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Amel Lazli, Ilhem Nouari, Nardjes Chater, Aissa Moali. Diurnal behaviour of breeding White-headed Duck *Oxyura leucocephala* at Lake Tonga, North-East Algeria. *Revue d'Écologie (La Terre et La Vie)*, 2014, 69 (2), pp.131-141. <hal-03530616>

HAL Id: hal-03530616

<https://hal.science/hal-03530616v1>

Submitted on 17 Jan 2022

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DIURNAL BEHAVIOUR OF BREEDING WHITE-HEADED DUCK
OXYURA LEUCOCEPHALA AT LAKE TONGA, NORTH-EAST ALGERIA

Amel LAZLI^{1*}, Ilhem NOUARI², Nardjes CHATER¹ & Aissa MOALI³

RÉSUMÉ. — *Comportement diurne de l'Érismature à tête blanche* *Oxyura leucocephala* au lac Tonga (Nord-Est algérien). — Le comportement diurne de l'Érismature à tête blanche *Oxyura leucocephala* a été étudié au lac Tonga, lac d'eau douce peu profond situé dans le Nord-Est algérien, au cours de deux saisons de reproduction. Les rythmes d'activités diurnes de 173 oiseaux ont été compilés, de la période de pré-nidification jusqu'à la mue postnuptiale. Des budgets d'activités séparés ont été construits pour chacun des mâles et des femelles d'Érismature. Durant la saison de reproduction, le sommeil s'est avéré être la principale activité diurne pour les mâles (40 %), ce qui reflète l'avantage de la thermorégulation au cours du repos pendant la journée. Les femelles se nourrissent plus que les mâles (respectivement 26 % et 19 %) au cours de la période de pré-nidification, indiquant ainsi leur besoin d'acquérir des nutriments et de l'énergie pour la production d'œufs et l'incubation. Les parades nuptiales et le comportement agonistique, plus importants pendant la pré-nidification (période de ponte et d'incubation), indiquent que certains mâles tenteraient de copuler avec d'autres femelles, alors que d'autres essaieraient de protéger leurs propres femelles contre cela. L'augmentation du temps imparti à la toilette à partir de juin et juillet pour les deux sexes indique le début du phénomène de mue. L'activité alerte est plus importante pendant la période postnuptiale. En effet, mâles et femelles d'Érismature allouent un même temps à la protection des poussins et des juvéniles contre différents ennemis. Ce travail présente des données récentes et inédites sur l'éco-éthologie d'une espèce menacée pendant la saison de reproduction et dont les études sur le sujet restent peu développées dans la nature, en particulier pour chaque sexe.

SUMMARY. — Over a period of two years, the diurnal behaviour of the globally threatened White-headed Duck *Oxyura leucocephala* was monitored at Lake Tonga, a shallow freshwater lake, part of the Numidian wetland complex located in North-East Algeria. Diurnal time-activity budgets of about 173 birds were compiled during two breeding seasons, from pre-breeding to postnuptial moult. Separate budgets were constructed for males and females White-headed Duck. During the breeding season, sleeping proved to be the main diurnal activity for males (40 %), reflecting the thermoregulatory advantage to resting during the day. Conversely, females feeding more (26 %) than males (19 %) during the pre-breeding period reflect their need to acquire nutrients and energy for egg production and incubation. Courtship and agonistic behaviour, more important during pre-breeding (i.e. laying and incubation periods), indicate that some males tried to engage in extra-pair copulation, and others tried to guard their females against this. Comfort increasing from June and July for both sexes reflect that moult takes place. Alert was more important during postnuptial period, males and females White-headed Duck allocated the same time to protect chicks and juveniles from different enemies. This study provides recent and original data on the behaviour of an endangered species, whose activities during the breeding season in the wild are little known, especially for each sex.

¹ Département de Biologie, Université d'El Tarf, BP: 73. 36 000 El Tarf. Algérie.

* Corresponding author. Email: la_amel13@yahoo.fr

² Laboratoire LCH 36170. Ain El Assel Wilaya d'El Tarf. Algérie. Email: ilmen_na@yahoo.fr

³ Université A. Mira. 06000 Bêjaia. Algérie.

The White-headed Duck *Oxyura leucocephala*, a globally endangered duck, is the only stiff-tail (*Oxyurini*) native to Europe, Asia and North Africa. It is listed both in the IUCN Red List and on both appendix I and II of the CMS (IUCN 2000; Hughes *et al.*, 2006). White-headed Duck prefers shallow, productive brackish “endorreic” wetlands having a closed basin hydrology (Ali *et al.*, 2007). Its populations have become fragmented and undergone major declines in recent decades. At present, four populations of White-headed Ducks are recognized: a migratory Central Asian population breeding mainly in northern Kazakhstan and southern Russia and wintering in western Asia, the Middle East and in eastern Europe as far west as Greece; a small and declining migratory East Asian population, wintering in Pakistan and perhaps originating from southern Russia and Mongolia; a population resident in Spain; and another resident in North Africa (Tunisia and North-East Algeria) (Hughes *et al.*, 2006).

In Algeria, the species is observed throughout the year, at the wetland complex of El Kala, in the extreme north-eastern part of the country, at the Guerbes-Sanhadja complex and also the Hauts Plateaux du Sud Constantinois. In El Kala, two sites are considered as most important for the species and have been designated as Ramsar sites: Lake Oubeira and Lake Tonga (Isenmann & Moali, 2000; Lazli *et al.*, 2011).

There have been few studies on the behaviour and ecological requirements of the White-headed Duck in North Africa, especially in Algeria during the breeding season, except for a study by Boumezbeur (1993). In general, little is known about this duck’s activities during the breeding season in the wild, although previous studies have been conducted on birds in captivity (Duran, 1961 in Matthews & Evans, 1974) and non-breeding birds in the Mediterranean region (Green *et al.*, 1999; Houhamdi *et al.*, 2009; Metallaoui *et al.*, 2009). Little is known on separate time-budget of males and females White-headed Duck. The present study calculated diurnal time-activity budgets of White-headed Duck during two breeding seasons (2008-2009), from pre-breeding to postnuptial moult. Reproductive periods were identified in a previous study (Lazli, 2011). We studied the behaviour of males and females during three periods: pre-breeding, breeding and postnuptial moult. The results are compared with those of previous work conducted on the same species at the same site (Boumezbeur, 1993), and with those of other authors carried out in Algeria (Houhamdi *et al.*, 2009; Metallaoui *et al.*, 2009) and in other countries (Green *et al.*, 1999).

METHODS

STUDY AREA

The study was conducted in northeastern Algeria, one of the warmest and rainiest areas on the Mediterranean basin, with a mean annual temperature of 15-19 °C and a mean annual rainfall of around 700 mm. In this area, near the coast, several wetlands are important areas for wintering and breeding waterbirds in Numidia. Most of these waterbodies have been designated for their international importance for waterbirds under the Ramsar convention, and have been legally protected during recent years as natural parks or local nature reserves.

Data were collected at Lake Tonga (36° 53' N, 08° 31' E), a freshwater wetland of 2 600 ha. It is protected as a Ramsar Site within the National Park of El Kala (North-East of Algeria) supporting 82 plant species and over 35 nesting waterbird species (Boumezbeur, 1993). It is connected with the sea by an artificial channel and about 80 % is covered by emergent vegetation, with large open water areas covered by the White Water Lily *Nymphaea alba*, especially during the White-headed Duck nesting season. This is the most important site in the Maghreb and thus in Algeria for White-headed Ducks with up to 200 breeding pairs recorded (Lazli, 2011), and about 1 300 birds counted in winter 2010 (International winter counts of 2010 – El Kala National Park), probably locally breeding birds possibly supplemented in winter by birds from Tunisia, Spain, the Balkans or Turkey.

This site has been experiencing increasing adverse environmental pressures, such as bank erosion, water scarcity in summer and eutrophication. Urbanization and the increasing demands for water for human consumption and agriculture have further exacerbated conservation problems at the lake (El Kala National Park Action Plan, 2011).

ABUNDANCE OF WHITE-HEADED DUCKS

Censuses of White-headed Ducks were carried out weekly between March and August 2008 and 2009. Counts were done in the morning, when bird activity was low and birds remained in flocks. Windy or rainy days were avoided. A Kowa 20×60 telescope and a pair of 10×50 binoculars were used to scan the water surface systematically, with observations made from elevated platforms, bird watching observatories, or other elevations to achieve good visibility. Thus, the total numbers of birds present across the site was recorded.

SAMPLING BIRD BEHAVIOUR

Behavioural observations were carried out between March and August, during nine hours of the day, from 07.00 to 16.00 hours, when regular surveys showed that over 50 White-headed Ducks were present on Lake Tonga, widely dispersed around the site. Nocturnal behaviour could not be recorded due to lack of night vision equipment.

A randomly selected focal duck (Altmann, 1974; Baldassarre *et al.*, 1988) was followed for 10 minutes. For each White-headed Duck male or female we recorded the following behavioural categories (see Green *et al.*, 1999): *feeding* (diving and inter-dive interval); *sleeping* (resting behaviour with head on back and eyes open or closed; birds moving while in the sleeping posture were included); *comfort* (preening, bathing, wing flapping, wing shivering, leg shaking, stretching, yawning, head shaking, bill dipping); *swimming*; *courtship* (Flotilla-swimming, Head-high- Tail-cock, Sideways-hunch and Kick-flap- Sideways-piping); *alert* (head-up, extreme head-up and head-up-tail-up) and *agonistic behaviour*.

Bird's activities were analysed per period: pre-breeding (i.e. pair formation, pre-laying) occurring between March and April-early May; breeding period (i.e. laying, incubation and brood rearing) between mid-May and mid-July; and postnuptial moult occurring from mid-July to late August. Comparison between males' and females' time budgets was conducted throughout these three periods.

A minimum of 30 birds were monitored weekly with care taken not to sample the same bird repeatedly.

A total of 216 hours were devoted to monitoring diurnal activities of White-headed Duck during the breeding seasons of 2008 and 2009.

DATA ANALYSES

To construct diurnal time-activity budgets each behaviour was expressed as the mean percentage of birds engaged in that activity. Separate budgets were constructed for each sex. All means are shown \pm standard deviation.

Effects of sex on per cent time spent in each activity were examined using Student pairwise t tests and to determine if there is a difference between diurnal activities and breeding periods measurements ANOVA method and Tukey test were used.

Analyses were run in R 2.14.1 and Minitab 15, differences were considered significant at $P \leq 0.05$.

RESULTS

ABUNDANCE OF WHITE-HEADED DUCKS

Censuses conducted in 2008 and 2009 show a change in the numbers of White-headed Duck from one year to another (Fig. 1). The peak counts were 268 birds (174 males, 94 females) present in the fourth week of July 2008 and 1 049 (467 males, 582 females) in mid-March 2009.

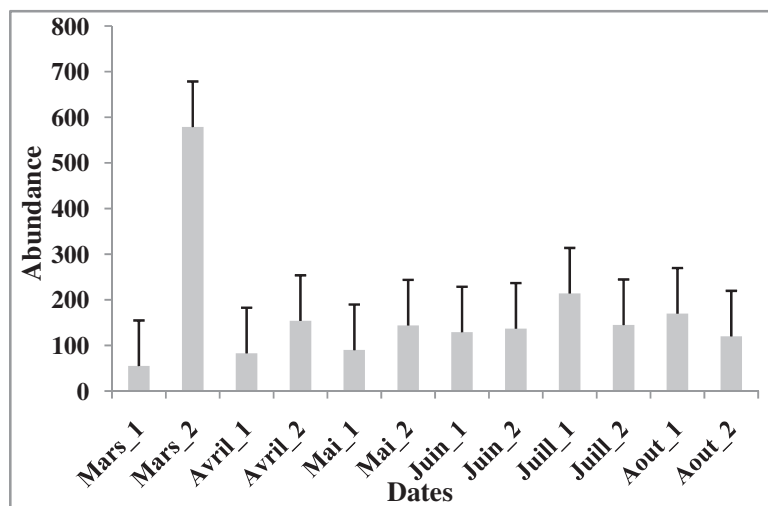


Figure 1. — Mean half-month (March, April, May, June, July, August) numbers of White-headed Ducks at Lake Tonga (2008-2009). Vertical lines are standard errors.

No significant differences were recorded for White-headed Duck numbers between 2008 and 2009 ($t = -0.999$, $df = 5$, $P = 0.363$).

TIME-ACTIVITY BUDGETS

Time-activity budgets of males and females White-headed Duck were constructed for the two considered seasons (Fig. 2 & 3).

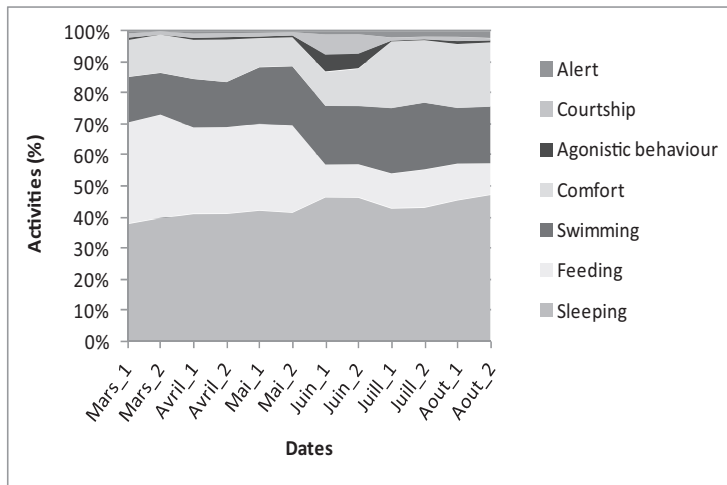


Figure 2. — Mean half-month (March, April, May, June, July, August) percentage of time allocated by White-headed Duck males to diurnal activities at Lake Tonga (2008-2009).

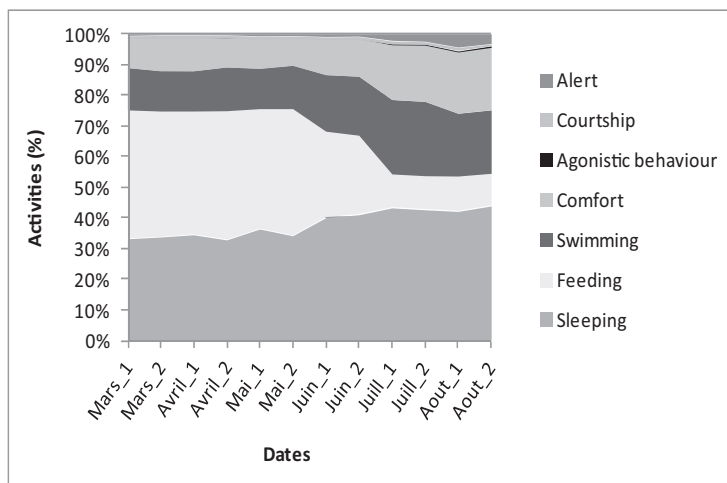


Figure 3. — Percentage of time allocated by White-headed Duck females to diurnal activities at Lake Tonga (2008-2009).

The monitoring of the diurnal time budget of males and females White-headed Duck at Lake Tonga during the two-breeding seasons (2008-2009), a total of 216 hours, indicated globally that sleeping was the main activity for males (44 %) against 38 % for females. However, females feed more (26 %) than males (19 %) (Fig. 2 & 3). No differences were recorded in swimming and comfort activities between sexes, except swimming in pre-breeding phase.

Percent of time engaged in various activities for male and female White-headed Duck differed among reproductive periods (Fig. 4, 5 & 6):

Prebreeding period (March – mid-May)

During this period, feeding was the dominant behaviour of female White-headed Duck throughout the two breeding seasons, followed by sleeping and swimming. These three activities were the dominant behaviours with over 89 % of all activities in 2008 and about 90 % in 2009. Time spent foraging (diving including dive pause) was greater during prelaying (~ 42 %) occurring between March and April (Fig. 3), than during laying (~ 30 %) for the two years (Fig. 4).

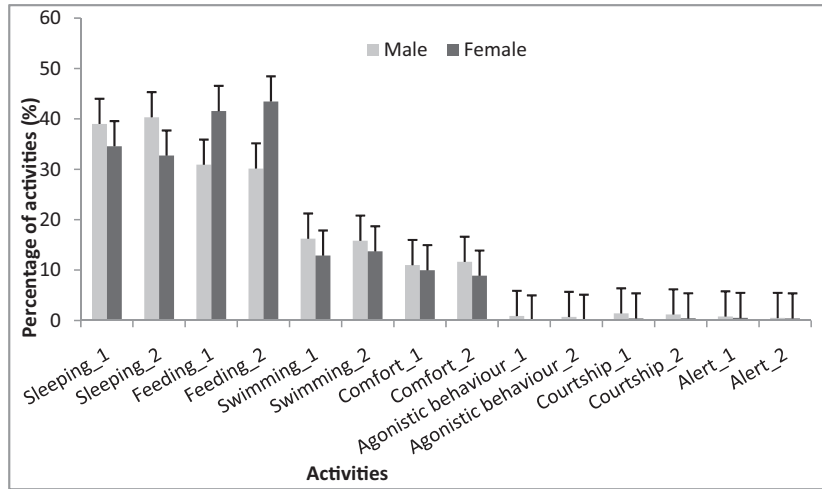


Figure 4. — Comparison of percentage of time allocated by males and females White-headed Duck to diurnal activities during the pre-breeding period at Lake Tonga (2008-2009). Vertical lines are standard errors.

However, sleeping was the main activity for male White-headed Duck, followed by feeding and swimming. These behaviours were the dominant ones with about 85 % of all activities in 2008 and 86 % in 2009 (Fig. 4).

For both sexes, feeding, entirely by diving, peaked in the morning and in late afternoon.

Percentage of time allocated in feeding did differ ($P < 0.05$) between females and males in pre-breeding period. Females spent more time feeding than males ($t = -12.695$, $df = 5$, $P = 5.389 \times 10^{-5}$). Conversely, males spent more time sleeping than females ($t = 6.777$, $df = 5$, $P = 0.001$).

Pair formation occurred at Lake Tonga from March; it peaked in April and was relieved with the increasing of courtship, agonistic behaviour and swimming of males. Males spent more time swimming than females ($t = 3.872$, $df = 5$, $P = 0.011$). Time spent in comfort did not differ between sexes ($t = 2.313$, $df = 5$, $P = 0.068$).

Courtship activity and agonistic behaviour often associated are recorded in late morning. Males spent more time courting than females ($t = 13.027$, $df = 5$, $P = 1.693 \times 10^{-6}$).

Alert behaviour was usually adopted in the presence of predatory birds as Western Osprey *Pandion haliaetus*, Marsh Harrier *Circus aeruginosus* or other species like coots and grebes. Time spent in alert for the two sexes did not differ ($t = 1.032$, $df = 5$, $P = 0.349$).

Breeding period (mid-May – mid-July)

During this period, sleeping was the main activity of males (Fig. 5). They spent most of the time sleeping than females ($t = 4.841$, $df = 5$, $P = 0.004$). Conversely, females spent more

time feeding than males ($t = -2.866$, $df = 5$, $P = 0.035$) (Fig. 6), especially during laying, which peaked mid-May (Lazli, 2011) and also during rearing brood.

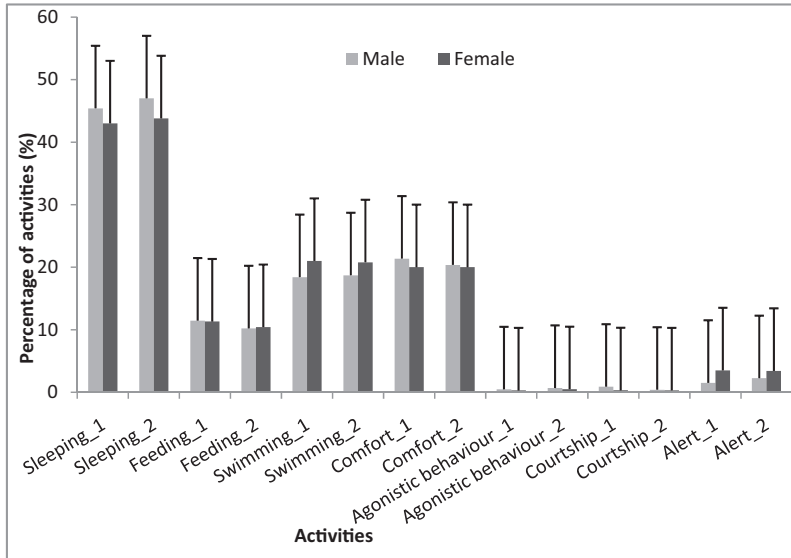


Figure 5. — Comparison of percentage of time allocated by males and females White-headed Duck to diurnal activities during the breeding period at Lake Tonga (2008-2009). Vertical lines are standard errors.

Time spent in swimming and agonistic behaviour did not differ between sexes (respectively, $t = 1$, $df = 5$, $P = 0.363$; $t = 1.902$, $df = 5$, $P = 0.115$). Similarly, no significant differences were recorded in courtship and alert between males' and females' White-headed Duck (respectively, $t = 1.490$, $df = 5$, $P = 0.196$; $t = -0.620$, $df = 5$, $P = 0.562$).

During this period, males spent more time in comfort than female ($t = 2.650$, $df = 5$, $P = 0.045$).

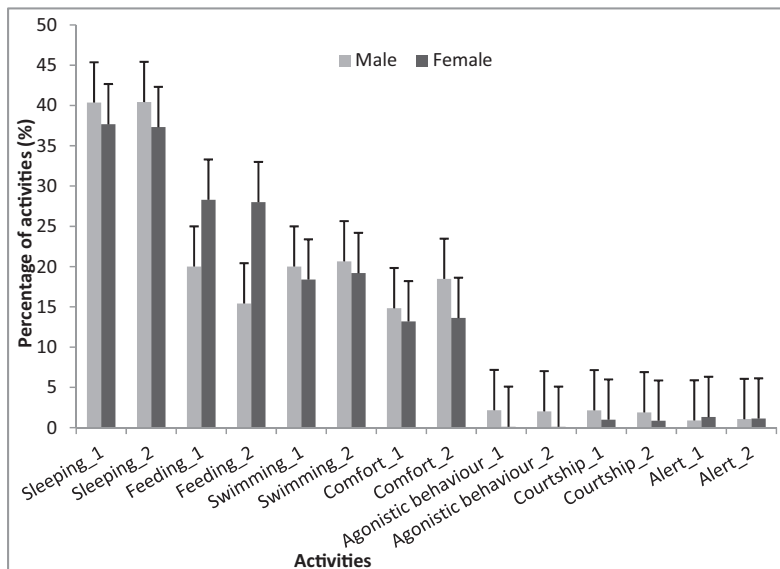


Figure 6. — Comparison of percentage of time allocated by males and females White-headed Duck to diurnal activities during postnuptial moult at Lake Tonga (2008-2009). Vertical lines are standard errors.

Postnuptial moult (mid-July – late August)

Sleeping proved to be the main diurnal activity of males and females White-headed Duck at Lake Tonga during this period (Fig. 6). Time devoted to comfort, especially preening, is relatively average with values not exceeding 20 % (Fig. 6). The highest values are recorded in July and August for males (Fig. 2) coinciding with the moulting period.

Time spent to courtship activity is less late morning in August compared with June where it increased throughout the morning. Alert was throughout the day in July and peaked in August at mid-day.

No significant differences were recorded between males' and females' White-headed Duck for all activities during this postnuptial period, except comfort and alert (Fig. 6). Females spent more time in comfort and alert than males (respectively: $t = 5$, $df = 5$, $P = 0.015$; $t = -5.329$, $df = 5$, $P = 0.012$).

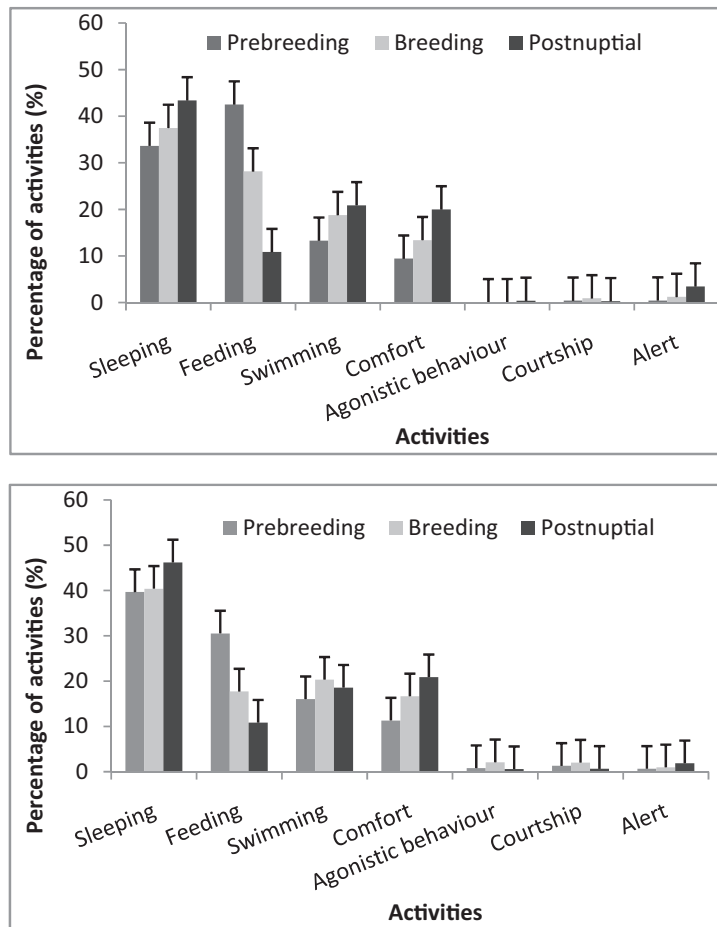


Figure 6. — Comparison of percentage of time allocated by males (upper graph) and females (lower graph) White-headed Duck to diurnal activities during the three reproductive periods at Lake Tonga (2008-2009). Vertical lines are standard errors.

Comparison of time-budget activities within periods

Statistical analysis shows a significant difference in time allocated by males White-headed Duck in feeding during the three breeding periods: $F = 30.85$, $df = 2$, $P = 0.000$. Tukey methods reveal that males spent more time feeding in pre-breeding than in breeding and moult periods.

Sleeping was the main activity for males in the three phases: $F = 4.04$, $df = 2$, $P = 0.039$. They spent more time sleeping in post-nuptial period (Fig. 6). They also spent more time swimming in pre-breeding and breeding phases: $F = 5.34$, $df = 2$, $P = 0.018$.

ANOVAS methods show a significant difference in time spent in comfort and alert, respectively: $F = 16.20$, $df = 2$, $P = 0.000$; $F = 5.97$, $df = 2$, $P = 0.012$. By Tukey tests, these two activities were most important in postnuptial than in pre-breeding and breeding phases.

No significant differences were recorded in courting ($F = 2.5$, $df = 2$, $P = 0.115$) and agonistic behaviour ($F = 1.87$, $df = 2$, $P = 0.189$) for males in the three breeding periods.

Like males, females spent more time sleeping in breeding season (Fig. 6). ANOVAS methods show a significant difference between the three periods: $F = 20.43$, $df = 2$, $P = 0.000$. Tukey tests reveal a difference between the three breeding phases.

Feeding was most important in pre-breeding and breeding periods than postnuptial (Fig. 6): $F = 20.17$, $df = 2$, $P = 0.000$. Females also spent more time swimming in pre-breeding than during the two other periods, $F = 11.36$, $df = 2$, $P = 0.001$.

Comfort was more important in postnuptial phase than in the two other phases (Fig. 6): $F = 14$, $df = 2$, $P = 0.000$. Females also spent more time in alert in moult period than pre-breeding and breeding phases: $F = 12.44$, $df = 2$, $P = 0.001$.

No significant difference was recorded in agonistic behaviour between the three considered periods: $F = 3.49$, $df = 2$, $P = 0.06$.

DISCUSSION

The White-headed Duck is present all year round in Numidia, North-East Algeria and it breeds in a wide range of sites like Garaet Mekhada, Wetland complex of Guerbes-Sanhadja and hauts plateaux constantinois (Boumezbeur, 1993; Dgf, 2002; Houhamdi *et al.*, 2009; Metallaoui, 2010). However, the real stronghold is still Lake Tonga where hundreds of breeding pairs can occur (Boumezbeur, 1993; Lazli, 2011).

The peak of 1 049 White-headed Ducks observed in March 2010 at Lake Tonga could be explained by the presence of the resident population complemented by over-wintering birds that had not yet left the site for breeding. The favourable conditions found at the Lake Tonga, relatively quiet area and availability of food resources, may also have accounted for the large numbers at the site.

The monitoring of White-headed Ducks' diurnal behaviour reveals that during pre-breeding males and especially females feed more than in breeding or postnuptial moult. Differential feeding rates between males and females probably result from their different needs during reproduction. Differences in foraging rates between sexes have been reported for other ducks (Drobney & Fredrickson 1979, Afton 1979). Activity budgets of female, particularly foraging, reflect their need to acquire nutrients and energy on the breeding grounds for egg production and incubation, as do many large-bodied Anatidae, for example Mallards *Anas platyrhynchos* (Krapu, 1981) and Ruddy Duck *Oxyura jamaicensis* (Tome, 1991). Feeding seems to be also important in the breeding period for females after appearance of first broods. Indeed, after a long period of fasting, females need to acquire the energy lost in laying and incubation.

Between 2008 and 2009, feeding activity peaked mainly in the morning and less in the afternoon, as found in several other duck species especially wintering ones (Paulus, 1988; Michot *et al.*, 1994; Green *et al.*, 1999). White-headed Ducks feed almost entirely by diving, mainly at night (Amat, 1984; Green *et al.*, 1999; Green & Hughes, 2001). Indeed, for all duck species night is a period of intense feeding activity (Tamisier & Dehorter, 1999). Potential reasons why White-headed Ducks feed mainly at night include lack of disturbance, avoidance of diurnal predators, thermoregulation and increased food availability (Tamisier, 1974; Jorde & Owen, 1988; McNeil *et al.*, 1992; Green *et al.*, 1999).

Sleeping, which occurred particularly at mid-day, was the dominant diurnal activity for males during the three considered breeding periods. A similar high level of daytime resting was recorded in other sites of Numidia (Houhamdi *et al.*, 2009; Metallaoui, 2010) and is a

common feature in ducks, which are especially active at night. Sleeping proved to be the main diurnal activity of the species at Lake Tonga between 1991-1992 accounting for 53 % of the time-budget (Boumezeur, 1993). The same author found 18 % for feeding activity, 22 % for swimming and 7 % for comfort.

In late winter, at Burdur Lake (Turkey), White-headed Ducks spent much of the day resting (Green *et al.*, 1999). This pattern may be explained by a thermoregulatory advantage to resting in the middle of the day, when surface temperatures are highest (Green *et al.*, 1999). Indeed, there is an advantage of energy to sleep during the day. Sleep and rest during sunshine hours can minimize heat losses by selecting the most suitable habitat for sun exposure.

White-headed Ducks concentrated together into density packed flocks when resting, but dispersed widely when feeding as recorded by Fox *et al.* (1994) and Green *et al.* (1999). The gregariousness of these birds is the way to reduce individual risk of raptor predation. Also, birds in flocks spent less time in alert than individual birds (Tamisier & Dehorter, 1999). Foraging birds presumably disperse away from flocks in order to forage at locations that allow a greater food intake (Green *et al.*, 1999).

The tendency for White-headed Duck to spend more time in locomotion activities progressed from pre-breeding to breeding phase (from May to July), may be linked to increased courtship activity, i.e. more time spent swimming in search of potential partners and courtship opportunities. However, others reasons for locomotion appeared to be the need for escape behaviour in response to overhead flights of raptors like Western Osprey and Marsh Harrier, or agonistic behaviour with conspecifics or other species, particularly Coots. Thus, from June, the relative frequency of raptor flights increased. We recorded several flights during our weekly observations, with an average over five per day.

During the study, the commonest activity in the morning was comfort in pre-breeding period, for both males and females. Indeed, this activity appears to increase from June and July, showing the beginning of moult. Possibly both sexes replace flight-feathers simultaneously July-August when young grow (Walravens, 1988; Cramp & Simmons, 1977). Observations indicate that comfort occurs in open water. Ducks seems noticeably "itchy" and spent a great deal of time and effort on re-arranging their plumage. In Spain, post-nuptial moult occurs in July (Anstey, 1989). In Turkey, the observations suggest that White-headed Duck post-nuptial moult occurs between July and early September (Anstey, 1989). Gordienko *et al.*, (1986) indicate that moult takes place on deeper open water wetlands and occurs from mid-July to late August.

Courtship was observed from mid-March, phase corresponding to the beginning of the pairing period and pre-laying, to mid-August. The importance of courtship activity during the study, particularly in May and June, is typical of breeding stifftails and consistent with the polygamous mating system of White-headed Ducks, in which males establish and court within territories at breeding sites (Amat & Sanchez, 1982; Torres & Arenas, 1985). The increasing of courtship activity in May and June corresponds to pairing and laying phases. Males engage more than females in courtship and agonistic behaviour during the incubation period, i.e. when their social mate has already laid its eggs, this may indicate that at least some males try to engage in extra-pair copulation whereas some males try to guard their females against this. Courting is performed mostly in flocks and gathers on average 1.3 female and 3.9 males (Lazli, 2011). Tamisier & Dehorter (1999) recorded an average of 1.3 female and 7.0 males for the courtship of teal.

Males and females White-headed Duck spent more time in alert, from first appearance of broods until postnuptial period when this behaviour increases to protect chicks and juveniles from raptors or other enemies.

Future studies that focus on nocturnal behaviour, relationship between behaviour and microhabitat use of individuals birds, and also relationship between distribution of birds and abundance of chironomids, may further the understanding of the breeding exploitation of Lake Tonga by White-headed Duck. Secondly, the study of time-budget of the species during the wintering period will also permit to know its ecological requirements and its strategy for overwintering.

ACKNOWLEDGEMENTS

We are extremely thankful to the National Park of El Kala for its logistical support and to the Tour du Valat (Research Center for the Conservation of Mediterranean Wetlands) for its warm hospitality and for providing access to its library. We are most grateful to an anonymous referee for valuable comments which have considerably improved previous versions of the manuscript.

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