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Spatio-Temporal Variation Patterns of Bird Community in the Oasis Ecosystem of the North of Algerian Sahara

SPATIO-TEMPORAL VARIATION PATTERNS OF BIRD COMMUNITY IN THE OASIS ECOSYSTEM OF THE NORTH OF ALGERIAN SAHARA

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ABSTRACT

The spatial and temporal variation patterns of birds were investigated in the Oasis ecosystem of the North of Algeria Sahara. This contribution aimed to investigate the poorly studied bird fauna of Bousaâda oasis. The direct observation method was used for bird counts, adopted only during the breeding period. A total of 53 species of birds from 29 families and 16 orders were assessed in the different habitats of the Oasis (palm, fruit trees and, cultivated crops). The Passeriformes order was the most abundant represented by 35 species and 16 families. The relative abundance and species richness were recorded during our study period over different seasons and thought that whole surveyed stations represent all the oasis habitats. The Boussaâda oasis holds 18 resident-breeders which is a transit zone for a number of migratory birds i-e 14 and 10 species for summer and winter migrants respectively) and11 occasional visitor ones. These results confirmed the positive effects of stations and seasons on the richness and abundance of birds of Bousaâda oasis.

Keywords: Oasis, bird, spatio-temporal, Algeria**.**

INTRODUCTION

Biodiversity studies attracted the world's attention to find its impacts on humans and provide parallel ecosystem services (Harrington et al., 2010). During the last century, reduction in biological diversity has directly affected the human activities (Heywood and Watson, 1995). The oasis is considered as a fragile ecosystem of the arid climate. The landscape mainly relies on the components of a desert-oasis-river (Yang et al., 2010). Over the centuries, oases have played a key role in the local socio-economic development and in the ensuring of ecological balance. Multiple factors both natural and human have seriously affected the oasis ecosystem during the last century (Botes and Zaid, 2002).

Oases help study survey biodiversity and their ecological characteristics because of their key habitats (Chenchouni, 2012). According to the Ramsar Convention, oases are considered a type of inland wetlands (Ramsar, 2007). However, the ecological characteristics of oases in Algeria varied between regions following their geographic location. Although, the ecosystems of arid and desert regions has very peculiar biodiversity related to locale biotope and climate (McGinley, 2007) particularly birds (Roshier et al., 2001; Mwaura, 2010; Chenchouni, 2012).

The avifauna of Algerian oases were reported by Heim de Balsac and Mayaud (1962) and Dupuy (1966) followed by updated data (Ledant et al., 1981; Isenmann and Moali, 2000; Samraoui, 2008). In southern Tunisia, many surveys were undertaken on the diversity and distribution of this avifauna (Selmi et al.,2002). Some studies were available on birds of oases in Algeria (Boukhemza, 1990; Chenchouni, 2012; Bensaci et al., 2013) but these were limited to few regions and were occasionally observed.

The present study was undertaken with the two basic objectives: i) to assess the bird diversity of the oasis located in arid climate differently to previous studies on Oases of Sahara Desert; and ii) to evaluate the spatio-temporal variation patterns of birds within Bousâada oasis.

MATERIAL AND METHODS

Study Area

Bousâada (35° 12' 36.97"^{o}N, 4° 10' 46.08"^{o}E) is a marvelous oasis, located in the centre of the northwardly located state of Algeria at an altitude of 602m above the sea level (Figure1). The oasis is delimited by three structural groups: high plains of the Algiers-Oran steppes to the north and east, Saharan desert to the south, and Saharan Atlas to the west (Kaabeche, 1990). The area has an arid climate (annual mean temperature 25°C, average annual precipitation <185.8 mm) with dry season extends all along the year.

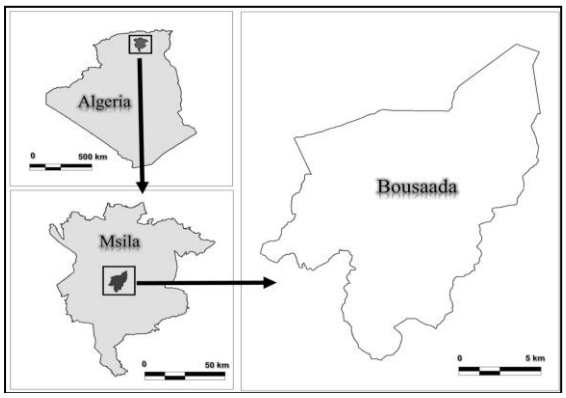

Figure 1: Study area location.

Bousâada oasis is the first one encountered while heading from the coastline to the Sahara Desert (Boutabba, 2013) Oasis is crossed by Oued Bousâada, flowing at the foot of a huge cliff used for irrigation. The landscape is dominated by palm trees (*Phoenix dactylifera L*.) mixed with fruit trees and cultivated crops.

Table 1: Characteristics of studied regions.

Bird Surveys

Bird surveys were conducted from March 2019 to March 2020 which covered all seasons of the year, with three passes are performed in each station during each season, which normally can detect all wintering, visitor passage and breeding species (Blondel, 1975). The most accurate and appropriate method is the territory-mapping method which is used for estimating the species richness and the avian communities abundance in open habitats (Bibby et al., 1992).

This approach based on the assessment of all contacted birds and their abundances during a period of 15 minutes. A pair of binoculars (8×42) and a field guide book were also used to identify the species of birds observed. Counts were performed in calm weather, avoiding harsh weather, wind and bitter cold). For this study total 19 census points (station) were selected non-randomly on the basis of habitat type and their accessibility. Overall, these stations located in four (4) studied regions: Zakat El-Kib (ZEK), Loulaj (LLJ), JnanLebtom 1 (JB1) and, JnanLebtom 2 (JB2) **(**Table 1). These regions have different habitat characteristics. Depending on their location, the surveyed stations are the subject of varied urban pressure and human disturbance. Phenological types used were (1) resident breeder (RB) species present all year with breeding proof; (2) winter visitor (WV) species observed exclusively during the rainy season; (3) summer visitor (SV) migratory species in summer; (4) occasional visitor (OV) species that observed in the study region at least once (Isenmann and Moali, 2000).

During the study period the total numbers of species counted at each station were defined as species richness. However, the species abundance

Region	No. of stations	Vegetation Species Richness (±SD)	NDVI
ZEK1	4	47.00 ± 6.40	0.38 ± 0.03
JB 2-1	5	32.4 ± 7.68	0.23 ± 0.03
JB 1-1	5	37.00 ± 13.68	0.35 ± 0.04
LLJ-1	5	38.00 ± 6.80	0.29 ± 0.09

NDVI: *The normalized difference vegetation index*

means the highest number of birds species counted at different points during surveys.

Data Analysis

Statistical tests were performed using SPSS 17.0 with a significance level of $P \leq 0.05$. All means are shown ± standard error of mean unless stated otherwise.

We used parametric tests and ANOVA to test all variables,when the normality (Kolmogorov–Smirnov test) and homoscedasticity (Levene test), the variables were transformed by logarithm or a square-root transformation, the ones did not conform the requirements for parametric tests, before all analyses (Underwood, 1996).

A one-way multivariate analysis of variance (MANOVA) was performed to test the effect of stations and seasons on therichness and abundance of assessed birds.

The Shannon's diversity index ($H' = -\sum pi \log pi$), where pi: is the proportion of individuals belonging to the i: the species) was used to identify theα-diversity of bird species in different stations (Magurran, 2004). High values of H' and low values of H' indicate high species diversity (Krebs, 1999).

Equitability (Evenness), the distribution of abundances among species was computed as J'= H'/lnS, whereas S is the number of species in each station (Magurran, 2004). Evenness was rangeing from 0 to 1 and all individuals were partitioned equally among species, as it approached 1 (Krebs, 1999).

RESULTS

Specific Richness

A total of 53 bird species, representing 40 genera, 29 families and 16 orders were recorded in the Oasis of Boussaâda from all surveyed stations (Table 1). Order Passeriformes has represented the highest number of species (35; 16 families). Order Columbiformes was represented by 4 species while orders Accipitriformes, Pelecaniformes and Charadriiformes by two species each. Other orders (11) were represented by only a single species, (Table 2).

Spatial Richness and Abundance Variation of Birds

The species mean richness varied significantly between surveyed stations (ANOVA: F1, 18= 7.76, P= 0.000). The high mean richness value was recorded in the JB1-2 (13.18±2.82) where the lower was marked in JB1-5 (5.18±3.06) (Table 3).

The species mean abundance varied significantly between surveyed stations (ANOVA: F1, 18= 6.79, P = 0.000). The high abundance was recorded in the JB2-1 (80.18±41.91) where the lower was in JB1-5 (9.54±6.50) (Table 3) one-way MANOVA confirmed the statistically significant difference in richness and abundance between stations,

Table 2: Taxonomic list of the bird species recorded at all the different surveyed stations in the Bousaâda oasis during 2019 to 2020.

Order	Family	Species	Common Name	Phenoloical Category
Passeriformes	Muscicapidae	*Phoenicurus moussieri*	Moussier's Redstart	OV
		Phoenicurus ochruros	Black Redstart	WV
		Phoenicurus phoenicurus	Redstart	OV
		Oenanthe deserti	Desert Wheatear	OV
		Oenanthe leucura	Black Wheatear	RB
		Lusciniame garhynchos	Nightingale	SV
		Erithacus rubecula	Robin	WV
		Ficedula hypoleuca	Pied Flycatcher	SV
		Muscicapas triata	Spotted Flycatcher	SV
	Sylviidae	*Sylvia atricapilla*	Black cap	WV
		Sylvia hortensis	Western Orphean Warbler	SV
		Sylvia melanocephala	SardinianWarbler	RB
	Phylloscopidae	*Phylloscopus collybita*	Chiff chaff	WV
		Phylloscopus sibilatrix	Wood Warbler	SV
		Phylloscopus trochilus	Willow Warbler	SV
	Fringillidae	*Chloris chloris*	Green finch	RB
		Serinus serinus	Serin	RB
		Bucanetes githagineus	Trumpeter Finch	OV
	Motacillidae	*Motacilla alba*	Pied Wagtail	WV
		Motacilla cinerea	Grey Wagtail	WV
		Anthustrivialis	Tree Pipit	OV
	Laniidae	*Lanius elegans*	Great Grey Shrike	WV
		Lanius senator	Woodchat Shrike	SV
	Passeridae	*Passer domesticus*	House Sparrow	RB
		Passer montanus	Tree Sparrow	RB
	Turdidae	*Turdus merula*	Black bird	RB
		Turdus philomelos	Song Thrush	WV

	Acrocephalidae	*Iduna opaca*	Western Olivaceous Warbler	SV
	Paridae	*Cyanistes teneriffae*	African Blue Tit	RB
	Alaudidae	*Galerida cristata*	Crested Lark	RB
	Emberizidae	*Emberiza striolata*	Striolated Bunting	RB
	Corvidae	*Corvus corax*	Raven	RB
	Hirundinidae	*Hirundo rustica*	Swallow	SV
	Sturnidae	*Sturnus vulgaris*	Starling	WV
	Cisticolidae	*Cisticola juncidis*	Zitting Cisticola	RB
Columbiformes	Columbidae	*Streptopeliade caocto*	Collared Dove	RB
		Streptopelia senegalensis	Laughing Dove	RB
		Streptopelia turtur	Turtle Dove	SV
		Columba livia	Rock Dove	RB
Accipitriformes	Accipitridae	*Neophronpercnopterus*	EgyptianVulture	SV
		Circus aeruginosus	Western Marsh Harrier	OV
Pelecaniformes	Ardeidae	*Bubulcus ibis*	Cattle Egret	RB
		Nycticorax nycticorax	Black-crowned Night-heron	OV
Charadriiformes	Charadriidae	*Charadrius dubius*	Little Ringed Plover	SV
	Scolopacidae	*Tringa ochropus*	Green Sand piper	WV
Ciconiiformes	Ciconiidae	*Ciconia ciconia*	White Stork	SV
Gruiformes	Gruidae	*Grus grus*	Crane	OV
Falconiformes	Falconidae	*Falco tinnunculus*	Kestrel	RB
Strigiformes	Strigidae	*Athenenoctua*	Little Owl	OV
Bucérotiformes	Upupidae	*Upupaepops*	Hoopoe	RB
Coraciiformes	Meropidae	*Merops apiaster*	Bee-eater	SV
Piciformes	Picidae	*Jynxtor quilla*	Wryneck	OV
Galliformes	Phasianidae	*Alectoris barbara*	Barbary Partridge	OV

(*RB=resident breeder, SV =summer visitor, OV: = occasional visitor, WV =winter visitor*)

F (36, 378) = 6.37, p <.0005; Wilk's Λ = 0.378.

Table 3: Spatial mean richness and abundance variations of assessed birds.

Station	Richness (Mean ± SD)	Abundance (Mean ± SD)
JB1-1	5.82 ± 4.75	18.09 ±11.84
JB1-2	13.18 ±2.82	44.27 ±40.90
JB1-3	8.45 ±4.03	28.64 ±18.40
JB1-4	6.45 ±2.84	12.91 ±5.28
JB1-5	5.18 ±3.06	9.55 ±6.50
JB2-1	12.82 ±2.68	80.18 ±41.91
JB2-2	8.00 ±1.84	39.82 ±18.62
JB2-3	6.73 ±2.24	39.82 ±23.37
JB2-4	7.18 ±1.83	50.64 ±30.02
JB2-5	7.09 ±1.22	52.91 ±30.33
LLJ1	11.00 ±4.05	33.18 ±44.27
LLJ2	7.45 ±3.08	10.09 ±8.29
LLJ3	8.36 ±1.63	20.09 ±32.33
LLJ4	9.36 ±2.46	10.82 ±5.56
LLJ5	7.18 ±2.44	11.00 ±5.80
ZEK1	11.91 ±2.07	68.82 ±32.53
ZEK2	10.55 ±4.01	52.18 ±40.37
ZEK3	10.55 ±2.25	52.09 ±24.62
ZEK4	10.73 ±1.68	45.18 ±24.41

Seasonal Richness and Abundance Variation of Birds

The species richness varied significantly between seasons (ANOVA: $F_{1,3}$= 3.65, P = 0. 013). The high mean richness value was recorded during spring (9.82±3.95) whereas the winter had the minimum richness (7.92±3.30) (Table 4). However, no significant difference in abundance was found between seasons (ANOVA: $F_{1,3}$= 5.07, P = 0. 069).

Similarly one-way MANOVA suggest a statistically significant differences in richness and abundance difference between seasons (F 36, 378 = 6.37, p <.0005; Wilk's Λ = 0.378).

Table 4: Seasonal mean richness and abundance variations of assessed birds.

Season	Richness (Mean ± SD)	Abundance (Mean ± SD)
Autumn	7.95 ± 2.87	27.92 ±25.76
Spring	9.82 ± 3.95	31.72 ± 23.82
Summer	8.75 ± 3.38	34.70 ±25.57
Winter	7.92 ± 3.30	53.50 ±53.57

Shannon-Weaver Diversity and Evenness (Equitability) Indexes

The highest value of the Shannon diversity index was observed in the JB1-3 (3.64) and the lower of 2.34 was recorded in the JB1-4 station (Fig 2). The maximum value of the equitability index was recorded in the LLJ5 station (0.77), where the minimum value was noted in the JB1-4 (0.53) (Figure 3).

Phenological Status of Birds

The avifauna of Bousâada Oasis is dominated by resident breeder species (18 species), followed by summer visitor species (14 species), occasional visitor (11 species), and winter migrant (10 species) (Figure 4).

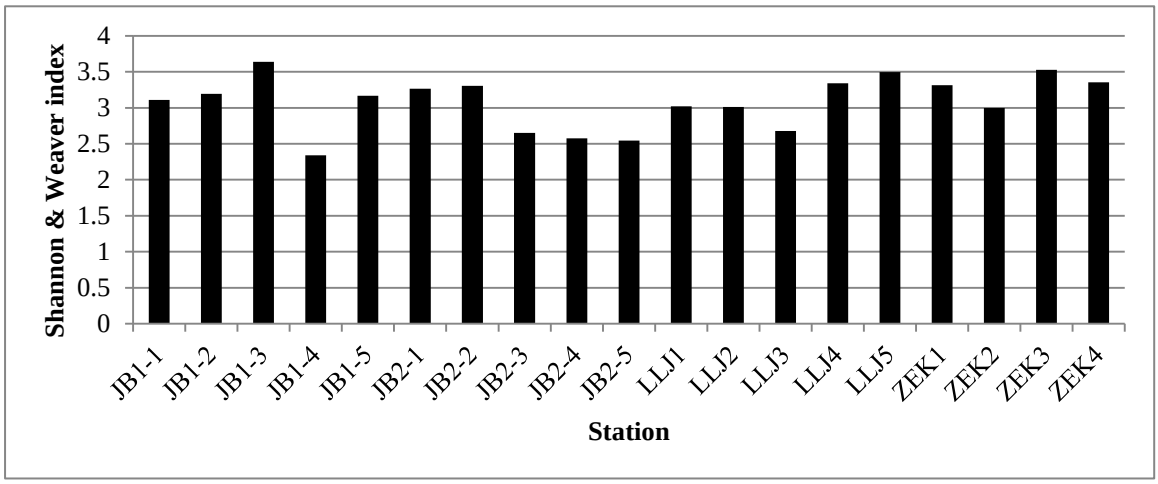

Figure 2: Shannon-Weaver diversity index variation of birds of Bousaâda Oasis.

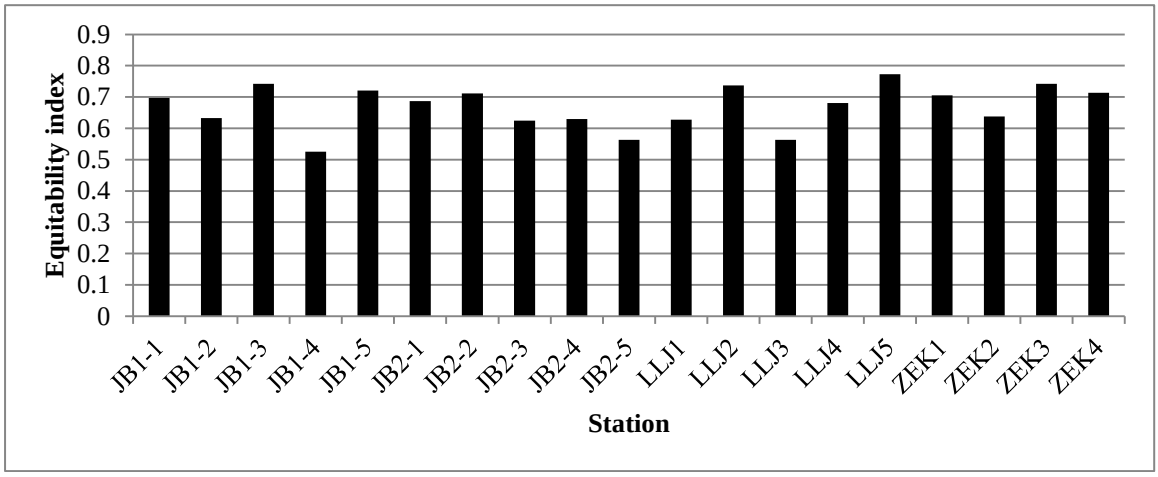

Figure 3: Evenness (Equitability) index variation of birds of Bousaâda Oasis.

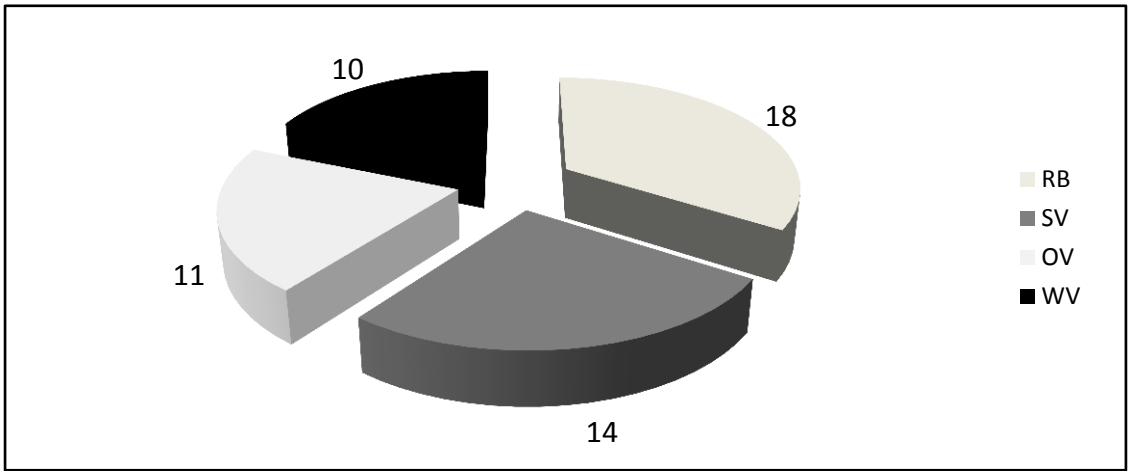

Figure 4: Phenological status of birds of Bousaâda Oasis.

RB: Resident breeder, SV: Summer visitor, OV: Occasional visitor, WV: Winter visitor

DISCUSSION

The inventory of birds in Bousaâda oasis suggests that 53 bird species, representing 7.66% of the Algerian birds (Isenman and Moali, 2000). However, in the Ziban region (Biskra, Algeria) Farhi and Belhamra (2012) identified 136 species representing 18 orders and 42 families (including waterbirds), of which Passeriformes were represented by 58 species (12 families). Guezoul et al., (2013) reported 59 species present over a larger area, covering three different oases of the Northern Algerian Sahara.

The assessed richness in the study area is lower than that reported in south Tunisian oases,(Selmi,2002: 86 species, 13 families, 4 orders).Species richness at Bousaâda oasis, was higher than that recorded by Guezoul et al. (2013) for different oasis (Biskra: 47, Oued Souf: 33 and Ouargla: 44).

The highest richness of oases birds in Algeria was recorded in Timimoun region (SWAlgeria), where 100 species (12 orders, 28 families and 59 genera) were described. Most of the species can be attributed to varied habitat sampled, such as oases, salt lake, reeds, and suburban area (Boukhemza, 1990).

Order Passeriformes is prominently represented in all avian populations that are present in the oasis (66% of assessed species). This is in line with previous studies on oases birds of Algeria (Farhi and Belhamra, 2012; Guezoul et al., 2013). The most of bird species in the surveyed oases were closely related to their phenology.

During the monitoring many species were presented in the most surveyed stations such as :Hybrid sparrow, Collared Dove, Laughing Dove, Turtle Dove, Rock Dove, Greenfinch and Blackbird), some of these are known to have an expansion of their distribution range over the Mediterranean basin (Bergier et al., 1999; Bendjoudi *et al*., 2013) and worldwide (Bonter et al., 2010). These species are considered as the most abundant and the common birds in all oases of the Tunisian Sahara (Selmi., 2002).

Bousaâda oasis is known to have a high anthropogenic pressure (urbanization, high rate of ground water extraction, land encroachment) which led to the loss of many habitats, affecting bird's richness and abundance. Donnelly and Marzluff (2006) confirmed that the increase in urban land cover badly effect the bird species richness and result in its decrease**.**

Assessed species represent different phenological status: 18 resident breeder species (34%), followed by 14 summer visitor species (26%), 11 occasional visitors (21%), and 10 winter migrant species (19%). The dominance of resident breeder species could be justified by the heterogeneity of the micro-habitats of oasis that contains palm and fruit trees and cultivated crops. Isenmann and Moali (2000) and Ledant et al., (1981), recorded that the species, like, *Phoenicurus ochruros, Erithacus rubecula, Sylvia atricapilla, Phylloscopus collybita, Motacilla alba, Motacilla cinerea, Lanius elegans Turdus philomelos, Sturnus vulgaris,* and *Tringaochropus*, as winter visitor to Algerao oasis. Other species, like, *Phoenicurus moussieri, Phoenicurus phoenicurus,* and *Bucanetes githagineus* are occasional visitors that use oasis as a stopover point during their trans-Saharan journey. These species stop on oases to supply energy to be able to reach their wintering or breeding site (Lavee et al., 1991, Bairlein, 1992; and Biebach et al., 2000).

Abundance of some species, such as feral pigeons, swallows, swifts, and a few other species that breed in walls indicated increased urbanization. Thus, landscape transformation of the oasis during last decade has been indicated previously (Botes and Zaid, 2002; Meddich et al., 2018).Significant special variation reveals the high quality of

habitats with high supply of seeds and productivity (Emlen, 1974).

The stations presented a high urban pressure and human disturbance were recorded a low species richness, which is in confirmation of Chace and Walsh (2006) and Sandström et al., (2006). Furthermore, The composition of vegetation in an area is closely associated with the composition and variations of bird communities and their abundance. (Sewell and Catterall, 1998; White et al., 2005 and Daniels and Kirkpatrick, 2006).

Shannon and Weaver's index allow us to measure the complexity of a stand. A high value of this index indicates a settlement in many species for a small number of individuals. Conversely, a low value of the latter is either or a settlement characterized by a small number of species for many people, or to a settlement in which there is a dominant species. In other words, he studied the equilibrium of populations in an ecosystem.

Despite the rapid urbanization of Bousaâda region, this relevant diversity can help to support the conservation measures of native avian populations, representing animportant biodiversity hotspots which is located in the arid region.

CONCLUSION

Our results confirmed that Bousaâda oasis represents an important habitat exploited as wintering grounds, stopover site during trans-Saharan migration, and breeding sites for several species. Regarding the strategic geographic situation of this region as a key in the regional scale biodiversity and bird's dynamic this needs further investigations on habitat preferences of birds.

REFERENCES

Bairlein F. (1992). Recent prospects on trans-Saharan migration of songbirds. Ibis., 134: 41–46.

Bendjoudi D, Chenchouni H, Doumandji S, Voisin JF (2013). Bird diversity in Plain Mitidja (N. Algeria) with emphasis on dynamics of invasive and expanding species. Acrocephalus 33.

Bensaci E, Saheb M, Nouidjem Y, Bouzegag A, Houhamdi M (2013). Biodiversité de l'Avifaune aquatique des Zones Humides Sahariennes : Cas de la Dépression d'Oued Righ (ALGÉRIE). Physio-Géo – Géographie Physique et Environnement VII 211-222.

Bergier P, Franchimont J, Thevenot M (1999). Implantation et expansion géographique de deux espèces de Columbidés au Maroc : La Tourterelle turque Streptopeliadecaocto et la Tourterelle mallee Streptopelia senegalensis. Alauda. 67: 23–36.

Bibby CJ, Burgess ND and Hill DA (1992). Bird census techniques. Academic Press, London.

Biebach H, Biebach I, Friedrich W, Heine G, Partecke J, Schmidl D (2000). Strategies of passerine migration across the Mediterranean Sea and the Sahara Desert: a radar study. Ibis., 142 : 623 – 634.

Blondel J (1975). L'analyse des peuplements d'oiseaux, éléments d'un diagnostic écologique : la méthode des échantillonnages fréquentiels progressifs. Revue d'Ecologie (La Terre et la Vie*).*, 29 : 533–589.

Botes A, Zaid A (2002). The economic importance of date production and international trade In Zaid A, (ed.). Date palm cultivation. FAO Plant Production and Protection Paper no. 156. Rome: Food and Agriculture Organisation of the United Nations, Pp: 45–56.

Boukhemza M (1990). Contribution a` l'étude de l'avifaune de la région de Timimoun (Gourara) : inventaire et donnée des bioécologiques. Magister dissertation. National Institute of Agronomy, El Harrach, Algeria.

Boutabba H (2013). Spécificités spatiales et logiques sociales d'un nouveau type d'habitat domestique du Hodna oriental, type « DiarCharpenti». Thèse de doctorat, Département D'architecture de Biskra, Algérie.

Boutabba H, Farhi A. (2013). Spécificités spatiales et logiques sociales d'un nouveau type d'habitat domestique du Hodna oriental, filetype«DiarCharpenti».Départe ment D'architecture de Biskra, Algérie.

Chace JF, Walsh JJ (2006). Urban effects on native avifauna: a review. Landsc Urban Plan., 74: 46 – 69.

Chenchouni H (2012). Diversity assessment of vertebrate fauna in a wetland of hot hyper arid lands. Arid Ecosystems. 2: 253– 263

Daniels GD, Kirkpatrick JB (2006). Does variation in garden characteristics influence conservation of birds in suburbia? Biol. Conserv., 133(3): 326–335.

Donnelly R, Marzluff JM (2006). Relative importance of habitat quantity, structure, and spatial pattern to birds in urbanizing environments. Urban Ecosyst., 9 : 99 – 117.

Dupuy A (1966). Catalogue ornithologique du Sahara Algérien. L'Oiseau et R.F.O 39, 140–160.

Emlen JT (1974). An urban bird community in Tucson, Arizona: derivation, structure, regulation. Condor., 76 :184-197.

Farhi Y, Belhamra M. (2012). Typologie et structure de l'avifaune des Ziban (Biskra, Algérie).*Courrier du Savoir.*, *13* : 127-136.

Guezoul O, Chenchouni H, Sekour M, Ababsa L, Souttou K, Doumandji S (2013). An avifaunal survey of mesic manmade ecosystems "Oases" in Algerian hot-hyperarid lands. Saudi J Biol Sci., 20 (1): 37–43.

Harrington R, Anton C, Dawson, TP, de Bello F, Feld CK and Haslett JR (2010). Ecosystem services and biodiversity 43 conservation: concepts and a glossary. Biodivers. Conserv., 19: 2773 – 2790.

Heim de Balsac H, Mayaud N (1962). Les oiseaux du Nord-Ouest de l'Afrique. Paul Lechevalier, Paris, France.

Heywood VH, Watson RT (1995). Global Biodiversity Assessment. Cambridge University Press, Cambridge.

Isenmann P, Moali A (2000). Birds of Algeria. Société d'études ornithologiques, Paris, France.

Kaabeche M (1990). Les groupements végétaux de la région de Boussaâda (Algérie). Essai de synthèse sur la végétation steppique du Maghreb. Thèse de doct. Univ. Paris Sud, centre d'Orsay. Pp: 93.

Krebs CJ (1999). Ecological Methodology.2nd Ed. California: Addison Wesley Longman Inc. Pp:

Lavee D, Safriel UN, Meilijson I (1991). For how long do trans-Saharan migrants stop over at an oasis? Ornis Scandinavica., 22: 33 – 44.

Ledant JP, Jacobs JP, Jacobs P, Malher F, Ochando B, Roché J (1981). Mise a` jour de l'avifaune algérienne. Gerfault., 71: 295–398.

Magurran AE (2004). Measuring biological diversity. Wiley–Blackwell, New York, Pp: 256.

De Balsac HH, Mayaud N (1962). Les oiseaux du nord-ouest de l'Afrique : distribution géographique, écologie, migrations, reproduction. P. Lechevalier. 10.

Meddich A, El Mokhtar MA, Bourzik W, Mitsui T, Baslam M, Hafidi M. (2018). Optimizing growth and tolerance of date palm (Phoenix dactylifera L.) to drought, salinity, and vascular fusarium-induced wilt (Fusarium oxysporum) by application of arbuscular mycorrhizal fungi (AMF). In Root Biology. Springer, Cham., Pp: 239–258.

Mwaura F (2010). The influence of geographic and morphometric factors on the distribution of water bird species in small high-altitude tropical man-made reservoirs, Central Rift Valley, Kenya. Afr J Ecol., 48: 676 – 690.

Ramsar (2007). Designating Ramsar sites: The Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance. Ramsar handbooks for the wise use of wetlands. Ramsar Convention Secretariat, Gland, Switzerland. 3(14): Pp: 110.

Roshier DA, Robertson AI, Kingsford RT, Green, DG (2001)). Continental-scale interactions with temporary resources may explain the paradox of large populations of desert waterbirds in Australia. J Landsc Ecol., 16: 547 – 556.

Samraoui B, Samraoui F (2008). An ornithological survey of the wetlands of Algeria: Important Bird Areas, Ramsar sites and threatened species, Wild fowl. 58: 71 – 98.

Sandström UG, Angelstam P, Mikusiński G (2006). Ecological diversity of birds in relation to the structure of urban green space. Landsc Urban Plan., 77: 39 – 53.

Selmi S, Thierry B, Robert B (2002). Richness and Composition of Oasis Bird Communities: Spatial Issues and Species – Area Relationships, The Auk., 119 (2): 533–539.

Sewell SR, Catterall CP (1998). Bushland modifications and styles of urban development: their effects on birds in south-east Queensland. Wild Res., 25:41 – 63.

Underwood AJ (1996). Experiments in ecology. their logical design and interpretation

using analysis of variance. Cambridge: Cambridge University Press.

White JD, Gardali FR. Thompson, Faaborg (2005). Resource selection by juvenile Swanson's Thrushes during the post fledging period. Condor., 107: 388 – 401.

WWF-World Wildlife Fund, McGinleyM (2007). Sahara Desert. In: Cleveland CJ (Ed.), Encyclopedia of Earth. Environmental Information Coalition, National Council for Science and the Environment. Washington DC.

Yang L, Li H, Yang XJ (2010). Wetlands of Yunnan. Beijing: China Forestry Publishing House.