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DIVERSITY AND STRUCTURE OF NESTING BIRDS IN THE COASTAL RIPARIAN ZONES OF GREAT KABYLIA IN ALGERIA

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Diversity and Structure of Nesting Birds in the Coastal Riparian Zones of Great Kabylia in Algeria. Hachour, K., Talmat-Chaouchi, N., Moulaï, R. — The study of the nesting birds of the coastal riparian zones in Great Kabylia in Algeria, allowed us to identify 45 species of birds, belonging to 12 orders and 26 families. The richest site in terms of species is Takdempt (31 species). The lowest diversity is noted at the level of Boudouaou wadi with 16 species. The values of the Shannon-Weaver diversity index (H') for all sites are quite high (≥ 3 bits). Concerning the global abundance of avifauna, the site that represents the highest centesimal frequency is that of Takdempt (20.87 %) and this is due to the presence of a colony of *Bubulcus ibis* (Linnaeus, 1758). The bird communities of the sampled sites are not identical, but the degree of similarity, in general, is quite high (≥ 50 %). The main factors controlling the diversity and the structure of the avifauna of Great Kabylia coastal riparian zones are represented by vertical and horizontal vegetation structure.

Key words: Coastal riparian zones, nesting birds, structure, Algeria.

Introduction

Watercourse riparian zones or riparian forests are hotspots of biodiversity and constitute a corridor for migratory species (Décamps, 2003). They have a role of great importance in regulating the dynamics of biological diversity (Décamps and Décamps, 2002). In the fluvial landscape, riparian ecosystems occupy a small proportion, but they harbor more biodiversity than adjacent terrestrial ecosystems (Naiman et al., 1993; Naiman and Décamps, 1997). Its interface situation gives it particular ecological characteristics: elasticity, permeability, biodiversity and habitat connection (Piégay, 1994).

Birds are excellent bio-indicators of the quality and functioning of habitats, as they are sensitive to environmental factors and disturbances (Blondel, 1995) as well as to the architecture of the vegetation and its floristic composition (Blondel, 1999). Within this context, Blondel (2003) distinguishes at least three groups of birds linked to riparian zones: forest birds, aquatic edge birds and terrestrial birds.

In Algeria, the diversity in riparian forests of watercourses, in general, has been approached mainly through the description of vegetation, especially in the North of the country (Bensettiti, 1985; Bensettiti, 1995; Bensettiti & Lacoste, 1999). There are just few works which have been done on the birds frequenting the edges of watercourses. In this context, one can mention the contributions of Benyacoub and Chabi (2000) on the avifauna of the riparian zones of the El Kala National Park, in Northeast part of the country, and the study conducted by Dahmana (2003) on the birds of the riparian zones of Soumman watercourse. So, it is within this framework that our study is inscribed; in fact, this study aims at assessing the diversity and the structure of coastal riparian zones birds of Great Kabylia region. The composition and the organization of this avifauna are addressed in thirteen (13) watercourses in relation to the most determining environmental factors.

Material and methods

The study region is located on the coast of Great Kabylia, in Algeria. It extends over a coastal line of more than 100 km. Its geographical position is 36°52'54.82'' N and 4°30'33.33'' E to the East, 36°46'04.73'' N and 3°24'42.38'' E to the West. The sites on the west side have a maximum elevation of 11 meters. The eastern sites, however, are higher, up to 100 meters in altitude (fig. 1). Thirteen sites were visited to observe the birds. These sites represent the main watercourses in the North of Great Kabylia. The first study site (S1) is in Boumerdes region, located 35 km all along the flying area of birds, in eastern Algiers (the capital). It is distant from the last site (S13) situated in the east, the Azzefoun region, by a distance of 115 km (fig. 1).

Our watercourses are located between two wetlands of international importance, classified in the Ramsar Convention: the Soummam watercourse in the East (Bejaïa) and Reghaïa Lake in the West (Algiers).

The region chosen for our study has a Mediterranean climate characterized by hot, dry summers and mild, wet winters (Quézel, 2000).

The description of the vegetation around the prospected watercourses is based only on the most abundant perennial and woody plant species. Herbaceous plants were not mentioned because of their minor role in the characterization of the physiognomy and structure of vegetal formations of riparian zones (Ater et al., 2008). The tree layer in our sites is mainly represented by *Populus alba* (L., 1753), *Eucalyptus globulus* (Labill., 1800), *Fraxinus excelsior* (L., 1753) and *Olea europaea* (L., 1753). The shrub layer is basically composed of *Salix pedicellata* (Desf., 1799), *Tamarix galica* (L., 1753), *Nerium oleander* (L., 1753), *Juncus acutus* (L., 1753), *Arundo donax* (L., 1753), *Phragmites australis* (Cav.) Trin. ex Steud., 1841, *Typha angustifolia* (L., 1753) and *Ricinus communis* (L., 1753). The creepers are represented by *Rubus ulmifolius* (Schott, 1818), *Rosa sempervirens* (L., 1753), *Hedera helix* (L., 1753) and *Convolvulus althaeoides* (L., 1753).

Environmental and other anthropogenic parameters which are considered in the study are mentioned in the description of the characteristics of the study region sites shown in table 1.

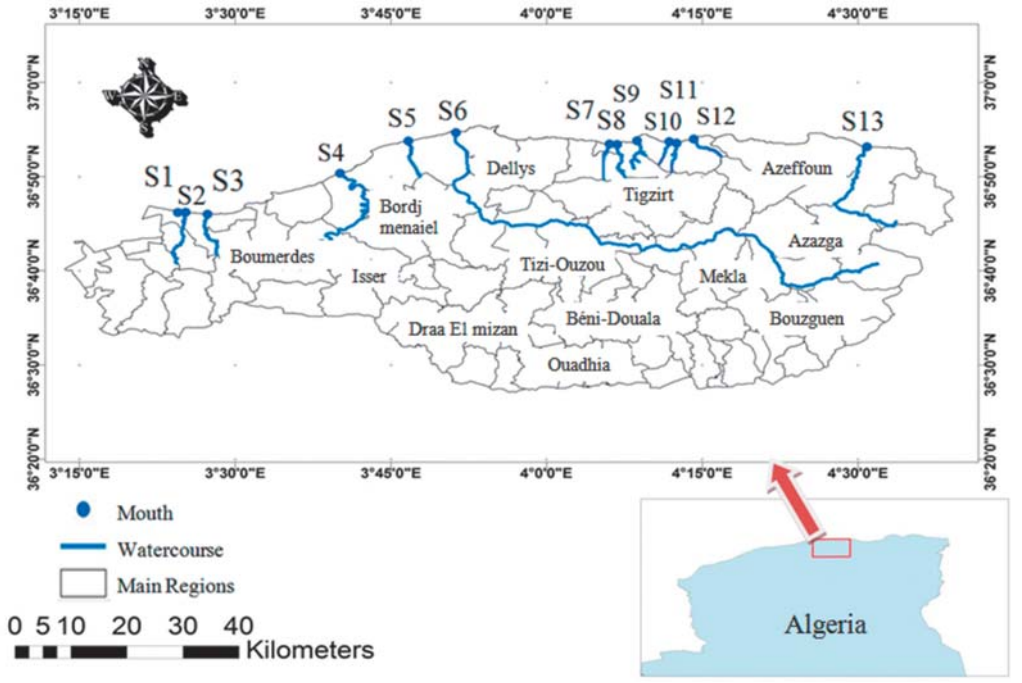

Fig. 1. Geographical Location of the Study Sites.

Table 1. A table summarizing the ecological features of the coastal watercourses in Great Kabylia (Algeria)

Parameters	BSR	AOA	WRZ	HVS	VVS	HOC	DO	WCV	WOW	WQ	AGA	WD	ANPH
Sites													
S1	6	9	3	2	2	2	2	1	2	2	2	1	1
S2	1	2	1	1	2	1	3	1	2	4	2	1	1
S3	4	8	1	1	2	1	2	1	1	3	3	1	2
S4	5	10	4	4	3	3	1	1	3	2	3	1	1
S5	4	11	2	3	2	2	2	1	2	2	3	2	1
S6	7	13	4	4	3	3	1	1	3	2	3	2	1
S7	2	7	2	3	2	1	1	3	1	1	1	3	1
S8	2	1	2	3	2	1	1	2	1	1	1	3	3
S9	2	3	2	3	2	1	1	2	1	1	2	3	1
S10	3	6	2	3	2	1	1	3	1	1	1	3	1
S11	2	5	2	3	2	1	1	3	1	1	1	3	1
S12	2	4	2	3	2	1	1	3	1	1	1	3	1
S13	5	12	3	3	2	2	2	2	2	1	2	1	1

Environmental parameters that can influence bird diversity and structure (table 1) are estimated on a numerical scale graded from least to greatest degree: bird specific richness (BSR) [1–7]; abundance of avifauna (AOA) [1–13]; width of riparian zone (WRZ) [1–4]; horizontal vegetation structure (HVS) [1–4], which is the diversity of plant species; vertical vegetation structure (VVS) [2–3], which is the presence of different plant strata or layers; height of the canopy (HOC) [1–3]; degree of opening in the riparian zone (DO) [1–3], which means the volume occupied by the vegetation; water current velocity (WCV) [1–3]; width of the watercourse (WOW) [1–3]; water quality (WQ) [1–4], which is indicated by degrees (degree1 represents good water quality and degree 4 means that water is very polluted, i. e., wastewater); agricultural activity (AGA) [1–3], which is also indicated by degrees (degree 1 means that the land is almost virgin, degree 2 represents the traditional and medium agriculture, and degree 3 means the industrial agriculture); pollution caused by wild dump (WD) [1–3]; and the anthropogenic noise and the proximity of houses (ANPH) [1–3] (table 1).

The counting of nesting avifauna frequenting the riparian zones of Great Kabylia watercourses is carried out using line transect method (Poilecot, 2002; Lamotte and Bourlière; 1969 and Blondel, 1975). It consists of a sampling of one kilometer line length for each site, from the mouth towards the upstream. All birds observed or heard are noted. The observation trips were carried out at least twice a month, for each site, from March to July. Concerning the counting of colonial birds, such as the Western Cattle Egret, *Bubulcus ibis* (Linnaeus, 1758), a visual estimation was necessary because the number of birds exceeded 200 individuals.

For the ecological analysis of the identified avifauna, few ecological indices are used, such as species richness, relative abundance (centesimal frequency), Shannon-Weaver diversity index (H'), equitability, and Sorensen's similarity index (Legendre & Legendre, 1979; Blondel, 1975). In order to determine the possible relationship between the structure of breeding avifauna and environmental parameters, a principal component analysis (PCA) is used (Saporta, 1990).

Results and discussion

The inventory of breeding avifauna in the coastal riparian zones of Great Kabylia has permitted to identify 45 species belonging to 12 orders and 26 families. The number of birds during the breeding period was 2583 (Appendix 1). We note that the order of Passeriformes dominates with 14 families (Passeridae, Troglodytidae, Turdidae, Paridae, Muscicapidae, Acrocephalidae, Cettiidae, Motacillidae, Sylviidae, Cisticolidae, Fringillidae, Pycnonotidae, Phylloscopidae, Malaconotidae). These families are represented by 27 species. The order of pigeons with the family Colombidae is represented by three species. Concerning the order of Coraciiformes, two families (Alcedinidae and Meropidae) are recorded with two species. Focussing on the order of Gruiformes, the family Rallidae is recorded with two species. The order of Charadriiformes (Charadriidae) is also recorded with two species. However, the orders of Bucerotiformes (Upupidae), Piciformes (Picidae), Galliformes (Phasianidae), Podicipédiformes (Podicipedidae), Pelecaniformes (Ardeidae) and Anseriformes (Anatidae) are represented by only one species (Appendix 1). The species richness of the breeding birds recorded in each riparian zone site in the study area varies between 16 and 31 species. The average richness is of the order of 23.62 species. The site with the highest species richness

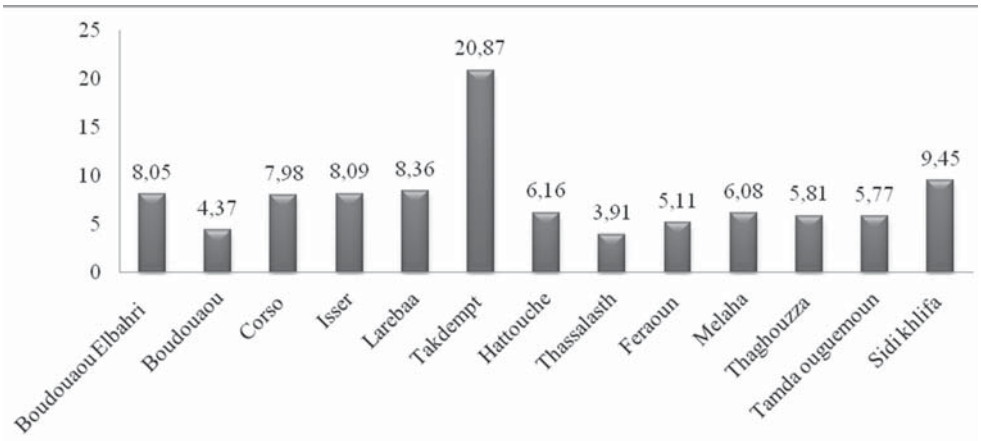

Fig. 2. Centesimal Frequency of Great Kabylia Coastal Riparian Zones Avifauna.

is S6, the watercourse of Takdempt, (31 species). The lowest diversity is recorded at Oued Boudouaou with 16 species. The values of the Shannon-Weaver diversity index (H') for all the sites are quite high (Appendix 1). They exceed the value of 3 bits. The highest diversity is observed in S4, i. e., Oued Isser (4.52 bits). The diversities of the other sites are between 4.51 bits and 3.56 bits. The lowest value is recorded at Takdempt (3.56 bits). Equitability index values range from 0.72 to 0.97. Concerning the global abundance of avifauna, the site that represents the highest centesimal frequency is that of Takdempt, that is S6 (20.87 %) (fig. 2). The second position occupied by S13, Sidi khlifa, (9.45 %), followed by S5, Larebaa, (8.36 %) and S4, Isser, (8.09 %) (fig. 2). The sites S7, S9, S10, S11, S12 are with abundances ranging from 5.11 % to 6.16 %. It should be noted that the two sites with the lowest relative abundance are S2, Boudouaou, (4.37 %) and S8, Thassalasth, (3.91 %) (fig. 2).

The birds communities in the sampled sites are not identical, but the degree of similarity is generally quite high. They share a large number of species in common. The greatest similarity is noted between sites S10 and S11 (97.67 %), followed by S10 and S12 (88.37 %). The combinations S3-S6, S7-S11, S8-S12, S11-S12, and S5-S10 have the same degree of similarity (that is 85.71 %). The lowest degree of similarity is found between S2-S7 and S2-S12 with the same degree (48.65 %). Intermediate values range from 50 % to 85.19 % (table 2).

Principal Components Analysis (PCA)

Considering the complexity of the relationships between environmental features and bird population at the study site level, principal components analysis (PCA) allows a simultaneous study of a large number of variables and a visualization of the relationships

Table 2. Sorensen similarity (%) is applied to the bird diversity of watercourses of Great Kabylia (Algeria)

Sites	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
S2	57.78											
S3	85.19	73.17										
S4	77.19	63.64	83.02									
S5	77.78	63.41	84	83.02								
S6	83.33	59.57	85.71	81.36	78.57							
S7	64	48.65	69.57	73.47	82.61	61.54						
S8	64	54.05	69.57	69.39	73.91	65.38	76.19					
S9	61.22	50	66.67	70.83	75.56	58.82	73.17	78.05				
S10	70.59	57.89	76.6	76	85.11	71.7	83.72	83.72	71.43			
S11	72	54.05	73.91	73.47	82.61	69.23	85.71	80.95	68.29	97.67		
S12	60	48.65	69.57	73.47	78.26	69.23	80.95	85.71	78.05	88.37	85.71	
S13	75	55.81	76.92	72.73	84.62	82.76	66.67	66.67	63.83	73.47	75	66.67

between the variables. This will help to show the organization of the structure of breeding avifauna according to the environmental variables and sites. The PCA data matrix is constructed departing from Appendix 1 and table 1 (fig. 3).

The PCA in figure 3 shows that 51.20 % of information is retrieved from both axes (D1 and D2). However, axis D1 (29.34 %) carries more information than axis D2 (21.86 %). The positive correlations between environmental variables and factors D1 and D2 are as follows: the height of the canopy (HOC) is 0.91 %, width of riparian zone (WRZ) is 0.83 %, pollution caused by wild dump (WD) is 0.82 %, width of the watercourse (WOW) is 0.80 %, vertical vegetation structure (VVS) is 0.79 %, horizontal vegetation structure (HVS) is 0.75 %, water current velocity (WCV) is 0.75 % and the agricultural activity (AGA) is 0.67 %. They are strongly and positively correlated with factors D1 and D2. This means that when these variables increase, bird specific richness (BSR) and its abundance (AOA) also increase.

The variables water quality (WQ) and degree of opening in the riparian zone (DO) are strongly but negatively correlated with axis D1 (DO is –0.90 % and WQ is –0.82 %). This means that when the degree of opening (DO) and/or the water quality (WQ) decrease, the richness of the avifauna (BSR) and its abundance (AOA) increase. The anthropogenic noise and the proximity of houses (ANPH) have a weak and negative correlation with axis D1 (–0.35 %). When noise decreases, the richness of the avifauna (BSR) and its abundance (AOA) increase but with a rather low intensity.

Concerning the analysis of bird groupings according to the different watercourses, the scattered points can be separated into two groups: group 1 and group 2. The sites S7, S8, S9, S10, S11 and S12 belong to group 1 (G1); they are sites that have strong correlations between them. Site S8 is slightly distant from the group, i.e., this is a slight peculiarity of this site. The avifauna of the sites belonging to group 1 (G1) contains the following species: *Accipiter nisus* (Linnaeus, 1758) (AN), *Hieraaetus pennatus* (Gmelin, JF, 1788) (HP), *Saxicola rubicola* (Linnaeus, 1766) (SR), *Alectoris barbara* (Bonnaterre, 1790) (AB), *Sylvia melanocephala* (Gmelin, JF, 1789) (SM), *Sylvia atricapilla* (Linnaeus, 1758) (SA), *Sylvia communis* (Latham, 1787) (SC), *Sylvia conspicillata* (Temminck, 1820) (SCO), *Troglodytes troglodytes* (Linnaeus, 1758) (TT), *Motacilla flava* (Linnaeus, 1758) (MF), *Motacilla cinerea* (Tunstall, 1771) (MC), *Pycnonotus barbatus* (Desfontaines, 1789) (PB), *Chloris chloris*

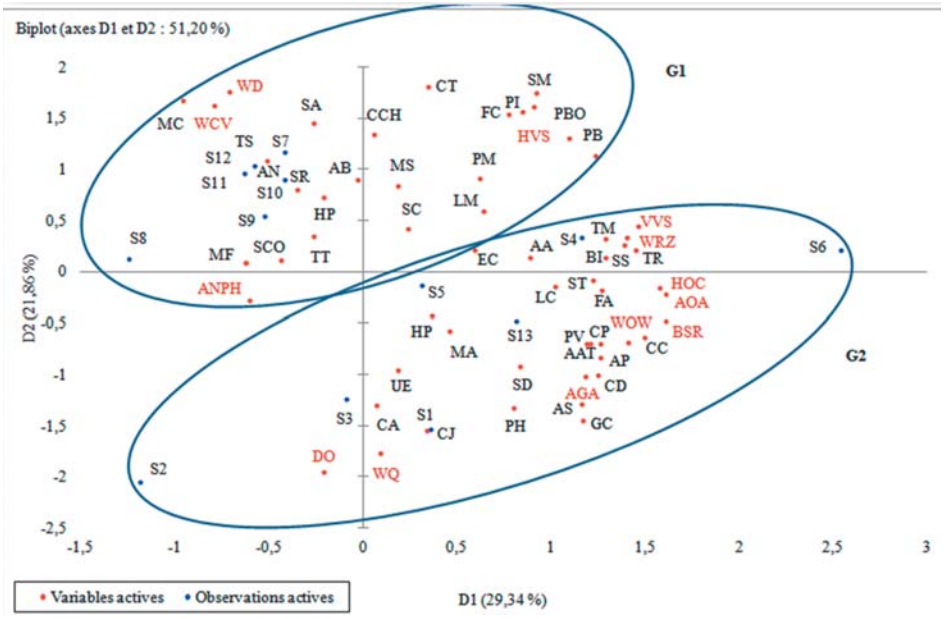

Fig. 3. Principal Components Analysis (PCA) Showing the Avifauna Organization According to the Study Sites and the Environmental Variables.

(Linnaeus, 1758) (CCH), *Muscicapa striata* (Pallas, 1764) (MS), *Cyanites teneriffae*(Lesson, R, 1831) (CT), *Parus major* (Linnaeus, 1758) (PM), *Luscinia megarhynchos* (Brehm, CL, 1831) (LM), *Fringilla coelebs* (Linnaeus, 1758) (FC), *Phylloscopus ibericus* (Ticehurst, 1937) (PI), *Phylloscopus bonelli* (Vieillot, 1819) (PBO) and *Tchagra senegalus* (Linnaeus, 1766) (TS) (fig. 3 and Appendix 1). However, group 2 (G2) is formed by the following sites: S1, S2, S3, S4, S5, S6 and S13, taking into consideration the fact that S6 is far from the center of group 2 but with a strong attraction to the scattered points and to the positive direction of axis 1. The site S2 is also very far from the center of group 2 and opposes S6, with a very weak capacity of attraction in regard to the scattered points. The avifauna of these riparian zones is essentially composed of *Elanus caeruleus* (Desfontaines, 1789) (EC), *Acrocephalus arundinaceus* (Linnaeus, 1758) (AA), *Turdus merula* (Linnaeus, 1758) (TM), *Serinus serinus* (Linnaeus, 1766) (SS), *Bubulcus ibis* (Linnaeus, 1758) (BI), *Linaria cannabina* (Linnaeus, 1758) (LC), *Hippolais polyglotta* (Vieillot, 1817) (HP), *Merops apiaster* (Linnaeus, 1758) (MA), *Upupa epops* (Linnaeus, 1758) (UE), *Charadrius alexandrinus* (Linnaeus, 1758) (CA), *Cisticola juncidis* (Rafinesque, 1810) (CJ), *Passer hispaniolensis* (Temminck, 1820) (PH), *Streptopelia decaocto* (Frivaldszky, 1838) (SD), *Streptopelia turtur* (Linnaeus, 1758) (ST), *Columba palumbus* (Linnaeus, 1758) (CP), *Cettia cetti* (Temminck, 1820) (CC), *Picus vaillantii* (Malherbe, 1847) (PV), *Alcedo atthis* (Linnaeus, 1758) (AAT), *Charadrius dubius* (Scopoli, 1786) (CD), *Acrocephalus scirpaceus* (Hermann, 1804) (AS), *Anas platyrhynchos* (Linnaeus, 1758) (AP), *Tachybaptus ruficollis* (Pallas, 1764) (TR), *Fulica atra* (Linnaeus, 1758) (FA) and *Gallinula chloropus* (Linnaeus, 1758) (GC) (fig. 3 and Appendix 1).

In total 45 species of breeding birds can be observed in the coastal riparian areas of northern Great Kabylia in Algeria. This number seems important because it relates to a single habitat. It represents nearly 40 % of the breeding avifauna of Great Kabylia, which involves 116 species recorded in the entire territory of this region (Moali, 1999) and nearly 12 % of the breeding birds in Algeria (Bellatreche et al., 2002). Data on breeding birds in the Algerian riparian zones are scarce. In this context, we can mention the work of Dahmana (2003), who recorded a total of 52 breeding species in all riparian zones of Soummam valley in Small Kabylia, Bejaia, or the work of Bougaham and Moulaï (2014) who identified 40 species in the riparian zones of the Western Babors in the same region. In North Africa, in Morocco, Ater et al. (2008) indicated the existence of 70 breeding species in the riparian zones of the entire hydrographic network of Laou stream. In the northern part of the Mediterranean, in Europe, 40 breeding species have been counted in two parcels of Oak-Elm forest in Weisweil region (Bade) (Ullrich, 2002). This kind of environment is quite similar to that of riparian zone from the side of physiognomy. In the south of France, Blondel (2003) made a list of 34 breeding species in the riparian areas of Camargue. The same number of breeding birds is given by Dronneau (2007) in Alluvial forest of Rhine. The latter author indicates that the composition of the avifauna of the mature Rhine Oak-Elm is similar to that of all European Deciduous forests. The same observation is made by Blondel (2003) concerning deciduous forests and riparian zones in the Mediterranean.

For the present study, the two sites S2 and S8 have the lowest values of bird species richness and abundance. For the latter site, the low bird abundance (3.91 %) is explained by the factor of noise resulting from nearby construction works. Despite the small influence of the anthropogenic noise and the proximity of houses (ANPH) (–0.35 %) in general, it probably disturbed the avifauna at the level of this riparian zone (fig. 3). However, the bird species richness is higher in S8 (21 species) compared to S2 (16 species) (table 1). This is explained by the greater diversity of vegetation (horizontal and vertical structures) in S8 compared to S2. We make the same observation in PCA, where it has been shown that S2 has a very low attraction capacity towards bird species (fig. 3). S2 is a site characterized by weak horizontal and vertical structures, the width of riparian zone (WRZ) is small, the degree of opening (DO) is the highest of all sites and the watercourse is extremely polluted by wastewater. Plant diversity is also low, dominated by *Phragmites australis* which is quite

resistant to water pollution. It is also illustrated in the PCA graph in figure 3 that this site has a very low attraction capacity towards avifauna. Site S6 has a colony of *Bubulcus ibis,* which explains the high abundance of birds recorded at this site (20.87 %) and justifies particularly its distant position in the PCA graph (fig. 3). The grouping of sites S7, S8, S9, S10, S11 and S12 (G1) is explained by the great degree of similarity in environmental characteristics, which are the width of riparian zone, horizontal and vertical vegetation structures, height of the canopy, degree of opening in the riparian zone, water quality, width of the watercourse and water current velocity (table 1). These sites are all on the eastern side of the study area, with a mountain profile. Consequently, they attract avifauna with similar requirements. The grouping of sites S1, S2, S3, S4, S5, S6 and S13 (G2) also have very similar environmental characteristics represented by the vertical structure of the vegetation, the velocity of water in the watercourse and the agricultural activity (table 1). The majority of these sites are located in the western part of the study area, with plains profile. As a result, they also attract avifauna with similar ecological requirements.

The factors governing the organization of the riparian avifauna in this study are mainly the height of the canopy (HOC) which has a great influence on the richness of the breeding avifauna, as the presence of large trees of considerable height means a contribution in the vertical structure of the habitat, providing additional ecological niches for bird species. The degree of opening in the riparian zone (DO) expresses the volume occupied by the vegetation; its contribution is explained by its role in providing ecological niches and shelter against predators. The width of riparian zone (WRZ) plays a role in the carrying capacity of the avifauna. The more it becomes wide, the more it offers a multitude of ecological niches. The wild dump (WD) occupies a portion of the riparian zone that is proportional to the size of the dump. Its impact lies in the limitation of bird habitat, thus limiting the richness of the avifauna. The water quality (WQ) and its pollution by wastewater has a great influence on the richness of the riparian vegetation (the horizontal structure), as previously mentioned in the description of site S2. Thus, the low diversity of vegetation attracts a low bird specific richness (BSR). In addition to that, high water pollution by wastewater decreases the visibility for fishing, diving and wading birds leading to a lower presence of this category of waterfowl. Concerning the width of the watercourse (WOW), we noticed that the watercourses are wider in the west sites of the study area (S1, S2, S3, S4, S5 and S6) which is a lowland area. The width of the watercourse in these sites in combination with the relatively calm water velocity with a slight slope makes these sites areas of flooding and sedimentation. Consequently, this favors the installation of a multitude of plant species (the horizontal structure). The clearing for agricultural needs in order to have easy access to pumping water from the watercourses has a direct impact on the degree of opening (DO) of the riparian zones. Thus, by reducing the volume of vegetation, we decrease the number of ecological niches. As for the water current velocity (WCV) of the watercourses, it has a great influence on the banks which are the supports of the riparian vegetation and their water supply. This means that as long as the water current velocity is stable, the riparian zone remains stable. In case of bad weather, the banks will be reshaped and the riparian zone will be modified or even disappear temporarily in extreme cases. All the environmental parameters mentioned above are closely linked to two main factors: the suppliers of ecological niches for the installation of avifauna. These are the vertical vegetation structure (VVS) (different plant strata) and the horizontal vegetation structure (HVS) that is the diversity of plant species. Thus, the differences observed in terms of diversity and abundance of nesting avifauna between the 13 riparian zones surveyed are linked first of all to the structure and physiognomy of the vegetation, which will determine the number of ecological niches available for birds. The other mentioned factors (HC, WRZ, WD, WOW, WCV, AGA, WQ, DO and ANPH) may also intervene.

The results of the present study are in line with some findings of similar ornithological works; for example, the work of Denis (2009) in Rhineland-Alsatian forests in France, where

he notes that the first criterion for differentiating avifauna is the volume of tree vegetation. Roche (1995) notes along the course of the Allier in France that in the highly forested upstream part of the river, the degree of opening of the habitat is the main factor of avifauna variations.

Conclusion

The architectural complexity of the riparian zones of the different sites in Great Kabylia has provided a significant capacity for birds. This has allowed sedentary and migratory species, whether forest, aquatic or edge species, to nest there. The results of this study showed that the riparian zones of the northern part of Great Kabylia have a diversified avifauna. The settlement of the avifauna is generally balanced, with the exception of Takdempt site, because of the dominance of colonial species, namely *Bubulcus ibis*.

It becomes clear that the conditions that determine bird diversity in the coastal riparian zones of Great Kabylia are related to the mosaic of biotopes. The presence of three types of edges (forest edge, terrestrial edge and aquatic edge) offers a great diversity of ecological niches. However, the anthropogenic impact limits the bird specific richness, whatever the nature of the disturbance (clearing, agriculture, wild dumps, contamination of the watercourses by wastewater, proximity to houses and the lack of quietness due to the noise resulting from construction works).

The diversity and numbers of bird species recorded at these thirteen (13) sites will serve as basic data for monitoring bird population dynamics in eventual future studies, particularly in terms of the evolution of the diversity and the abundance of the present avifauna according to anthropogenic disturbances.

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Appendix 1. List of breeding avifauna in the coastal riparian zones of Great Kabylia (Algeria)

List of nesting birds	Scientific names' abbreviation	Study sites												
Accipitridae	-	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Accipiter nisus	AN							2		2				
Elanus caeruleus	EC				2									
Hieraaetus pennatus	HP									2				
Passeridae														
Passer hispaniolensis	PH	11	8	26			18							17
Troglodytidae														
Troglodytes troglodytes	TT	4	4		3	5		4	2		2	4	6	4
Turdidae														
Turdus merula	TM	8	8	6	8	10	14	10	6	7	8	8	9	12
Paridae														
Cyanites teneriffae	CT	2	2	4	4	5	6	5	4	4	6	6	6	4
Parus major	PM	1		3	2	2	4	2	2	5	2	2	2	2
Muscicapidae														
Luscinia megarhynchos	LM	6	7	11	7	12	16	8	8	14	9	16	8	13
Muscicapa striata	MS				7	7		13		5			5	8
Saxicola rubicola	SR							2						
Acrocephalidae														
Acrocephalus scirpaceus	AS	7	8	11	6	8	12	4			3	3		9
Acrocephalus arundinaceus	AA			2	2		2						2	
Hippolais polyglotta	HP	3	6	5	3	6	8		3	2	3		9	

Cettiidae														
Cettia cetti	CC	11	6	8	8	6	14	7	5	6	6	6	5	12
Motacillidae														
Motacilla cinerea	MC					4		6	5	5	7	8	7	
Motacilla flava	MF								2					
Sylviidae														
Sylvia melanocephala	SM	5		6	10	9	12	11	7	8	10	9	8	8
Sylvia atricapilla	SA			4	8	6	2	8	6		8	7	6	
Sylvia communis	SC				2					2				
Sylvia conspicillata	SCO								2					
Cisticolidae														
Cisticola juncidis	CJ	13	12	12	6	9	11	7	6	12	8	8	7	11
Fringillidae														
Chloris chloris	CCH	8	7	8	11	11	9	13	5	9	9	14	12	6
Fringilla coelebs	FC	3		7	14	12	12	14	6	7	15	8	8	9
Linaria cannabina	LC					12	8							8
Serinus serinus	SS	14	11	14	15	18	24	16	8	16	16	9	15	16
Pycnonotidae														
Pycnonotus barbatus	PB	8		7	9	8	14	9	6	9	8	11	8	12
Phylloscopidae														
Phylloscopus bonelli	PBO	7		6	8	6	13	7	6	7	8	7	11	7
Phylloscopus ibericus	PI	5		3	6	4	6	6	3	6	5	5	6	5
Malaconotidae														
Tchagra senegalus	TS										2	5	4	
Upupidae														
Upupa epops	UE	4												
Charadriidae														
Charadrius dubius	CD	5		4		2	6							5
Charadrius alexandrinus	CA	28	5	4										
Picidae														
Picus vaillantii	PV	2					2							2
Alcedinidae														
Alcedo atthis	AAT	2					2							1
Meropidae														
Merops apiaster	MA	3												10
Columbidae														
Streptopelia turtur	ST	6		6	12	7	6	5			5	2		5
Streptopelia decaocto	SD	5	5	10	3	19	12		5	4				9
Columba palumbus	CP	11	8	18	16	16	24				12	10		34
Phasianidae														
Alectoris barbara	AB						3		4		5	2	5	4
Podicipedidae														
Tachybaptus ruficollis	TR				2		6							
Ardeidae														
Bubulcus ibis	BI						240							
Anatidae														
Anas platyrhynchos	AP	6	4	5	8		11							
Rallidae														
Gallinula chloropus	GC	15	12	16	18	12	16							11
Fulica atra	FA	5			9		6							
Total headcount	N	208	113	206	209	216	539	159	101	132	157	150	149	244
Species richness	S	29	16	25	28	25	31	21	21	20	22	21	21	27
Shannon-Weaver diversity index	H'	4.52	3.9	4.37	4.54	4.5	3.57	4.2	4.3	4.1	4.3	4.2	4.3	4.45
Equitability	E	0.93	1	0.94	0.94	1	0.72	1	1	1	1	1	1	0.94

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