

Structure and dynamics of granivorous birds in rice fields lowlands of the Yamoussoukro District, Central Côte d'Ivoire

ABSTRACT

Aims: This study was conducted to identify seed-eating birds and their dynamics in four rice-growing lowlands.

Place and Duration of Study: Nana, Petit Bouaké, Subiakro and Zatta rice-growing lowlands in the Yamoussoukro district (Central Côte d'Ivoire) from May 2021 to April 2022.

Methodology: Seed-eating birds were surveyed using the line transect method between 6.30 am and 6.30 pm. At each site, four surveys were carried out per month.

Results: In total, 22 species of seed-eating birds belonging to six families and three orders were inventoried in the rice-growing lowlands of the Yamoussoukro district. Among them, Village weaver *Ploceus cucullatus*, Red-headed Quelea *Quelea erythrops* and Bronze Mannikin *Spermestes cucullata* were the predominant species. Five other species, Red-eyed Dove *Streptopelia semitorquata*, Magpie Mannikin *Spermestes fringilloides*, Northern Grey-headed Sparrow *Passer griseus*, Yellow-mantled Widowbird *Euplectes macroura* and Black-winged Bishop *Euplectes hordeaceus* were regular in these lowland rice fields. Numbers of these seed-eating birds were highest at the Subiakro site and at the spike development and maturation of the rice. In addition, their numbers were highest between March and October and lowest between November and February.

Conclusion: This study indicates that eight seed-eating birds are likely to cause significant damage to rice crops, but their pressure could be reduced by planning harvests between November and February.

Keywords: Birds, Seed-eating, Variations, Rice fields, Yamoussoukro, Côte d'Ivoire.

1. INTRODUCTION

Rice, the main source of food for more than half the world's population [1-2], has many natural pests. Its main pests are weeds, insects, rodents, fish, birds and, to a lesser extent, molluscs and crustaceans. Microorganisms such as phytophagous nematodes, fungi and viruses that develop on rice also cause a wide variety of diseases [3-4]. Of all these natural pests, birds are certainly the best-known of rice crops [5].

The losses caused by these pests hamper the growth of rice [6]. Damage caused by pests has been estimated to millions of dollars worldwide [7-8]. These losses also pose a serious food security problem for subsistence farmers [9]. Hence, there is a need to protect rice fields from pest birds [10]. Thus, particular attention has been paid to their biology, ecology, and level of impact to consider reducing their harmful actions on rice fields [11-12]. In fact, losses are the consequence of many factors that require a perfect knowledge of the pests and the agronomic conditions of the rice crop [13].

In Africa, the most widespread and best-known species is undoubtedly the Red-billed Quelea *Quelea quelea* (Linnaeus, 1758), which is the main pest of cereal crops [14-18]. It's extremely large populations descend on fields in huge flights, causing serious economic losses [19-20]. In Côte d'Ivoire, other granivorous birds just as gregarious as the Red-billed

Quelea are found in rice fields [21-23]. In addition, [Oudoukpé et al. \[24\]](#) and [Kouadja et al. \[25\]](#) have shown that their damage is very extensive and variable in time and space. However, there is limited knowledge pertaining to these birds. The aim of current ornithological study was to identify seed-eating birds and their dynamics in the rice-growing lowlands of Yamoussoukro.

2. MATERIAL AND METHODS

2.1 Study Area

Yamoussoukro District ($6^{\circ} 15'$ and $7^{\circ} 35'$ north latitude, and $4^{\circ} 40'$ and $5^{\circ} 40'$ west longitude) is located 245 km north-west of Abidjan [26]. It covers an area of 4,651 km², approximately 1.7% of the surface of Côte d'Ivoire. The terrain is slightly hilly, with an average altitude of 200 meters. The district is crisscrossed by a dense hydrological network comprising the Bandama, Kan and N'zi rivers and their tributaries, as well as around thirty lakes, ten of which are man-made [27]. The climate of the Yamoussoukro district is a transitional humid tropical type characterized by four seasons, including two dry seasons and two rainy seasons [28]. Rainfall in the region varies from 900 to 1100 mm per year, with an average temperature of around 26°C and relative humidity of between 75 and 85% [29]. There are several lowlands Yamoussoukro District, including Nanan (40 ha), Petit Bouaké (200 ha), Subiakro (140 ha) and Zatta (85 ha), where current study was carried out (Fig. 1).

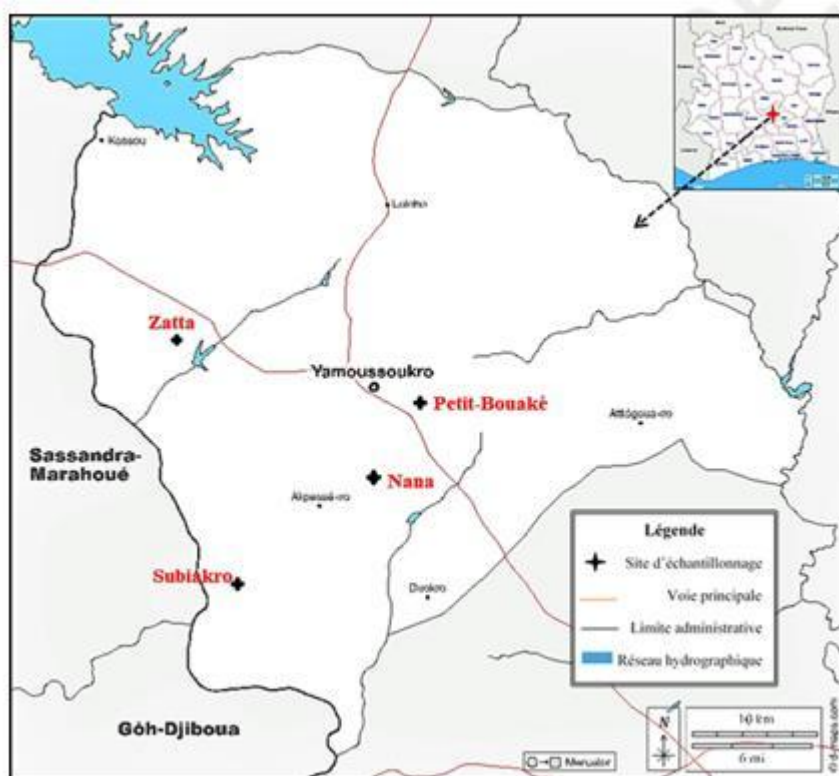


Fig. 1. Map showing the collection sites.

2.2 Data collection

Data were collected from May 2021 to April 2022 using the line transect method between 6:30 am and 6:30 pm [30]. At each site, four surveys were carried out per month. During these surveys, birds were identified and counted using binoculars. Only granivorous terrestrial birds were considered in this study. Additional information such as habitat types, stage of rice cultivation and activity was recorded. In the lowland surveyed, the rice-growing stage considered were Seedbeds, Ploughing & Flooding, Sowing & Growing, Spike development & Maturation, Harvesting, Regrowth, and Uncultivated. Seed-eating birds were identified according to Borrow and Demey [31] and Chappius [32].

2.3 Data Analysis

Biogeographical status was defined according to Dowsett and Dowsett-Lemaire [33]. For each species, the maximum number of individuals counted during a visit was used for final analyses. The species observed were characterized based on their relative frequency. According to Thiollay [34], a species is said to be D (Dominant), when its relative frequency is greater than or equals to 5%; Re (Regular), when its frequency ranges between 1 and 4.9%; Ra (Rare), when its frequency varies between 0.2 and 0.9%; Ac (Accidental), when it represents less than 0.2%. The relative frequency (Fr) is calculated using Microsoft Excel 2010 software based on the following mathematical formula:

$$Fr = \left(\frac{ni}{N} \right) * 100$$

ni: sum of all contacts with species i; N: $\sum ni$: sum of contacts with all species.

Anova test was used to compare the averages of granivorous birds between sites and stages of rice cultivation. Correspondence Factor Analysis (CFA) was used to present the distribution of seed-eating birds according to rice-growing stage. These statistical tests were performed using STATISTICA 7.1 software.

3. RESULTS

3.1 Diversity of seed-eating birds

An average of 4.186 ± 2.102 individuals belonging to 22 species of seed-eating birds, six families and three orders were estimated in the four rice-growing lowlands of Yamoussoukro. The most represented families were Estrildidae (8 species, 16% of individuals) and Ploceidae (6 species, 77% of individuals). Other families had less than two species and there was only 7% of individuals (Table 1).

The most abundant species were the Village Weaver *Ploceus cucullatus* (Fr = 44.6%), the Red-headed Quelea *Quelea erythrops* (Fr = 30.2%) and the Bronze Mannikin *Spermestes cucullata* (Fr = 9.6%). These three species accounted for more than 84% of the seed-eating birds recorded. Five other species, the Red-eyed Dove *Streptopelia semitorquata*, the Magpie Mannikin *Spermestes fringilloides*, the Northern Grey-headed Sparrow *Passer griseus*, the Yellow-mantled Widowbird *Euplectes macroura* and the Black-winged Bishop *Euplectes hordeaceus* are regular in these lowland rice fields. They accounted for around 13% of the total number of individuals. Other species accounted for only 3% of the individuals.

3.2 Spatial and Temporal Variation

Seed-eating bird numbers varied according to a month and site. The highest numbers were observed between March and October, peaking in September (Fig. 2). In contrast, the lowest

numbers were reported between November and February. The three most abundant species influenced this variation. Village weaver and Red-headed Quelea numbers increased from March to September, when they reached their peak, and then gradually declined in the other months. However, Bronze Mannikin numbers were high between February and March, then remained relatively constant in the other months (Table 1).

The rice-growing lowland at Subiakro was the site visited by the most seed-eating birds. The other sites were visited by seed-eating birds in approximately the same proportions. These variations in numbers per site were statistically significant (Anova, $ddl = 3$; $F = 14.2$; $p = .001$).

Seed-eating birds mainly visited the lowland rice fields during spike development and maturation of the rice (Fig. 3). They visited, in decreasing order, Harvested plots, Regrowing plots, Ploughing & Flooding plots and Sowing & Growing plots. However, there were few visits to uncultivated plots and seedbeds. The numbers of granivorous birds per rice-growing stage were statistically different (Anova, $ddl = 6$; $F = 3.26$; $p = .05$).

UNDER PEER REVIEW

Table 1. List of seed-eating bird species and their monthly numbers in the surveyed sites from May 2021 to April 2022.

Ordres/Familles/Espèces	S B	May 21	June 21	July 21	Aug 21	Sept. 21	Oct. 21	Nov. 21	Déc. 21	Jan. 22	Feb. 22	March 22	April 22	Ema x	Fr
GALLIFORMES															
Phasianidae															
<i>Pternistis achantensis</i> (Temminck, 1854)	R						2							2	0.02
<i>Pternistis bicalcaratus</i> (Linnaeus, 1766)	R	1	1		3	3	6	15	4		5	13	5	15	0.14
COLUMBIFORMES															
Columbidae															
<i>Streptopelia semitorquata</i> (Rüppell, 1837)	R	426	153	91	74	80	339	293	156	200	163	289	505	505	4.66
<i>Spilopelia senegalensis</i> (Linné, 1766)	R	27	22	43	12	18	11	16	16	14	7	62	63	63	0.58
<i>Turtur afer</i> (Linné, 1766)	R		1	1	2	2	2						1	2	0.02
PASSERIFORMES															
Passeridae															
<i>Passer griseus</i> (Vieillot, 1817)	R	13	10	29	37	19	60	67	165	78		15	3	165	1.52
Ploceidae															
<i>Amblyospiza albifrons</i> (Vigors, 1831)	R			2	1	2								2	0.02
<i>Ploceus cucullatus</i> (Müller, PLS, 1776)	R	2305	2577	2994	3234	4835	2477	1360	746	645	305	830	1855	4835	44.6
<i>Ploceus superciliosus</i> (Shelley, 1873)	R			4			5				4	4	4	5	0.05
<i>Quelea erythrops</i> (Hartlaub, 1848)	M	600	1340	1500	1200	3274	722	567	3	31	520	1339	1219	3274	30.2
<i>Euplectes hordeaceus</i> (Linné, 1758)	R		3	25	116	86	28	38						116	1.07
<i>Euplectes macroura</i> (Gmelin, JF, 1789)	R	36	57	125	155	151	63	56	25	32	25	11	28	155	1.43
Estrildidae															
<i>Spermestes cucullata</i> (Swainson, 1837)	R	400	282	266	231	427	319	349	458	528	1043	1005	679	1043	9.62
<i>Spermestes fringilloides</i> (Lafresnaye, 1835)	R	60	216	441	231	308	157	61	91	71	18	179	338	441	4.07
<i>Spermestes bicolor</i> (Fraser, 1843)	R		15	8	27	14				2		4	10	27	0.25
<i>Estrilda melpoda</i> (Vieillot, 1817)	R	5	22	35	30	50	23	16	9	4	35	41	2	50	0.46
<i>Ortygospiza atricollis</i> (Vieillot, 1817)	R				36	55	39	25	73	49	28	61	14	73	0.67
<i>Amandava subflava</i> (Vieillot, 1819)	R							12	5	39	18		4	39	0.36
<i>Lagonosticta senegala</i> (Linné, 1766)	R		2		2		2			2				2	0.02
<i>Lagonosticta rufopicta</i> (Fraser, 1843)	R	3		4	1	2	2		5			8	7	8	0.07
Viduidae															
<i>Vidua macroura</i> (Pallas, 1764)	R			3	4	17								17	0.16

Vidua togoensis (Grote, 1923) R 1 0.01

Total général 3876 4701 5571 5396 9343 4257 2875 1756 1696 2171 3861 4737 **1084**
0

SB: Biogeographical Status; R: Residents; M: African migratory; Emax: Maximum number; Fr: Relative Frequency

UNDER PEER REVIEW

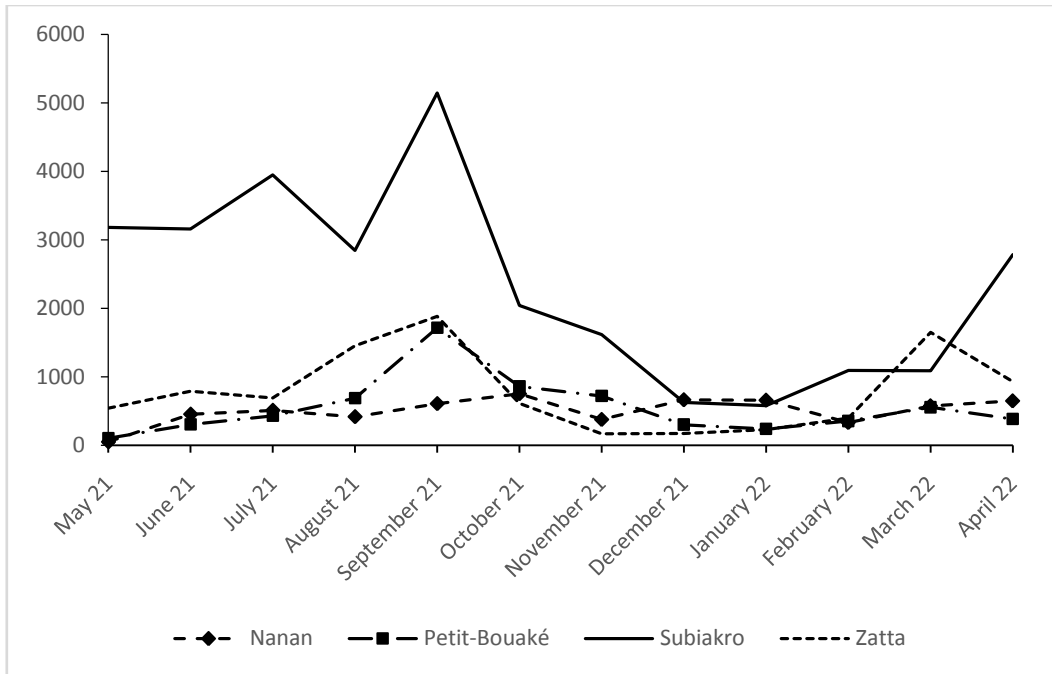


Fig. 2: Monthly variation in seed-eating bird numbers by site

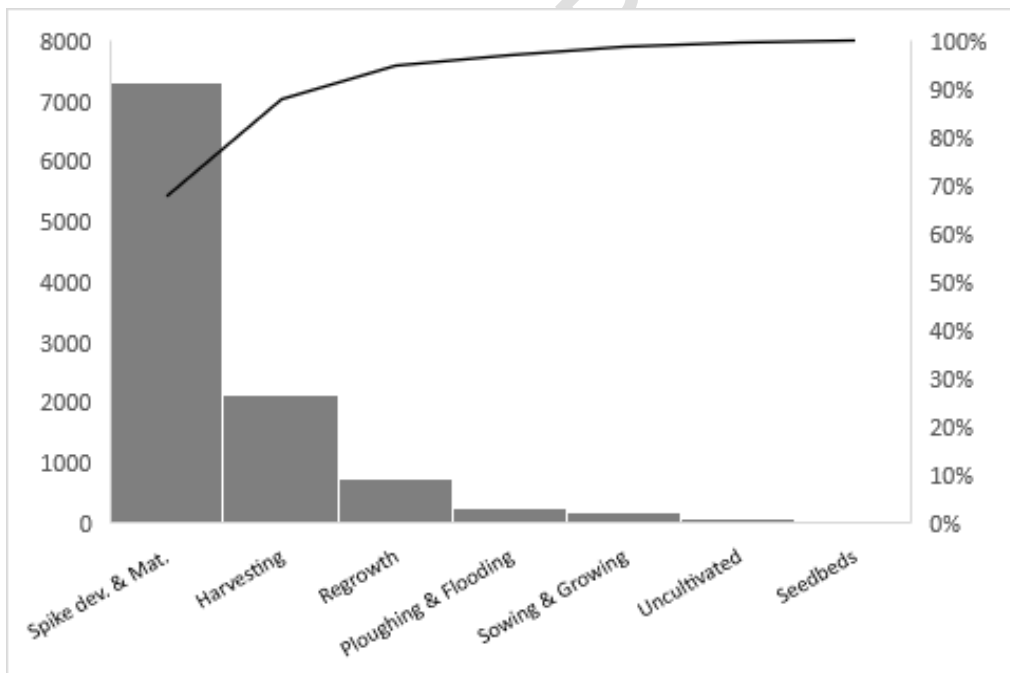


Figure 3: Proportion of seed-eating birds by rice-growing stage

3.1 Species distribution according to rice-growing stage

The **bird's** species were distributed according to the stage of rice cultivation. Two groups of birds can be distinguished (Figure 4). The first group was composed of the following species

Streptopelia semitorquata, *Spilopelia senegalensis*, *Ortygospiza atricollis*, *Passer griseus* and *Lagonosticta senegala*, which were found at the seedbeds, ploughing & flooding, sowing & growing, and harvesting stages. Among these birds, the Red-eyed Dove was the species with the highest numbers at these stages (Fig. 5). The second group of birds found during the spike development & maturation, regrowth and uncultivated stages was composed of *Ploceus cucullatus*, *Quelea erythops*, *Lonchura cucullata*, *Lonchura fringilloides*, *Lonchura bicolor*, *Ploceus superciliosus* and *Amandava subflava*. Among these, the Village weaver and the Bronze Mannikin were present at all stages of rice cultivation. While Village weaver numbers were abundant at all stages apart from the Ploughing & Flooding stage, those of the Bronze Mannikin remained moderate and even virtually absent during the establishment of seedbeds. The numbers of Red-headed Quelea were high and became more abundant during the spike development and maturation of the rice (Fig. 5).

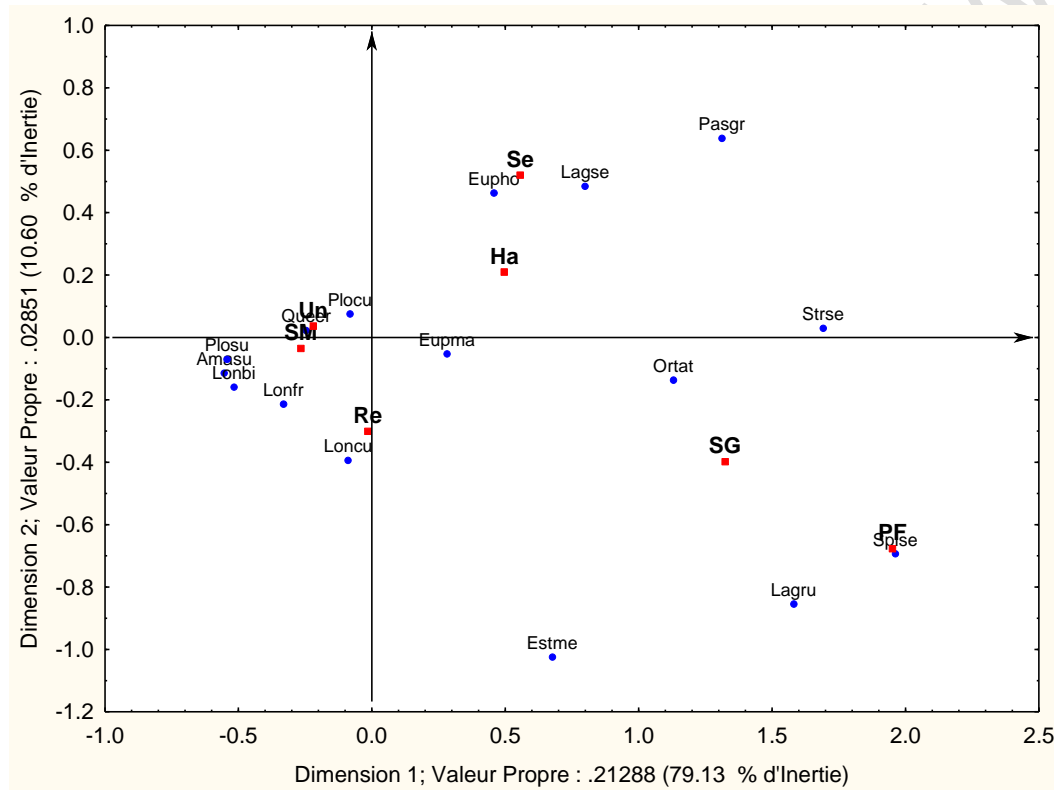


Figure 4: Seed-eating bird numbers according to rice-growing stage

Se: Seedbeds; PF: Ploughing & Flooding; SG: Sowing & Growing; SM: Spike development & Maturation; Ha: Harvesting; Re: Regrowth; Un: Uncultivated.

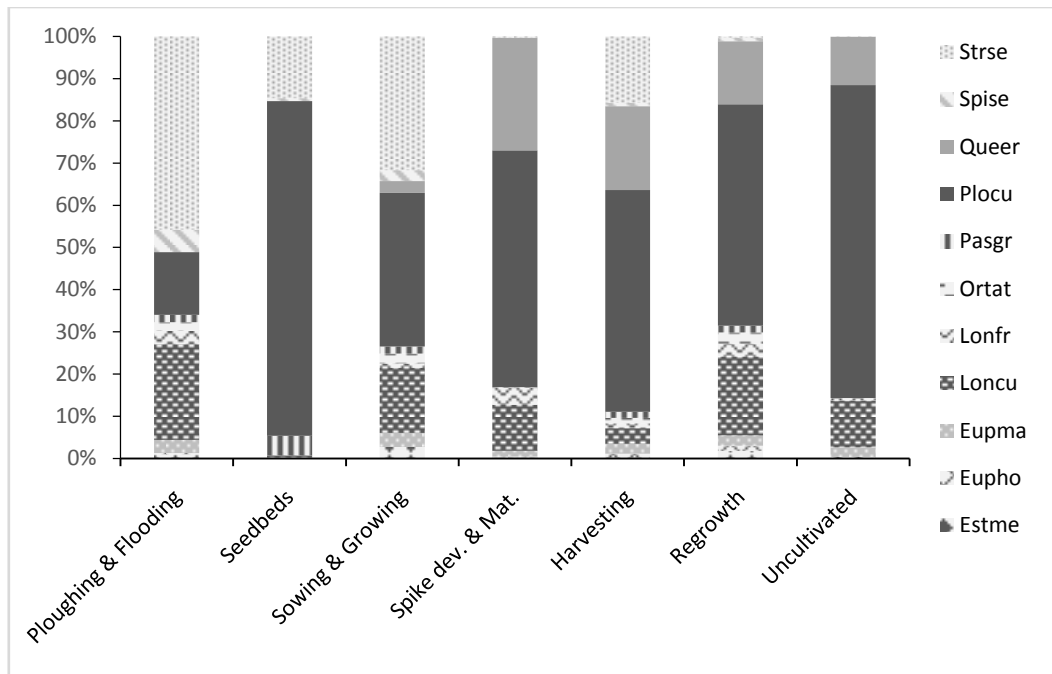


Figure 5: Seed-eating bird species proportions by rice-growing stage

4. DISCUSSION

Granivorous birds visited the rice-growing lowlands of Yamoussoukro to feed mainly on cultivated rice grains. These seed-eating birds belong mainly to the Ploceidae and Estrildidae families. These two families mainly contain granivorous birds, which have been reported in several studies to be responsible for most of damage to cereal crops [35-37]. Moreover, De Grazio [7] states that the damage caused by birds is similar throughout the world and often concerns the same crops and the same groups of birds.

Numbers of these birds were quite high in the rice-growing lowlands of Yamoussoukro and were estimated at several thousand individuals every day. However, they were lower than those counted in the Grand-Bassam wetland by **Odoukpé and Yaokokoré-Béibro** [21]. This difference should be due to the size of the cultivated plots, which covered several hectares in the Grand-Bassam wetland. The number of granivorous birds in rice fields is influenced by several parameters, including the field size [38-39].

The highest numbers were observed between March and October, which coincides with the period of intense rice cultivation in the region. This means that granivorous birds can find plenty of food available. They gather there, reproduce, and proliferate rapidly when they are not limited by the food available to raise their young. A drop in their numbers was observed between November and February. Similar results were reported in Grand-Bassam by **Odoukpé et al.** [23] and, **Odoukpé and Yaokokoré-Béibro** [24]. This observation might be due to the reduction in the area under cultivation, but also the movements of certain birds such as the Red-headed Quelea, which migrate at this time. In addition, many granivorous birds do not behave in a very gregarious way during the breeding season.

Temporal variations in granivorous birds were almost similar from one site to another. However, the highest numbers were recorded in the rice-growing lowland of Subiakro. This site is one of the most important lowlands in terms of area and intensity of rice cultivation. In

addition, various types of vegetation and several other agricultural crops were found near this lowland. The conditions offer granivorous birds a diversity of trophic resources and protection from predators [40]. In fact, the use of plant cover, hiding in the foliage of trees or in the shelter of a shrub appears to be an anti-predator strategy [41]. Although the other rice-growing lowlands also offer a variety of vegetation, granivorous were less abundant. This difference might be due to the low intensity of rice cultivation at these sites. This situation is exacerbated by the lack of government support for rice growers.

Variations in the numbers of granivorous birds were strongly influenced by the presence and stage of rice grain development in the fields. However, the Village Weaver and the Bronze Mannikin were present at all stages of rice cultivation. These two passerines are fond of cultivated cereals in all their forms and feed on them as much as possible [42-43]. Another passerine, the Red-headed Quelea, is also fond of cultivated cereals but prefers the milky stage [23]. This species was mainly observed the rice heading stage. These three bird species had the highest numbers in the rice-growing lowlands of Yamoussoukro. Odoukpé and Yaokokoré-Béibro [21] had already reported them as the most abundant species in the rice fields of Grand-Bassam. This similarity could be explained by the uniformity of the behavior of these passerines from one region to another. According to Ruelle [5], they are the main species pest of rice crops in the Gulf of Guinea. While these small passerines prefer to feed on the ears of rice, turtle doves and other passerines take over when the rice grains are on the ground. The Red-eyed Dove is one of the most abundant species at these stages. Indeed, at harvest time, this species feeds exclusively on cultivated seeds [44]. According to Stafford et al. [45], grain not collected during harvest is usually the most abundant potential food of birds in rice fields.

Although these granivorous birds feed preferentially in rice fields in the lowlands of Yamoussoukro, other studies have indicated that they do not disdain small wild seeds [46]. According to Rodenberg et al. [38], their pressure is strong in rice fields containing weeds. Under these conditions, traditional methods of protecting rice fields prove inadequate [47]. However, in addition to the potential ways in which birds can damage crops, there are various ways in which they can potentially improve production [48-50]. More in-depth research should therefore be carried out to improve the protection of rice fields against these birds.

5. CONCLUSION

The study of bird structure and dynamics in the rice-growing lowlands of Yamoussoukro showed that 22 granivorous species were attracted by rice cultivation. These granivorous species mainly belong to the Ploceidae and Estrildidae families. Their numbers varied depending on the site and the stage of rice cultivation. The most abundant species were *Ploceus cucullatus*, *Quelea erythrops* and *Spermestes cucullata*. In addition, five other species were regular visitors, including *Streptopelia semitorquata*, which had the highest numbers during the rice gleaning stages. This study suggests to the rice growers to plan their harvests between November and February to reduce pressure from seed-eating birds. However, it is suggested monitoring the most abundant bird species to gain a better understanding of their ecology and movements with a view to proposing sustainable methods for protecting the rice fields.

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