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Species composition and distribution of birds in Aburi Botanic Garden, Ghana

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Abstract

Traditionally, botanic gardens have been set aside to conserve mainly trees, but it has additional contributions to harbor birds and other faunal species. Conservationist have neglected the animal component of the botanic gardens, it is against this background that this study sought to investigate into the bird species composition, abundance, and their distribution in the Aburi Botanical Garden, Ghana. The garden was stratified into Botanic Reserve (closed forest) and Cultivated Area (open forest), and a total five transects were distributed in each area. Bird census was carried out along these transect between the hours of 6am to 10am and 4pm to 6pm each day for three days The Botanic Reserve constituted more species with fewer individuals whereas the Cultivated Area had more individuals with fewer species. Food and light penetration were the main determining factors in the distribution and abundance of birds in the Botanic Gardens. The distribution of birds and their abundance were suspected to be influenced by the habitat type and the kind of resources it avails.The bird species dominant in the area are generalist species with only a small fraction being specialist species. It is therefore recommended that policies of the Botanic Gardens should include the protection of birds and other faunal species because of their interdependent relationship.

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Introduction

Land-use change is a key driver of current and future biodiversity change in the tropics, and conversion of native forests to pastures, croplands, botanical gardens and other human-dominated habitats is the primary cause of biodiversity loss (Luck and Daily,2008; Sala *et al*., 2000).The accelerating extinction of species is the tip of the iceberg of global wildlife declines that threaten to disrupt vital ecosystem processes and services. Although patterns of biodiversity loss have been explored extensively, their ecological implications have been extended to cover Botanic Gardens. According to Şekercioğlu *et al.* (2004, 2006) even though only 1.3% of bird species have gone extinct since 1500 AD, the global number of individual birds is estimated to have experienced a 20–25% reduction during the same period, indicating that avian populations and dependent ecosystem services are declining faster than species extinctions would indicate.

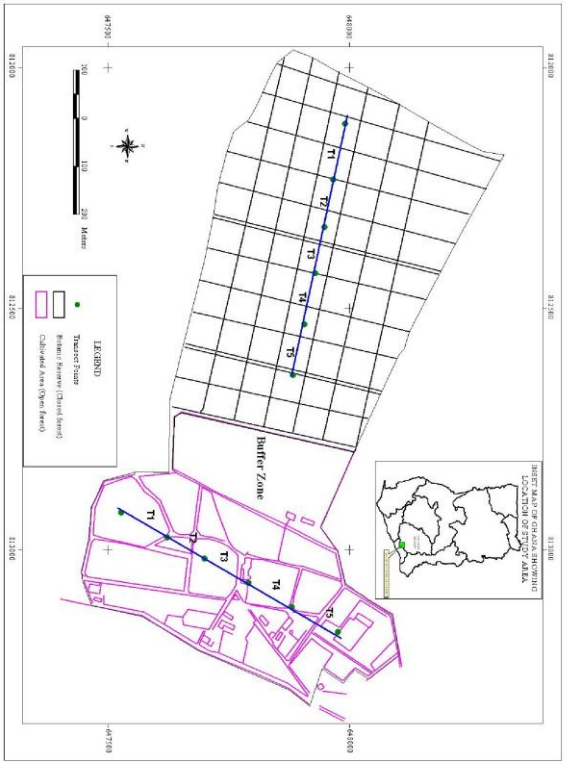

Fig. 1. Map of Aburi Botanic Garden (Source: Parks and Gardens, 2000)

The issue of resource conservation has grown along with human population growth and as such, numerous attempts and measures have been put in place to conserve the world's biodiversity. These measures include laws and policies and the creation of conducive environment to support the regeneration of species of conservation interest. This may take the form of establishment of Game, Resource and Strict Nature reserves, National Parks, Wildlife Sanctuaries, Zoos (Cowlishaw and Dunbar, 2000) and Botanical gardens (Parks and Gardens, 2000).Numerous management strategies are employed in the sustenance and conservation approach, but changing situations avail themselves which further induces amendment in the management approach (Brooks *et al*., 2001).

Botanic Garden is a place where plants are grown and displayed primarily for scientific, educational and recreational purposes. Although they are well known for their importance to plant science and their significant role in conserving plant diversity, it must be noted that, plant communities are not devoid of fauna, as the two are simply inseparable and their interdependences are more complex than what meets the naked eye. This concept of Botanic gardens dealing with plants alone has become a one way management strategy in the issue of conservation. While conservation seems to embrace fauna and flora issues, the botanical garden concept discriminate among the two while they each aim at attaining goals of sustainability and conservation. To date no faunal survey has been conducted at gardens in Ghana because of the misconception that botanic gardens deal with plants alone. Yet there are over 2,300 bird species in the African Region, a high proportion of which are endemic to the continent. Although birds present huge opportunities for nature tourism, it is also one of the reliable indicators of terrestrial biological richness (Bibby, 2000) yet they have been neglected in the Botanic Gardens which serve as refuge to many. It is against this background that anavifaunal survey wascarried out within the botanic garden in Ghanato

inform management in the formulation of strategies of the Ghana's biodiversity conservation. The objectives of this study were toassess the abundance and diversity of the bird species inhabiting the Botanical Garden and todocument a list of birdspecies in the botanic garden.

Materials and methods

Study area

The Aburi Botanic Garden is situated on the Akuapem Ridge located at about38 km north east of Accra the capital city of Ghana on an elevation of 370 to 460 m (1200 – 1500 Ft.) above sea level.Geographically, it is found on Latitude 5.8469 N and Longitude 0.1755Wwhich covers an area of 64.8 hectares (160 acres). The garden been divided into two distinct zones which differ in vegetation structure, namely the botanical reserve or closed forest which covers about 52.6 hectares and cultivated area or open forest which covers about 12.2 hectares (Fig. 1).The garden is composed of tree species such as *Celtisadolfi-frederici, Celtiszenkeri,Triplochitonscleroxylon, Cylicodiscusgabunensis,* and *Piptadeniastrum Africana,Hymenoistegiaafzelii,*and *Myrianthussp.* There are also special plant collections such as Ornamentals: *Araucaria spp., Bambusa nana, Calophyllummophyllum, Cedrela spp., Delonixregia, Dilleniaindica, Elaeocarpussearratus, Enterolobiumcyclocarpum, Ficusleprieuri, Garciniaxanthochymus, Murraya exotica* (Parks and Gardens, 2000).

Site classification

The site was stratified into two blocks based on the vegetation type, which is closed (Botanic Reserve) and open canopy forest (Cultivated Area):

i) The cultivated area (Lawn 1 to 10): which was mainly an open forest of artificially and natural growing trees and shrubs. It is further divided into ten different lawns comprising of palm, spices as well as local and foreign timber species.

ii) The Botanic Reserve or Natural vegetation area: is made up of a natural forest with little or no alteration at all. In it grows indigenous timber species, climbers, lianas and shrubs.

To equalize sampling intensity, five (5) transects where laid systematically in both the Botanic Reserve and the Cultivated Area. Each transect was 1000m long. Transects were laid on existing paths and distance was calculated with a GPS (Global Positioning System).

Bird Census procedure

Transects were walked at an average speed of 100m/hr.All birds sighted were recorded with counts repeated twice a day for three days. Coordinates of the beginning and end of each transect were obtained using a Garmin GPS Arc-Map 60Cx with an error of ± 5m whilst direction of alignment was determined using a sunto compass.

The survey team composed of three persons and was maintained throughout the survey to ensure consistency in the data collection procedure.The survey was done twice in a day that is morning (6.00-10.00) and evening (16.00-18.30). Using Olympus binoculars with exit pupil diameter of 2.5,birds were identified by sight with the help of Field Guide to birds of West Africa with Nomenclature after Borrow and Demey (2001).

Calculation of community parameter

Assumptions on normality and homogeneity of all cases were justified based on examinations of residuals. A difference in the abundance of birds within the two fragments of the gardens was determined by Mann Whitney U test.Diversity (Hs) of the total community in the two fragments of the Garden was calculated using Shannon Index as represented in the formula below:

$$Hs = -\sum_{i=1}^{s} Pi \ln Pi$$

Pi = n*i*/N, where p*i* is proportion ofindividuals found in the *i*th species, n*i* is the number of individuals of species and N is the total number of individuals.

The ratio of the observed to maximum diversity can be taken as a measure of evenness (E). Evenness was calculated as; E = Hs/InS

Where S is the number of species in each community

Dominance (d) expressed the proportional importance of the species and was calculated as; d = n*i*/N*100

To compare species composition between habitat types, the Söerensen index (Cs) of species similarities was used and calculated as; $Cs = 2S_1. S_2/S_1 + S_2$

Where S1 or S2 is the number of species in each community and S1.2 being the number of species shared between then. Cs is constrained between 0 (no species in common) and 1.0 (all species in common).

The frequency of occurrence in percentage was determined from the raw data by dividing the number of occurrence of a species in a transect by the total number of plots occupied by a particular species and multiplying by 100%. The relative status of each species based on the frequency of occurrence is defined below.

- Rare: species found between 1% – 50% of the census plots
- Common: species found between 51% – 75% of the census plots
- Abundant: species occurring between 76% - 100% of the census plots

All these calculations were carried out using PAST (PaleontologicalStatistics software) Version 2.13 (Hammer *et al.*, 2001) and Microsoft office Excel.

Results and discussions

Density, diversity and the distribution of bird species in the different fragments of the garden

A total number of 541 individual birds were sighted from 10 transects during the entire study period in the area with a total number of 148 individuals sighted within the Botanic Reserve belonged to 50 species whereas 393 individuals belonged to 45 species were sighted within the cultivated area.

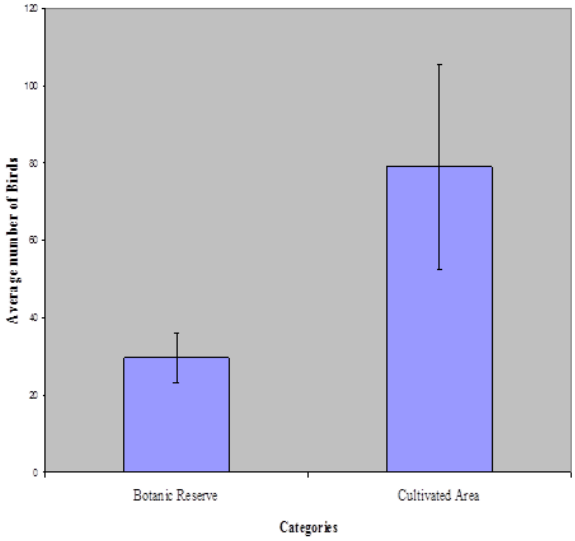

Fig. 2. Graph showing the average number of birds within the botanic reserve and cultivated area

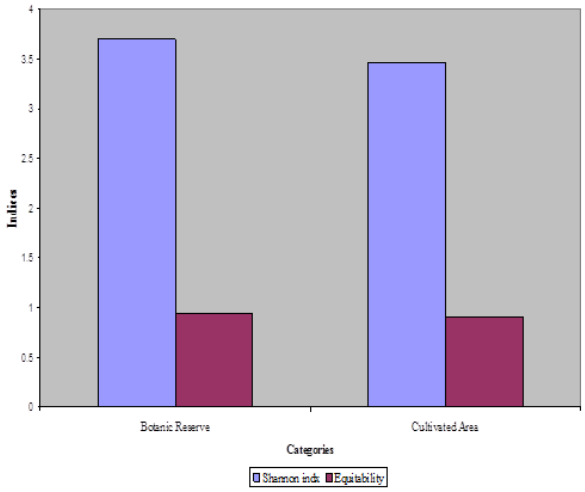

Fig. 3. Graph Showing Shannon's diversity and evenness indices of bird species within the botanic reserve and cultivated area.

The mean number of birds encountered per 100m in the cultivated Area was 79.0 (SD= 26.6) whereas that of Botanic Reserve was 29.6 (SD= 6.43) birds as shown in Fig. 2. Mann Whitney U Test was used to evaluate the hypothesis that the bird density occurring in the Botanic Reserve and Cultivated Area are the same. But the result indicated that at 0.05 alpha level, the

difference in medians of the bird densities were significant as $p < 0.05$ ($U = 1898$, $p = 0.039$).

The Shannon Index was used to evaluate the diversity of bird Species in both categories of the garden. The Shannon Index for the Cultivated Area was 3.462 with (lower confidence level 3.59 3.77 upper CL at 95% whereas the Botanic Reserve encountered an index of 3.698 (3.32 - 3.48 CL at 95 %.) An evenness of 0.90 and 0.95 was detected respectively.Diversity't'test indicate that there was no significant difference between the diversity of birds in the two fragments of the garden($t = 1.6522$, $p = 0.099$).

The distribution of bird species and abundance shows no significant difference between the two fragments of the study area. It has been speculated that birds fly across to both sides of the garden. The birds take refuge within the gardens as it is the only one of its kind in the vicinity. The garden therefore can serve as a model to demonstrate the needfor back yard garden that would secure birds with its diverse range of floral species from accelerated rate of deforestation. However, some species were found to be existent in one fragment alone which indicates the presence of habitat specialist and the habitat generalist species which thrive in both fragments of the garden for either food or shelter resources. Thus from the Söerensen Index, it was indicated that about 80% of the species found were habitat generalist whereas only 20% are habitat specialist which either belong to the Botanic Reserve or to the Cultivated Area.

Relative dominance, abundance, frequency of occurrence, and the variation of species in the various fragments of the garden

The cultivated area of the botanic garden was found to support more individual bird species (393 individuals) than the Botanic Reserve (148 individuals) ($U = 1898$, $p = 0.03992$). This may be due to the alteration made to the original natural vegetation area that has been replaced with cultivated floral plants.

The relatively dominated species was*Lamprotomissplenditus* (Splendid Glossy Starling)with 11.4% whereas that of the species with the less dominated were*Cypsiurusparvus*(African palm swift), *Vidusmacroura*(Pin – Tale Whydah)with relative dominance of 0.3% in the cultivated area (Table 1). But the Botanic reserve recorded a relative dominance of 8.1% for the most abundant species example *Corvusalbus*(African pied Crow) and a 0.7% for the less dominant species example *Turturafer* (Blue spotted wood dove), and *Touracopersa* (Green Turaco) (Table 2).

With reference to Table 2 it could be deduced that for every 100m within the cultivated area, there was an abundance of 9.0 birds, example was *Lamprotomissplenditus*(Splendid Glossy Starling) for the most abundant species as against 0.2 birds for the less abundant species e. g.*Cypsiurusparvus*(African palm swift), *Vidusmacroura*(Pin – Tale Whydah) etc.(Table 1). But for every 100 meters in the Botanic reserve there was an abundance of 2.4 birds e.g.*Corvusalbus*(African pied Crow) for the most abundant species as against 0.2 birds for the less abundant species e. g.*Cypsiurusparvus*(African palm swift), *Vidusmacroura*(Pin – Tale Whydah) (Table 2). The bird species found in each fragment of the garden were birds which found their needed resources within the area. The presence of abundant food resources may be a main determining factor in the relatively high densities in the cultivated area (open forest). In the process of developing the cultivated area for scenic view, it offered the opportunity for a wide variety of food resources which mayinducedseveral kinds of feeders being dominant in the area (Insectivorous, Nectarous, frugivorous). In general, a habitat defines the activities of the bird species though some could be endemic to their niches where as some depend on prevailing conditions such as predators, food and season as suggested by Bunnun and Howell (2002).

Table 1. Species composition, relative dominance, abundance and the frequency of bird occurrence within the cultivated area.

Bird Species	Scientific Name	Relative Dominance	Abundance /100m	Frequency Of Occurrence
Gray Headed Sparrow	*Passer griseus*	0.5	0.2	20
African Palm Swift	*Cypsiurusparvus*	0.3	0.2	20
Fire Bellied Wood Pecker	*Dendropicospyrrhogaster*	0.3	0.2	20
Levaillant's Cuckoo	*Oxylophuslevaillantii*	0.3	0.2	20
Pin-Tale Whydah	*Vidusmacroura*	0.3	0.2	20
Buff Throated Sunbird	*Nectariniaadelberti*	0.5	0.4	20
African Pied Waged Tail	*Motacilla aguimp*	0.5	0.4	40
African Pigmy King Fisher	*Ceyxpictus*	0.5	0.4	40
Yellow Billed Kite	*Milvusaegyptius*	0.5	0.4	40
Green Sun Bird	*Anthreptesrectirostris*	0.8	0.6	20
Johanis Sun Bird	*Cinnyrisjohannae*	0.8	0.6	20
Laughing Dove	*Stigmatopeliasenegalensis*	0.8	0.6	20
Didric Cuckoo	*Chrysococcyxcaprius*	0.8	0.6	40
Chestnut Breasted Malkoha	Phaenicophaeuscurvirostris	0.8	0.6	60
Spotted Fly Catcher	*Muscicapastriata*	1.0	0.8	40
Black and White Manikin	*Spermetes bicolor*	1.0	0.8	60
Yellow White Eye	*Zosteropssenegalensis*	1.0	0.8	80
Pied Fly Catcher	*Ficedulahypoleuca*	1.3	1.0	80
Willow Warbler	*Phylloscopustrichilus*	1.3	1.0	80
Woodland King Fisher	*Halcyon senegalensis*	1.5	1.2	60
Olive Sun Bird	*Cyanomitraolivaceus*	1.5	1.2	80
Black Neck Weaver	*Ploceusnigricollis*	1.5	1.2	100
Yellow Spotted Barbet	*Buccanodonduchaillui*	1.8	1.4	20
Red Rump Tinker Bird	*Pogoniulusatroflavus*	1.8	1.4	60
Splendid Sunbird	*Cinnyriscoccinigaster*	1.8	1.4	80
Yellow Fronted Tinker Bird	*Pogoniuluschrysoconus*	2.0	1.6	40
Village Weaver	*Ploccuscuculatus*	2.0	1.6	60
African Pied Crow	*Corvusalbus*	2.0	1.6	80
Black Kite (Hawk)	*Milvusmigrans*	2.0	1.6	80
Little Swift	*Apusaffinis*	2.0	1.6	80
Northern Gray Headed Sparrow	*Passer griseus*	2.0	1.6	80
Hairy Breasted Barbet	*Tricholaemahirsuta*	2.5	2.0	60
Cattle Egret	*Bubulcus ibis*	2.5	2.0	100

Coloured Sun Bird	*Anthothreptes simplex*	2.8	2.2	80
Red Eyed Dove	*Streptopeliasemitorquata*	2.8	2.2	80
Broad Billed Roller	*Eurystomusglaucurus*	2.8	2.2	100
African Green Pigeon	*Treroncalvus*	3.0	2.4	80
Hooded Vulture	*Necrosyrtesmonachus*	3.0	2.4	80
Speckled Tinker Bird	*Pogoniuluschrysoconus*	3.3	2.6	80
Band Swallow (White)	*Atticora fasciata*	3.5	2.8	100
Superb Sunbird	*Cinnyrissuperbus*	4.1	3.2	80
Grey Crowned Negrofinch	*Nigritacanacapillus*	5.3	4.2	60
Common Bubul	*Pycnonotusbarbatus*	5.8	4.6	100
African Pied Hornbill	*Tockusfasciatus*	6.1	4.8	100
Grey Backed Camaroptera	*Camaroptera brachyuran*	6.1	4.8	100
Splendid Glossy Starling	*Lamprotomissplenditus*	11.4	9.0	100

Status of birds in the Aburi Botanic Gardens

In the cultivated area, 49.9% of the species were classified as abundant species, among them were *Cinnyriscoccinigaster*(Splendid Sunbird), *Corvusalbus*(African Pied Crow), *Milvusmigrans* (Black Kite), *Apusaffinis*(Little Swift), *Passer griseus*(Northern Gray Headed Sparrow), *Pycnonotusbarbatus*(Common Bubul), *Tockusfasciatus*(African Pied Hornbill), *Camaroptera brachyuran* (Grey Backed Camaroptera), and *Lamprotomissplenditus* (Splendid Glossy Starling). Furthermore 15.2% were classified as common; among them are Phaenicophaeuscurvirostris (Chestnut Breasted Malkoha), *Spermetes bicolor* (black and white Manikin), *Halcyon senegalensis* (Woodland King Fisher), *Pogoniulusatroflavus*(Red Rump Tinkerbird), Ploccuscuculatus (Village Weaver), Tricholaemahirsuta (Hairy Breasted Barbet) etc. In addition, 13.0% were classified as uncommon *Motacilla aguimp* (African Pied Waged Tail), *Ceyxpictus* (African Pigmy King Fisher), *Milvusaegyptius* (Yellow Billed Kite), *Muscicapastriata*(Spotted Fly Catcher), *Chrysococcyxcaprius* (Didric Cuckoo), *Pogoniuluschrysoconus* (Yellow Fronted Tinker Bird) etc., whereas 21.7% were classified as rare *Passer griseus*(Gray Headed Sparrow), *Cypsiurusparvus*(African Palm Swift), *Dendropicospyrrhogaster*(Fire Bellied Wood Pecker), *Oxylophuslevaillantii*(Levaillant's Cuckoo), *Vidusmacroura*(Pin-Tale Whydah), *Nectariniaadelberti* (Buff Throated Sunbird) etc.

In the Botanic Reserve, 12% of the species were classified as abundant examples are *Cypsiurusparvus* (African Palm Swift), *Tockusfasciatus* (African Pied Hornbill), *Vidusmacroura* (Pin-Tale Whydah), *Cyanomitraolivaceus* (Olive Sun Bird), *Atticora fasciata* (Band Swallow-White), *Corvusalbus* (African Pied Crow) etc. In addition, 14% was classified as common; among them are *Hedydipnacollaris* (Collard Sun Birds), *Phylloscopustrichilus* (Willow Warbler), *Milvusmigrans* (Black Kite), *Ploceusnigricollis* (Black Neck Weaver), *Motacilla aguimp* (African Pied Waged Tail), *Treroncalvus* (African Green Pigeon) etc. Furthermore, 26% was classified as uncommon examples include *Cinnyrisjohannae*(Johanna's Sun Bird), *Pycnonotusbarbatus* (Common Bubul), Nigrita bicolor (Chestnut-breasted Negrofinch), *Rhaphidurasabini* (Sabine Spinetail), *Chrysococcyxcaprius*(Didric Cuckoo), Oxylophuslevaillantii(Levaillant's Cuckoo), *Andropadusvirens*(Little Green Bull),

Pogoniulusatroflavus(Red Rump Tinker Bird), *Apalissharpii* (Sharpe's Apalis), *Pogoniuluschrysoconus*(Speckled Tinker Bird),*Muscicapastriata* (Spotted Fly Catcher), *Cinnyrissuperbus* (Superb Sunbird), *Nigritafusconotus* (White Breasted Negrofinch) etc. Whereas 48% was classified as rare, among them are *Turturafer* (Blue Spotted Wood Dove), *Bledacanacapillus* (Grey Headed Bristle Bill), *Macrosphenusconcolor* (Grey Long Billed), *Touracopersa* (Green Turaco), *Chrysococcyxklass* (Klaas's Cuckoo), *Apusaffinis* (Little Swift), *Kaupifalcomonogrammicus* (Lizard Buzzard), *Andropadusvirens* (Little Green Bull), *Pholidornisrushiae* (Tit Hylia) etc.

Table 2. Species composition, relative dominance, abundance and the frequency of bird occurrence within the botanic reserve.

Bird Species	Scientific Name	Relative Dominance	Abundance /100m	Frequency Of Occurrence
Blue Spotted Wood Dove	*Turtur afer*	0.7	0.2	20
Grey Headed Bristle Bill	*Bledacanacapillus*	0.7	0.2	20
Grey Long Billed	*Macrosphenusconcolor*	0.7	0.2	20
Green Turaco	*Touracopersa*	0.7	0.2	20
Klaas's Cuckoo	*Chrysococcyxklass*	0.7	0.2	20
Little Swift	*Apusaffinis*	0.7	0.2	20
Lizard Buzzard	*Kaupifalcomonogrammicus*	0.7	0.2	20
Little Green Bull	*Andropadusvirens*	0.7	0.2	20
Tit Hylia	*Pholidornisrushiae*	0.7	0.2	20
Woodland King Fisher	*Halcyon senegalensis*	0.7	0.2	20
Yellow Spotted Barbet	*Buccanodonduchaillui*	0.7	0.2	20
Yellow Whiskered Greenbull	*Andropaduslatirostris*	0.7	0.2	20
Broad Billed Roller	*Eurystomusglaucurus*	1.4	0.4	20
Cattle Egret	*Bubulcus ibis*	1.4	0.4	20
Emerald Cuckoo	*Chrysococcyxcaprius*	1.4	0.4	20
Olive Bellied Sunbird	*Cinnyrischloropygius*	1.4	0.4	20
Pied Fly Catcher	*Ficedulahypoleuca*	1.4	0.4	20
Senegal Coucal	*Centropussenegalensis*	1.4	0.4	20
Tamborian Dove	*Turturtympanistria*	1.4	0.4	20
Didric Cuckoo	*Chrysococcyxcaprius*	1.4	0.4	40
Levaillant's Cuckoo	*Oxylophuslevaillantii*	1.4	0.4	40
Little Green Bull	*Andropadusvirens*	1.4	0.4	40
Red Rump Tinker Bird	*Pogoniulusatroflavus*	1.4	0.4	40
Sharpe's Apalis	*Apalissharpii*	1.4	0.4	40
Speckled Tinker Bird	*Pogoniuluschrysoconus*	1.4	0.4	40
Spotted Fly Catcher	*Muscicapastriata*	1.4	0.4	40
Superb Sunbird	*Cinnyris superbus*	1.4	0.4	40

White Breasted Negrofinch	*Nigrita fusconotus*	1.4	0.4	40
Chestnut Wattle Eye	*Platysteira castanea*	2.0	0.6	20
Green Hylia	*Hylia prasina*	2.0	0.6	20
Pale Fly Catcher	*Melaeno pallidus*	2.0	0.6	20
Splendid Glossy Starling	*Lamprotomis splenditus*	2.0	0.6	20
Chestnut Breasted Negrofinch	*Nigrita bicolor*	2.0	0.6	40
Sabine Spinetail	*Rhaphidura sabini*	2.0	0.6	40
Black Kite (Hawk)	*Milvus migrans*	2.0	0.6	60
Black Neck Weaver	*Ploceus nigricollis*	2.0	0.6	60
Common Bubul	*Pycnonotus barbatus*	2.7	0.8	40
African Pied Waged Tail	*Motacilla aguimp*	2.7	0.8	60
African Green Pigeon	*Treroncalvus*	2.7	0.8	60
Pin-Tale Whydah	*Vidusmacroura*	2.7	0.8	80
White Throated Bee Eater	*Meropsalbicollis*	3.4	1	20
Grey Crowned Negrofinch	*Nigritacanacapillus*	3.4	1	60
Willow Warbler	*Phylloscopustrichilus*	3.4	1	60
African Pied Hornbill	*Tockusfasciatus*	3.4	1	80
Collard Sun Bird	*Hedydipnacollaris*	4.1	1.2	60
African Palm Swift	*Cypsiurusparvus*	4.1	1.2	80
Olive Sun Bird	*Cyanomitraolivaceus*	4.1	1.2	80
Johanna's Sun Bird	*Cinnyrisjohannae*	4.7	1.4	40
Band Swallow (White)	*Atticora fasciata*	4.7	1.4	80
African Pied Crow	*Corvusalbus*	8.1	2.4	80

In the botanic reserve six (6) different species were found to be exclusive to the area. They include *Cypsiurusparvus*(African Palm Swift), *Corvusalbus* (Africa Pied Crow), *Ploceusnigricollis*(Black Neck Weaver), *Melaenopallidus* (Pale Fly catcher), *Vidusmacroura* (Pink Tail Whydah) and *Ploccuscuculatus* (Village Weaver). Where as in the Cultivated Area five different species including; *Bubulcus ibis* (Cattle Egret), *Corvusalbus* (African Pied Crow), *Streptopeliasemitorquata* (Red eyed Dove), *Pogoniuluschrysoconus* (Sparkled Tinker bird), and *Lamprotomissplenditus*(Splendid Glossy Starling) were found to be exclusive to the area.

The cultivated area has a higher average number of birds abundant as compared to the Botanic Reserve (Figure 2). This could be due to the different diversities in plants, nuts, flowers, foliage and a myriad of insects in the area, this can attract nectarous, insectivorous and frugivorous birds which aid in pollination and seed dispersal (Struhsaker, 1987).A daily influx of tourist is speculated to influence the distribution of birds in the garden; birds which can tolerate human intrusions inhabit the cultivated area where visitors to the garden use. Birds which cannot tolerate human intrusions were more comfortable in the Botanic reserve because of the probable little human intrusion.

Conclusion and recommendation

The distribution of birds and their abundance is influenced by the habitat type and the kind of resources it avails. Thus each bird's specific requirements are the set of conditions that the habitats possess. The environment of the study area primarily is stable, and the conservation of various plants species also in turn conserve a diversity of birds and other fauna such as butterflies, ants, reptiles etc. On the broader scale, the primary conservation of plant diversity equally leads to the secondary conservation of less and conspicuous yet important organisms of the ecosystem.

Food and light determined the presence or absences of birds within the two habitat types. Habitats with a higher light penetration (Cultivated Area) support a large number of individual birds yet fewer species, and habitats with a lower light penetration (Botanic Reserve) support smaller number of individuals with more different species.

The bird species dominant in the area were generalist species with only a small fraction being specialist species

In Ghana, birds are not the centre of attention in the issue of conservation and sustainability. Thus the feasible way to input birds into sustainable plans is to conserve their habitat and food resources for today and tomorrows generation.

Based on the result of the study, the following recommendations were made:

1. The study did not cover behavioural patterns of birds; an understanding of this will further explain bird distribution and abundance in the various habitat types.
2. The study area is home to many other fauna, example reptiles such as lizards and snakes, insects like butterflies and ants, and Vertebrates like rodents and birds should be studied since they serve as indicators of the environment.
3. Policies of the Botanic Gardens should include the protection of birds and other faunal species because of their interdependent relationship.
4. Bird monitoring programs should be instituted to constantly update existing information on birds since they are capable of migrating.

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