**Research Article**

# CHARACTERIZATION BY HABITAT AND BIOGEOGRAPHICAL STATUS OF THE AVIFAUNA IN THE TOGODO PROTECTED AREA COMPLEX, SOUTH-EAST TOGO

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### Abstract

The protected areas of Togo are subject to strong pressures, mainly due to the influence of populations. The conservation of avifauna is intrinsically linked to the originality of natural habitats which influence the distribution of birds. This study aims to characterize the avifauna of the Togodo protected area complex by habitat and biogeographical status. The ornithological inventory was based on the listening point method. The bird census was carried out in four habitats: savannah, forest, savannah-forest ecotone, and wetland. Thus, 30 surveys were carried out in the savannah, 27 in the forest, 09 in the ecotone and 09 in the wetland. In total, 132 species divided into 40 families and 15 orders were recorded. The characterization shows: 108 species from the savannah, 15 species from the ecotone, 05 species from the wetland and 04 species from the forest. Biogeographically, 113 resident species were recorded, including 67 non-breeding and 46 breeding species, 13 intra-African migratory species and 06 Palearctic migratory species.

**Keywords:** Avifaunal diversity, Togodo protected area, Habitat, Biogeographical status, Togo.

## INTRODUCTION

The avifaunal diversity in an area is linked to the condition of the habitats. The rate of forest degradation in Africa in 2010 was 4%. In Togo, the annual deforestation rate was 5.1% (i.e., 20,000 hectares per year) in 2010 (MERF et FAO, 2021) and 5.8% since 2011 (MERF, 2014). Togo is therefore one of the (Akodewou, 2018) countries in the world with the highest deforestation rate. Nowadays, due to the extent of the degradation of natural environments, the conservation of biodiversity, especially avifauna, is a major concern for humanity. The threats to biodiversity are many and varied. The main cause is the strong growth of the human population, which generates a very high demand for food and space. Thus, the traditional changes in land use and anthropic pressures linked to the demographic weight induce serious impacts on semi-natural habitats and protected areas. As a result, habitat fragmentation has effects on bird communities (Yabi, 2017). In addition, the overexploitation of natural resources is due to the increasing consumption of the human population (Aléza, 2010; Hounkpè, 2013). Pollution also affects not only human health but also plants and animals including birds (Triplet, 2015). Global warming is another constraint on natural environments. And as many species cannot adapt to it, they move to other more livable areas (Adjonou, 2011; Hounkpè, 2013). Vegetation fires are among the direct causes of degradation of natural resources and especially of natural habitats. The main actors of vegetation fires are transhumant herders (Adjonou *et al.*, 2010). In the south of the country, this deforestation is very pronounced. Birds therefore flee these degraded environments and move to the so-called conserved areas, including the Togodo protected area complex.

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These forests contribute to the moderation of air and soil temperature by increasing the relative humidity, which is beneficial to birds. This study assesses the avifauna of the complex by characterizing them by habitat and biogeographical status with for better conservation of the avifauna and ecosystems.

### Study area

Located between 6°23' and 7° North latitude and between 1°23' and 1°34' East longitude, the Togodo protected area complex covers an area of about 25500 hectares. It comprises two units: the classified forest of Togodo-South with an area of about 15000 hectares and Togodo-North with an area of 10500 hectares (Adjonou *et al.*, 2016). Figure 1 shows the location of this complex. North Togodo is in the Plateaux Region while South Togodo is in the Maritime Region. Together they form the Togodo protected area complex. The Mono River, natural border between Togo and Benin, forms the western boundary of the complex. To the north, the complex is bounded by the Assrama River and the village Gbohoulé. Tométi-Kondji, Zouvi, Donomadè and Danwohoé are the villages that delimit the complex to the south. To the east, Déwé is the village bordering the complex. According to (Sogoyou-Bekeyi, 2010), the Togodo protected area complex lies on the Precambrian peneplain where altitudes vary slightly. Migmatite outcrops occur in the north-east of the complex, giving rise to the Adjrarala Rapids. Ferralitic and ferruginous soils predominate and are very fertile. There are also silty-sandy soils on the riverbanks and clayey-silty soils along the watercourses. These soils support a relief with an average altitude of 100 m. It is a plain relief sheared by talwegs. A few inselbergs are found in the south and a granitic ridge is observed in the centre. Mount Gbéto (228 m) is the highest point in this area. These plateaus are a detrital formation of Post-Eocene age on sesquioxidic soils, weakly ferralitic (Lévêque, 1979 ; Kokou *et al.*, 2005).
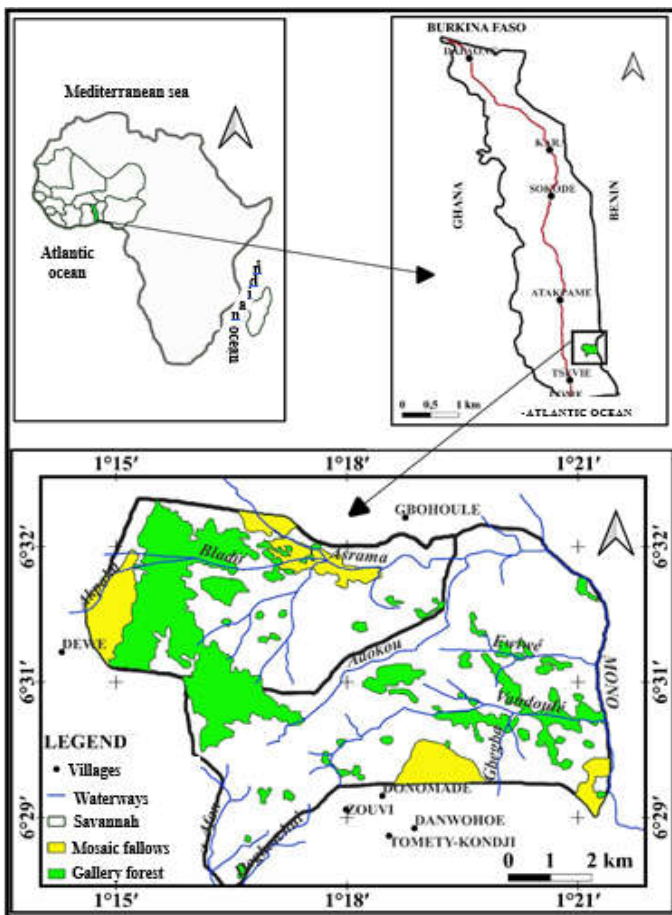
**Figure 1. Location map of the study area**

The Togodo protected area complex has a sub-equatorial climate. The climatic regime is bimodal with four seasons: (i) a long rainy season (March-April to July with a maximum in May). During this period, the vegetation of the Togodo complex is lush, favorable for bird nesting; (ii) a short dry season in July; (iii) a short rainy season from mid-September to October; (iv) and a long dry season from November to March. The dry season is dominated by the harmattan, which blows from the north-east, causing a drop in hygrometry and a drying out of the vegetation. Thus, from December to January, most birds migrate to other more favorable locations. The temperature is also a factor that greatly influences the climate. It varies with the seasons. The average temperature is 25°C in the study area. The hydrographic network of the Togodo protected area complex is dendritic. The different watersheds run from West to East towards the Mono River and from North to South towards the Gulf of Guinea (Lévêque, 1979 ). There are three major rivers that flow into the Mono (Asrama, Ewiwé and Vandoulé). Three main types of vegetation formations (savannahs, forest islands and gallery forests) are found in Togodo Park (Bonnet, 2015). The Togodo protected area complex is located in the north of ecological zone V (Akodewou, 2019). It is characterized by an open landscape made up, on the one hand of a mosaic of vegetation such as crops, fallow land, oil palm thickets (*Elaeis guineensis*) and, on the other hand, of little disturbed vegetation (Guinean savannah and patches of semi-deciduous dense forest) (Kokou *et al.,* 1999). The complex shelters a relatively diversified fauna found in all types of vegetation formations. Small mammals are largely composed of rodents (*Mus musculus, Rattus*) often found in fallows, fields, and savannahs. Antelopes (*Hippotragus equinus*) and buffalo (*Syncerus caffer*) are also present. There are also primates (highly endangered):

the Patas (*Erythrocebus patas*), the red-bellied monkey (*Cercopithecus erythrogaster erythrogaste*), the mone (*Cercopithecus mona*), the tantalus monkey (*Chlorocebus tantalus*), the Magistrate Colobus (*Colobus vellerosus*) and the olive baboon (*Papio anubis*) (Agbessi *et al.,* 2017 ; Ségniagbeto *et al.,* 2018). The hippopotamus (*Hippopotamus amphibius*) observed in the Afito pond during the collection of ornithological data, the buffalo (*Syncerus caffer*), the harnessed Guib (*Tragelaphus scriptus*), the defassa Cobe (*Kobus ellipsiprymnus*) are all threatened species (UICN/PACO, 2008). This complex also hosts reptiles, namely the Nile Crocodile (*Crocodylus niloticus*), the Nile Varan (*Varanus niloticus*) or the Seba Python (Python sebae). In addition to these types of animals, a variety of birds can be observed. This is the case for birds of the Streptopelia, *Strix woodfordii, Camaroptera chloronata, Cuculus clamosus, Crinifer piscator, Bycanistes fistulator, Circaetus cinerascens* families (Bonnet, 2015).

## MATERIALS AND METHODS

### Materials and data collection tools

The study material is avifauna. The following tools were used:

- binoculars branded Nikon; characteristics PROSTAFF 3S, 10x42 7° WATERPROOF 100-1000m for bird watching;
- Sony-Xperia smartphone with the ''Mobile Topographer'' application to record the coordinated points of the campsites;
- West African bird identification guides: (Borrow and Demey, 2012) for bird identification;
- Topographic map of the complex for routing and camp locations.

### Methodology

**Data collection:** Data collection lasted 15 days from 29 June to 11 July 2021. It was based on the listening point method. Listening stations were set up throughout the park. These listening stations installed one after the other, are 100 m radius listening points. They are set up according to pre-established coordinate points on the topographic map of the park. A total of 75 listening stations were surveyed. These listening points or stations are at least 1 km apart (Lougbégnon and Codjia, 2021). These listening stations are located according to the different types of plant formations that constitute the birds' preferred habitats. Thus, a total of 30 listening stations were established in the savannah (Figure 2).
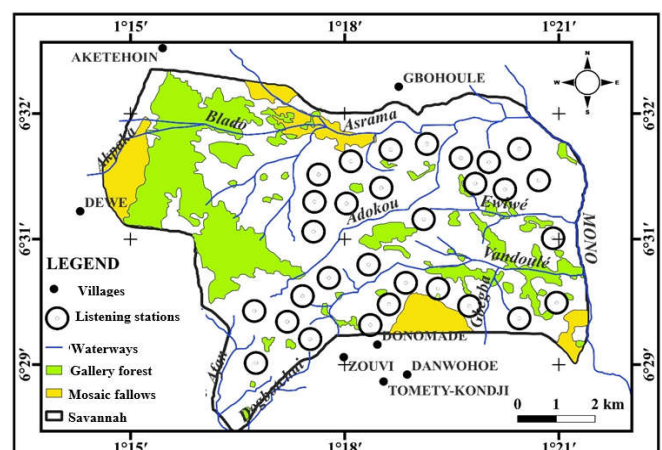


**Figure 2. Distribution of listening stations in the savannah**

The map of figure 2 is based on the coordinates of the listening stations taken in the field during the species census. These coordinates were transformed into csv format using Excel 2016 and then projected into QGIS 3.20 software.

The census of bird species in gallery forests was carried out at 27 listening stations (Figure 3)
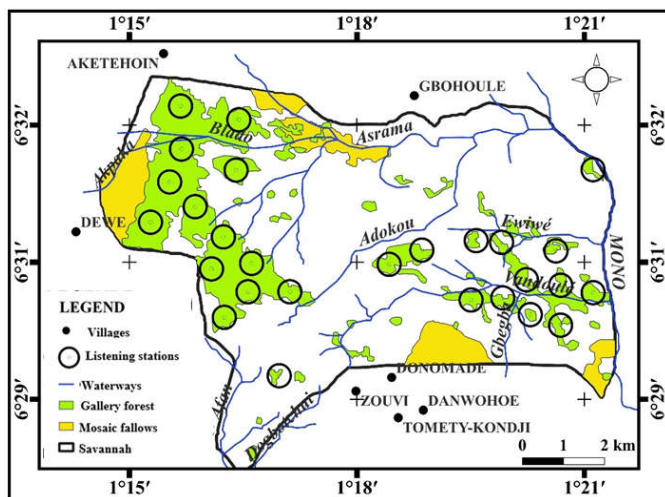


**Figure 3. Distribution of listening stations in gallery forests**

To better understand the relationships between birds and their environment, 9 listening stations were set up in the savannah-forest ecotone (Figure 4)
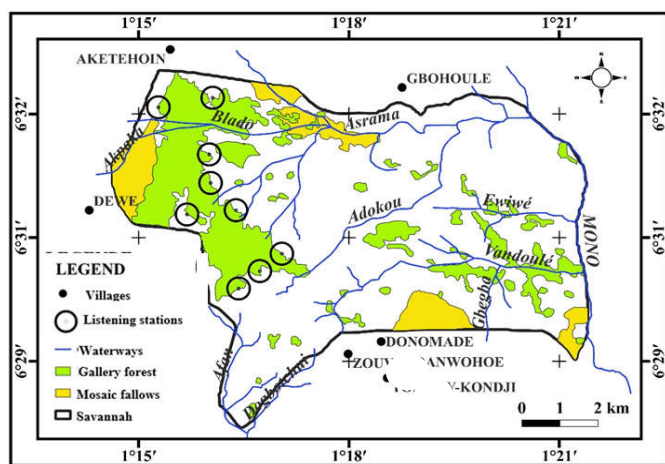


**Figure 4. Distribution of listening stations in ecotone erea**

This census was completed by 9 listening stations in the wetlands. The distribution is shown on the map in Figure 5. The wetland listening stations are randomly located along the main watercourses of the complex. However, delineating these vegetation formations has not been easy. The delimitations made are based on general knowledge and changes in vegetation according to the environment. The bird census was carried out from 6 am to 6 pm. At each listening station, birds were observed and counted for 30 minutes to contact the maximum number of birds possible. The method of Progressive Frequential Sampling (Lougbégnon *et al.,* 2007) was adopted. Thus, the species contacted were only noted in absence or presence and not in abundance in order to limit bias, and each station was only visited once. All birds (spotted with binoculars) posed in a tree, on the ground or in flight were observed (plumage colour, length and then shape of bill and legs) and recorded. Birds were also identified by their calls,

feathers left behind or fallen, or by their nests. Their identification is done with the help of the identification guide by N. (Borrow and Demey, 2012).
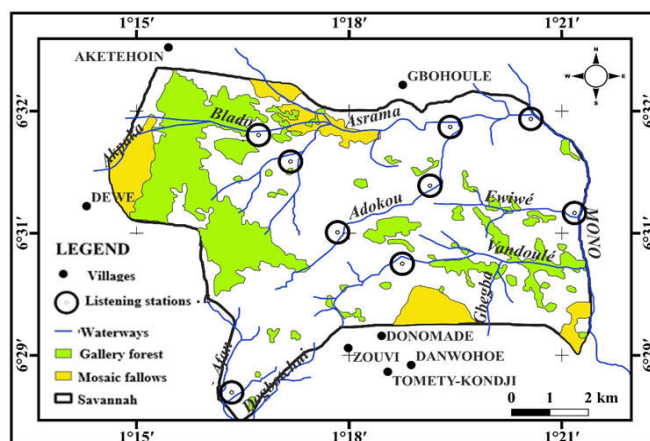


**Figure 5. Distribution of listening stations in wetlands**

**Data processing**

***Preferred habitats:*** The different types of vegetation formations in the Togodo complex, notably savannah (S), forest (F), savannah-forest ecotone (S/F) and wetland (W), are considered as preferential habitats for birds. The data collected based on these four groups were subjected to a Ward's Hierarchical Ascending Classification (CAH) to determine the avifaunal groupings.

***Production of biogeographic spectra:*** Biogeographic spectra were determined using the biogeographic status of the bird species encountered. These spectra show the origin of the species according to their biogeographical distribution. This makes it possible to judge the specificity of the different avifaunal groups. The classification adopted is that of (Borrow and Demey, 2012). Thus, a distinction is made between non-breeding residents (R-N), breeding residents (RN), palearctic migrants (MP) and seasonally moving birds (DS).

***Discrimination of avifaunal groups:*** A survey-species matrix was made considering the presence or absence of species. The species are ordered in rows and the surveys in columns. Thus, for each species surveyed, the family, order, habitat and biogeographical status are assigned. Once the matrix has been constructed, it is subjected to multivariate analyses. In order to carry out the redundancy analysis (RDA) and the hybrid redundancy analysis (hRDA), a coding of the species name was carried out. The first three letters of the genus name and the first three letters of the specific epithet form a six-letter code for each species. This highlights the different avifaunal groupings that emanate from them and the coexistence relationships that exist. In these various analyses, the Excel 2016 spreadsheet and the XLSTAT 2008 and Canoco 4.5 software are used. The categorization of the different groups of birds discriminated thanks to the dendrogram was elaborated taking into account the species recorded in the complex.

## RESULTS

### Overall characterization of the species surveyed

The majority of birds in the Togodo complex are savannah species (Figure 6). Indeed, 108 bird species (*Accipiter badius*, *Amadina fasciata*, *Centropus senegalensis*....) are savannah

and they represent 81.8%. There are 15 species in the ecotone zone (11.4%), including *Chysococcyx klaas*, *Bubo africanus*, *Corvus albus*, etc. The species of the humid zone and the forest are few with respectively 5 species (*Actophilornis africanus*, *Gallinula chloropus*...) and 4 species (*Cypsirus parvus*, *Eurystomus glaucurus*...).
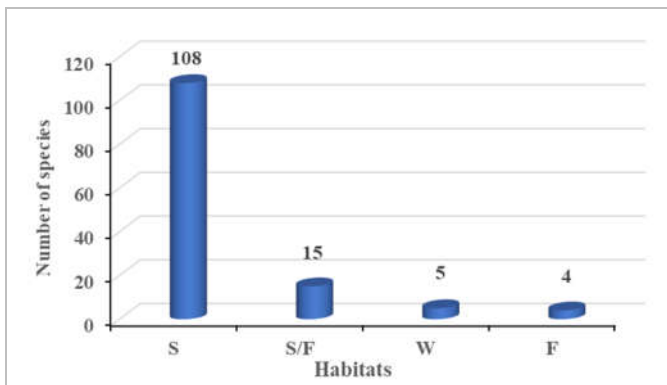


**Figure 6. Overall characterization of birds by habitat**

This characterization is completed by the biogeographical status. The result reveals that 67 species (50.8%), are non-breeding residents such as *Accipiter badius*, *Cisticola rufus*, *Estrilda caerulescens* while 46 species (34.8%) are breeding residents, including *Anaplectes rubriceps*, *Centropus senegalensis*, *Euplectes franciscanus* (Figure 7). There are also intra-African migrant species and Palaearctic migrants. They represent respectively 13 species (9.8%) (*Anthreptes platurus*, *Cuculus gularis*) and 6 species (4.5%) (*Gallinula chloropus*, *Motacilla flava*, *Streptopelia turtur*...) (Figure 7).
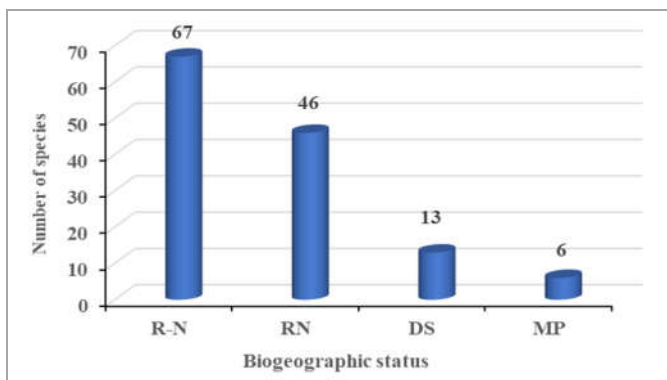


**Figure 7. Characterization of birds by biogeographic status**

**Interpretation of the ecological groups from the CAH**

The ecological groups are derived from Ward's dissimilarity dendrogram (Figure 8). This dendrogram distinguishes four groups. The horizontal axis represents the dissimilarity (D) to which the survey groups are assigned. It is therefore find savannah, forest and savannah-forest ecotones and wetland. These four groups are obtained when the dendrogram is cut at height D = 110. This shows an important structuring of the habitat types of the Togodo protected area complex.

**Characteristics of savannah birds:** Birds in ecological group G1 are those of savannah. This group consists of 30 surveys with a total of 104 bird species recorded. These species are divided into 40 families and 11 orders. The first three most represented species are *Phoeniculus purpureus* (90%), *Anaplectes rubriceps* (70%), and *Centropus senegalensis* (70%) of relative frequencies.
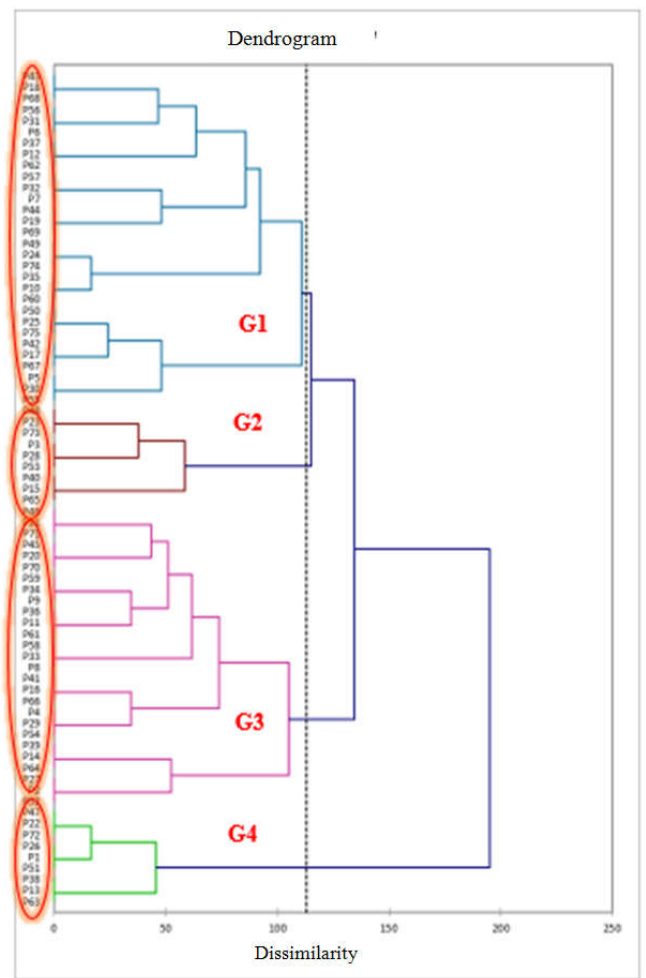


**Figure 8. Ward's dissimilarity dendrogram (CAH)**

The least represented species are *Tockus fasciatus*, *Vidua macroura* and *Vidua wilsoni* with 10% each. As for the families, the most represented are *Sylviidae*, *Ploceidae* and *Phoeniculidae* with 100% each. The least represented are *Strigidae*, *Muscipacidae* and *Caprimulgidae* with 10% each. The Shannon Index (1.93 bits) indicates, as in the whole, a low diversity. The Pielou Equitability (0.96) is high due to a high and balanced population. Figure 9 shows the distribution of bird species by biogeographical status. Thus, 55 species or 53% are non-breeding residents, 31 are breeding residents (31%), 13 other species are seasonal migrants (9%) and four are both non-breeding residents and seasonal migrants. The last five species are Palaearctic migrants.
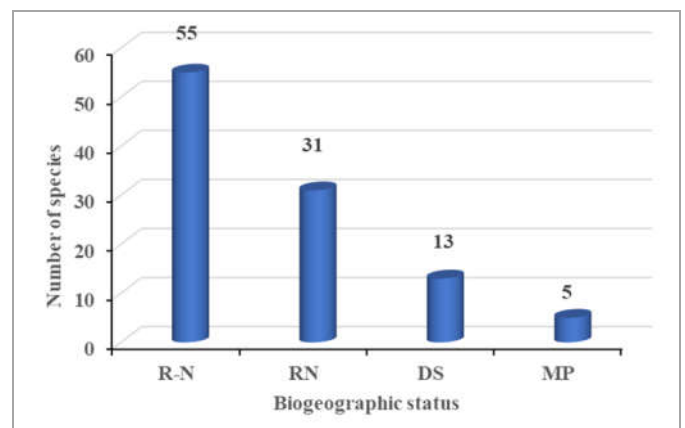


R-N: Non-breeding resident, RN: Breeding resident, DS: Seasonally displaced, PM: Palearctic migrant.

**Figure 9. Biogeographic status of savanna species**

**Characteristics of birds in the ecotone group:** Group G2 is an association of nine stations in savannah-forest ecotone with 63 bird species. The species are divided into 32 families and 12 orders. The most represented species are *Accipiter badius*, *Anthreptes platurus*, *Corvus albus* (100% each). The least represented species are *Poicephalus senegalus*, *Quelea erythrops*, *Vidua interjecta* (33% each). The most represented families with identical frequencies (100%) are *Accipitridae*, *Alcedinidae* and *Columbidae*. The least represented families have a frequency of 33% each, notably *Strigidae*, *Sturnidae* and *Viduidae*. Figure 10 shows their distribution by biogeographical status. This figure shows 29 species or 46% as non-breeding residents. As for the breeding residents, they are 21 (33%). However, eleven species (10%) are seasonal migrants. Only two species are palearctic migrants.
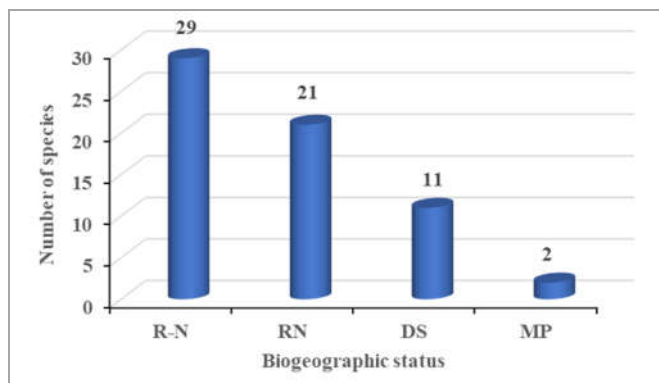


R-N: Non-breeding resident, RN: Breeding resident, DS: Seasonal displacement, PM: Palearctic migrant.

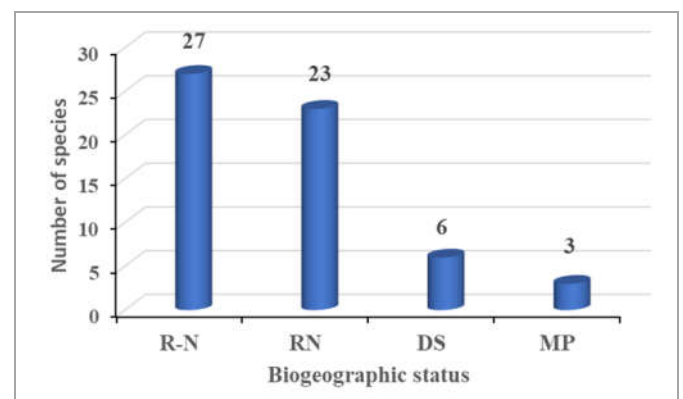**Figure 10. Biogeographic status of birds in ecotone group**

**Characteristics of forest birds:** Group G3 (forest birds) consists of 27 records from all forest types. It contains 100 species in 38 families and 14 orders. *Ploceus heuglini* (100%), *Ploceus melanocephalus* and *Ploceus nigricollis* (78% each) are the most represented species. The least represented are *Tockus nasutus*, *Treron waalia* and *Vidua wilsoni* with a frequency of 11% each. The most represented families in this grouping have a frequency of 100% each (*Cuculidae*, *Estrildidae* and *Malaconotidae*). *Musophagidae*, *Paridae* and *Rallidae* are the least represented families with 11% frequency each. Figure 11 shows the species composition according to biogeographical status. The most represented species are non-breeding residents with 48 species or 46%. Breeding residents follow with 40 species or 40%. In addition, nine species (7%) are seasonal migrants. Three species are Palearctic migrants (Figure 11). However, three species are non-breeding residents on the move.
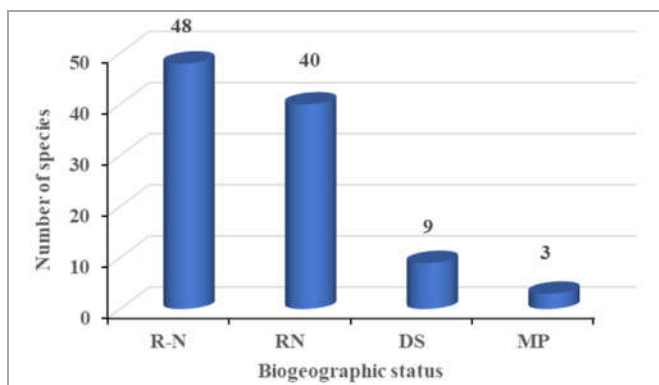


R-N: Non-breeding resident, RN: Breeding resident, DS: Seasonal migrant, PM: Palearctic migrant.

**Figure 11. Biogeographic status of forest birds**

**Wetland bird characteristics:** Group G4 consists of nine wetland stations. This is the group of birds correlated with wetlands. A total of 59 species are divided into 28 families and 11 orders. With a frequency of 100%, the *Cercotrichas galactotes* and *Circaetus cinerascens* are the most represented species. *Poicephalus senegalus*, *Prinia subflava* and *Pytilia phoenicoptera* have a frequency of 33% each and are therefore the least represented species. In terms of families, the most represented are *Estrildidae* and *Sylviidae* (78%) followed by *Columbidae* (67%). *Sturnidae*, *Turdidae* and *Viduidae* are the least represented with a relative frequency of 11%. This area is not a preferred habitat for these birds. They come just to quench their thirst. The distribution of the species of this group in biogeographical status is given in figure 12. This figure shows that 27 bird species (49%) are non-breeding residents. Thus, 23 species (40%) are breeding residents, six species are seasonal migrants and three are Palearctic migrants (Figure 12).



R-N: Non-breeding resident, RN: Breeding resident, DS: Seasonal displacement, MP: Palearctic migrant.

**Figure 12. Biogeographic status of wetland birds**

**Discrimination of ecological groups from the RDA**

This discrimination reveals the distribution of bird species according to the different ecological groups. Their distribution according to biogeographical status and the correlations between birds, their habitat and biogeographical status are also discussed.

**Species distribution according to plant formations:** The submission of the data (surveys, species and habitats) to an RDA analysis reveals three groups of birds according to the habitats G1, G2 and G3 (Figure 13). G1 groups birds that are more correlated with both savannah and forest areas, notably *Bubulcus ibis*, *Streptopelia turtur*, *Lagonostica rara....* However, the species *Picoides obsoletus*, *Tockus nasutus* and *Poicephalus senegalus* are in G2 and are closer to the forest areas. G3 includes birds that are most often found in wetlands. These are *Prinia subflava*, *Actophilornis africanus* and *Camaroptera brevicaudata*. The absence of the savannah group is due to the fact that the analysis software did not take it into account when designing the diagram and most of the species contacted are found in the savannah.

**Distribution of birds by biogeographical status:** A second analysis of the RDA was carried out with the survey data, species and biogeographical status (Figure 14). Three grouping classes are also obtained. Group G1 is made up of birds that are Palearctic migrants and seasonal migrants. These include *Motacilla flava*, *Pogoniulus chrysoconus* and *Milvus migrans*.

G2 is the class of birds that are either non-breeding residents or seasonal migrants (*Bubo africanus*, *Cuculus clamosus*, *Euplectes macrourus*). Finally, group G3 determines a correlation between the seasonally moving bird species. Seasonally moving bird species include *Cisticola brachypterus*, *Halcyon chelicuti* and *Streptopelia senegalensis*.



**Figure 13. Distribution of birds by preferred habitat (RDA)**



**Figure 14. Distribution of birds by biogeographic status (RDA)**

**Discrimination species by habitat and biogeographic status**

There is a correlation between species (regardless of their biogeographic status) and the plant formations that constitute their habitat. Thus, figures 15 are discriminated by hRDA in order to identify the relationships between species, their habitats and biogeographical status. This analysis shows that the birds in Togodo Park are grouped according to both biogeographic status and habitat preference into three distinct groups. The first group of birds (G1) is a collection of migratory Palaearctic species that are seasonally moving. These species are correlated with wetlands. Group G2 is composed of non-breeding residents in seasonal movement. These are birds associated with forest plant formations. Group

G3 includes all seasonally moving bird species. These birds are dependent on both savannah and forest plant formations. And, group G4 (absent on the diagram due to the design) states that the resident breeders are exclusively savannah species.
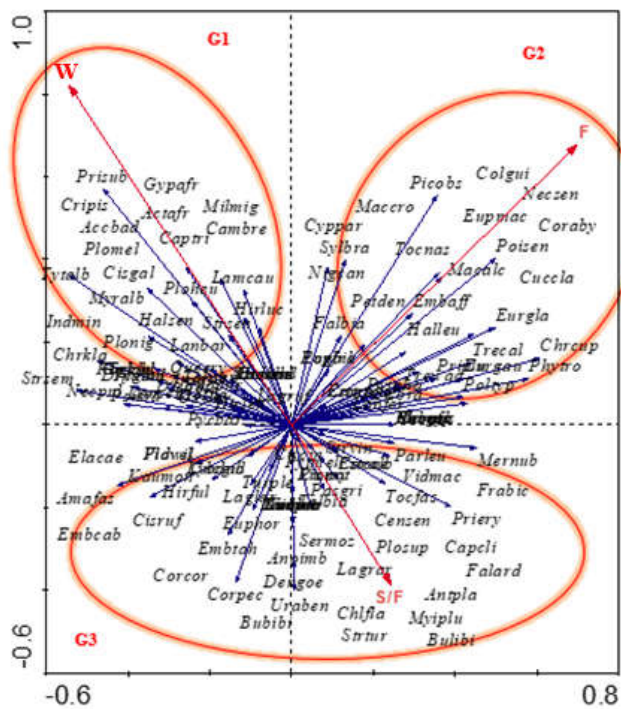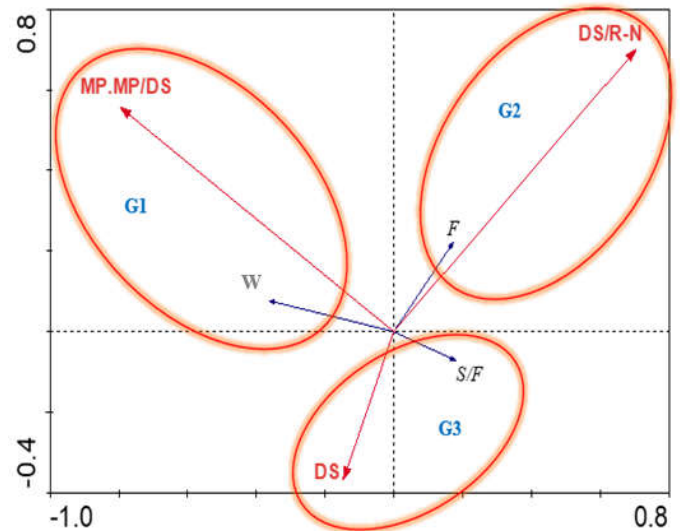


**Figure 15. Correlation of species, habitats and biogeographic status**

## DISCUSSION

The birds are structured in four avifaunal groups according to the habitat types including savannah, the forest, the forest-savannah ecotone and the wetland. These different ecological habitats are contiguous. This explains the similarity of the avifaunal groupings. There is therefore a similarity between the species of all ecological groups. Overall, savannah species predominate with 108 bird species. The species of the ecotone biotope (species that are dependent on the savannah and forest) follow with only 15 species. There are also 4 typical forest bird species and 5 wetland species. Biogeographically, 113 bird species are resident including 46 breeding and 67 non-breeding species. In addition, 13 bird species are intra-African migrants and 6 other species are Palaearctic migrants (*Streptopelia turtur*, *Phylloscopus trochilus*, *Milvus migran...*). These data are different of those the classified forest of Téné in Ivory Coast (Yaokokoré-Béibro *et al.,* 2015), where 92 bird species have been recorded including 59 forest species are typically and 33 savannah species. In biogeographic terms, 81 species are residents, 3 intra-African migrants and 1 Palearctic migrant. These numbers are lower than those obtained in the Togodo complex of protected areas. This numerical inferiority of bird species could be explained by the fact that the state of the habitats of the Togodo protected area complex is better than that of the Téné classified forest. It can also be linked to the duration and period of bird data collection on the field. These results are similar to those of West African sub-region, mainly in Benin (Yabi *et al.,* 2017). The 140 species recorded were divided into three biogeographical zones: (i) Guinean zone (forest): 16 species (11.42%); (ii) Sudanian zone (savannah): 31 species (21.14%); (iii) and the Sudano-Guinean zone (savannah-forest ecotone): 27 species (19.29). These data do not take into account the wetlands, which are an excellent tool for characterizing habitats. All birds, regardless of their preferred habitat, visit wetlands in search of water to quench their thirst. Another example from Benin reveals that the analysis of the distribution of avifauna shows 569 bird species, 92.97% of the species are from open forests. The wooded
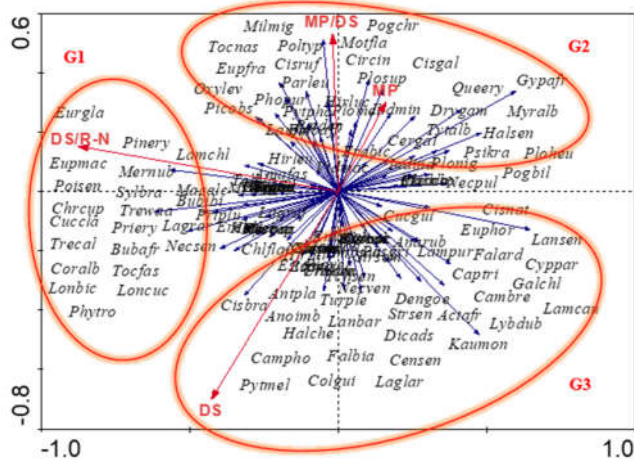
savannah is a home for 89.10% of the bird species and the humid zone contains 83.4% of the species (Chaffra *et al.,* 2019). The results of the Togodo protected area complex are therefore preliminary to future studies on avian biodiversity and the characterization of bird distribution in Togo. Indeed, resident birds (113 species) predominate in the Togodo protected area complex. This is due to the fact that they are savannah species. The savannah (whether shrub or tree) occupy the largest area of the complex. It is a vast expanse of grass that provides abundant food for granivorous birds and ruminants, especially rodents. The latter attract their predators, namely raptor birds. It is this chain of relationships between the different animals that explains the fact that the savannah alone contains 81.8% of the species. The forest serves as a shelter for certain birds that take refuge there to escape their potential predators. The complex also has several water bodies and is considered as a ramsar site (Sessi, 1998). However, few water birds were observed due to the less suitable census period.

## Conclusion

Overall, the savannah is a home for many bird species in the Togodo protected area complex. There are also some forest, savannah-forest biotopes, and wetland species. Biogeographical characterization shows that resident species are largely dominant. Thus, Palearctic migratory species and intra-African migrants are few. Although these results are quite convincing, they are an overview of the distribution of birds in this complex. In Togo, ornithological studies remain relatively unexplored and are not considered in biodiversity conservation strategies. Therefore, more studies should be carried out to document the distribution of birds on a national level to assess the quality of ecosystems.

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