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Time activity budgets and spatial association of Non breeding Mallard with other Waterbirds Wintering at Beni Haroun Dam North East Algeria

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ABSTRACT

Artificial wetlands are becoming necessary environments for wintering waterbirds, because of the degradation of natural wetlands due to various anthropogenic pressures and to climate change. Monitoring of wintering Mallard *Anas platyrhynchos* in the Beni Haroun dam has shown a high abundance during the first season (2016-2017) with a maximum of 1158 individuals. Assessment of diurnal time budget of Mallard exhibited the dominance of three main activities: sleeping (53.59%), swimming (15.09%) and grooming (12.43%). Regarding the interspecific association, a mosaic of neighbor species was observed with different distances to shoreline and different behaviors for individuals Mallards. We noted that there is a very highly significant difference ($P \leq 0.001$) in terms of the average distance between these species and the shoreline. Thus, the analysis of behavior-association dependence showed significant links ($P \leq 0.05$).

Key words : *Behaviors, Artificial wetlands, Shoreline, Neighbor species, Anthropogenic pressures.*

Introduction

During these last decades, the natural wetlands of North Africa, in particularly those of Algeria, have undergone a worrying deterioration under the influence of various anthropic pressures, namely pollution, overgrazing, pumping, drainage, drying and cultivation (Samraoui *et al.*, 1992; Samraoui *et al.*, 2014; Bouldjedri *et al.*, 2011). The degradation of these sites is particularly a consequence of the severity of dry periods (Touchan *et al.*, 2011; Lazri *et al.*, 2015) as a result of climate change which will be more restrictive and more selective in the future (Tabet, 2008), thus affecting the abundance, site-use and distribution of wintering birds (Sokos *et al.*, 2016). To this end, artificial wetlands have become the favorable environment for wintering waterbirds. A characterization of waterbird behavior, and habitat use patterns in these man-made wetlands in North Africa can support conservation management

and planning in the context of global change (Samraoui *et al*., 2011).

The Anatidae is one of the main families of waterbirds that use the wetlands of North Africa for wintering and breeding (Bensizerara and Chenchouni, 2019). The mallard (*Anas platyrhynchos*) is a common waterbird species, present in Algeria (Samraoui and Samraoui, 2008), reflecting an ability to occupy different types of wetlands (Rodrigues and Fabião, 1997; Cherkaoui *et al*., 2017) and a high plasticity to adapt to different climatic variations (Pawlina *et al*., 1993).

In Algeria, the Mallard is a sedentary – breeder (Bensaci *et al*., 2013; Dziri *et al*., 2014). Most of the scientific work carried out relates mainly to diurnal time budget (Dziri *et al*., 2014; Houhamdi, 2002; Maazi, 2009), diet (Cherif *et al*., 2017) and breeding characteristics. Nevertheless, the Mallard is poorly studied in artificial wetlands. These areas, which could have a crucial role in the conservation of biodiversity (Zou *et al*., 2017), can constitute an alternative and / or complementary potential refuge for this species.

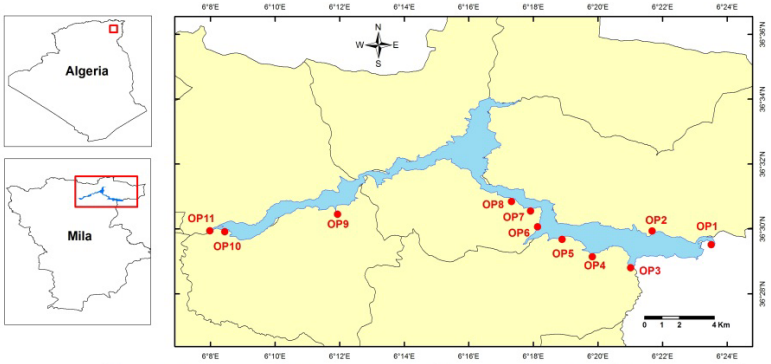
The objective of this work is to improve and consolidate the understanding of the ecological requirements of Mallards wintering in artificial wetlands. Emphasis is placed on the diurnal time budget and interspecies association in the habitats used. It constitutes a contribution and an enrichment of current knowledge on this species in the region of North Africa and especially in the artificial Algerian wetlands, which could constitute an refuge in the face of the constraints of the future climate change.

Study area

This study is carried out on the Beni Haroun dam which is located in Mila province (36 ° 33 ’19 ‘’ ‘N and 6 ° 16’ 11 ‘’ E; Fig.1). It constitutes the largest dam in Algeria, and the second in North Africa, settled on Kebir-Rhumel basin. It is flooded by two main effluents: Oued El Kebir and Oued El Rhumel (Ounissi and Bouchareb, 2013; Habila *et al*.,2017; Chebbah and Kabour,2018), and has a capacity of 960 million m3 (Hamed *et al*., 2018). Providing water supply to more than two million habitants by 2030 and irrigation of more than 100,000 hectares (Marouf and Roumini, 2016; Bouaroudj *et al*., 2019) is expected. Its construction was ended in 2003 (Mebarki, 2009), and it became an artificial wetland characterized by rich biodiversity and important stopover for wintering waterbirds (Chabou *et al*., 2020).

Materials and Methods

Fieldwork was carried twice-monthly, between October and March, during two wintering seasons (2016-2017 and 2017-2018) using a telescope KOWA 20x60. The first survey was allocated to the workforce census from the 11 observation stations (Fig. 1). These stations are selected for two reasons: accessibility and visibility of waterbirds groups. Individual counts were made when the total number of birds was fewer than 200. When the number of



Observing points	Geographical coordinates	
OP1	Gharslim	36°29'04.93''N, 06°25'05.54''E
OP2	Metlili	36°29'57.53''N, 06°21'39.97''E
OP3	Kikaya 3	36°28'39.64''N, 06°20'54.52''E
OP4	Kikaya 2	36°29'04.19''N, 06°19'49.61''E
OP5	Kikaya 1	36°29'35.88''N, 06°19'02.04''E
OP6	Medouis	36°30'07.35''N, 06°18'05.69''E

Observing points	Geographical coordinates	
OP7	Ferdoua 1	36°30'33.79''N, 06°17'52.43''E
OP8	Ferdoua 2	36°30'51.15''N, 06°17'16.97''E
OP9	Djlama	36°30'36.31''N, 06°12'05.02''E
OP10	Elmalah1	36°29'26.52''N, 06°08'18.76''E
OP11	Elmalah2	36°29'56.58''N, 06°07'16.07''E

Fig. 1. Geographical positions of Beni Haroun Dam in Mila (northeastern Algeria).

birds is greater than 200, we proceed by estimating the size of the population by dividing the flock into small equal parts and counting the number of birds in each part (Boulkhssaim *et al*., 2013). The second survey was devoted to the study of the diurnal time budget, the interspecific association in the habitats used by the mallard duck and the neighboring species at three stations, selected according to the effective concentration (OP2, OP4, and OP11).

SCAN method was applied in order to monitoring the diurnal time budget of mallard (Altmann, 1974; Losito *et al*.,1989; Khan *et al*., 1996; Mahaulpatha *et al*., 2002) from 8 am to 4 pm every sampling day. Seven activities were considered: Sleeping, Feeding, Swimming, Grooming, Resting, Courtship and Flying.

The interspecific association was characterized by the activity shown by the mallard individual during this association in the habitat used, in addition to the total distance D (D is equal to the sum of the distance of the mallard individual studied at the shoreline and the distance between that individual and the nearest neighboring individual). Distances were calculated using bird length as a unit of measure (Allouche and Tamisier, 1989). Three habitats (areas) used by the mallard duck were determined according to the water depth namely; i) shallow <1 m, ii) medium deep 1- 5 m, ii) deep ˆ 5 m.

Statistical analysis

To compare the averages of the time allocated for each of the Mallard activities, as well as the deviations in terms of average distance to the shore compared to the nearest neighbor, the data collected were analyzed by an analysis of variance after verification of their normality. The multiple comparisons between these means was made using the Bonferroni correction. The Khi-square independence test was used to verify the association activity- nearest neighbor and to study the distribution of species in the association during each activity. The risk of error of 5% was retained for all statistical tests and the data for this study was statistically processed using IBM SPSS 24.

Results

The results of mallard during the two wintering seasons at the Beni Haroun Dam are presented in three key points; 1) trends in numbers, 2) Activity budget, 3) interspecific association.

Trends in numbers

The presence of the Mallard at the Beni Haroun Dam was observed throughout the study period for the two seasons, (Fig. 2). In October, there was an average of 112 ± 63 individuals, which increased gradually to reach a maximum of 875 ± 177 individuals in January. Then, numbers decline until the end of March (285 ±149). During the second season, the abundance has decreased significantly comparing to the first one.

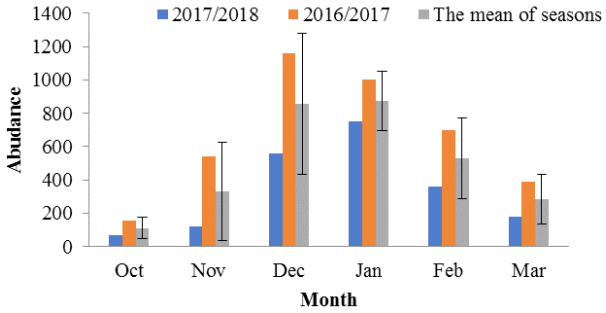


Fig. 2. Trends of Mallard population wintering in Beni Haroun Dam

Activity budget

The diurnal time budget monitoring indicated that sleeping was the main activity (53.59 %) followed by swimming (15.09%) and grooming (12.43%), feeding (11.84 %), resting (5.74 %) and at last courtship and flying respectively with (0.71%) and (0.6%) (Fig. 3).

At the beginning of wintering, the Mallard spent 59.59% of budget time in sleeping and (11.71%) to grooming, that represents 71.29% of its budget time in comfort activities. Sleeping occurred mainly on the banks and shallow water. Its value increases gradually to reach a maximum in December (77.57%), then decreases towards the end of the win-

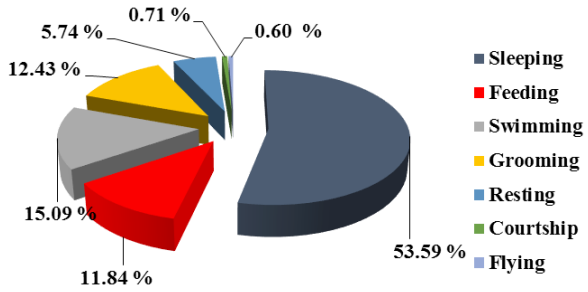


Fig. 3. Rates of the different daytime activities of Mallard duck *Anas platyrhynchos*.

tering season (Fig. 4). Grooming activity represents a sawtooth shape trend with a maximum recorded in November with a rate of 18.47%. Feeding was often observed on the mudflat and shallow water and the peak of this activity was 16.82% and 17.55% in January and March respectively. Swimming rate was low between October and December, then gradually increased to a peak of 26.82%in March. Resting showed the same pattern of the previous activity with a peak of 9.72% in February. Courtship was observed only during November and December with a maximum of 2.45%. Flying is considered an activity rarely manifested.

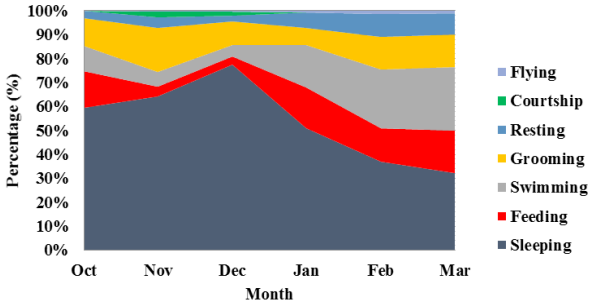


Fig. 4. Seasonal changes in proportions (%) of time spent by Mallard on different activities at Beni Haroun Dam.

Interspecific association

Mallard was observed in association with different neighbor species at different distances from the shoreline (Fig. 5). The closest association to the shoreline was observed with the Wigeon *Anas penelope* and the Great Crested Grebe *Podiceps cristatus*. According to the position of nearest neighbor species, we noted the following order: Wigeon < Great Cormorant *Phalacrocorax carbo*< Grey Heron *Ardea cinerea* < Common Coot *Fulica atra* < Common Shelduck *Tadorna tadorna* < Common Teal *Anas crecca* < Yellow-legged Gull *Larus michahellis* < Black headed Gull *Larus ridibundus* < Great Crested Grebe (Fig.5). Difference in average distance between these neighboring species and the shoreline is significantly higher (ANOVA, $F_{8.260} = 5.68$, $P = 0.00 < 0.05$).

The comparison between distance averages led to distinguish two groups, the first composed by Wigeon, Great Cormorant, Grey Heron, Common Coot, Common Shelduck, Common Teal, Yellow-legged Gull and Black-headed Gull, and the second composed only by Great Crested Grebe.

The association with the different neighbor species varied with the behavior of the Mallard (Fig.6). For the associations closest to the shoreline, we recorded the dominance of sleeping activity, On the other hand, swimming activity was noted in distant associations.

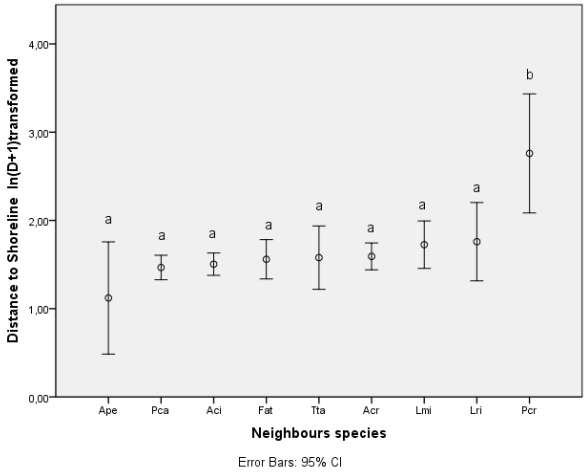


Fig. 5. The position of neighbor species the mallard duck compared to the shoreline Wigeon (Ape), Great Cormorant (Pca), Gray Heron (Aci), Common Coot (Fat), Common Shelduck (Tta), Common Teal (Acr), Yellow-legged Gull (Lmi), Black-headed Gull (Lri) and Great Crested Grebe (Pcr).

Behavior analysis and associations were significant ($X^2_{32} = 48.082$ $P = 0.034$); so frequencies of the neighbor species depends on the activities of the Mallard.

The frequency of Grey Heron and Great Cormorant composing the association statically differs with the change in activity of the duck studied. However, the other species do not represent significant values (Table 1).

Nevertheless, during the feeding activity, the

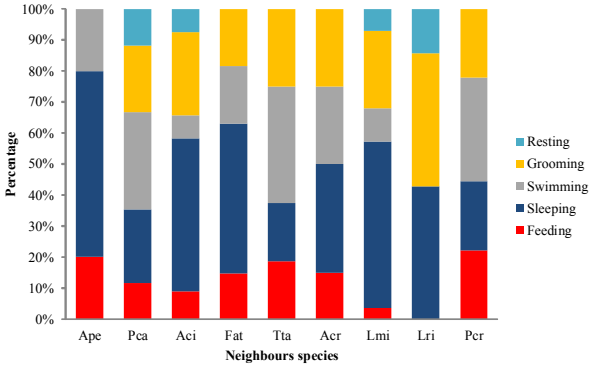


Fig. 6. Association of the mallard duck with the different neighbour species according to their behaviors.

Common Teal dominates the association (28%) of neighbors Mallard species. While during sleeping and grooming, the Grey heron dominates neighbor's species of Mallard (31% and 28% respectively). During the swimming activity the Great Cormorant and the Common Teal dominate neighbor species of Mallard. For resting activity, the Great Cormorant and the Grey Heron characterize the association (Table 1).

For the feeding activity, neighbor species associated to mallard were: Black headed Gull and the Wigeon. However, the Black headed Gull is the only species absent from the association composing during swimming. The Wigeon is also absent during the feeding activity, as well as the Common Teal, Great Crested Grebe, Common Coot, and Common Shelduck during resting.

Discussion

The current study gives information on the wintering behavior and the interspecific association of Mallard in the habitats used in Beni Haroun dam. Indeed, North Africa is considered a key region for wintering and staging migrating birds for Palearctic-trans-Saharan migrants (Samraoui *et al*., 2011; Sayoud *et al*., 2017). But since 1900, it has lost half of the wetlands through anthropogenic effects and climate change (Green *et al*., 2002; Maziane *et al*., 2014). As a result, this loss has led waterbirds to use new or artificial habitats (Sebastián-González *et al*., 2010). In these conditions, the Mallard reacts and migrates to more favorable environments to pass through winter (Diefenbach *et al*., 1988) and to benefit from the necessary energy that it allows, like other ducks, to have a better breeding success during the breeding season (Tamisier *et al*., 1995).

During each wintering season, the Mallard is present with significant numbers compared to other ducks. The counts have shown a decrease in the second season comparing to the first one, explained by irregular rainfall especially in the highlands (Tabet, 2008; Rouabhi *et al*., 2018), which includes a significant number of broad and shallow natural wetlands (Samraoui and Samraoui, 2008; Boulkhssaim *et al*., 2013). The precipitation rate recorded during the second season is very high, which is probably due to filling of natural wetlands. Ducks were concentrated in these artificial wetlands during dry winters and dispersed in natural wetlands during the rainy years (Kloskowski *et al*., 2009), which explains the decline in numbers during 2017-2018.

In general, activity budget analyzes are justified by its importance in defining the ecological and physiological behavioral adaptations of avian species (Khan *et al*., 1996; Mahaulpatha *et al*., 2002). In this site, the Mallard spent much of its day time (53.59%) in sleeping. This result confirms that the dam is more important for resting than for feeding during the day (Mahaulpatha *et al*., 2002). This suggests that feeding during the winter season is mainly a nocturnal activity (Tamisier and Dehorter, 1999; Guillemain *et al*.,2002, Arzel *et al*., 2006; Bengtsson *et al*., 2014; Korner *et al*., 2016), which requires this species to resting during the day to save energy and store fat (Khan *et al*., 1996).

The gradual increase in the rate of this activity between October and December is explained by the decrease in temperature (Quinlan *et al*., 1984).

Table 1. Frequency of species composing the association during Mallard activities.

		Activities				
		Feeding	Sleeping	Swimming	Grooming	Resting
Species	Aci	$18.8\%_{a,b}$	$31.4\%_{a}$	$9.3\%_{b}$	$28.1\%_{a,b}$	$35.7\%_{a,b}$
	Acr	$28.1\%_{a}$	$20.0\%_{a}$	$27.8\%_{a}$	$23.4\%_{a}$	$0.0\%^{1}$
	Lmi	$3.1\%_{a}$	$14.3\%_{a}$	$5.6\%_{a}$	$9.4\%_{a}$	$14.3\%_{a}$
	Pcr	$6.3\%_{a}$	$1.9\%_{a}$	$5.6\%_{a}$	$3.1\%_{a}$	$0.0\%^{1}$
	Lri	$0.0\%^{1}$	$2.9\%_{a}$	$0.0\%^{1}$	$4.7\%_{a}$	$7.1\%_{a}$
	Pca	$18.8\%_{a,b}$	$11.4\%_{a}$	$29.6\%_{b,c}$	$17.2\%_{a,b}$	$42.9\%_{c}$
	Fat	$12.5\%_{a}$	$12.4\%_{a}$	$9.3\%_{a}$	$7.8\%_{a}$	$0.0\%^{1}$
	Tta	$12.5\%_{a}$	$2.9\%_{a}$	$11.1\%_{a}$	$6.3\%_{a}$	$0.0\%^{1}$
	Ape	$0.0\%^{1}$	$2.9\%_{a}$	$1.9\%_{a}$	$0.0\%^{1}$	$0.0\%^{1}$

The values of the same rows and sub-tables that do not share the same index differ significantly at $p < 0.05$ 1. This category is not used in comparisons because its column proportion is zero

Grooming is registered with maximum values during the first months of the season when Mallards clean their plumage probably after a long migration distance (Maazi, 2009). The feeding activity is carried out mainly in mudflats (Davis *et al*., 2014; Osborn *et al*., 2017) and shallow areas (Guillemain *et al*., 2000; Mason *et al*., 2013; Murakani *et al*., 2015), which represent the most productive areas of the dam lake (Mahaulpatha *et al*., 2002). The maximum of this activity is recorded in both January and March when the low temperatures require the species to feeding during the day to complement nocturnal diet and the other hand in March, mallards accumulate reserves (fattening) in preparation for the breeding season (Guillemain *et al*., 2002; Maazi, 2009; Korner *et al*., 2016).

Swimming increased from January to the end of the season in medium to the deeper parts of the dam. This increase reflects a behavioral response of this species to human disturbances (Mahaulpatha *et al*., 2002) such as fishing, boat movements and the agricultural activity. Resting succeeds the swimming activity which explains its increase in parallel with the swimming during this period. Pair formation occurs mainly between September and December (Turnbull and Baldassarre, 1987), which is in good agreement with our results which also indicate that the courtship is observed between November and December. While it was reported only in December by (Maazi, 2009; Dziri *et al*., 2014) in the natural sites of eastern Algeria.

The spatial relationships between different species of waterbirds are influenced by several parameters such as water depth (Green and El Hamzaoui, 2006), our study on the associations between mallard and other birds shows that the majority of these nearest neighbors are located in a shallow area. This may be related on one hand to the dominant sleeping activity of this species and its preference for the shallow zone and on the other hand, by its high productivity for trophic resources (Mahaulpatha *et al*., 2002). The shallow depth attracts nearest neighbor such as the Great Cormorant and the Grey Heron for rest and the Wigeon for feeding (Houhamdi and Samraoui, 2003). During the foraging activity, the Common teal dominates the association of Nearest neighbor because it feeds and shares the same trophic resources with the mallard duck during the winter period (Guillemain *et al*., 2010).

Conclusion

Artificial wetlands, which can play a key role in the conservation of aquatic birds, can provide alternative and / or complementary potential refuge for waterbirds, especially during strong climatic periods. Our results showed the presence of the Mallard at the Beni Haroun Dam throughout the study period with a high abundance recorded during the first season. Results of diurnal time budget are comparable to data reported previously in eastern Numidia wetlands and the Highlands, whose dominant activity is sleeping while the parade was recorded for two months (November and December). The study of the association of the mallard duck with other species shown a mosaic of neighbor species with different distances from the shoreline. It presenting significant links between the average distance between these species and the shoreline and according to dependence: behavior – associations, influenced mainly by the depth of water and the richness of trophic resources. This study has identified some aspects of the wintering behaviour of the Mallards. However, some species wintering (Marbled Teal *Marmaronetta angustirostris* and the Ferruginous Duck *Aythia nyroca*) merit further investigation in future work in this artificial wetlands, especially with the continuous degradation of natural wetlands and severe periods of drought.

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