

## DIURNAL AND NOCTURNAL BEHAVIOUR OF FERRUGINOUS DUCK *AYTHYA NYROCA* AT LAC DES OISEAUX, NORTHERN ALGERIA

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**SUMMARY.**—*Diurnal and nocturnal behaviour of ferruginous duck Aythya nyroca at Lac des Oiseaux, northeast Algeria.*

**Aims:** There have been few studies on the behaviour and ecological requirements of the ferruginous duck *Aythya nyroca* in the Mediterranean region. In order to fill this gap, the diurnal activities of the species were monitored over a period of four years. In addition, data were collected on its nocturnal behaviour during the wintering season 1999-2000.

**Location:** Lac des Oiseaux, northeast Algeria.

**Results and Discussion:** Results indicated sleeping as the main diurnal activity whereas feeding dominated during the night. Diurnal feeding, peaking at the start of the wintering period, exhibited a marked seasonal decline, mirrored by an increase in sleeping and swimming. Nocturnal feeding and sleeping were inversely correlated and they displayed, respectively, a progressive increase and decrease between October and March. Feeding peaked in the middle of the night when sleeping reached its lowest values. Flight was most prominent around dawn.

**Key words:** anatidae, diving ducks, population dynamics, time budget, daily activity, Algeria, North Africa.

**RESUMEN.**—*Comportamiento diurno y nocturno del porrón pardo Aythya nyroca en Lac des Oiseaux, noroeste de Argelia.*

**Objetivos:** Existen pocos estudios sobre el comportamiento y requerimientos ecológicos del porrón pardo *Aythya nyroca* en la región mediterránea. Por esta razón, se realizó un estudio durante cuatro años en los que se monitorizó la actividad diurna de esta especie. Además, en el invierno de 1999-2000 se registró la actividad nocturna de esta especie.

**Localidad:** Lac des Oiseaux, noroeste de Argelia.

**Resultados y Discusión:** Los resultados muestran que dormir fue la principal actividad durante las horas de luz y la alimentación fue la principal durante la noche. El tiempo dedicado a la alimentación durante el día presenta un marcado declive estacional, mientras que la tendencia opuesta fue observada en las actividades de nadar y descanso.

Durante la noche, el tiempo dedicado a alimentarse y a dormir estaban inversamente correlacionados y mostraron un progresivo incremento y descenso, respectivamente, entre octubre y marzo. El máximo tiempo dedicado a la alimentación durante la parte central de la noche se observó cuando el tiempo dedicado a dormir había alcanzado el mínimo valor. Esta especie realiza el vuelo principalmente en el amanecer.

**Palabras clave:** anatidae, patos buceadores, dinámica poblacional, time budget, actividad diaria, Argelia, norte de África.

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## INTRODUCTION

Listed as "Near Threatened" on the IUCN Red List of Threatened Animals, the ferruginous duck *Aythya nyroca* is also present as a priority species on four prominent international Conservation treaties: European Union Bird Directive, Bern Convention, Bonn Convention and African-Eurasian Migratory Waterbird Agreement (BirdLife International, 2000; Robinson and Hughes, 2003). There is an international concern about both population decline and range contraction (Robinson and Callaghan, 2003).

In the Mediterranean region as elsewhere, time-activity budgets have been used extensively to provide valuable information on duck habitat use and wintering strategies (Sjöberg and Danell, 1981; Tamisier, 1985; Jorde and Owen, 1988; Paulus, 1988; Tamisier and Dehorter, 1999) crucial for effective wetland management. However, our knowledge of the behavioural ecology of diving ducks (Aythyini) (Hill and Ellis, 1984; Bergan *et al.*, 1989; Lovvorn, 1989; Hohman and Rave, 1990; Michot *et al.*, 1994; Woodin, 1994; Jeske and Percival, 1995) is far lagging behind that of dabbling ducks (Anatini) (Tamisier, 1972; 1976; Asplund, 1981; Danell and Sjöberg, 1982; Paulus, 1984; Al-louche, 1988; Brodsky and Weatherhead, 1985; Miller, 1985; Turnbull and Baldassarre, 1987; Rave and Baldassarre, 1989). In addition, the behavioural ecology and habitat use of resident Mediterranean ducks scattered mainly across North Africa, the Iberian Peninsula and the far Eastern Mediterranean region have barely been studied (Green, 1998b; Green *et al.*, 1999; Green and El Hamzaoui, 2000; 2006).

Conservation actions can neither be focused nor effective unless adequate data on the ecology of the species are forthcoming (Petkov, 2003; Robinson, 2003). Such knowledge is sparse and it is fair to state that in North Africa, the species has scarcely been studied (Boumezber, 1993; Azafzaf, 2003) and both its seasonal movements and reproductive ecol-

ogy remain poorly known. As part of a project aimed at understanding the wintering strategies of ducks within the coastal wetlands of Numidia, northeast Algeria (Houhamdi and Samraoui, 2001b, 2003), we studied over a four-year period, the diurnal time budget of the ferruginous duck at Lac des Oiseaux. We also collected data on the nocturnal activities of the species over a wintering season.

## MATERIAL AND METHODS

Lac des Oiseaux (36°47'N, 08°7'E), a shallow pond of 70 ha, is part of a large and varied wetland complex located in Numidia, northeast Algeria (Fig. 1). Listed as a Ramsar site since 1999, it is a sanctuary to wintering waterbirds which may number over 10,000 birds (Samraoui *et al.*, 1992). The vegetation is dominated by *Scirpus lacustris*, *Typha angustifolia*, *Scirpus maritimus* and to a lesser extent by *Nymphaea alba* and small stands of *Phragmites australis*. A total of 65 bird species are regularly seen on the site (Houhamdi and Samraoui, 2001a) which is used as nesting habitat by a number of birds (*pers. obs.*).

Hunting in and around the lake is relatively infrequent, if not absent, thus providing a rare and relatively safe haven to waterfowl in the region. Human disturbance, mainly due to children, is present but irregular and it may force the waterfowl to regroup in the centre of the lake and leave preferred habitats.

Weekly observations by a single observer and from the same observation points were made from October 1996 to October 2000 using a 20 x 60 telescope (Meopta) and a pair of 10x50 binoculars. Individual counts were carried out whenever the total number of ducks was fewer than 200. When this number was exceeded, an estimate of the population size was achieved by dividing the flock into small equal parts and through extrapolation.

A map was used to carefully record the spatial distribution of ferruginous duck and the

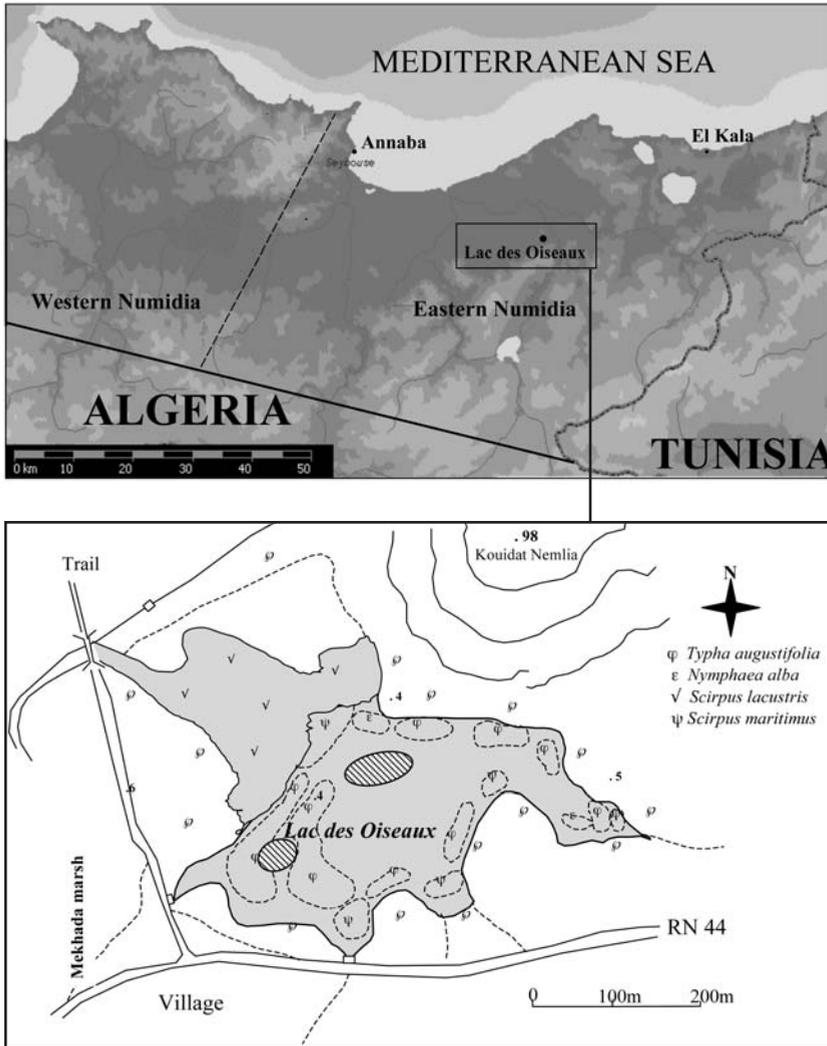


FIG. 1.—Maps of Lac des Oiseaux, northeast Algeria, displaying the location of wintering ferruginous duck during 1996-2000. Wintering ducks are mostly concentrated in areas represented by diagonal hatching.

[Mapa de Lac des Oiseaux, noreste de Argelia, mostrando las zonas donde los porrones pardos fueron localizados en invierno en los años 1996-2000. Las áreas barreadas fueron las zonas con mayores concentraciones de porrones pardos.]

bird's time budget was monitored weekly from 0700h to 0930h and from 12 noon to 1430h. These two periods were lumped together after a preliminary analysis revealed no significant differences. A randomly selected focal duck (Altmann, 1974) was followed for 10 minutes

and its behaviour divided arbitrarily into five activities: feeding, swimming, preening, sleeping and flying. A minimum of 12 birds were monitored weekly with care taken not to sample the same bird repeatedly and when, on the rare occasions, the focal bird disappeared

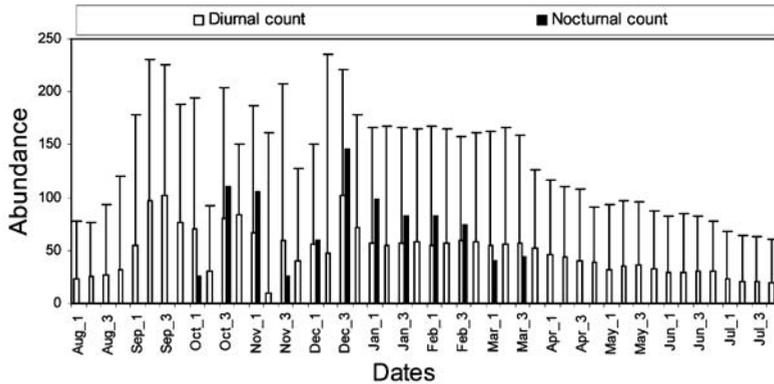


FIG. 2.—Weekly counts of ferruginous duck at Lac des Oiseaux, during 1996-1999. Vertical lines are standard errors.

[*Conteos semanales de porrones pardos en Lac des Oiseaux durante los años de estudio (1996-1999). Las barras verticales representan los errores standard.*]

behind stands of vegetation, a new bird exhibiting a similar behaviour was selected for the remaining sampling period. Although flying birds were never selected as starting focal birds, the method was unlikely to lead to a strong bias in winter as birds rarely flew unless disturbed. During the breeding period, however, our sampling could underestimate flying activities as ducks readily engage in aerial pursuits (McKinney, 1965; Smith, 1968). Although swimming is probably correlated with pairing and agonistic display, this preliminary study, unfortunately, did not record direct information on courtship activities which represent a small but critical percentage of the time budget of ducks. Courtship behaviour was most apparent between January and March. A total of 452 hours were devoted to monitoring diurnal activities and additional observations (42 hours) were carried out at night using a 30 x 60 Ghortex intensifier GEN II, between 2000h and 0600h, to record nocturnal activities during the wintering season 1999-2000. A diurnal data matrix (52 weeks / 5 activities) was assembled and analysed using multivariate statistical analysis provided by the ADE-4 package (Thioulouse *et al.*,

1997). Months were divided into blocks of 4 or 5 weeks and years were lumped together after nonparametric tests ( $\chi^2$ ) indicated no significant differences in activity budgets between the 4 years.

## RESULTS

Although, ferruginous duck were present at Lac des Oiseaux in August, their number steadily increased starting from that month onwards and it peaked in mid-December (Fig. 2). From January to March, the number of birds remained fairly stable before exhibiting a drop to a level maintained just by resident birds. The number of recorded nests of the ferruginous duck at Lac des Oiseaux never exceeded 5 during the study period. These birds occupied the southern parts of the lake (Fig. 1b) and they were found for most of the day hidden in the stands of *Typha angustifolia*. In contrast, during the wintering season, ferruginous duck were seen swimming in the open water and exceptionally near the northwest Bulrush patch.

The monitoring of the diurnal time budget during the four-year period, a total of 350 hours,

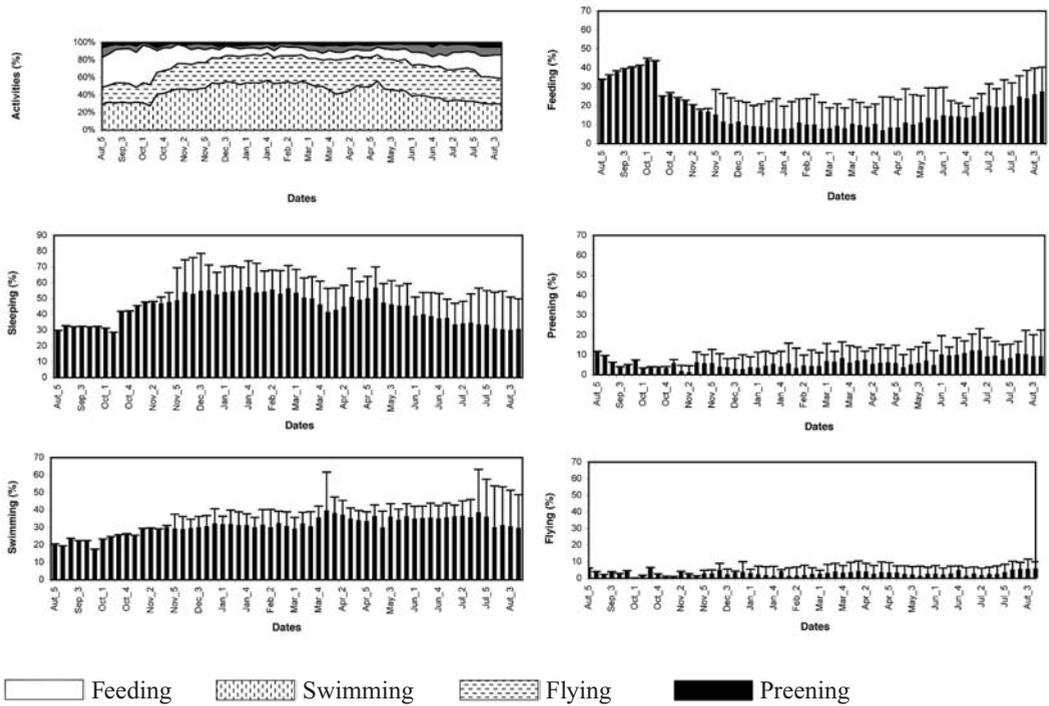


FIG. 3.—Percentage of time allocated by ferruginous duck at Lac des Oiseaux, to (a) diurnal activities ((b) sleeping, (c) swimming, (d) feeding, (e) preening, (f) flying) during 1996-2000. Vertical lines are standard errors.

[Porcentaje de tiempo dedicado a distintas actividades diurnas (a) durante los años 1996-2000 ((b) dormir, (c) nadar, (d) alimentación, (e) limpieza de plumaje, (f) volar). Las barras verticales representan los errores standard.]

indicated that sleeping was the main activity (43.5 %), followed by swimming (30.7 %), feeding (17.2 %), preening (5.9 %) and flying (2.7 %) (see Fig. 3a).

The start of the wintering season (end of August-mid-October) coincided with a peak in feeding activity (~ 40 %). Time devoted to feeding dropped sharply to 25 % before gradually hitting its lowest level of around 10 % (Fig. 3d).

Sleeping proved to be the main diurnal activity of ferruginous duck at Lac des Oiseaux and it displayed an inverse relationship to feeding: the lowest values (~ 30 %) were recorded at the start and at the end of the wintering period (Fig.3b).

Swimming which is often associated to feeding made up a significant part of the ferruginous duck's behaviour (Fig. 3c). This activity increases gradually from 20 % at the start of the wintering season to around 40 % in July before exhibiting a drop in the month of August. Time devoted to preening is relatively minor with values rarely exceeding 10 % (Fig. 3e). The highest values are recorded in the summer months and they coincide with the moulting period which spans the months of July and August. Flight occupies also a small proportion of the ferruginous duck's time, due mainly to disturbance caused by marauding marsh harrier (Fig. 3f).

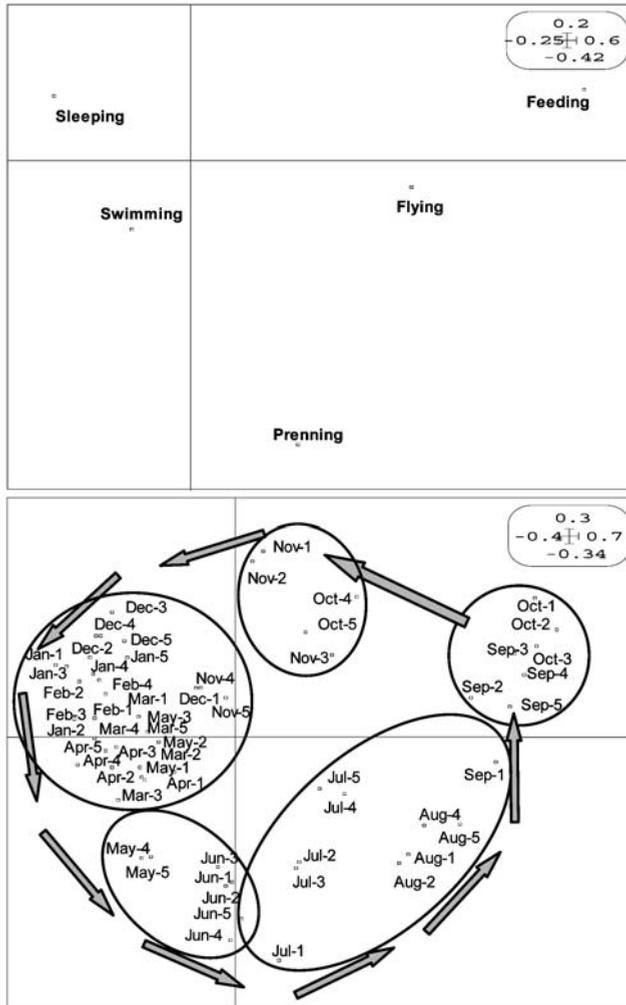


FIG. 4.—Plot of factorial plane 1x2 of correspondence analysis of the diurnal activities of ferruginous duck at Lac des Oiseaux. (a) Ordination of dates, (b) ordination of diurnal activities, (c) histogram of eigenvalues.

[Gráfica mostrando el análisis de correspondencia de las actividades diurnas de los porrones pardos en el área de estudio. (a) Ordenación de las fechas, (d) Ordenación de las actividades diurnas y (c) histogramas de “eigenvalues”.]

The factorial plane of the first two axes of the correspondence analysis (91 % of inertia) showed a distinct temporal structure of the behaviour of ferruginous duck at Lac des Oiseaux, marked by a gradual seasonal change (Fig. 4a). The first axis (73 %) opposed two distinct ac-

tivities: feeding, which peaked during the early phase of the wintering season, and sleeping, which dominated the diurnal behaviour of ferruginous duck from December to April. This axis can be viewed as an “energy axis” where ducks first devoted their time to gaining en-

ergy and then adapted their behaviour to minimize their energy expenditure during the coldest part of the wintering season. The second axis (18 %) highlighted preening as an activity which occurred mainly between June and August (Fig. 4b), a period which coincides with the moult.

Nocturnal counts of ferruginous duck at Lac des Oiseaux indicated that the birds did not leave the site at night (Fig. 2). Their behaviour, however, exhibited a distinct shift at night with feeding being a major activity (66.9 %). This pattern of nocturnal behaviour was relatively constant during the whole of the wintering season (Fig. 5b) and it exhibited a humpbacked shape with an increase of feeding from dusk to the middle of the night before a drop was recorded (Fig. 5g). Other activities were relatively unchanged during the wintering phase. Similarly to what had been found for diurnal activities, sleeping was inversely related to feeding and reached its lowest values in the middle of the night (Fig. 5h). Nocturnal flights are only noticeable prior to sunrise (Fig. 5j).

## DISCUSSION

The ferruginous duck is present all year round in Numidia, northeast Algeria and it breeds in a wide range of habitats ranging from dune slacks (Samraoui and de Bélair, 1997) to large brackish marshes like Lac Fetzara and Garaet Mekhada (Samraoui and Samraoui, 2008). However, the real stronghold is still Lac Tonga where nesting of hundreds of breeding pairs can occur. Outside Numidia, it can occupy and even breed in salt lakes across the Hauts Plateaux and the Sahara (Samraoui and Samraoui, 2008).

This wide pattern of habitat use is similar to that reported by Green (1998a) who found that ferruginous duck in Turkey required extensive and densely vegetated wetlands but otherwise did not have specialized microhabitats requirements. This is also supported by the fact that whilst ferruginous duck feed mainly by div-

ing (Green, 1998b), they also use different feeding techniques like upending, surface feeding and even wading in shallow water (Cramp and Simmons, 1977) and they cannot easily be separated from the dabbling ducks in either habitat use or feeding behaviour (Green, 1998b).

Although Lac des Oiseaux is not an important breeding site for the ferruginous duck, its importance as a wintering ground and a stopover site cannot be underestimated (Houhamdi and Samraoui, 2001a). Our results indicate that diurnal activities of ferruginous duck were similar to that of Teal which devoted a sizeable part of its diurnal time to sleeping whereas nocturnal behaviour was dominated by feeding (Tamisier, 1970; 1974; Houhamdi and Samraoui, 2001b). In contrast to teal, ferruginous duck do not seem to use the Mekhada marsh and Lac des Oiseaux as a "functional unit" (Tamisier, 1985) and appear to use Lac des Oiseaux both as a feeding and a roosting ground.

Both ferruginous duck and teal adopt a distinct pattern of diurnal behaviour from wigeon which uses a sizeable part of its diurnal time within the coastal wetlands of Numidia to feeding (Houhamdi and Samraoui, 2003). Whereas wigeon may be constrained by its low nutrient diet to feed during the day (Campredon, 1982), both teal and ferruginous duck may resort to diurnal feeding only to meet heavy energy requirements not entirely met by nocturnal feeding. Why many species of waterfowl feed mainly at night is still unclear. Various explanations including avoidance of diurnal predators, food availability and the need to visually select food, thermoregulation, etc. have been put forward (Jorde and Owen, 1988; McNeil *et al.*, 1992; Green *et al.*, 1999).

Results on time budget of ferruginous duck do not support a division of the wintering season in restoring, pairing or fattening periods as occurs in teal (Paulus, 1988; Tamisier and Dehorter, 1997; 1999). The recorded peak in diurnal feeding activity between end of July and October could represent a "restoring period" for newly arrived birds but it could alter-

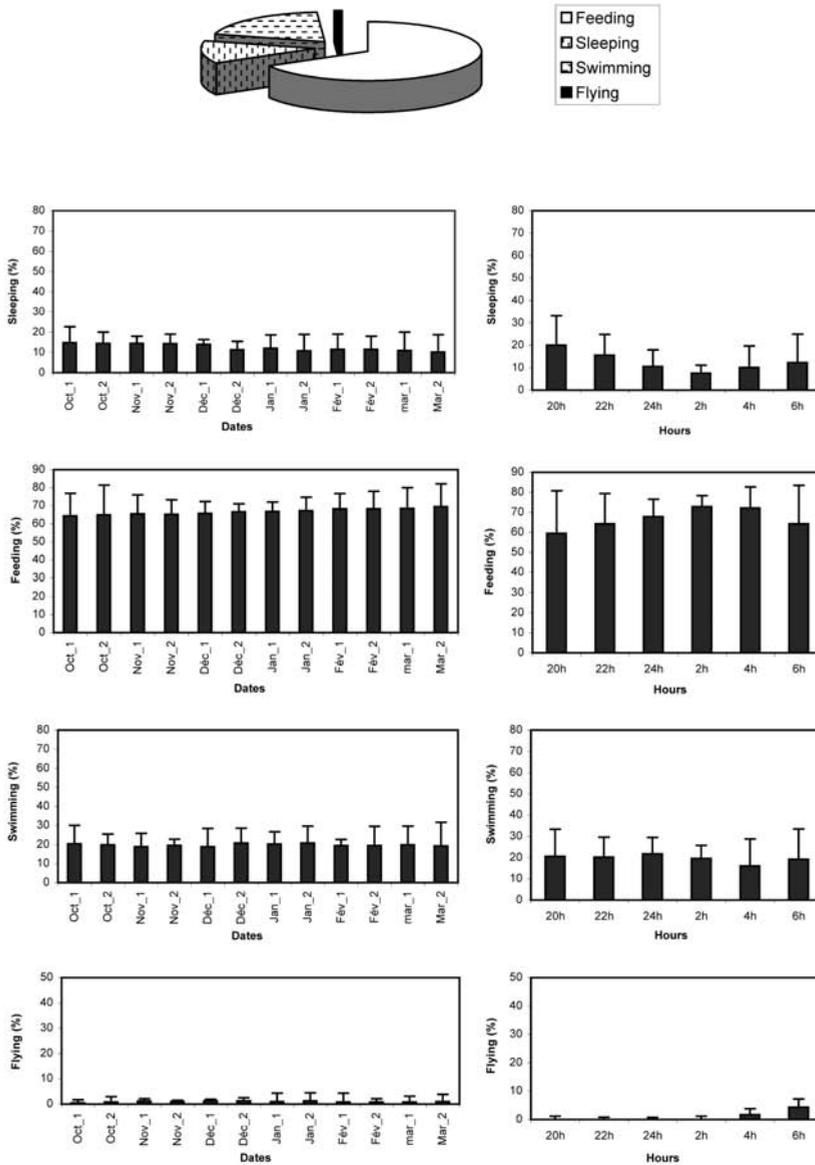


FIG. 5.—(a) Seasonal changes of time allocated by ferruginous duck at Lac des Oiseaux to nocturnal activities ((b) feeding, (c) sleeping, (d) swimming, (e) flying) during 1999-2000. (f) Hourly changes of nocturnal activities ((g) feeding, (h) sleeping, (i) swimming, (j) flying) of ferruginous duck at Lac des Oiseaux. [a) Porcentaje de tiempo dedicado a distintas actividades nocturnas ((b) alimentación, (c) dormir, (d) nadar, (e) volar). (f) Cambios horarios de las actividades nocturnas ((g) alimentación, (h) dormir, (i) nadar, (j) volar) de los porrones pardos en Lac des Oiseaux.]

natively be related to greater foraging needs of newly fledged young birds and it also coincides with greater daily energy requirements due to moulting. It would be most interesting to know how this pattern is altered in habitats like Lac Tonga which houses a wide variety of microhabitats and where extensive reproduction (May-June) and moulting (July-August) take place. Previous studies have highlighted the need to sample waterbird behaviour at distinct microhabitats within a wetland complex (Woodin, 1994; Green *et al.*, 1999).

Dispersal of the ferruginous duck is very poorly known but the population at Lac des Oiseaux does not probably face the same energy requirements as long-distance migrants like teal and wigeon. If swimming is taken as a surrogate for courtship activities, its increase and highest values in spring are consistent with observed patterns of diving ducks which generally "pair" later than dabbling ducks. This is consistent with breeding of the ferruginous duck at Lac Tonga and Lac Fetzara, mostly carried out between May and June (*pers. obs.*), much later than species like mallard and coot (Samraoui and Samraoui, 2007).

Further research targeting cross-seasonal relationships between winter and breeding activities of North African ducks is needed as it appears that whilst the behaviour of ducks in Lac des Oiseaux, as elsewhere, is energy-driven (Jorde and Owen, 1988), local conditions may modulate seasonal and diel changes of activities aimed at meeting the birds' physiological and social requirements.

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