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Composition and Structure of Urban Bird Assemblages in the North-Eastern Region of Algeria (Kser Sbihi)

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ABSTRACT

We evaluated the diversity and abundance of urban birds in the city of Ksar Sbahi during the period 2014 - 2015 for the first time. This study was conducted in a semi-arid region in north-eastern Algeria, in an old city characterized by homogeneous habitats. A total of 37 species belonging to 21 families and 11 orders were recorded using the point indices of abundance method. The distribution of species over time is strongly influenced by months and seasons, but bird numbers do not vary significantly. 24 species are Passeriformes (64.86%) and 13 are non-Passeriformes (35.14%). The most represented families were Muscicapidae with 06 species then Fringillidae with 04 species and Columbidae with 03 species. According to trophic balance 11 species (29.73%) are granivores, 16 species (43.24%) are insectivores, 06 species (16.22%) are carnivores and 04 species (10.81%) are polyphagous (omnivores). the stand of birds studied consists of two dominant species Pass domesticus: House Sparrow (15.76%), Fringilla coelebs: Common Chaffinch (10.84%), then Columba livia: Rock Dove (8.34%), Streptopelia turtur European Turtle Dove (6.86%) and Streptopelia decaocto Eurasian Collared Dove (5.75%) so the Serinus serinus European Serinus (6.21%) the rest of the species have an abundance which does not exceed 5%. These results are important for estimating the effect of urbanization on biodiversity and urban bird population structure in relation to habitat factors and provide a new vision for the conservation of natural habitats in cities.

Keywords: *Biodiversity, Birds, Ecosystem, Semi-Arid, Algeria.*

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1. INTRODUCTION

Urban areas can play an important role in the conservation of biological diversity. Most research aimed at determining the habitat requirements of various bird species have focused on natural ecosystems, while urban ecosystems have been largely ignored (Gilbert, 1989; Jokimaki, 1996). However, with the rapid expansion of urban and suburban development and the habitat modification associated with it, the importance of understanding the relationship between avifauna and urban habitats is quite obvious (Blair, 1996; Clergeau et al., 1998).

The number of avian species living in the city has greatly increased over the last century, which has resulted in a change in their habits, nest site, diet, rhythm of life and tolerance to the human species (Malher and Magne, 2010). Birds are one of the good indicators of the state of biodiversity because of their high position in food webs (Si bachir, 2012).

In Europe, urban birds have been particularly studied in Germany since 1989 (Otto and Witt, 2002). Follow-ups in England were conducted from 1988 to 1994 in Greater London (Hewlett, 2002), France (Clergeau et al., 1998), Italy (Dinetti, 1994) and Brussels (Weiserbs and Jacob, 2007).

According to Isenmann and Moali (2000), the first data on Algerian avifauna were collected as early as 1939; but, the first important work for North Africa in general and Algeria in particular is the book published by Heim de Balsac and Mayaud (1962) which is a synthesis of the data recorded since the beginning of the inventories of the Algerian avifauna, followed quickly by the work of Etchecopar and Hüe (1964). Ledant et al. (1981) published the first update of the Algerian avifauna. It was not until 2000 that Isenmann and Moali published an exhaustive synthesis of the Algerian avifauna.

The Algerian urban avifauna are not well known except for some works (Merabet et al., 2011; Kaf et al., 2015).

In order to understand the distribution of avian populations in the city of Ksar Sbahi (North-East of Algeria) in relation to the urbanization gradient and to know the evaluation of ornithological wealth, abundance and diversity, a year-long study was done for the first time on birds.

2. MATERIAL AND METHODS.

Study site

This study was carried out in the city of Ksar Sbahi (36 ° 04'01.55 "N 7 ° 15'23.34" E), also called Gadiaufala, located in northeastern Algeria, exactly at the extreme north of the wilaya of Oum El-Bouaghi (Algeria) (figure1). It is perched on a mountain ridge 850 meters above sea level. It has a population of 12 895 inhabitants with an average density of 100 inhabitants / Km².This population is exposed to the development of urbanization with rapid growth (ONS, 2008).

Ksar Sbahi, is a historic city dating back to Roman times, was called Gazophyla under Byzantine rule, from 534 to about 700, being one of the oldest inhabited cities of the wilaya of Oum El

Bouaghi. Its first urban settlements date back to the French colonial period (1830-1962). It has a colonial architecture like most Algerian cities with many gardens, a former post office, an Aleppo pine forest and Roman ruins including many steles. It is a remarkable site of tourism. The archaeological riches of the city have made it a mosaic between the past and the present, a real open-air museum (Bouchareb, 2006).

The study area covers about 17,700 ha, located in the semi-arid bioclimatic stage, the average annual precipitation is 270 mm to 450 mm / year with cold winters and very hot summers. Average monthly temperatures are 4.3 ° C in December and 38.8 ° C in July (ONM, 2017).

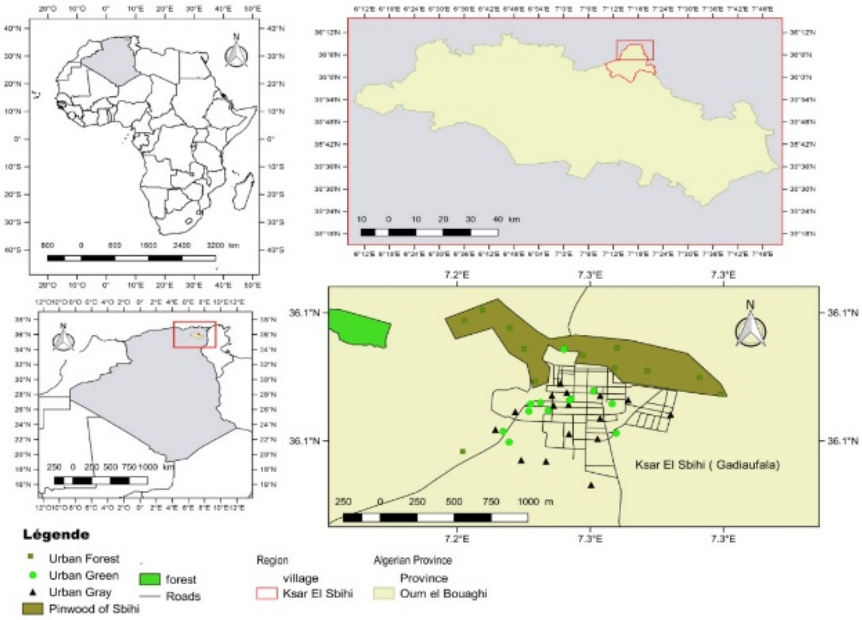


Figure 1. Geographical location map of the study site (original)

Bird census

Ornithological field inventories can take different forms depending on the purpose of the work (Jeanneau et al., 2009). The most appropriate method is Punctual Abundance Indices (PAI), which has been developed and described by (Blondel et al., 1970). It consists of noting all the birds observed or heard during a period of 20 minutes from a fixed point of the territory, all auditory or visual contacts with the birds are noted without limitation of distance.

The inventory of an avian stand is made in two separate counts, one at the beginning and the other at the end of the breeding season so as to contact the early and late breeders. At the end of the two counts for each point, the highest number of couples is retained. It is the average PAI of the species for the point and year considered (Ochando, 1988). PAIs are not comparable between different species of detectability, but only for the same species (Muller, 1987).

This technique estimates the composition of avifauna communities at different listening points, which is expressed by diversity, richness and abundance (Konan et al., 2015).

The birds have been recorded in 40 stations (partial PAI) to ensure sufficient coverage of the study site in terms of bird abundance. These sampling points distributed homogeneously over the three habitat types which are:

-the gray frames, defined by spaces occupied mainly by constructions, cover an area of 108 hectares and delimited by 16 points (PAI),

- the green frames, they are spaces occupied by constructions and a part of the vegetation (trees, shrubs and ornamental plants) estimated by an area of 20 hectares (Kaf et al., 2015) and delimited by 12 sampling points (PAI),
- an urban forest presented by a pine forest of forestry (DGF, Internal Report 2011), which is delimited by 12 survey points (PAI) and occupies 55 hectares.

Data Analysis

Stand Composition Indices

It is the measure of the number of species (or richness) and the quantity expressed in abundance and in frequency (we will not speak here of biomasses) of individuals contained in the stand, with particular reference to the way they are distributed among the different taxa.

a- Specific richness (S)

This is the total number of species. We will distinguish the specific richness or total richness S which is the total number of bird species contacted at least once at the end of the N records (Blondel, 1975).

b- Relative Abundance (Ab%)

It is defined by the number of individuals of a species in relation to the total number of individuals of all species in the same sample. The latter is expressed as a percentage by the following formula: Ab% = (ni / N) × 100 (Faurie et al., 1984).

c- Frequency (Fi%)

The frequency of occurrence, or the constancy of a species, is the ratio expressed as a percentage between the total number of samples where this species is noted and the total number of all samples taken. Fi = (Pi100) / P (Dajoz, 1982).

Stand structure index

a- Shannon-Weaver Index (H ')

The diversity index of Shannon and Weaver (H ') which has been estimated by the following formula: $H' = - \Sigma (n_i / N \log2 n_i / N \log2 n_i / N)$, where n_i and N are the number of individuals of each species and the total number of individuals (MacArthur., 1955).

b- Index of the maximum diversity (H'max)

The maximum diversity (H'max = Log2 S), the calculation of H'max gives access to equitability (Ponel, 1983; Blondel, 1979).

c- Equitability

The calculation of the Shannon and Weaver diversity index (H ') and of the regularity (equitability: E = H'/ H'max) makes it possible to evaluate the specific diversity and the state of numerical equilibrium of bird populations. (Blondel, 1966).

3. RESULTS AND DISCUSSION

The results include 40 surveys by PAI, ie 80 frequency surveys (partial PAI; (NF = 2 NA) (Blondel, 1979). These surveys were carried out in 3 urban (habitats) formations in the city of Ksar Sbahi.

1- Composition of the avian population

The avian populationof all habitats, for the study period considered, consists of 37 species from 21 families and 11 orders with a cumulative number of (539.5 pairs) and an PAI of 1079 birds (Table 1).

1-1- Species richness

Total specific richness in the city of Ksar Sbahi is in the order of **37** species. It represents **9.11%** of the avifauna of Algeria (Isennman et al., 2000), of which 24 species are passeriformes (64.86%) and 13 species are non-passeriformes (**35. 14%).** The best represented orders are Columbiformes (03 species, 226 individuals), Apodiformes (02 species, 77 individuals) and Bucerotiformes (01 species, 23 individuals) (Table 1).

Table 1: Taxonomic list of urban avifauna of Ksar Sbahi (2015).

n.	Taxons	Ab %	IPAm	Fi%	UICN	DZ	Diet	Guild	phenology
No Passeriformes									
O1	**Galliformes**								
F1	Phasianids								
1	*Coturnix coturnix*	0,93	0,12	7,5	LC	NP	Granivorous	terrestrial	MB
O2	**Ciconiiformes**								
F2	storks								
2	*Ciconia ciconia*	1,58	0,21	20	LC	**P**	Carnivorous	terrestrial	MB
O3	**Pelecaniformes**								
F3	herons								
3	*Bubulcus ibis*	1,3	0,17	20	LC	NP	Insectivorous	terrestrial	RB
O4	**Accipitriformes**								
F4	Accipitridaes								
4	*Milvus migrans*	0,28	0,03	7,5	LC	NP	Carnivorous	aerialist	MB
O5	**Columbiformes**								
F5	Pigeons								
5	*Columba livia*	8,34	1,12	60	**VU**	NP	Granivorous	terrestrial	RB
6	*Streptopelia turtur*	6,86	0,92	62,5	LC	NP	Granivorous	terrestrial	RB
7	*Streptopelia decaocto*	5,75	0,77	55	LC	NP	Granivorous	terrestrial	RB
O6	**Strigiformes**								
F6	Strigidae								
8	*Athene noctua*	0,19	0,02	5	LC	**P**	Carnivorous	aerialist	RB
O7	**Apodiformes**								
F7	Apodidae								
9	*Tachymarptis melba*	2,59	0,35	15	LC	NP	Insectivorous	aerialist	MB
10	*Apus apus*	4,54	0,61	20	LC	NP	Insectivorous	aerialist	MB
O8	**Coraciiformes**								
F8	Bee-Eaters								
11	*Merops apiaster*	0,74	0,1	15	LC	**P**	polyphage	arboreal	MB
O9	**Bucerotiformes**								
F9	Upupidae								
12	*Upupa epops*	2,13	0,28	40	VU	**P**	Insectivorous	terrestrial	MB
O10	**Falconiformes**								

F10	falcons								
13	*Falco tinnunculus*	0,46	0,06	12,5	LC	**P**	Carnivorous	aerialist	MB
Passeriformes									
O11	**Passeriformes**								
F11	Shrikes								
14	*Lanius senator*	0,83	0,11	15	LC	NP	Carnivorous	terrestrial	MB
F12	Corvidae								
15	*Corvus corax*	0,93	0,12	22,5	LC	NP	Carnivorous	aerialist	RB
F13	Paridae								
16	*Cyanistes teneriffae*	0,65	0,08	12,5	LC	NP	Insectivorous	arboreal	RB
17	*Great Tit*	0,56	0,07	7,5	LC	NP	Insectivorous	arboreal	RB
F14	Alaudidae								
18	*Alauda arvensis*	1,3	0,17	12,5	LC	NP	Granivorous	Bush	RB
19	*Galerida theklae*	1,02	0,13	15	LC	NP	Granivorous	terrestrial	RB
20	*Calandrella brachydactyla*	0,56	0,07	10	LC	NP	Granivorous	terrestrial	MB
F15	swallows								
21	*Delichon urbicum*	4,54	0,61	25	LC	NP	Insectivorous	aerialist	MB
F16	Sylviidae								
22	*Sylvia cantillans*	0,74	0,1	12,5	LC	NP	Insectivorous	Bush	PV
23	*Sylvia melanocephala*	1,39	0,18	20	LC	NP	Insectivorous	Bush	RB
F17	Turdidae								
24	*Turdus merula*	2,87	0,38	42,5	LC	NP	polyphage	arboreal	RB
25	*Turdus viscivorus*	1,3	0,17	15	LC	NP	polyphage	arboreal	RB
F18	Muscicapidae								
26	*Muscicapa striata*	4,91	0,66	57,5	LC	NP	Insectivorous	aerialist	MB
27	*Ficedula speculigera*	0,65	0,08	10	LC	NP	Insectivorous	aerialist	MB
28	*Phoenicurus moussieri*	0,74	0,1	15	LC	**P**	Insectivorous	terrestrial	RB
29	*Monticola solitarius*	0,28	0,03	7,5	LC	NP	Insectivorous	terrestrial	RB
30	*Saxicola rubicola*	0,19	0,02	5	LC	NP	Insectivorous	Bush	RB
31	*Oenanthe leucura*	1,48	0,2	22,5	**VU**	NP	Insectivorous	terrestrial	RB
F19	Sparrows								
32	*Passer domesticus*	15,76	2,12	55	LC	NP	Granivorous	terrestrial	RB
F20	Motacillidae								
33	*Motacilla alba*	0,46	0,06	10	LC	NP	Insectivorous	terrestrial	PV
F21	Fringillidae								
34	*Fringilla coelebs*	10,84	1,46	75	LC	NP	Polyphage	arboreal	RB
35	*Chloris chloris*	3,8	0,51	52,5	LC	NP	Granivorous	arboreal	RB
36	*Linaria cannabina*	2,32	0,31	35	LC	NP	Granivorous	terrestrial	RB
37	*Serinus serinus*	6,21	0,83	57,5	LC	**P**	Granivorous	terrestrial	RB

Abbreviations
Ab %: **relative abundance**, Fi%: **frequency**, PAI a: **punctual index of average abundance**, UICN: **International Union for the Conservation of Nature**, DZ: **status in Algeria**, Diet: **food system**, O: **Order**, F: **Family**
PV: **passage visitor**, RB: **resident breeder**, MB: **Migrant breeder**. LC: **Minor concern**.
VU: **Vulnerable species.**

1-2- Relative Abundance

The Passeriformes comprise 24 species of 11 families and 694 individuals which represent 64.32% of the abundance. This order is dominated by the Fringillidae family (04 species, 250 individuals, mean PAI = 3.12), the Passeridae (01 species, 170 individuals, mean PAI = 2.12), and the Muscicapidae (06 species, 89 individuals, mean PAI = 1.11).

In terms of abundance determined from the number of individuals of the different species and their respective populations, the stand consists of two dominant species *Passer domesticus*: House Sparrow (15.76%) and Fringilla coelebs: Common Chaffinch (10.84%), then the Columbidae Columba livia: Rock Dove (8.34%), *Streptopelia turtur European Turtle Dove* (6.86%) and *Streptopelia decaocto* Eurasian Collared Dove (5.75%) and the *Serinus serinus* European Serin (6.21%). The rest of the species have an abundance that does not exceed 5%.

1-3- Frequency

The relative frequency determined from detection of the different species in the respective listening points indicates that only 08 species have a frequency greater than 50%, (*Fringilla coelebs*: Common Chaffinch 75%, *Streptopelia turtur*: Eurasian Collared Dove 62.5%, *Columba livia*: Rock Dove 60%,

Muscicapa striata: Spotted Flycatcher and *Serinus serinus*: European Serin 57.5%, *Streptopelia decaocto*: Eurasian Collared Dove, *Passer domesticus*: House Sparrow 55% and *Chloris chloris*: European Greenfinch 52.5%). 29 species have a frequency varying between (5% and 42.5%) and are the least present in the surveys.

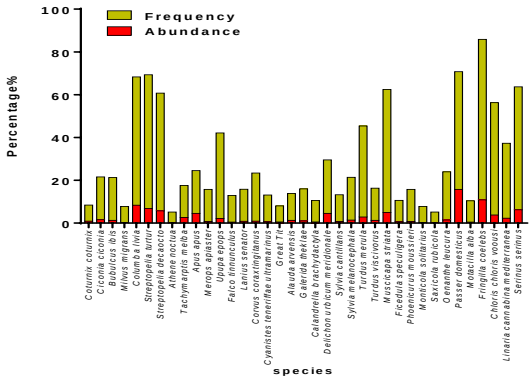


Figure 2. Abundance and frequency variation of bird species in the city Ksar Sbahi (2015)

2-Structure of the avifaunal population

The Shannon-Weaver Diversity Index measures the complexity of community diversity. The great value of this index (H '= 1.57 bits) in the city of Ksar Sbahi reflects a considerable and important diversity. In contrast, the regularity index (equitability) is directly related to the abundance distribution on species richness (E = 0.99) which indicates the specialization and equirepartition of species in their habitats.

2-1- Ornithological features of Ksar Sbahi avifauna

2-1-1- Statutes of conservation

According to the IUCN Global Red List: 02 species (5.41%) are Vulnerable (VU) (European Turtle Dove: *Streptopelia turtur* and Black Wheatear: *Oenanthe leucura*), the remaining 35 species (94.59%) have a status of Least Concern (LC) (IUCN., 2017). At the national level and according to the law in Algeria, 07 species (18.92%) are protected and 30 species of birds (81.08%) are unprotected. (Figures 3 and 4).

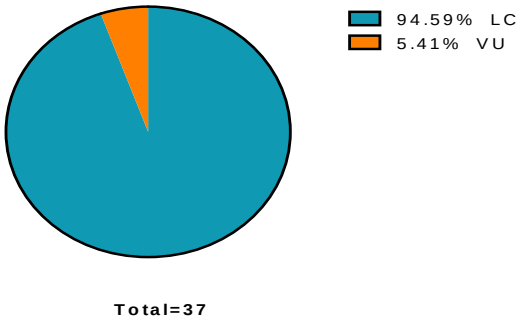


Figure 3. Conservation status of Ksar Sbahi avifauna according to the IUCN red list

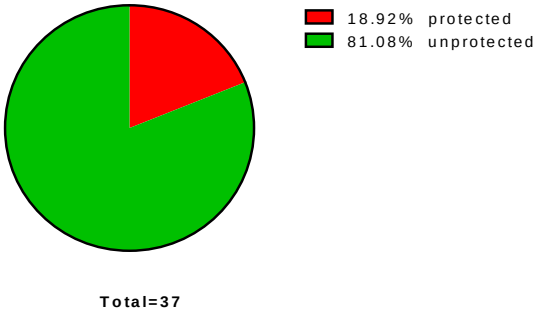


Figure 4. Conservation status of Ksar Sbahi avifauna according to the Algerian law

2-1-2- Guilds and trophic categories

According to bibliographic resources (Heinzel, 2014), (Svensson, 2015), (Benyacoub, 1993), (Mostefai, 2010) and (Menaa, 2016), the trophic categories of urban birds are as follows: 11 species (29.73%) are granivorous, 16 species (43.24%) are insectivorous, 06 species (16.22%) are carnivorous and 04 species (10.81%) are polyphagous (omnivorous) (Figure 5).

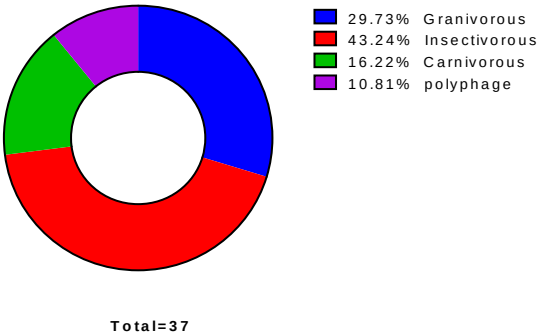


Figure 5. Trophic categories of bird species inventoried at Ksar Sbahi (2015)

The trophic guilds are in decreasing order of following: 17 Terrestrial species (45.95%), 09 Aerialist species (24.32%), 07 Arboreal species (18.92%) and 04 Bush species) (10.81%) (Figure 6).

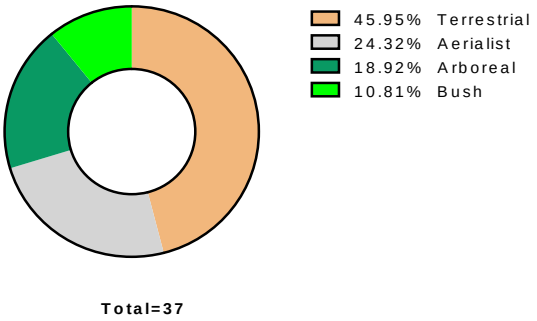


Figure 6. Trophic guilds of bird species inventoried at Ksar Sbahi (2015)

2-2 - Phenological structure of avifauna

More than half of the species are sedentary and breeder (59.46%), 35.13% are migratory breeding birds and 05.41% are passage visitors (Table 2) (Figure 7).

Table 2: Summary of phenological status of urban birds in Ksar Sbahi 2015

		Not passeriforme		Passeriforme	
Abbreviation	**Phenology**	**Number of species**	**Percentage %**	**Number of species**	**Percentage %**
MB	Migrant Breeder	8	21,62	5	13,51
RB	Resident Breeder	5	13,51	17	45,95
PV	Passage visitor	0	0,00	2	5,41

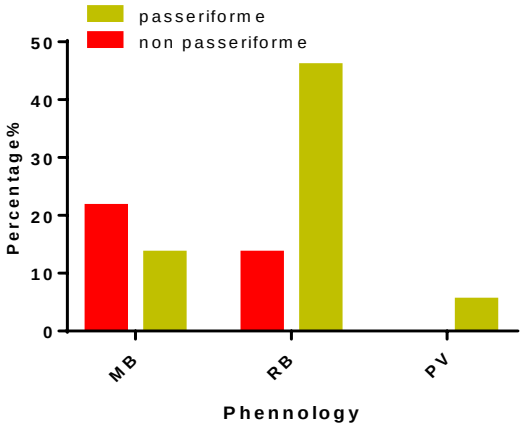


Figure 7. Phenological review of the nesting and emigration status of Ksar Sbahi birds (2015)

2-3- Composition and structure of avifauna in different habitats

The habitats are organized in mosaic but in concentric forms. The urban forest (pine forest) is in the form of a horizontal band from East to West and located north of the city. Gardens, parks, and hedgerows (urban green habitat) are presented by patches, just like the gray habitat (frames, buildings, houses) in the form of gray concrete parcels. Each habitat has a specific richness more or less important.

2-4- Specific composition of avifauna

2-4-1- Specific richness

The gray habitat has the highest species richness of Ksar Sbahi City with 31 species grouped into 19 families with a population (270.5 pairs) and an PAI of 541 birds. Urban forest habitat with 28 species and 14 families with a population (150 pairs) and an PAI of 300 birds.

The green urban habitat includes 28 species and 16 families with a population (118.5 pairs) and an PAI of 541 birds.

In the gray habitat the species richness is **31** species. It represents **83.78**% of the total specific richness of the city where 18 species are passeriformes (**58.06%**) and 13 species are non-passeriformes **(41.93%)**.

In urban forest habitats and green urban, species richness is of equal value with **28** species. It represents **75.67%** of the total specific richness of the city. In the urban forest habitat, 20 species are passeriformes (**71.42%**) and 08 species are non-passeriformes (**28.58%).** In the green urban habitat, 19 species are passiform (67.86%) and 09 species are non-passeriform (**32.14%**) (Figure 8).

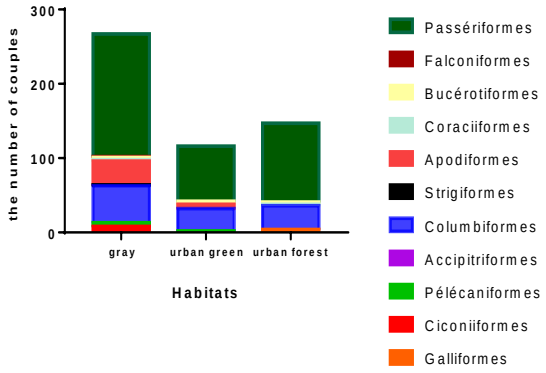


Figure 8. Number of pairs of bird orders in the habitats of the city of ksar sbahi 2015

2-4-2- Abundance

Passeriformes are the dominant species in the three habitats comprising 10 families and counting 149 individuals which represent 62.87% of the abundance in green urban habitat. With 09 families and 331 individuals representing 61.18% of abundance in gray habitat. 08 families and 213 individuals representing 71% of abundance in urban forest habitat. Sparrows are confined mainly to habitats rich in vegetation. The best represented orders are Columbiformes with 03 species and 101 individuals in gray habitat. With 65 individuals in the urban forest habitat and 60 individuals in green urban habitat. Apodiformes with 02 species and 64 individuals in gray habitat. There are 13 individuals in the green urban habitat. Ciconiiformes, Bucerotiformes and Galliformes are also poorly represented (Figure 9).

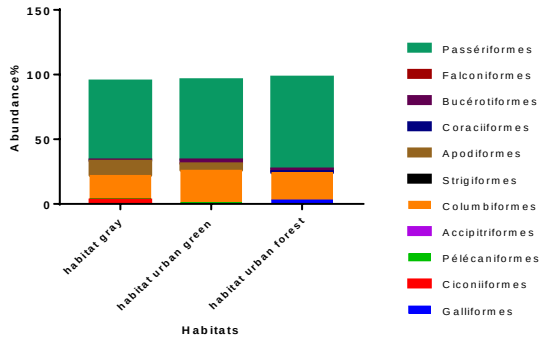
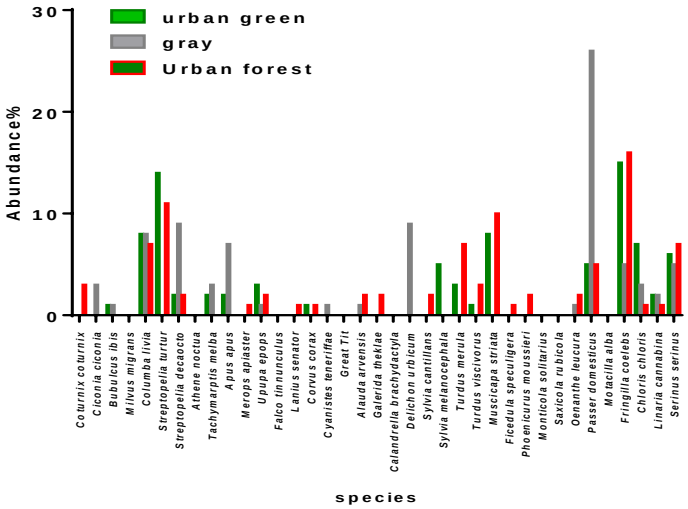


Figure 9. Percentage of avian population by habitat of the city of Ksar Sbahi (2015)

The abundance of different species and their populations varies from one habitat to another. In the purely urban environment, the gray habitat, House Sparrow (26.25%) *Passer domesticus* dominates. In the plant environment, it is the Common Chaffinch *Fringilla coelebs* that dominates (Figure 10).



Fiureg 10. Abundance variation (Ab%) of bird species in Ksar Sbahi habitats (2015)

The relative frequency determined from the detection of the different species in the different listening points shows that only 08 species have a frequency higher than 50%, (Fringilla coelebs: Common Chaffinch with 75%, *Streptopelia turtur*: Eurasian Collared Dove with 62.5 %, *Columba livia*: Rock Dove with 60%, *Muscicapa striata*: Spotted Flycatcher and *Serinus serinus*: European Serin with 57.5%, *Streptopelia decaocto*: Eurasian Collared Dove and *Passer domesticus*: House Sparrow with 55% and *Chloris chloris*: European Greenfinch with 52.5%. It is noted that 29 species have a frequency that varies from 5% to 42.5% and are the least present in the surveys. More than half of the species are found to be sedentary (59.46%), 43.24% are wintering birds, 40.54% are passage visitors and 35.14% are migrant breeders (Figure 11).

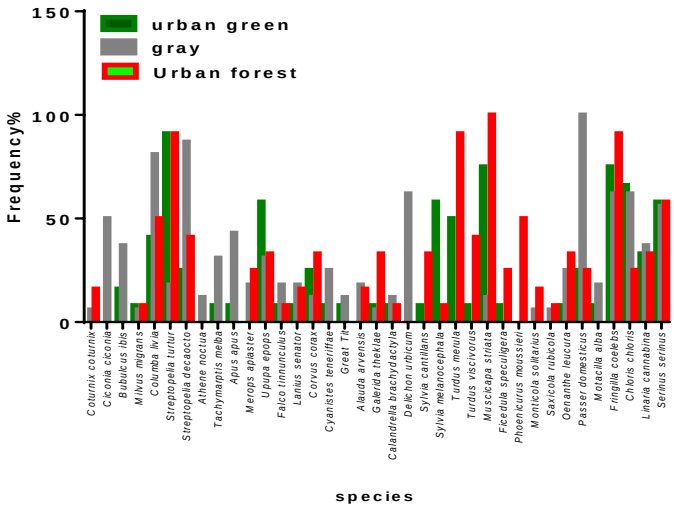


Figure 11. Frequency variations (Fi%) of bird species in habitats of Ksar Sbahi (2015)

4. CONCLUSION

This study is an analysis of variations in the structure and composition of urban birds along a gradient of habitats in an ancient Algerian city.

The analysis of the different ornithological characteristics (wintering, nesting, presence-absense of remarkable species (protected) by habitat, allowed us to establish an order of ornithological importance of all the habitats of the city for the conservation of the avifauna. The composition and structure of urban bird populations vary among the three habitat types.

The first gray built habitat covers a very large area and offers a large area of feeding and nesting birds.

However, it should be noted that the disturbance factor, which is often of anthropogenic origin, can influence the presence of a given species in a particular habitat and influence its diversity (Cherkaoui et al., 2007).

Green habitat is the most degraded environment in the city and is under heavy human pressure, particularly through the presence of household waste. However, the urban forest is more or less conserved and it is, without a doubt, one of the reasons why this formation offers a habitat of choice for some key species at the level of the whole city.

The species richness is low in our study compared to the results reported in the bibliography in the Mediterranean cities with 42 species in Rennes (France), 43 species in East Donges (France), 60 species nest in the center of Paris (Malher and Magne, 2010).

In Europe, the richness is much higher than that of our study area where only 37 species were noted. One finds that 86 breeding species identified in Florence (Italy) (Dinetti, 1994), 103 species regularly nest on the Land of Berlin (Otto and Witt, 2002) and 126 species were identified from 1988 to 1994 in Greater London (Hewlett, 2002). Our results are close to those of neighboring cities, Aïn Beïda (Algeria): 32 species (Benchabane et al., 2018) and Oum El Bouaghi: 30 species (Kaf, 2015).

Chace and Walsh (2006) reported that species richness decreases due to loss of natural habitat and reduced resource availability. In the study area, urban density varies between 65 and 90% in the center, where it is lower in peri-urban areas (35 to 60%). Bird species richness decreases with increasing urban land cover (Donnelly and Marzluff 2006; Pennington et al., 2008), unlike Ksar Sbahi city, higher habitat richness, but, the richness of passeriformes is very important in green habitats, as passerines are confined to plant formations (Blondel 1969, Cherkaoui et al. 2007).

The recorded richness and abundance may reflect the combined effect of the phenological status of the species in the study area and the quality of the habitats represented by food availability (Bolger, 2001; Marzluff, 2001).

The predominance of urban ecosystems by species largely dominated by the columbines, illustrates an image of their importance at the global level. Our results confirm previous studies in other urban areas of the world where passerines are mainly represented by more than 60% of bird species (Blondel and Mourer-Chauvier, 1998; Aliabadian et al., 2005).

It shows that the urban forest and the green environment are key habitats for any conservation measure of avifauna in the city of Ksar Sbahi. The largest number of species is concentrated at the city level (gray habitat), while green habitats and the urban forest host fewer species.

The diurnal raptors, Strigiformes and Falconiformes count one species for each order, are always represented by a small size that rarely exceed 04 individuals, which explains their restricted distribution at the level of the city and habitats. This is confirmed by previous studies (Boal et al., 1999; Chace et al., 2006).

The total density of nesting birds is often higher in urban areas than in the surrounding natural habitat (Walcott, 1974; Gavareski, 1976; Lancaster and Rees, 1979; Beissinger and Osborne, 1982).

The protection of avifauna in Algeria is relatively recent since the first text relating to the protection of protected non-domestic animal species dates from 20 August 1983. This measure was subsequently reinforced, in particular with the decree relating to the practice of hunting for the 1990-1991 season, the decree of 17 January 1995 on protected non-domestic animal species in Algeria, Law No. 04-07 on Hunting on 01 August 2004 (Belhamra, 2005).

The results of our study are similar to those described for urban birds in many parts of the world, however, the structure and composition of the avifauna are strongly related to the socio-economic model, to the strong urbanization structure and to the guilds of birds.

Given the species richness, that of our city is less diversified than most cities in the Mediterranean region, but important in Algeria. The very limited number of urban gardens and the rate of vegetation (bioclimate with semi-arid vegetation) in this city could be one of the main causes of these results.

Our results provide essential information for urban planners, citizens and environmental activists about the importance of urban ecosystems and their biodiversity, but a huge effort is needed to improve the situation by planning green spaces and encouraging the planting of indigenous trees. In future urban development plans, it is recommended to pay attention to green spaces, to the management of household waste to safeguard urban forests, because they represent key habitats for biodiversity.

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