

Diversity and abundance of birds devastating rice-growing in the town of Daloa and its outskirts (Centre-West, Cote d'Ivoire)

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Abstract

Rice devastating birds are responsible for many losses in rice fields around the world. In Cote d'Ivoire, data on birds in inland are almost non-existent. A study on these birds was carried out from November to December 2019 in three rice fields (Zepreguhe, Abattoir and Kennedy) in the town of Daloa and its outskirts. The study aimed to know the population of those birds in this area. The main method used was the fixed-point, time-dependent counts or point-in-time abundance index (PIA) method. It was possible to count 2368 individuals of 41 species belonging to 14 families of eight orders. The Shannon-Wiever diversity (H'); equitability (E); dominance (IDO) and IPA

indices of rice devastating birds in this zone are 3.03, 0.82, 24.79 and 135 respectively. The best-represented family is the Ploceidae with 12 species and 882 individuals. The Village Weaver *Ploceus cucullatus* and the Northern Grey-headed Sparrow *Passer griseus* represent the two most abundant species with numbers of 368 and 219 individuals respectively. Of the three study sites, the Zepreguhe site is the most important in terms of specific richness (38 species), relative abundance (37.54%) and PIA (PIA = 155). Further studies are planned to monitor the diversity and population dynamics of these birds over the long term and to determine the extent of their impact on rice production in this area.

Keywords: Devastating birds, Population, Rice, Daloa, Cote d'Ivoire

Introduction

The overall increase in the human population is leading to the disappearance of many natural areas for agriculture, industrial construction, and fish ponds (Terborgh, 1989; Mayaux et al., 2003; Brou Yao et al., 2005; Koné et al., 2014). Many wild animal species, including birds, interact with these anthropogenic activities. Some nest or nest in buildings (Swallows, Sparrows, Owls, etc.), others take advantage of the opening up of forests (Partridges, Larks, Pipits, etc.) and many others to find alternative environments and look for abundant food : waste, fruit, cereals, etc. (Terborgh, 1989). In some cases, birds are accused of harming economic activities such as agriculture, fruit and fish farming, etc. (Terborgh, 1989).

Some species are specific predators while others are generalists (O'Connor & Shrubbs, 1986 ; Boutin et al., 1999). Crop-destroying birds have been responsible for much damage throughout the world (De Grazio, 1978) and are a hindrance to the development of rice fields in Africa (Tréca, 1985). They thus pose enormous problems and their control is a fundamental element in increasing rice yields (Chhann, 1975).

In Cote d'Ivoire, studies on rice devastating birds are mainly those of Odoukpé, et al. (2014a), in the rice fields of Grand-Bassam (in the coastal zone). Thus, data on these birds in the inland and particularly in the Haut-Sassandra region are almost non-existent. However, many bird populations cause enormous damage in the inland rice lowlands. This is the case in the rice-growing lowlands of the town of Daloa and its outskirts, particularly in the districts of Abattoir, Kennedy and the village of Zepreguhe (Pers. Obs.).

The objective of this study is to know the population of rice devastating birds in the rice fields of the town of Daloa and its periphery for a better management of these birds. Specifically, it aims to grasp the diversity of rice-devastating birds in the study area and determine their abundance.

Materials and methods

Study site

This study took place in the rice-growing lowlands of the town of Daloa and its periphery in the centre-west of Côte d'Ivoire in the Haut Sassandra region (Figure 1) between 6°53' North latitude and 6°27' West longitude (MPD, 2015). This area is marked by a Guinean-type climate, characterised by a sub-equatorial two-season rainfall regime (Eldin, 1971). There is a rainy season from March to October with a peak in June with 107.38 mm of rain and a dry season from November to February. The total annual rainfall was 477.17 mm in 2019 with an average temperature of 26°C (www.Tutiempo.net). The vegetation is semi-deciduous humid forest type. It is characterised by the almost simultaneous fall of leaves from large trees during the dry period (Avit et al., 1999). Mammalian fauna (Bamba, 2015; Kouakou et al., 2017) and ornithological fauna (Zéan et al., 2018) are relatively rich.

Site selection and data collection

The inventories took place from November to December 2019. Three rice-growing sites were selected based on their geographical location in relation to the city of Daloa, their area (at least 4 hectares) and, above all, the availability of rice planted during this season of the year. They are Zepreguhe (in the East), Abattoir (in the South) and Kennedy (in the West) (Figure 1). In each of the three study sites, two fixed observation points, P1 and P2, were selected for bird observation and identification. Two selection criteria guided the location of these observation points : the stage of development of the rice plant (ripening stage and milky stage and/or sowing) in order to get an idea of the food choice of the different bird species, and the distance between these two points (≥ 500 m) in order to minimise double counting errors.

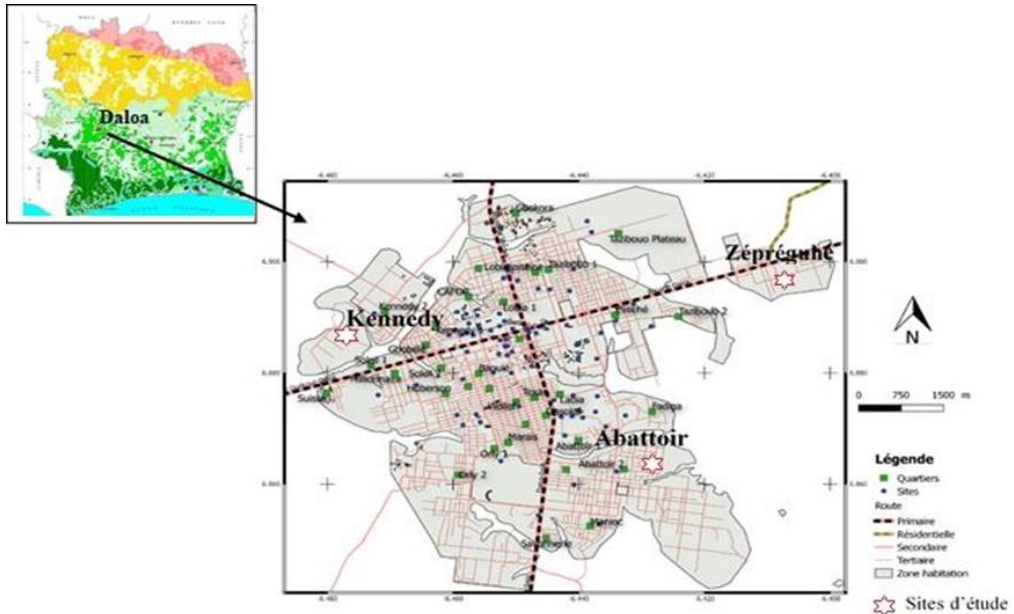


Figure 1. Location of study sites in the town of Daloa

Point P1 of each study site was generally located in a portion of the rice field where the seedlings are at the mature stage, while point P2 was positioned in the portion where the seedlings are at the milky and/or sowing stage. These observation points were positioned using a GPS (Map source Garmin GPS 64). The inventories took place each day from 6: 30 am to 9.30 am and 3: 30 pm to 6: 30 pm, which is when the birds are most active. Four days were devoted to each of the six sampling points in the study area (two per site). The main methodology adopted in this study was that of counting birds from a fixed observation or listening point within a fixed time period or the Punctual Index of Abundance (PIA) developed by Blondel et al. (1970) as defined by Bibby et al. (1998).

Observations were made using a pair of binoculars (Bushnell 8 x 42). In this study, only birds that were observed by sight and actually causing damage in the rice fields were included. Thus, each time slot was considered a counting session. Therefore, for a given session or three-hour time slot (corresponding to nine series of counts of 20 minutes each), only the highest PIA value obtained in one of these series of counts was retained as the PIA of devastating birds. The daily PIA of devastating birds for this point will therefore be the average number of morning and afternoon PIAs.

Data analysis

The data collected in the field allowed us to calculate (using the Excel spreadsheet, R.2.8.0 software, and Statistica version 7.1) the various

parameters related to the notion of relative frequency, abundance, diversity, dominance index (DOI) and point index of abundance (PIA). The Shannon-Wiever's diversity index (H') and Equitability index (E) were calculated for the study zone. Statistical analyses based on the specific richness and abundance (number of individuals) of devastating birds at the different study sites were made with the Newman-Keuls Test (one-factor ANOVA ; $p = 0.29$). For each of the species listed, the conservation status according to BirdLife International (2019) and IUCN (2019) and the biogeographic or migratory status according to Borrow and Demey (2008) were defined. The nomenclature, taxonomy and order of species were established according to the *Handbook of the Birds of the World and BirdLife International* as published by Lepage (2017).

Results

Diversity of birds devastating rice

The six sampling points of the three sites surveyed in this study were used to identify 41 species of devastating birds divided into 14 families of eight orders (Table I). In terms of biogeographical status, the bird population is dominated by 78% sedentary species (S), 5% occasional species (O), 5% intra-African migratory species (M), and 12% mixed-status species (S/M or S/P). Photographs of some of these inventoried species are shown in Figure 2. The Shannon-Wiever's diversity index (H') and equitability index (E) for this study area are 3.03 and 0.82 respectively.

In terms of orders, the Passeriformes are the most important. With 22 species from six families, they represent 53.65% of the specific richness of devastating birds. As for the non-Passeriformes, they make up 46.35% of the total species richness of birds with 19 species belonging to seven families (Table II). Among these non-Passeriformes, Pelecaniformes are the most diverse with eight species all being part of the Ardeidae family. All recurrent species are in the category of species of *Least Concern* (LC). As far as families are concerned, the Ploceidae are the best represented with 12 species, i.e. 29.27% of the population. The least represented families are those of the Ciconiidae, Corvidae, Cucullidae, Jacanidae, Phasianidae, Pycnonotidae, Scopidae and Viduidae with one species each. In terms of species richness per study site, Zepreguhe is the richest with 38 species, i.e. 92.69% of the total diversity. It is also the most diverse ($H' = 2.96$). The lowest richness was recorded at the level of the slaughterhouse site with 22 species (53.65%) and a diversity index of 2.65. As for equitability, the species of the Abattoir site seem to be the most evenly distributed across the whole site ($E = 0.86$). The Newman-Keuls Test (one-factor ANOVA ; $p = 0.07$) showed that there is no significant difference between the avifaunal species richness of the different

study sites. The three sites are therefore homogeneous in terms of species (Figure 3).

Abundance of rice devastating birds

The study revealed the presence of 2368 individuals from 14 families and eight orders. The Village Weaver *Ploceus cucullatus* and the Northern Grey-headed Sparrow *Passer griseus* represent the two most abundant species with respective numbers of 368 and 219 individuals respectively. The results of these observations are presented in Table I. The order Passeriformes is the most abundant. Indeed, this order represents 75.30% of the devastating bird population with 1783 individuals belonging to six families. Non-passeriformes make up only 24.70% of the total number of birds, with 585 individuals belonging to seven families (Table I). Among these non-Passeriformes, Pelecaniformes are the most numerous with 357 individuals of birds, i.e. 15.08%.

The least represented order is that of the Ciconiformes with three individuals, i.e. 0.13%. As for families, the most important are those of the Ploceidae, Estrildidae, Ardeidae, Passeridae and Columbidae with respective numbers of 882; 513; 354; 309, and 174 individuals.

Table I : Summary list and numbers of devastating rice-cultivating bird species

Orders/Families/Species	Name in English	Zepreguhe		Abattoir		Kennedy		ET	CS	BS
		ECU	Fr (%)	ECU	Fr (%)	ECU	Fr (%)			
GALLIFORMES										
PHASIANIDAE										
<i>Pternistis bicalcaratus</i> (Linnaeus, 1766)	Double-spurred Francolin	3	0,34	1	0,13	0	0	4	LC	S
COLUMBIFORMES										
COLUMBIDAE										
<i>Turtur afer</i> (Linnaeus, 1766)	Blue-spotted Wood Dove	2	0,22	0	0	0	0	2	LC	S
<i>Streptopelia semitorquata</i> (Rüppell, 1837)	Red-eyed Dove	18	2,02	23	2,96	81	11,5	122	LC	S
<i>Spilopelia senegalensis</i> (Linné, 1766)	Laughing Dove	11	1,24	32	4,12	7	0,95	50	LC	S
CUCULIFORMES										
CUCULIDAE										
<i>Centropus senegalensis</i> (Linnaeus, 1766)	Senegal Coucal	3	0,34	3	0,39	4	0,57	10	LC	S
GRUIFORMES										
RALLIDAE										
<i>Crex egregia</i> (Peters, 1854)	African Crake	6	0,67	0	0	0	0	6	LC	M
<i>Zapornia flavirostra</i> (Swainson, 1837)	Black Crake	4	0,45	0	0	3	0,43	7	LC	S

<i>Gallinula chloropus</i> (Linnaeus, 1758)	Common Moorhen	4	0,45	0	0	2	0,28	6	LC	S
<i>Gallinula angulata</i> Sundevall, 1850	Lesser Moorhen	4	0,45	1	0,13	0	0	5	LC	S/M
CICONIFORMES										
CICONIDAE										
<i>Ciconia episcopus</i> (Boddaert, 1783)	Woolly-necked Stork	1	0,11	0	0	2	0,28	3	LC	S
PELECANIFORMES										
ARDEIDAE										
<i>Ixobrychus sturmii</i> (Wagler, 1827)	Dwarf Bittern	0	0	0	0	3	0,43	3	LC	S
<i>Ardeola ralloides</i> (Scopoli, 1769)	Squacco Heron	3	0,34	8	1,03	0	0	11	LC	S/P
<i>Bubulcus ibis</i> (Linnaeus, 1758)	Cattle Egret	12	1,35	116	15	7	0,99	135	LC	S/M
<i>Butorides striata</i> (Linnaeus, 1758)	Green-backed Heron	2	0,22	7	0,9	5	0,71	14	LC	S
<i>Egretta garzetta</i> (Linnaeus, 1766)	Little Egret	6	0,67	8	1,03	1	0,14	15	LC	S
<i>Egretta intermedia</i> (Wagler, 1829)	Intermediate Egret	61	6,86	76	9,79	32	4,55	169	LC	S
<i>Egretta alba</i> Linnaeus, 1758	Great Egret	1	0,11	3	0,39	3	0,43	7	LC	S

Table I (Continued 1)

Orders/Families/Species	Name in English	Zepreguhe		Abattoir		Kennedy		ET	CS	BS
		ECU	Fr (%)	ECU	Fr (%)	ECU	Fr (%)			
SCOPIIDAE										
<i>Scopus umbretta</i> Gmelin, 1789	Hamerkop	2	0,22	0	0	1	0,14	3	LC	S
CHARADRIIFORMES										
JACANIDAE										
<i>Actophilornis africanus</i> (Gmelin, 1789)	African Jacana	3	0,34	0	0	10	1,42	13	LC	M
PASSERIFORMES										
CORVIDAE										
<i>Corvus albus</i> Müller, 1776	Corbeau pie	16	1,8	26	3,35	0	0	42	LC	s
PYCNONOTIDAE										
<i>Pycnonotus barbatus</i> (Desfontaine, 1789)	Common Bulbul	8	0,9	12	1,55	8	1,14	28	LC	S
PLOCEIDAE										
<i>Quelea erythroptus</i> (Hartlaub, 1848)	Red-headed Quelea	23	2,59	0	0	9	1,28	32	LC	S/M
<i>Quelea quelea</i> (Linnaeus, 1758)	Red-billed Quelea	27	3,04	0	0	12	1,71	39	LC	O
<i>Euplectes afer</i> (Gmelin, 1789)	Yellow-crowned Bishop	23	2,59	0	0	0	0	23	LC	S
<i>Euplectes franciscanus</i> (Isert, 1789)	Northern Red Bishop	8	0,9	0	0	0	0	8	LC	S/M

<i>Euplectes ardens</i> (Boddaert, 1783)	Red-collared Widowbird	58	6,52	0	0	3	0,43	61	LC	S
<i>Euplectes hordeaceus</i> (Linnaeus, 1758)	Black-winged Red Bishop	23	2,59	61	7,86	7	0,99	91	LC	S
<i>Euplectes macrourus</i> (Gmelin, 1789)	Yellow-mantled Widowbird	10	1,12	0	0	3	0,43	13	LC	S
<i>Ploceus luteolus</i> (Lichtenstein, 1823)	Little Weaver	0	0	0	0	11	1,56	11	LC	S
<i>Ploceus nigricollis</i> (Vieillot, 1805)	Black-necked Weaver	42	4,72	0	0	10	1,42	52	LC	S
<i>Ploceus heuglini</i> Reichenow, 1886	Heuglin's Masked Weaver	85	9,56	29	3,74	39	5,56	153	LC	S
<i>Ploceus cucullatus</i> (Müller, 1776)	Village Weaver	179	20,13	74	9,54	115	16,4	368	LC	S
<i>Ploceus nigerrimus</i> Vieillot, 1819	Vieillot's Black Weaver	27	3,04	0	0	4	0,57	31	LC	S
ESTRILDIDAE										
<i>Lagonosticta senegala</i> (Linnaeus, 1766)	Red-billed Firefinch	7	0,79	0	0	23	3,27	30	LC	S
<i>Estrilda melpoda</i> (Vieillot, 1817)	Orange-cheeked Waxbill	19	2,14	6	0,77	17	2,42	42	LC	S
<i>Spermestes cucullatus</i> Swainson, 1837	Bronze Mannikin	44	4,95	50	6,45	96	13,7	190	LC	S
<i>Spermestes bicolor</i> (Fraser, 1843)	Black-and-white Mannikin	35	3,95	65	8,38	77	11	177	LC	S
<i>Spermestes fringilloides</i> (Lafresnaye, 1835)	Magpie Mannikin	0	0	24	3,09	50	7,12	74	LC	S
VIDUIDAE										
Table I (Continued 2)		Zepreguhe		Abattoir		Kennedy				
Orders/Families/Species	Name in English	ECU	Fr (%)	ECU	Fr (%)	ECU	Fr (%)	ET	CS	BS
<i>Vidua macroura</i> (Pallas, 1764)	Pin-tailed Whydah	9	1,01	0	0	0	0	9	LC	S
PASSERIDAE										
<i>Passer domesticus</i> (Linnaeus, 1758)	House Sparrow	17	1,92	58	7,47	15	2,13	90	LC	O
<i>Passer griseus</i> (Vieillot, 1817)	Northern Grey- headed Sparrow	83	9,34	93	12	43	6,13	219	LC	S

ECU : Cumulative number of birds ; **ET** : Total number of birds in the three study sites ; **Fr** : Relative Frequency ; **LC** : Least Concern ; **O** : Occasionnal ; **S** : Sedentary ; **M** : Intra-african migratory ; **P** : Palearctic Migratory ; **SB** : Biogeographic status ; **CS** : conservation Status.

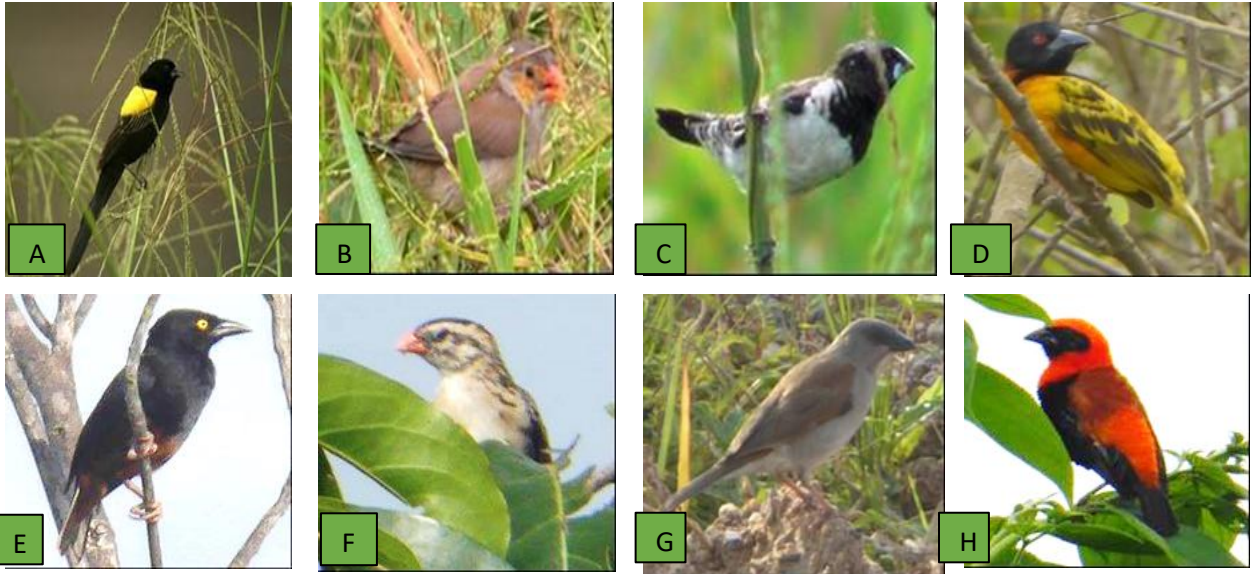


Figure 2. Photographs of some of the birds recorded on the study sites

A: Yellow-mantled Widowbird *Euplectes macroura*; **B:** Orange-cheeked Waxbill *Estrilda melpoda*; **C:** Bronze Mannikin *Spermestes cucullatus*; **D:** Village Weaver *Ploceus cucullatus*; **E:** Vieillot's Black Weaver *Ploceus nigerrimus*; **F:** Pin-tailed Whydah *Vidua macroura*; **G:** Northern Grey-headed Sparrow *Passer griseus*; **H:** Black-winged Red Bishop *Euplectes hordeaceus*

Table II: Assessment of the observations

	Zepreguhe		Abattoir		Kennedy		ET
	ECU	Fr (%)	ECU	Fr (%)	ECU	Fr (%)	
Number of Individuals (NI)	889	100	776	100	703	100	2 368
Species richness (SR)	38		22		32		41
Number of Families (NF)	14		9		11		14
Number of orders (NO)	8		6		7		8
Shannon-Wuever's Diversity Index (H')	2,96		2,65		2,76		3,03
Equitability (E)	0,81		0,86		0,8		0,82
Dominance Index (DOI)	29,47		26,93		29,87		24,79
Punctual Index of Abundance (PIA)	155		127		122		135

ECU: Cumulative number of birds; ET : Total number of birds in the three study sites; Fr: Relative frequency

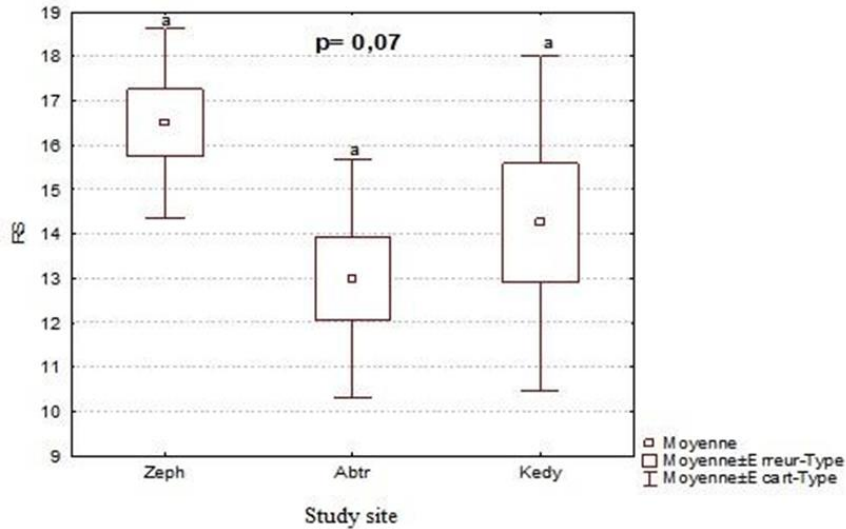


Figure 3. Statistical analysis of the bird species richness of the three study sites (RS: Species richness; Abtr: Abattoir; Kedy: Kennedy; Zeph: Zepreguhe)

These families alone account for more than two-thirds of the birds observed in the study area. The least represented families are those of the Ciconiidae and Scopidae with three individuals each. The statistical analysis of the abundance of devastating birds at the different study sites based on the number of individuals with the Newman-Keuls Test (one-factor ANOVA ; $p = 0.29$) showed that there is also no significant difference between the number of individuals at the different study sites. It is then concluded that the three sites are homogeneous in terms of the number of individuals (Figure 4).

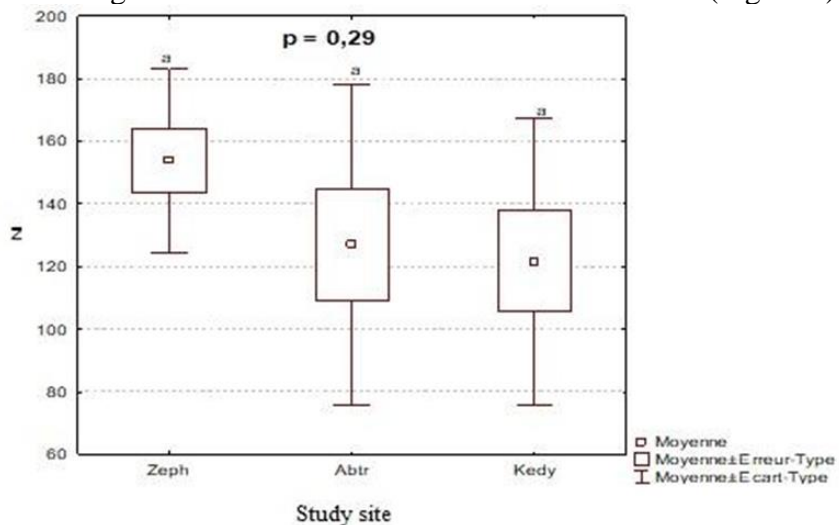


Figure 4. Statistical analysis of bird numbers at the three study sites (NI: Number of individuals; Zeph: Zepreguhe; Abtr: Abattoir; Kedy: Kennedy)

Discussion

Talking about diversity, in terms of species richness, 41 species of devastating birds belonging to 14 families and eight orders were recorded in this study. The results of our work are higher than those of Odoukpé et al. (2014a), who recorded 25 species of devastating birds in the rice fields of Grand-Bassam. As far as the species is concerned, the results of our study show a similarity with those of Odoukpé, et al. (2014a). The two studies have 25 species of rice-devastating birds in common. These are, among others, the presence of species such as : the Northern Grey-headed Sparrow *Passer griseus*; the Village Weaver *Ploceus cucullatus*; the Vieillot's Black Weaver *Ploceus migerrimus*; the Bronze Mannikin *Spermestes cucullatus*; the Black-and-white Mannikin *Spermestes bicolor*; the Red-headed Quelea *Quelea erythrops*, etc. Furthermore, our results showed that the stand of rice devastating birds is dominated by the order of passeriformes (75.30%) and that the families best represented in this stand are Ploceidae, Passeridae and Estrildidae. This is in line with data from (De Grazio, 1978) and Odoukpé et al. (2014b) according to which, the birds responsible for most of the damage caused in the rice fields are inevitably the small granivorous passerines. This study also indicated that the most abundant rice devastating birds in our study area are: *Ploceus cucullatus* (15.54%); *Passer griseus* (9.25%), *Spermestes cucullatus* (8.02%) and *Spermestes bicolor* (7.47%) which are all species of granivorous passerines. For other authors such as De Grazio (1978), Da Camara-Smeets and Manikowski (1981), Ruelle (1982), Odoukpé, et al. (2014a) and Odoukpé et al. (2014b), some bird species such as *Quelea erythrops*, *Euplectes afer*, *Euplectes macroura*, *Estrilda melpoda*, *Streptopelia semitorquata*, *Ploceus heuglini* and *Egretta intermedia* have been reported greatly as the most part as the most devastating species of crops, especially rice. Thus, the presence of these species in our study sites confirms the results of those authors. The data from our study also indicated that the rice fields in and around the city of Daloa are more abundant in *Ploceus cucullatus*, *Spermestes cucullatus* and *Spermestes bicolor* with relative frequencies of 16.4%, 13.7% and 11% respectively. This result could be explained by the specific ecology of these species, notably by the fact that they are gregarious and above all sedentary species on all our study sites. These results are in line with those of Odoukpé et al. (2014a) and Odoukpé et al. (2014b) who showed that *Ploceus cucullatus*, *Spermestes cucullatus* and *Spermestes bicolor* gather the largest numbers and form the most spectacular bird bands in rice fields. As for the diversity index, the highest value ($H' = 2.96$) was obtained at Zepreguhe. This makes Zepreguhe the most diverse site in terms of species. This could be explained by the fact that this site contained several plots where the rice was still in the milky-pasty stage during our field sampling. This confirms the work of Akande (1978); Funmilayo (1980);

Ruelle and Bruggers) (1982 and Brooks and Ejaz (1990) which indicated that the milky-pasty stages corresponded to intense bird activity. With regard to the equitability index, the three sampling sites have statistically the same equitability indices. Bird species are therefore equitably well distributed across the sites.

In terms of abundance, the relative abundance, DOI and PIA of the study area are 2368; 24,79 and 135 respectively. For each of the three study sites (Zepreguhe, Abattoir and Kennedy) the corresponding values of these different indices are 889; 29.47; 155 for Zepreguhe, then 776; 26.93; 127 for Abattoir and finally 703; 29.87 and 122 for Kennedy. Thus, with the exception of the DOI, the two other parameters evaluated (relative abundance and PIA) are higher at the Zepreguhe site. This could be explained by the fact that the Zepreguhe site was less monitored by farmers compared to the other two sites.

Conclusion

This study showed the presence of 2368 birds of 41 species of rice devastating birds distributed among 14 families of 8 orders. The Shannon-Wiever's diversity index (H'); equitability (E); dominance (DOI) and PIA of rice-devastating birds in this area are 3.03; 0.82; 24.79 and 135 respectively. Seventy-eight percent (78%) of the species surveyed are sedentary. All species inventoried are of *Least Concern* (LC). Among these bird species, Passeriformes are the most important order with 22 species representing 53.65% of the species richness of these birds in the study area. At the family level, the Ploceidae are best represented with 12 species for a total of 882 individuals. The Village Weaver *Ploceus cucullatus* and the Northern Grey-headed Sparrow *Passer griseus* represent the two most abundant species with respective numbers of 368 and 219 individuals. Of the three study sites, Zepreguhe appears to be the most important in terms of species richness (38 species), relative abundance (37.54%) and PIA (PIA = 155). Zepreguhe site is the most diverse with 38 species and a diversity index of 2.96. Nevertheless, the Abattoir site seems to be the most equitably distributed (E= 0.86). The species *Ploceus cucullatus* dominates with 16.4% of the total population. These data are preliminary, further studies are planned to monitor the diversity and population dynamics of these birds in the short and long term and to determine the extent of their impact on rice production in the Haut-Sassandra region.

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Data Availability: All data are included in the content of the paper.

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