however 6% of the species recorded were open species that are associated with open fields generally (Table 3).

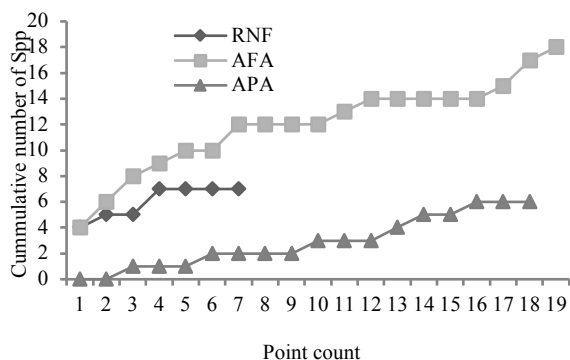


Fig. 1: Cumulative number of individual birds sampled in various survey areas; the number of individual birds increases with increasing sampling number of point counts

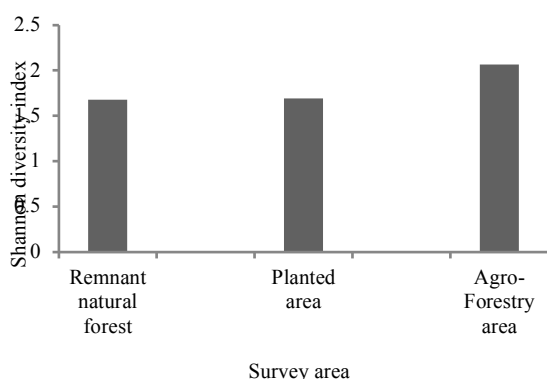


Fig. 2: Bird species diversities in the various survey areas

The cumulative number of individual birds in the various survey plots is plotted against the number of point counts in Fig. 1. As expected there is generally an increase in the cumulative number of birds with increasing number of point counts. In the case of the actual plantation area, there was a gradual increase in the number of species which eventually leveled up at the last three point counts indicating sufficient sampling was carried out. The graph also indicates that, a low number of individual birds were recorded as compared to the other areas. In the RNF, it was seen that the number of birds increases with each point count. The whole remnant natural forest of 5.0 ha was sampled since the distance between each point count was 100 m. In the case of the AFA area, there was a sharp increase in the number of individual birds initially, but this increase turned to a gradual increase with increasing number of point counts. It also seems that sufficient sampling was not carried out in this case since the number of species still increased even at the last point count.

Bird species diversity: The Jaccards similarity index based on the number of birds was calculated using Eq. (2). This showed the similarity between the bird

species diversity in the remnant natural forest compared to the agro forestry area to be equal to 0.21, while that for the remnant natural forest compared to the actual plantation area is equal to 0.18. These results indicate that the three survey areas are different in terms of number of bird species occurring in them. However the Shannon diversity index for birds calculated for the remnant natural forest as shown in Fig. 2 is 1.682 while that of the actual plantation area and agro forestry areas are 1.693 and 2.074, respectively. Figure 2 illustrates the bird diversities of the respective areas. The bird species diversity values indicate the agro forestry area as being the most diverse followed by actual plantation area and then the remnant natural forest.

Seed dispersal: Of the 32 different bird species recorded in this survey, 25% of these birds are seed dispersing birds. These include *Francoelinus bicalcaratus*, *Lamrotornis splendidus*, *Pycnonotus barbatus*, *Treron australis*, *Tockus nasutus*, *Streptopelia semitorquata* and *Turtur afer*. However seed eating birds belonging mainly to the families Ploceidae and Estrildidae were not considered seed dispersers because these birds destroy the seeds they eat through digestion and don't disperse them.

DISCUSSION

Mammal survey: The questionnaire method used for this study met the objectives of the study which was to assess the presence or absence of various seed dispersing mammals in and around the plantation. With this method, it was easy to gather large amounts of data within a relatively short period of time. In addition it can easily be adjusted to meet the goals of a specific study. The method was used with success by Hofmann *et al.* (1999) for an economic analysis of bush meat: a natural resource of the moist forest regions of West Africa. This study was carried out in Toumodi (Côte d'Ivoire) and Kumasi (Ghana). Nett (2002) used this method to study the population trends of selected mammals in south eastern Côte d'Ivoire. The research site of her study shares boundaries with the semi-deciduous forest of Ghana and also studied all the mammals that were studied in the current research. Vordzogbe *et al.* (2005) and Owusu *et al.* (2005) both used this method together with other methods and recorded 19 and 24 mammalian species in Sefwi-Wiawso (semi-deciduous forest) and Afadjato/Agumatsa range (dry semideciduous/savanna) respectively.

Ofori *et al.* (2012) also combined the questionnaire method with a transect-walk in their study of mammals in the semi-deciduous forest of Ghana and reported 23 mammals.

Bush meat is a delicacy for both rural and urban folks of Ghana. Knoell (2004) reports that 44% of

households practice hunting. But this number probably includes occasional hunters. Only nine regular hunters were found in Papasi and Dwendabi all together and therefore only these were considered hunters since specific information about various seed dispersing mammals were required. Hunting in groups is a common but unlawful practice in Ghana, which is often tied to customary rites and practices. Sayer *et al.* (1992) cited bush meat as the most important non timber forest product in Ghana. The mammal survey indicates that most of the species surveyed are in or around the plantation and therefore play or have the potential to play an important role of seed dispersal. Frugivory and seed dispersal play an important role in tropical forest regeneration (Bleher and Böhning-Gaese, 2001). It is vital that these mammals are protected so that they can play their required role in the ecosystem. As there are only a few hunters in the two surrounding villages around the plantation, it should be easy to educate these hunters about the need for the protection of these mammals. It is also worthwhile to provide an alternative source of income for these hunters.

Considering the fact that three of the species found in or around the plantation area, *Atherurus africanus*, *Epixerus ebi* and *Tragelaphus euryceros* are listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (Inskipp and Gillett, 2003), it gives credence to the protection of these species. It is also important to note that 40% of the species found in or around the plantation are of conservation concern. These include *Cercopithecus atys lunulatus*, *Cephalophus niger*, *Cephalophus dorsalis*, *Cephalophus sylvicultor*, *Epixerus ebi* and *Hystrix cristata* (IUCN, 2008). It is believed that large seeds coevolved with particular animal dispersers (Harrington *et al.*, 1997). It will be important to protect these mammal species since it will be disadvantageous to the plants if the disperser population is disrupted (Thébaud and Strasberg, 1997; Harrington *et al.*, 1997).

Bird survey: The methods used for this survey are widely used by many ecologists (Sutherland, 1996; Hawkins and Goodman, 1999; Goodman *et al.*, 2000). The 32 species of birds recorded in this study are low compared to other studies conducted on the African continent. Hawkins and Goodman (1999) reports 123 species in the Réserve Naturelle Intégrale d'Andohahela, in southern Madagascar which is a nature reserve. However this study was conducted within a three months period as compared to 10 days in the current survey. Goodman *et al.* (2000) however recorded 84 species in Parc National (PN) de Marojeje in northeastern Madagascar in a study conducted within one month.

Research in the semi-deciduous forests of Ghana by Beier (1993) reported 83 species of birds in a study carried out within a 4 months period while Kangah-

Kesse *et al.* (2007) reported 41 species in three months at the Abiriw Sacred Grove also in the semi-deciduous forest of Ghana. The relatively short period of ten days within which the current bird survey was carried out could be a factor responsible for the low number of bird species recorded. The high number of individual birds recorded in the AFA compared to the other sites, might be due to higher food abundance for birds in this than in the other areas. The natural forest also had a higher number of individual birds as well as bird species because there is more food in form of fruits on which birds feed. There is however no known bird species that feeds on Teak seeds which might explain the low numbers of birds recorded in the APA, though birds may rest on teak trees. The present data of the number of birds does not differ between the RNF and the AFA. But fewer birds occurred in the actual plantation area. In terms of species numbers more species were found in the RNF than in either the AFA or the APA.

In conclusion a considerable number of the seed dispersing mammals selected for the mammalian survey are still found in the area and may in one way or the other be responsible for seed dispersal of native tree species within the plantation and beyond. Protecting the RNF provides suitable habitats for these mammals and birds. A high number of individual birds were recorded in the Agro Forestry Area (AFA) compared to the remnant natural forest and the Actual Plantation Areas (APA).

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