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The Wintering Behavior of the Great Crested Grebe (*Podiceps Cristatus*) and the Little Grebe (*Tachybaptus Ruficullis*) in the Lake Timerguanine (East of Algeria).

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ABSTRACT

Our study is based on the diurnal time budget and the counting of the great crested grebes (Podiceps cristatus) and the little grebe (Tachybaptus ruficullis) during 24 months (from September 2013 to March 2014 and from September 2015 to March 2016). We have followed-up the diurnal behavior of the two species from the seasonal evolution of their time budget, using a telescope (60×20) and a pair of binoculars (10x50). The absolute method was used because the number of the birds did not exceed 200 individuals. We have used the SCAN method for the study of the diurnal time budget. Our results show that this natural lake plays an essential role in the wintering of the two species and other birds. The study of the diurnal behavior shows that feeding is the most important activity with a value of 51.12% for the great crested grebe and 51.25% for the little grebe over the year 2013-2014. While in 2015-2016 a value of 48% for the little grebe and 51.99% for the great crested grebe followed by swimming, whereas the other activities occupy only one small percentage in the assessment of the diurnal activities of the two species.

Keywords:*Diurnal Behavior, Podiceps Cristatus, Seasonal Evolution, Little Grebe, Lake Timerguanine.*

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1. INTRODUCTION

The great crested grebe (*Podiceps cristatus*) is an excellent diver which feeds mainly on small fishes and aquatic larvae (Perrins, 1991). It is an elegant bird and the largest of its family. It has a long, slender-shaped neck that is often held erect (Rouibi, 2014).

The little grebe is the smallest of all grebes with a length of the body that can vary from 15 to 16 cm, and is orange-colored on the cheeks and flanks. During the breeding phase, it is easily identified by the dark plumage growth and a visible white spot on the throat (Bologna, 1980). The Great crested grebe is a species of the family *Podicepididae* or grebes. This family has 22 species that are extremely adapted to the aquatic environment (Géroudet, 1946). This sedentary and breeding species in Algerian wetlands is widespread throughout the eastern Algeria (Samraoui & Samraoui, 2007) it is an excellent biological model that can be used as a good bio-indicator of the structure and functioning of aquatic environments.

There is a paucity of studies on the history, breeding and strategies of dispersal and survival of North African waterbirds, although such data are important for understanding population dynamics and assessing population viability (Cheriet et al, 2015).

Our study was conducted in Lake Timerguanine. It is a very important lake ecosystem in the Oum El Bouaghi region because it is a freshwater body that is used for and farmland irrigation (Samraoui, 2007, Ouldjaoui, 2010). In this work we discussed the ecology of aquatic birds in the region of Oum El Bouaghi through the systematic enumeration of the bird population in the region. We also tried to study the diurnal behavior of great crested grebe and little grebe.

2. MATERIALS AND METHODS

Study sites

The Lake Timerguanine (35°39'33" N and 06°59'02" E) is part of the eco-complex wetland in high plain of eastern Algeria (Saheb, 2003). This body of water is located 25 km south of Oum El Bouaghi department, is limited in north by the municipality of Ain Zitoun. It is accessible by the road connecting Oum El Bouaghi to Khenchela (Fig A). Its overall area 15286.7 ha including 202.7 ha for the large Timerguanine and 84 ha for the small Timerguanine (Saheb, 2009). The origin of water is Oued Boulefrais which originates in the massifs of Aurés and which regularly floods the basins of Timerguanine (Maazi, 2005). The climate is semi-arid in cold winter, with one to two months of frost each year (Houhamdi et al, 2009). The prevailing wind direction is northwest. Average rainfall is 390.94 mm annually (Maazi,2009). It usually dries up in summer because the evaporation is very intense and the water is soft. This water body is a favorable

place for many species of waterfowl, such as *Burhinus oedicnemus*, *Glareola pratincola* (Collared Pratincole), as well as Melanocorypha calandra (calandra lark) (Samraoui, 2005). The aquatic fauna of this water body is rich and diversified, among the insects, odonates are present in large numbers (*Ischnura graellsii*, *Erythromma viridulum*, *Sympecma fusca*, *Mallagma deserti*, *Orthetrum cancellatum*, Anax parthenope). The aquatic vegetation and the water of this water body play a very important role in the success of many economic activities (Kaf, 2011).

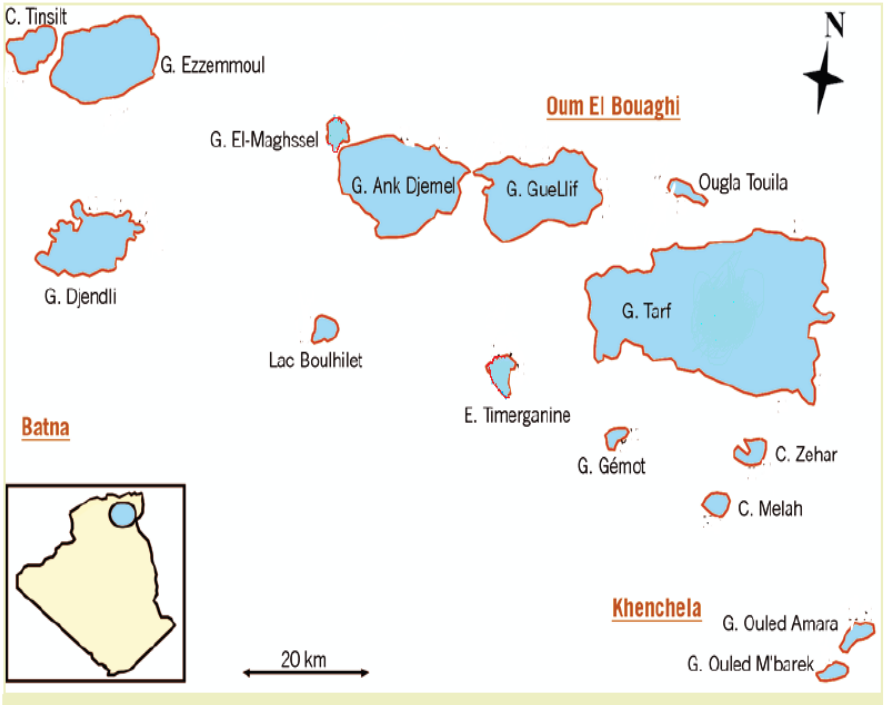


Figure A. Geographical location map of the study site (Maazi, 2005)

3. METHODOLOGY

Our study was conducted over a period of 24 months from the second half of September to the end of March for the year 2013-2014 and from the second half of October to the end of March for the year 2015-2016.

The enumeration and study of the diurnal budget of the great crested grebe and little grebe were conducted twice a month at Lake Timerguanine.

a. The absolute method

For both grebes we used the absolute method, in which case the population is directly estimated in its absolute value and all individuals are counted. This is the method that will be used when the population is near the observation point and the number of individuals does not exceed 200 individuals (Tamisier & Dehorter, 1999b, Ouldjaoui, 2010)

The absolute method has different variants and the choice of one or the other depends on:

- Size of the site.
- The size of the bird population to be counted.
- The homogeneity of the population (Schricke, 1985)

b. The SCAN method (Instantanious scan sampling)

The diurnal activity rate assessment was followed by the SCAN method (Instantanious scan sampling), This method based on the observation of a group allows to record the instant activities of each individual, then thanks to mathematical transformation the time difference of each of them is completed (Altmann, 1974). It has the advantage of being the only method applied in densely vegetated sites where waterbirds are not always observed for long periods of time (limit focused sampling). It also eliminates the choice of individuals (Baldassare et al.1988).

The study of this report was established by regular observations made every day of output, with a scan performed every hour, from 8:00 to 16:00 in this water body. Seven (07) activities were measured: feeding, sleep, which are essential activities for waterbirds, swimming, toilet or plumage maintenance, flight, parry activities and antagonist behaviors that are considered comfort activities. The food activity was subdivided into four different modes: feeding with the beak on the water, feeding by immersion of the head in the water, feeding by tilting of the front of the body in the water and feeding on foot in mudflats and banks. Each activity is synonymous with the nutritional need status of the birds.

4. RESULTS

1) Study of the daily activity record of the great crested grebe and the little grebe during the years 2013-2014.

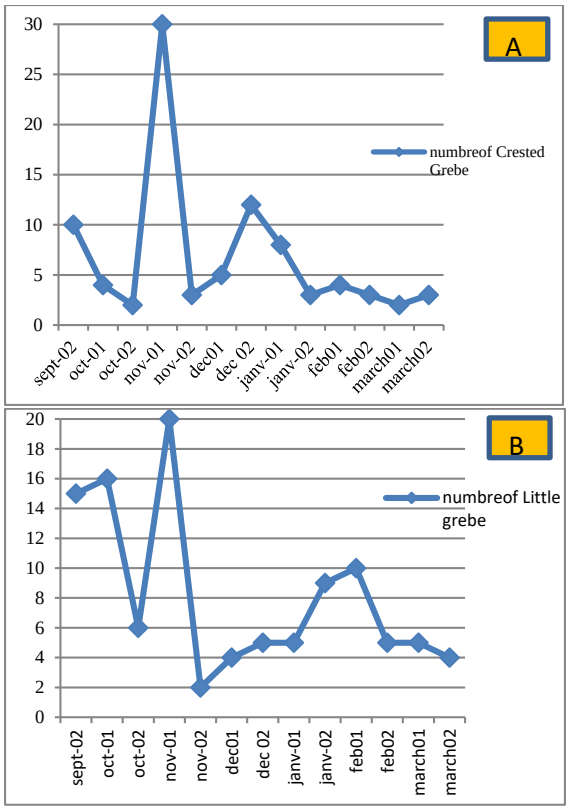
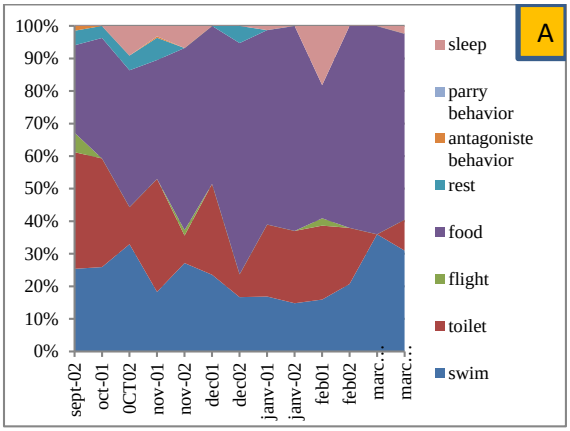


Figure 1. The evolution of the effectives of A: Great crested grebe and B: Little grebe at Lake Timerguanineduring the year (2013-2014).

The great crested grebe and the little grebe occupy Lake Timerguanine from September with a number of 10 and 15 individuals respectively. The maximum population for both species is observed at the beginning of November with a number of 30 individuals for the great crested grebe and 20 individuals for the little grebe, after which we noticed a decrease in numbers throughout the rest of the wintering period with varied numbers between 13 and 3 individuals for the great crested grebe and 6 individuals for the little grebe respectively.



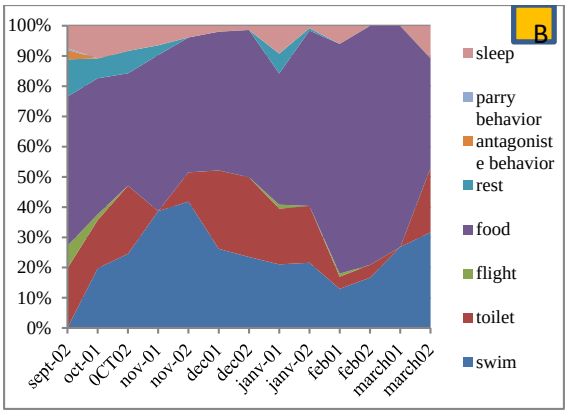


Figure 2. Seasonal evolution of the daily activities of A: Great crested grebe and B: Little grebeduring the year (2013-2014)

The seasonal evolution of diurnal activities for both species from September to March shows that feeding dominates throughout the study period. The highest rate of feeding is recorded in December for the great crested grebe and in January and February for the little grebe where the bird spends more than 65% of its time feeding. Swim and toilet rank second in the daytime budget.

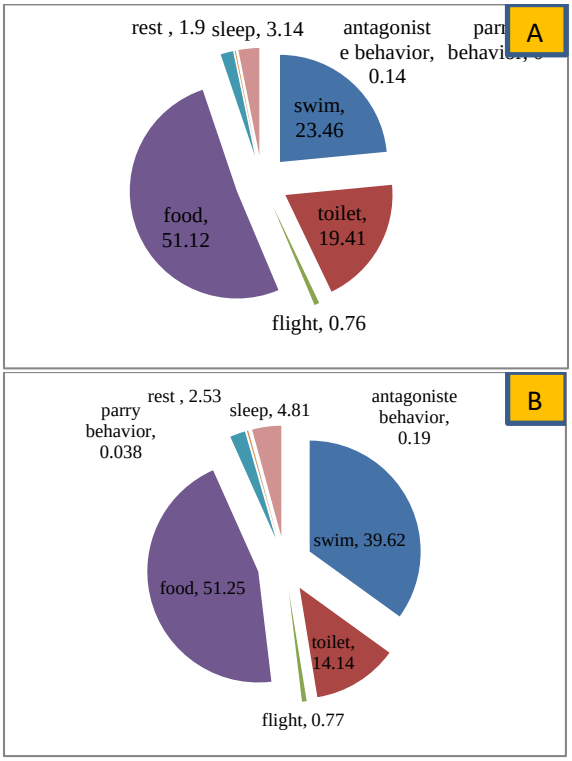


Figure 3. The average annual activity of A: Great crested grebe and B: Little grebe at Lake Timerguanine during the year (2013-2014)

The average annual diurnal activity in both species shows that the feed dominates with an annual percentage of 51.12 for the great crested grebe and 50.25 for the little grebe, respectively. This activity is often observed in the water and rarely performed in the edge (figure 3).

-Swimming ranks second in the assessment of the diurnal activity rate for both species, it occupies relatively low rates at the beginning of the season with a value close to 20% for both species, the annual average of this activity is 23.46% for the great crested grebe and 26.26 for the little grebe respectively (figure 3).

The toilet or the plumage maintenance behavior comes in the 3rd rank of the assessment of the activity rate for the two species; the annual average of this activity is 19.41% for the great crested grebe and 14.14% for the little grebe respectively.

-Sleeping is the main comfort activity of birds (Tamisier and Dehorter 1999); this activity comes fourth in the activity rate assessment for the two species, the annual average of this activity is 3.14% for great crested grebe and 4.81% for the little grebe respectively (figure3).

Rest is a comfort activity for both species; this activity is observed practically throughout the study period in Lake water and rarely in the border. The annual average is 1.9 % for great crested grebe and 2.53% for the little grebe respectively.

The parry behavior is observed with the beginning of reproduction; this activity is observed and noted mainly in water. The average of this activity is 0.76% for the great crested grebe and 0.77% for the little grebe respectively. This activity is manifested mainly for the two species from the month of February, when couples begin to form (figure 3).

Flight and aggressive interactions occupy only a weak proportion in the assessment of activity for both species with low values throughout the study period (2013-2014). Flight is often observed during disturbances caused or during the change of habitat, while aggressive interactions are often noticed during the training of couples

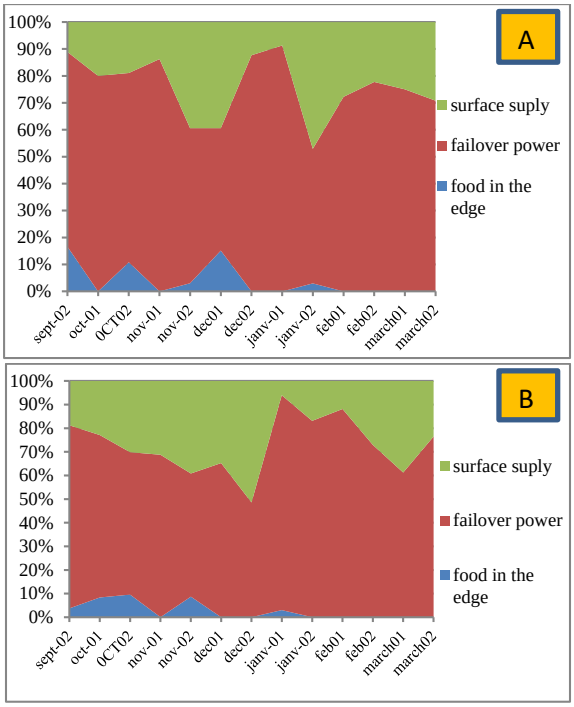


Figure 4. Seasonal evolution of the different feeding habits of A: Great crested grebe and B: Little grebeat Lake Timerguanine during the year (2013-2014).

We have noted that the great crested grebe and the little grebe feed on 03 types of feeding (surface feeding, tilt feeding, feeding on the border). The evolution of the different types of feeding shows that the tilt feed dominates throughout the study period, especially in January, when we recorded the highest value of this type of feeding for both species. The lowest values are noted at the beginning of December for the great crested grebe and at the end of December and March for the little grebe respectively.

Surface feeding comes second in the activity rate record of the species, the highest value of this activity at the end of January for the great crested grebe and at the end of December for the little grebe where we recorded the maximum of this activity with a rate of 50%, while the feeding on the border occupies a very low percentage and rarely observed (figure 4).

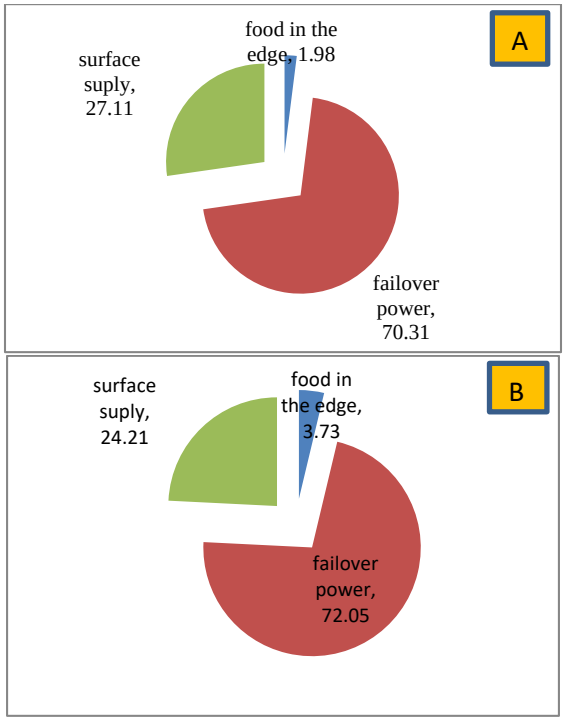


Figure 5. The annual average of the different types of feeding of A: Great crested grebe and B: Little grebeat Lake Timerguanine during the year (2013-2014).

Annual averages of different types of feeding also show that tilt feeding dominates with an annual rate of 72.05 % for great crested grebe and 70.31% for little grebe, respectively. This activity is always observed when the bird feeds in the deep waters. Surface feeding ranks second with an annual average of close to 24% for the great crested grebe and 27% for the little grebe respectively. This activity is often observed in the shallow waters near the border of Lake. However, feeding in the border is rarely observed, it occupies a low annual average of 3.73% for the great crested grebe and 1.98% for the little grebe, respectively (figure 5).

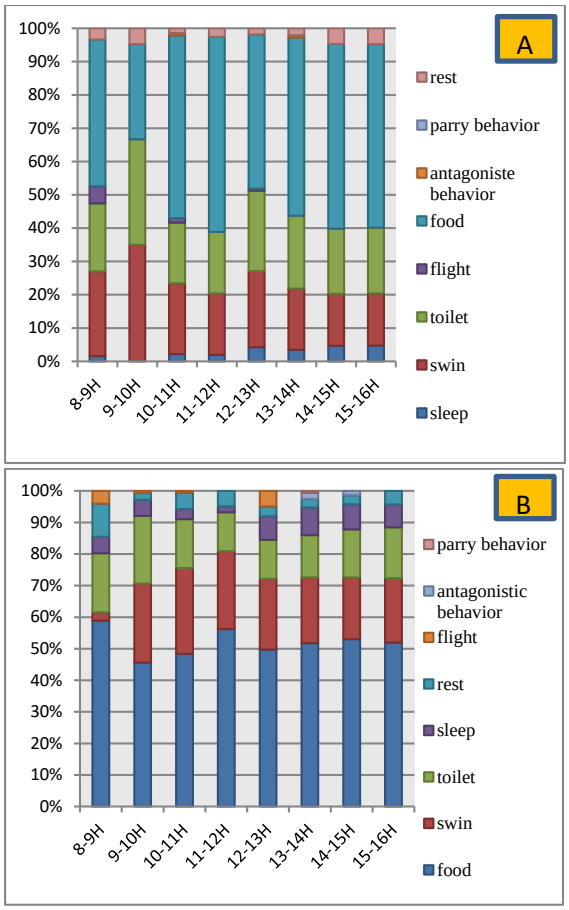


Figure 6: Daily time budget of A: Great crested grebe and B: Little grebe at Lake Timerguanine during the year (2013-2014).

The daily time budget study of great crested grebe and little grebe shows that feeding dominates during all hours of the day with variable values between 60% and 30% for the great crested grebe and between (50- 60%) for the little grebe, followed by swimming and toilet with varying percentages between 15-30% for both species, the other activities occupy only low values(figure 6).

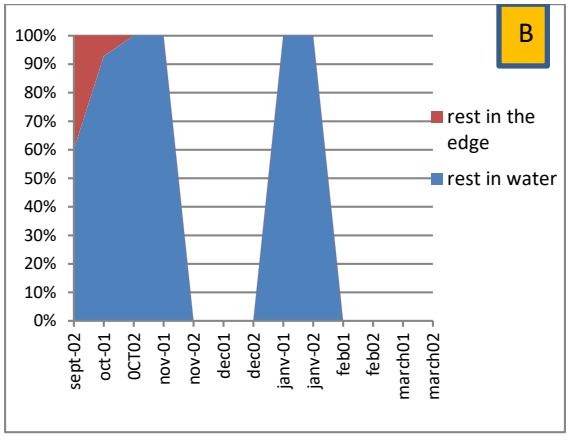


Figure 7. Seasonal evolution of the different types of rest of the little grebe at **Lake Timerguanine during the year (2013-2014).**

We have distinguished two types of rest in the little grebe (rest in the border and in the water (figure 7).

The seasonal evolution of the different types of rest of the Little Grebe shows that the rest in the water is dominant throughout the study period with values reaching up to 100%, especially in the middle of the wintering period (from month of November until February). The rest in the border takes place mainly in the first two months of the wintering period (September and October). the maximum of this activity is recorded at the end of September with a percentage of 25%(figure 7).

We also noted that the rest is completely absent at the beginning of December and from the month of February (figure 7).

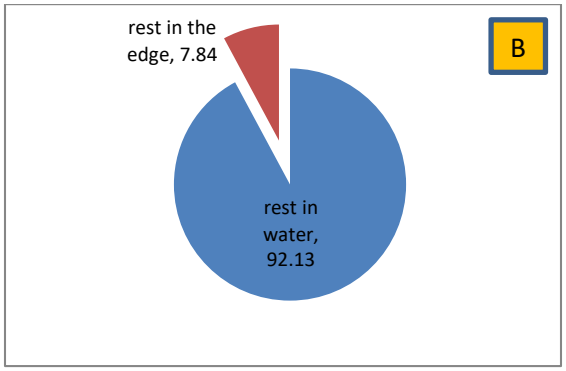
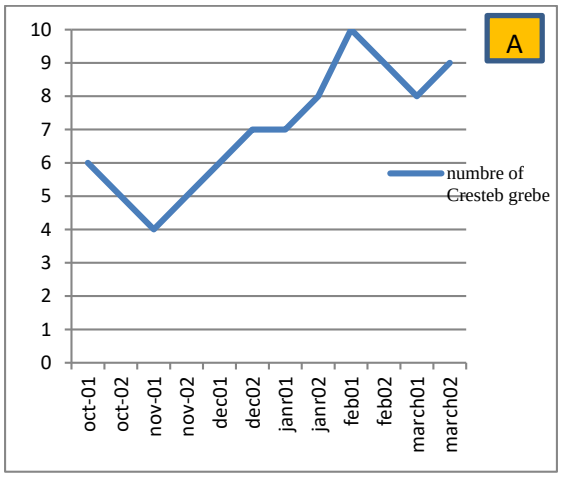


Figure 8. Annual average of the different types of rest of B: the little grebe at Lake Timerguanine during the year (2013-2014).

The following figure shows that annualaverage rest in the water occupies only 2.53% of the time allocated to our work. The resting takes place in the water (2.19%) and rarely on the border (0.34%).

2) Study of the assessment of the rate of diurnal activities of the* Great *crested grebe and the Little grebe during the year 2015-2016.



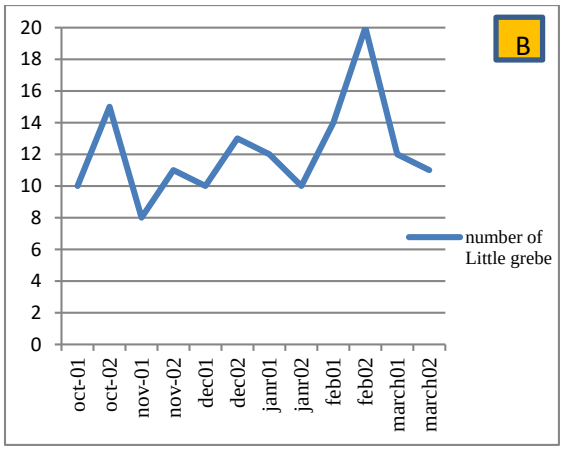


Figure 9. The numbers evolution of the A: Great crested grebe and of the B: Little grebe on the levelof Lake Timerguanine during the year (2015-2016).

The two species start to occupy LakeTimerguanine from October with 6 individuals for the great crested grebe and 10 individuals for the little grebe. The number falls in November for both grebes with a number of 4 and 8 individual, respectively. We noticed then an increase in the numbers during all the remaining period of wintering with numbers of 10 and 20 for both grebes, respectively (figure 9).

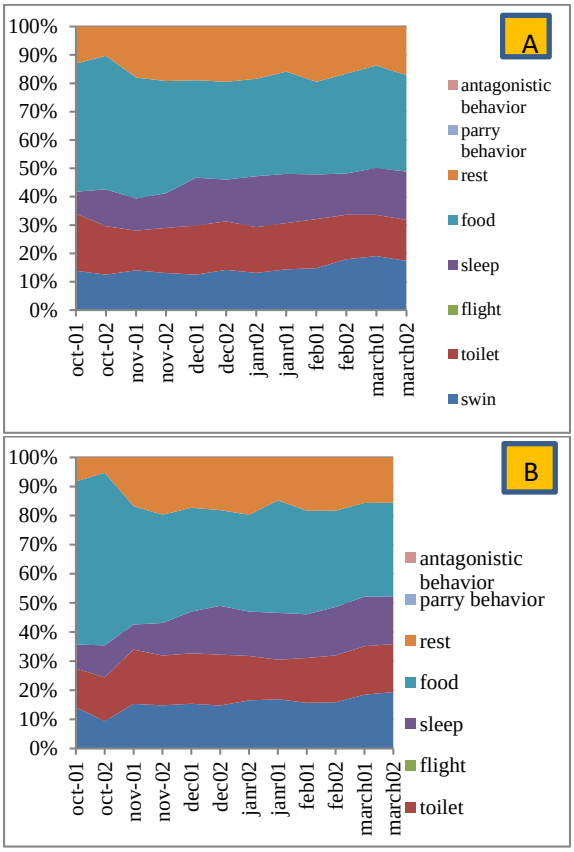


Figure 10. Seasonal evolution of the diurnal activities of A: The Great crested grebe and B: the Little grebeat Lake Timerguanine during the year (2015-2016).

The seasonal evolution of the diurnal activities of the great crested grebe and the little grebe from October to March shows that the food dominates during all the period of study. The highest rate of the food is recorded in February for both species, and the smallest percentage at the beginning of November for both grebes. This decrease in the feeding is with the profit of other activities like the rest and the swim.

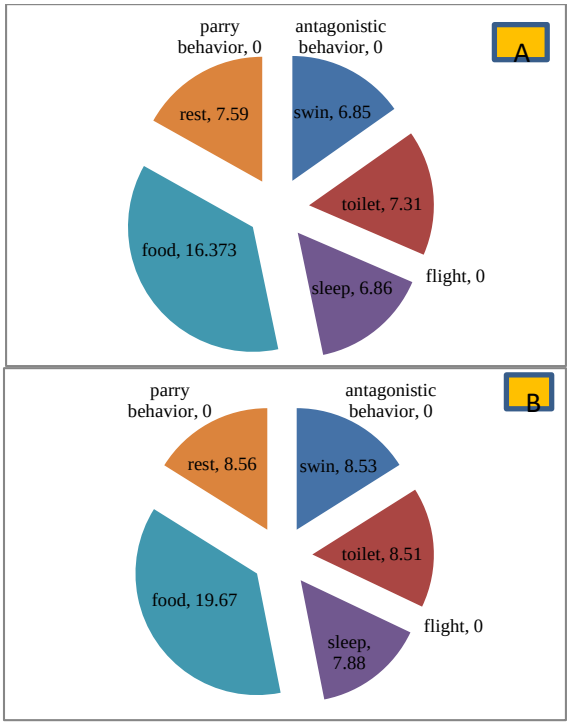
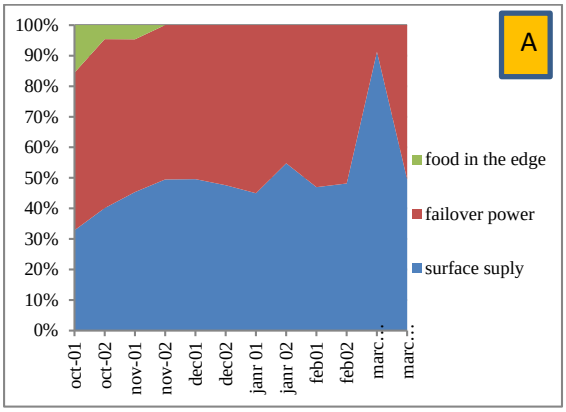


Figure11. the average of the diurnal activities of A: The Great crested grebe and B: the little grebe at Lake Timerguanine during the year (2015-2016).

The annual average diurnal activity in both species shows that feeding dominates with an annual percentage of 16.37% for great crested grebe and 19.69% for the little grebe, followed by rest (7-8%) for the great crested grebe and the little grebe, respectively. And the swimming and the toilet with an annual average of 8.5% for the two species while the other activities occupy only a small proportion in the diurnal activity rate report (figure 11).



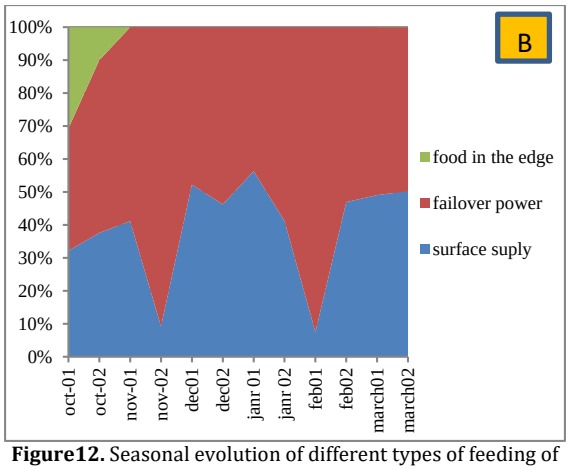


Figure12. Seasonal evolution of different types of feeding of Great crested grebe and Little grebeat Lake Timerguanine during the year (2015-2016).

We noticed that the two species feed on three types of feeding (surface feeding, tilt feeding, border feeding). The seasonal evolution of the different types of food shows seasonal changes in these activities. The tilt feeding dominates throughout the study period for both species, a decrease in this type of feeding is observed in early October in favor of the surface feeding that comes in second position.

The latter is also observed throughout the study period, especially in early of January. The border feeding is rarely observed for these species (figure 12).

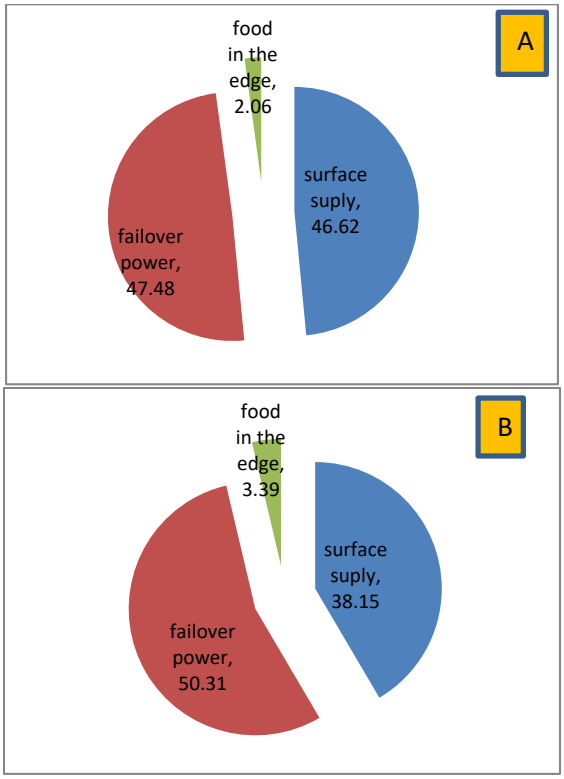


Figure 13. Annual average of the different feeding types of Great crested grebe and little grebeduring the year (2015-2016).

The annual average of the different types of feeding in the two grebes shows that tilt feeding dominates with a percentage equal to 47.48% for the great crested grebe and 50.31 % for the little grebe. This activity is always observed when the bird feeds in deep water. Surface feeding comes in second place with an annual average of 46.62% for great crested grebe and 38.15 for the little grebe. This activity is often observed in shallow waters, near the border of Lake Timerguanine, while feeding in the edge is rarely observed for these species, it occupies a low annual average equal to 3% (figure 13).

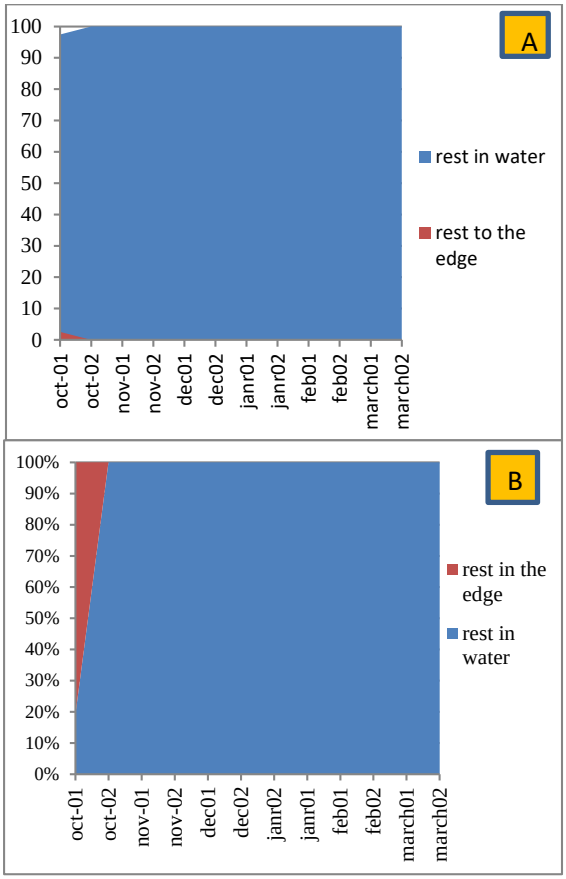


Figure 14: the seasonal evolution of the different types of rest of A: The Great crested grebe and B: The Little grebe at Lake timerguanine during the years (2015-2016).

We have distinguished two types of rest in both species (rest on the border and in the water). The seasonal evolution of the different types of rest of the great crested grebe and the little grebe shows that the rest in the water is dominant during all the study period with values reaching up to 100% for the two grebes including the whole period wintering (from November to March). Rest on the edge occurs mainly for the two grebes in the first two months of the wintering period (October and November), and the maximum of this activity is recorded at the end of October with a percentage of 20% for the great crested grebe and the little grebe.

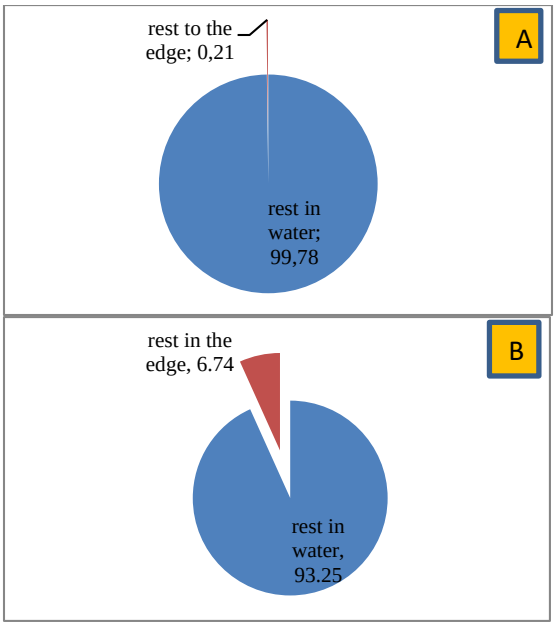


Figure 15. Annual average of the different types of rest of A: Great crested grebe and B: the little grebeat Lake Timerguanine during the year (2015-2016).

The following figure shows that the rest for these species takes place in the water 100% for both grebes and rarely on the edge 0% for the great crested grebe and 3% for the little grebe (figure 15).

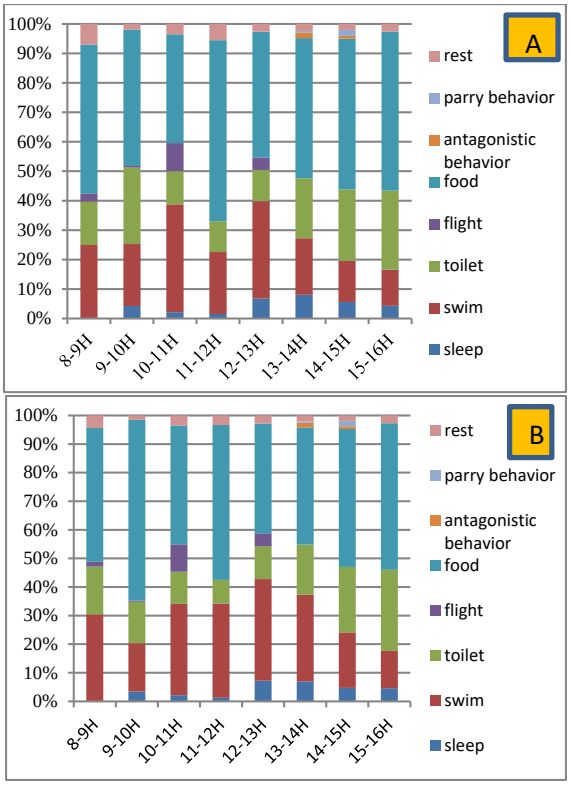


Figure 16. Daily time budget for A: Great crested grebe and B: Little grebe at Lake Timerguanine during the year (2015-2016).

The daily time budget study of great crested grebe and little grebe shows that feeding dominates during all hours of the day with values varying between 60% and 30% for the great crested grebe and 50% and 60% for the little grebe followed by swimming and toilet. The other activities occupy only low values.

5. DISCUSSION

Lake Timerguanine is an important ecosystem in the wilaya of Oum El Bouaghi, it plays a vital role in the accommodation and wintering of several species of water birds. It has a significant specific richness; about fifteen species were identified during the wintering period. (Boulkhssaim, 2008).

Effective evolution

The great crested grebe and the little grebe are two less frequent species in Lake Timergianine. They occupy the site from September with numbers not exceeding 30 and 20 individuals for the great crested grebe and the little grebe, respectively during the year 2013-2014. During 2015-2016 they occupied the site from October with numbers not exceeding 10 and 20 individuals of the two species respectively (from figure 1 to figure 9). Probably the existence of alternative sites in the region, particularly deep water bodies such as dams, offers a favorable location for the species and explains the relatively low numbers of the two species in the site.

The two grebes are reported as breeding in several sites in Algeria (Tonga Lake, Mellah and Bird Lake), Reghaia and Boughzoul (Isenmann and Mouali, 2000).

Several sporadic observations have been made by several researchers in the high plains of eastern Algeria, 10 and 15 individuals were observed at Guaret Boulhilet (Ledant and al, 1981).

Observations made by (Heim DE Balsac, 1949) also showed that the complex of highland wetlands of eastern Algeria is less represented by the two species compared to other Eco complex like the El kala complex. it reported 55 individuals for the great crested grebe and 36 individuals for the little grebe respectively, for all the Eco complex of wetlands in the region (Allain, B.D. 1997).

- **The diurnal activity**

The great crested grebe diurnal activity balance study shows feeding dominates with a seasonal average of 51.12-16.37% during the year 2013-2014, followed by swimming (23.46%; 2013-2014), rest (7.59%; 2015-2016) and toilet (19.41-7.31%), while other activities occupy only a small percentage. Very few studies and scientific information exist on the diurnal behavior of great crested grebe and little grebe.

- **Seasonal evolution of diurnal activity**

The seasonal evolution of diurnal activity in great crested grebe from September to March also indicates that feeding dominates throughout the study period. The highest rate of feeding is recorded in December and the lowest percentages are at the end of September, and this reduction in feeding is in favor of other activities such as toilet and rest.

Several studies on the behavior of waterbirds show that feeding is the dominant activity throughout the year, especially during the wintering season (Boulkhssaim and Al 2006, Tamisier and Déhorter 1999). We have noted that the great

crested grebe feeds on three types of feed (surface feeding, tilt feeding border feeding).

- **The evolution of different types of feeding**

The evolution of different types of feeding shows that the tilt feeding dominates throughout the study period especially in the month of January where we have observed the highest value of this type of feeding. The lowest values are noted at the beginning of December.Surface feeding comes in second position in the species' activity rate. The highest value of this activity is observed at the end of January, while border feeding occupies very low percentages and is rarely observed. This variability in feeding for waterbirds allows species the best exploitation of the water body and access to different habitats (Boulkhssaim et al, 2006).

- **Study of daily time budget**

The great crested grebe daily time budget study shows that the feeding dominates throughout the day, and the values vary between 60% and 30% for 2013-2014 and 2015-2016, respectively. The highest values are observed in the evening especially from 13H, followed by the swimming and toilet, other activities occupy only low values.

The study of the activity record of the little grebe during the winter of 2013-2014 shows that the bird spent more than half of its time feeding. We observed that the feeding dominates practically throughout the study period, particularly in January and February, when the bird spent more than 65% of its time feeding.

A decrease in the feeding is noticed in November and January months, coinciding with a period of cold that affected the region. Swim and toilet rank second in the diurnal time budget of the species. The seasonal evolution of these activities reaches the maximum in early November.

- **Study of Annual averages**

Annual averages of little grebe daytime activities also show that the feeding dominates with a percentage equal to 50.25% and 19.67% in 2013-2014 and 2015-2016, respectively. This activity is often observed in water and rarely observed in the border.

Swimming ranks second in the balance of the little grebe daytime activity, and is often accompanied by other activities (feeding, foraging, parrying, and aggressive interaction). The values of this two activities are low at the beginning of the season with a value close to 20%, and the annual average is 26.26%., The toilet or the behavior of the plumage maintenance comes in the 3rd position of the balance of the rhythm of activity of little grebe and it is registered from the month of September with a rate of 15%, and the maximum reaches in January with a rate of 25%. The annual rate is 14.14%.

The other activities occupy small proportions in the activity rate record of the species with values not exceeding 5%.

This study shows that little grebe spends more than half of its time on feeding.

Little information on the diurnal time budget of the grebes has been made; however, studies have reported a low trophic resource rate in this site which may be responsible for increasing the time allotted for the feeding of water birds (Piersma, 1988b).

Nighttime feeding may be even more important on this site, especially during the short winter days. Particularly cold periods appeared to decrease feeding activity during the study period (Boulkhssaim, 2008).

6. CONCLUSION

The lake Timerguenine is a very important lake ecosystem in the wilaya of Oum El Bouaghi because it is the only freshwater lake that is used at the same time in the drinkability of animals and the irrigation of agricultural land. This ecosystem fed mainly by Oued Boulafreise during the rainy season.

Our study (from September 2013 to March 2014) was based on the diurnal behavior and count of great crested grebe and the little grebe, to see the status and understand the ecology of the two grebe species.

The results of our work showed that both species are less frequent species in the Lake Timerguenine site.

The study of diurnal activity rhythm shows that feeding is the dominant activity with a rate of 51.12% and 51.25% in 2013-2014, and 16.73% and 19.67% in 2015-2016 for great crested grebe and little grebe, respectively. During the entire study period either for pre-migratory fattening or for the recovery of energy lost during migration or as a supplement to the feeding which is essentially nocturnal.

Studies should be conducted to understand the dominance of feeding activity (trophic ration, capture of individuals and measured weights, study of nocturnal activity). It could be more interesting to follow the study of the budget time of these grebes over a period of 8 hours to be able to more accurately quantify the time devoted to each activity and better understand the operation of the lake during the day. The swimming, toilet and sleeping are comfort activities with very low rates (0.03-3,14% in 2013-2014, and 8.53-8.51% in 2015-2016) for the two species. Finally, the study site is an unfavorable environment for the great crested grebe and the little grebe.

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