Status and diurnal behaviour of the Shelduck *Tadorna tadorna* in the Hauts Plateaux, northeast Algeria

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Abstract

Between December 2002 and July 2005, the wetland complex of Oum El Bouaghi, northeast Algeria, was surveyed for Shelduck *Tadorna tadorna*, and their diurnal behaviour was monitored. Numbers of Shelduck recorded were far higher than previously noted for the whole of Algeria, with up to 68,000 individuals counted in January 2005. Possible reasons for this unexpected result are discussed. The analysis of time budgets revealed that Shelduck behaved differently at two sites and during the course of the winter. They devoted over half their time during the day to feeding, whereas other activities (swimming, sleeping, preening and loafing) were less frequent (5–13%). Courtship and agonistic behaviour were mostly evident in spring, coinciding with the start of the breeding period. Short-term shifts in foraging methods (upending versus surface feeding) enabled the Shelduck to exploit a range of habitats and to adapt to seasonal changes within these habitats.

Key words: Anatidae, Tadorninae, wintering numbers, daily activity, time budget, salt lakes, Algeria, North Africa.

Shelduck *Tadorna tadorna* in Algeria are part of the dispersed Mediterranean/Black Sea population, which is scattered across both sides of the Mediterranean Sea (Cramp & Simmons 1977; Wetlands International 2002). The population as a whole, and in North Africa in particular, remains poorly known (Ledant *et al.* 1981; Isenmann & Moali 2000). The entire region may also be an important wintering area for the migratory Northwest European population (Walmsley 1986, 1987). The present study aimed to count Shelduck wintering within the wetland complex of Oum El Bouaghi, Algeria (Fig. 1), and to describe their behaviour and habitat use. Time budgets have proved to be important tools for unravelling the ecological requirements of wildfowl by relating feeding activity to habitat selection (Baldassarre *et al.* 1988; Paulus 1988). This in turn provides fundamental information on the functional role of wetlands, and how changes in habitat may affect birds using the ecosystem (Baldassarre & Bolen 1994; Tamisier & Dehorter 1999).

Study Sites and Methods

The Hauts Plateaux, sandwiched between the Saharan Atlas and the narrow coastal plains of Algeria, include an impressive number of wetlands. Most of these are vast, shallow salt lakes that have been little studied and are poorly known. The wetland complex of Oum El Bouaghi is part of this huge complex and is bordered by the towns of Oum El Bouaghi in the north and Khenchla in the south (Fig. 1). In locality designations, the words 'Garaet' or 'Sebkhat' (salt lake), 'Djebel' (hill) and 'Oued' (wadi) are abbreviated to 'G.', 'S.', 'D.' and 'O.' respectively. The main waterbodies found within this complex (mean altitude of 950 m) are:

(1) G. Tarf (35°42'N, 7°08'E): The largest salt lake (25,500 ha) in the region, fed by rainfall and by the seasonal streams, O. Boulefreis, O. Maarouf, O. Remila and O. Gueiss .

(2) G. Ank Djmel (35°46.30'N, 6°52.00'E): This salt lake, adjacent to G. Guelif, covers 8,550 ha and is located at the foot of D. Ank Djmel, part of the Oum Kechrid mountain range. The site is fed primarily by O. Ghezel and, at times of high water level, by overspill from G. Guelif.

(3) G. Guelif (35°47.20'N, 7°00.00'E): This 5,525-ha salt lake, which is surrounded by D. Guelif to the north, D. El Tarf to the east, D. Fedjoudj to the south and G. Ank El Djmel to the west, is fed mainly by O. Tallizerdane, O. El Haouassi and O. Ourleiss.

(4) S. Boumia or Djendli (35°42.00'N, 6°31.55'E): This 3,700-ha salt lake is surrounded by three hills: D. Bouarif to the south, D. Toumbart to the north and D. Tafraout to the west, with the Boulhilet and Chemora plains to the east.

(5) S. Jemot (35°38.71'N, 7°00.83'E): This small (57 ha) lake is a satellite site for G. Tarf and is bisected by the Oum El Bouaghi to Khenchla road.

(6) G. Ezzemoul (35°53.14'N, 6°30.20'E): A 6,000-ha saltpan, close to the town of Aïn M'lila, subject to commercial salt extraction.

(7) Chott Tinsilt (35°53.62'N, 6°30.00'E): This saltpan of 3,600 ha is separated from G. Ezzemoul by the RN3 road from Constantine to Batna.

(8) S. Tazougart (35°23.78'N, 7°19.92'E): An elongated salt lake, divided into a series of units, and fed by O. Ounrhal. This study took place at the site known as Ouled Amara (950 ha).

(9) G. Marshel (35°48.528'N, 6°44.437'E): A salt lake, rarely sampled because it was considered unsafe during the study period.

(10) G. Timerganine (35°34.655'N, 6°58.275'E): A freshwater pond of 700 ha fed mainly by O. Boulefreis.

(11) Zaher or chott El Maleh: a brackish wetland of 875 ha and a satellite site for G. Tarf.

(12) G. Boucif (35°47.211'N, 7°04.991'E): a brackish pond of 170 ha, north of D. Tarf.

Twice-monthly counts were carried out from September 2002 to July 2005 using a x20–60 telescope. Individual birds were

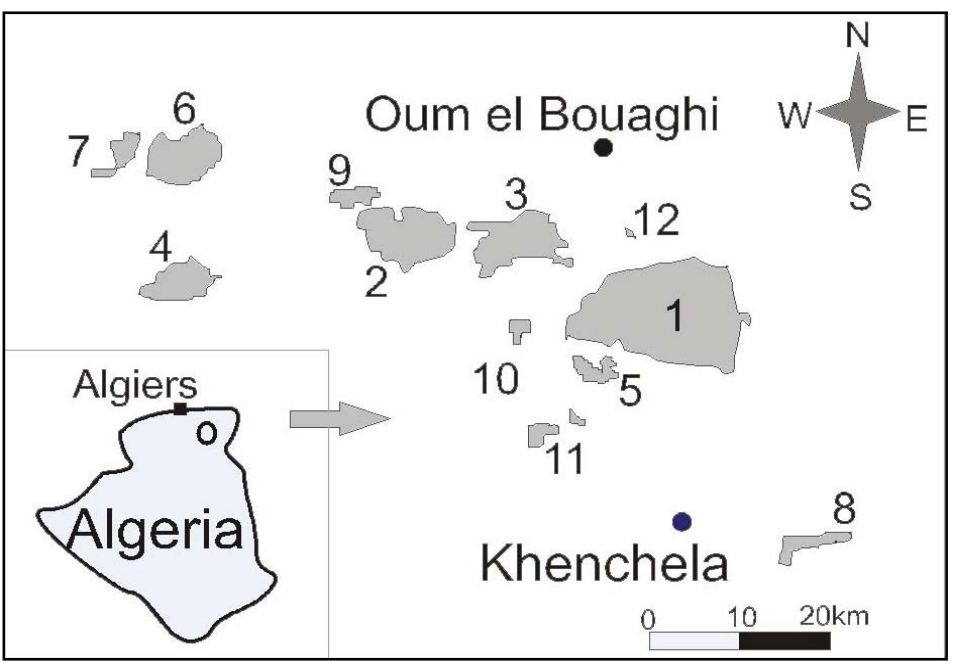

Figure 1. Map of the wetland complex of Oum El Bouaghi, in the Algerian Hauts Plateaux, where twice-monthly counts of Shelduck were made in winters 2002/03, 2003/04 and 2004/05. Behavioural observations were recorded at G. Guelif (2002/03) and Tazougart (2003/04). Site locations are: 1 = G. Tarf, 2 = G. Ank Djmel, 3 = G. Guelif, 4 = S. Boumia, 5 = Zaher, 6 = G. Ezzemoul, 7 = Chott Tinsilt, 8 = S. Tazougart, 9 = G. Marshel, 10 = G. Timerganine, 11 = Jemor, 12 = G. Boucif.

counted when the numbers present were small. When more than 200 birds were present, total numbers were estimated by dividing the flock into small equal blocks (50–200 birds according to flock size) and counting the number of blocks.

To reduce the risk of recording the same birds twice, counts were made from a single counting position for each site, taking into account topography and bird concentration. This sampling method is subject to different biases, and count accuracy may differ between observers. However, as found in the Camargue, where the method was tested intensively (Tamisier & Dehorter 1999), it is believed that errors are unlikely to exceed 10–15% of the total numbers counted.

Time budgets were monitored at twice-monthly intervals, starting from December 2002 to May 2003 and from September 2003 to July 2004, using scan sampling (Altmann 1974). All scans lasted 8 h (with a scan carried out every half hour between 08:00 h and 16:00 h), with a total of 248 h devoted to these observations (88 h at G. Guelif in 2002–2003 and 160 h at S. Tazougart in 2003–2004). G. Guelif was selected in the first year because it was easily accessible and the majority of Shelduck in it could be monitored easily. It dried up in the summer of 2003 and the study switched to S. Tazougart, one of the few sites in the region that had water in September when the collection of activity budget data resumed. Behaviour was divided into eight activities: feeding, sleeping, swimming, preening, loafing, flying, agonistic behaviour and courtship. Feeding was additionally divided into surface feeding (including head dipping while swimming), upending and sieving mud with the bill while wading. The maximum water depth never exceeded 50 cm and 70 cm at G. Guelif and S. Tazougart, respectively, throughout the study period. One-way ANOVA were performed using STATISTICA 6.0 with a significance level of $P \leq 0.05$, to determine whether behavioural patterns differed within and between years. Tukey tests were conducted to determine the mean values that differed significantly. All means are shown ± standard deviation.

Results

The wetland complex of Oum El Bouaghi attracted a total of 28,000, 45,000 and 68,000 Shelduck in January 2003 (winter 2002/03), December 2003 (winter 2003/04) and December 2004 (winter 2004/05), respectively (Table 1). These wetlands began to be occupied by Shelduck in the second week of September, and this number increased gradually to reach a maximum at the end of December/early January before decreasing progressively (Fig. 2). Fewer than 1,000 birds remained at the end of March and just a few dozens were present at the end of June.

The diurnal time budgets recorded for Shelduck within two sites, at G. Guelif (2002/03) and S. Tazougart (2003/04), indicate that the birds devoted over half their time to feeding (68% and 50% in 2002/03 and 2003/04 respectively; Table 2, Fig. 3). At both sites feeding was significantly the dominant diurnal activity ($F_{7,80} = 226.57$, $P < 0.0001$ at G. Guelif and $F_{7,151} = 63.70$, $P < 0.0001$ at S. Tazougart). Marked fluctuations in the time allocated to feeding coincided with periods of cold weather in February and

Table 1. Maximum counts of Shelduck in the main sites of the Oum El Bouaghi wetlands complex. Maximum counts for the whole study area (M.C.W.S.A.) were recorded on 18 January in winter 2002/03, 16 December in winter 2003/04 and 15 December in winter 2004/05. Maximum counts for each site (M.C.S.) are also provided with date of sampling.

Site	Winter	M.C.W.S.A.	M.C.S.	Date of M.C.S.
G. Boucif	2002/03	6,000	6,000	18/01/2003
G. Guelif	2002/03	17,000	17,000	18/01/2003
G. Tarf	2002/03		8,500	04/03/2003
Jemot	2002/03	3	7	08/02/2003
Tazougart 1	2002/03	8	500	12/01/2003
Tazougart 2	2002/03	5,000	5,000	26/01/2003
G. Ank El Djmel	2002/03		50	30/09/2002
G. Boumia	2002/03		9,000	06/02/2003
G. Boucif	2003/04	0	10	04/11/2003
G. Guelif	2003/04	5,000	7,000	13/01/2004
G. Tarf	2003/04	15,900	17,500	16/12/2003
Tazougart 1	2003/04	125	200	21/12/2003
Tazougart 2	2003/04	1,250	1,200	09/12/2003
G. Ank El Djmel	2003/04	11,000	11,000	16/12/2003
G. Boumia	2003/04	11,000	15,000	02/12/2003
Chott Tinsilt	2003/04	410	830	13/01/2004
G. Ezzemoul	2003/04	300	2,500	27/01/2004
Timerganine	2003/04	0	40	23/09/2003
G. Marshel	2003/04		243	12/02/2004
G. Boucif	2004/05	250	420	07/01/2005
G. Guelif	2004/05	22,000	22,000	15/12/2005
G. Tarf	2004/05	12,500	17,000	01/12/2004
Jemot	2004/05	0	40	04/02/2005
Tazougart 1	2004/05	0	105	06/01/2005
Tazougart 2	2004/05	88	825	06/01/2005
G. Ank El Djmel	2004/05	28,000	28,000	15/12/2004
G. Boumia	2004/05	1,800	9,600	06/01/2005
Chott Tinsilt	2004/05	30	3,400	01/12/2004
G. Ezzemoul	2004/05	3,800	3,800	15/12/2004
Timerganine	2004/05	0	17	07/03/2005
Zaher	2004/05		78	14/03/2005

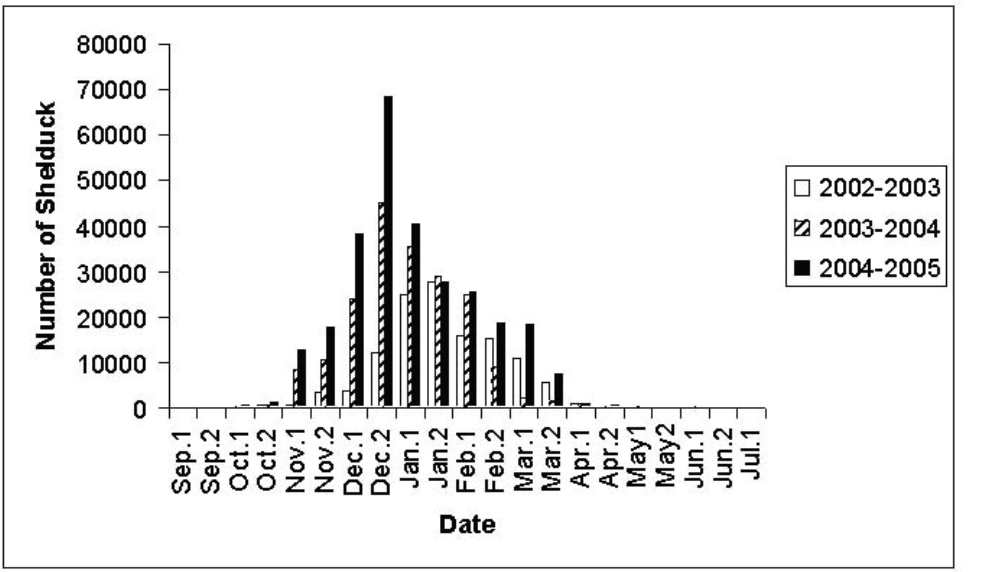

Figure 2. Maximum numbers recorded during twice-monthly counts of Shelduck across the Oum El Bouaghi wetland complex between 2002 and 2005.

Activity (%)	G. Guelif (2002/03)	S. Tazougart (2003/04)
Sleeping	5.78 (± 4.9)	13.07 (± 6.6)
Swimming	8.68 (± 3.1)	11.97 (± 9.8)
Preening	7.30 (± 5.7)	7.43 (± 5.2)
Flying	1.26 (± 1.0)	2.50 (± 1.9)
Feeding	67.71 (± 10.5)	49.92 (± 19.7)
Loafing	5.03 (± 2.0)	10.79 (± 6.8)
Agonistic behaviour	0.54 (± 0.6)	1.32 (± 2.0)
Courtship	3.70 (± 3.7)	2.95 (± 3.8)

Table 2. Mean percentage of time spent by Shelduck on different activities at G. Guelif and S. Tazougart.

April (Fig. 3b), when Shelduck devoted more time to resting and swimming. Differences in the time allocated to different activities were, however, highly significant between the two sites ($\chi^2_7 = 539.31$, $P < 0.0001$), with a greater proportion of time spent feeding at G. Guelif. Seasonal changes in the time spent feeding displayed a similar pattern, with a high value of ~ 70% during the early part of the wintering period of 2002/03 , followed by a decrease in feeding activity to ~ 50% of diurnal time in late winter and spring. In 2003/04, the drop occurred much earlier (February as opposed to April).

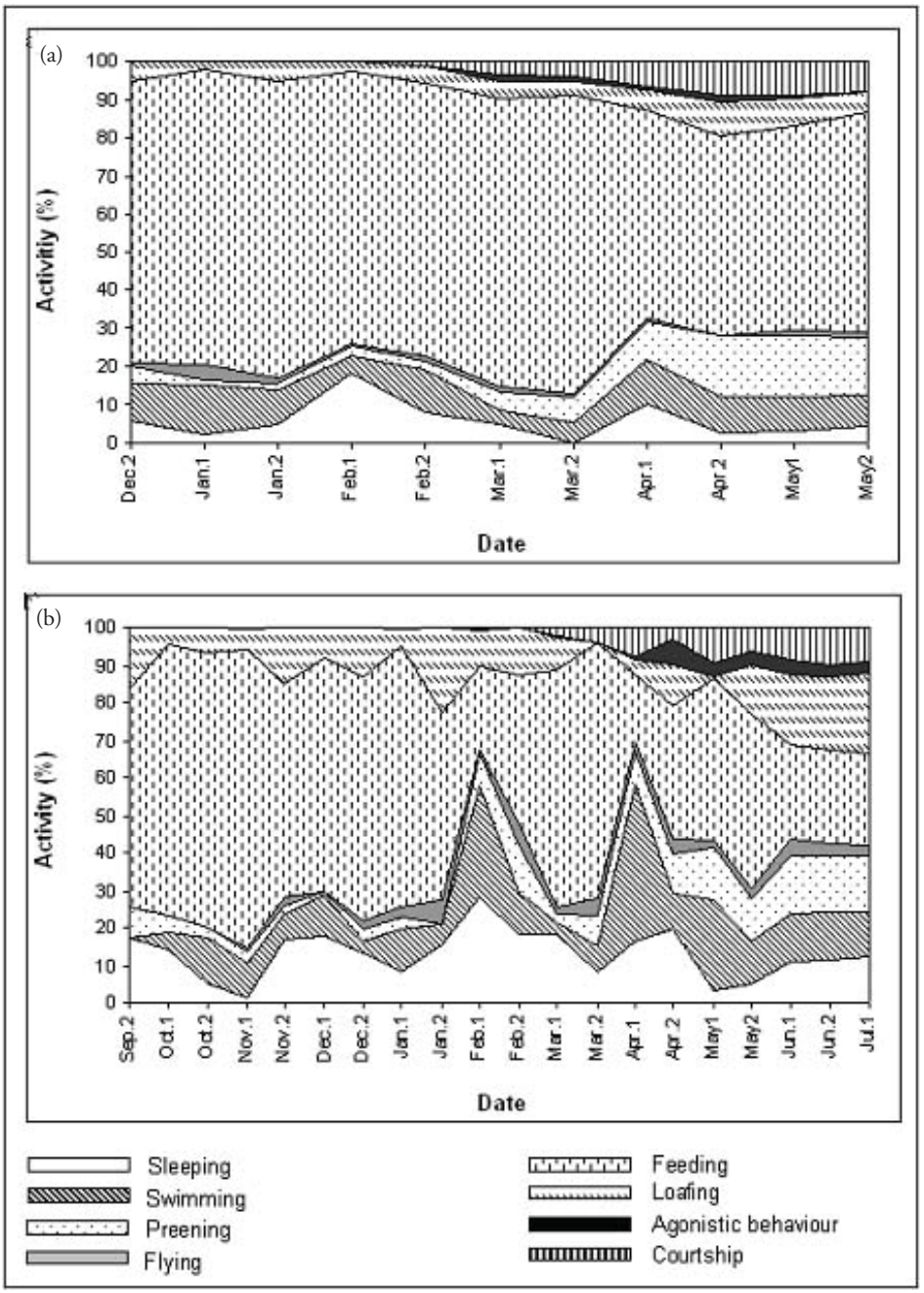

Figure 3. Percentage of time spent by Shelduck on different activities at (a) G. Guelif, 2002/03, and (b) S. Tazougart, 2003/04.

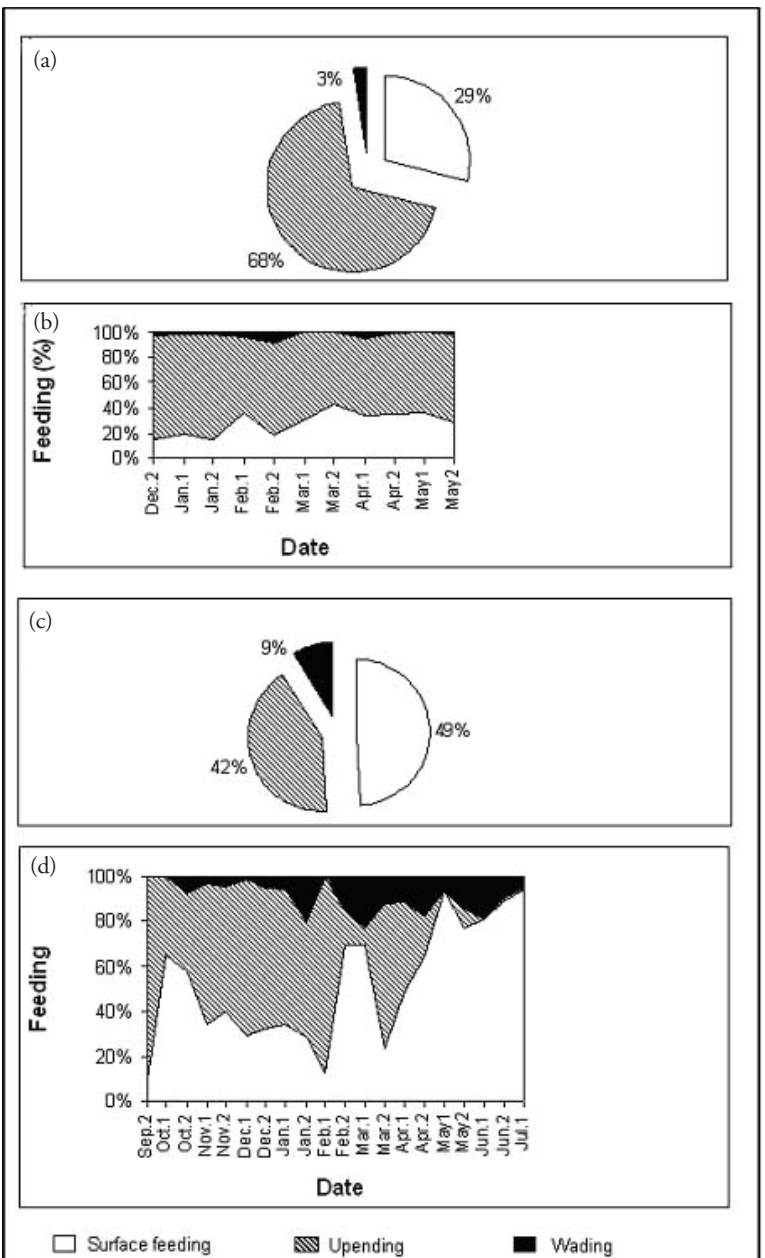

Figure 4. Percentage of time allocated to three distinct ways of feeding by Shelduck: a) Mean feeding time spent at G. Guelif; b) Seasonal changes in feeding behaviour at G. Guelif; c) Mean feeding time spent at Tazougart; d) Seasonal changes in feeding behaviour at Tazougart.

Feeding, which was the dominant activity, was carried out in two main ways: upending and surface feeding. Wading in shallow waters and on the shores of both salt lakes averaged 3% (2002/03) and 9% (2003/04; Fig. 4). Upending dominated other feeding methods at G. Guelif, with a mean value of 68%, compared with 29% of feeding time spent surface feeding. Time apportioned to surface feeding increased from less than 20% in December to nearly 40% in spring as water receded.

The difference in feeding behaviour between the two successive years was highly significant ($\chi^2_2 = 626.59$, $P < 0.0001$). At Tazougart, Shelduck spent marginally more of their foraging time on surface feeding (mean = 49%) than on upending (mean = 42%). Seasonal changes in foraging methods mirrored large fluctuations in water levels provoked by late spring rains. From mid-spring, surface feeding gradually superseded upending, which disappeared altogether near the end of the study period.

Time spent swimming had the second highest mean value (9% in 2002/2003 and 12% in 2003/2004) with the highest values recorded between January and April. The Shelduck spent a much smaller proportion of their time sleeping and, to a lesser extent, loafing during the day. Maximum values for sleeping were recorded in early February and for loafing at the end of January/early February.

Time devoted to preening was similar in both seasons ($F_{1,28} = 0.002$, n.s.); values decreased from September until January before increasing again. Flying was observed rarely (2.5%) during the wintering period and was only observed following a disturbance caused by wandering herders or birds of prey.

Aonistic behaviour was also rarely observed but was first observed in February; it increased gradually to reach a maximum at the end of April. This burst of aggressiveness coincided with the start of the breeding period. Courtship occupied small mean values in both years (3.7% and 2.9% in 2003 and 2004, respectively) with highest values recorded at the end of April/early May. Successful breeding was recorded and was found to be widespread across most wetlands of the region (Boulekhssaïm & Samraoui, unpubl. data).

Discussion

Heim de Balsac & Mayaud (1962) listed the Shelduck as a common species within Algeria with at least two known breeding sites: Lac Fetzara and Lac Halloula. No systematic study of the Shelduck has ever been undertaken in the whole of North Africa, but wintering counts, which have been carried out sporadically in the past, produced an estimated Algerian population total of 1,500–5,100 Shelduck in 1971 (Johnson & Hafner 1972) in the wetland complex of Oum El Bouaghi, a region also known as the 'Constantinois'. Numbers were subsequently estimated by Walmsley (1986, 1987) to vary between 1,000 and 7,500 with a mean value of 4,000. A midwinter count of 3,160 birds in January 1994 (Rose 1995) seemed to support these past surveys.

This study indicates for the first time that the shallow salt lakes within the Algerian Hauts Plateaux provide important breeding and wintering habitats for Shelduck. Yet there remains a major discrepancy between

the counts made during the present study and those of previous surveys. One possible reason for this is the terrain, which covers a vast area and is difficult for ornithologists not familiar with the region to access and cover adequately. A good knowledge of the terrain is certainly important for providing accurate figures. There is reason to believe that there has been a shortage of information on the ornithological importance of the Algerian Hauts Plateaux, as many waterbirds (e.g. Avocet *Recurvirostra avosetta*, Slender-billed Gull *Larus genei*, Gull-billed Tern *Gelochelidon nilotica*, Ruddy Shelduck *Tadorna ferruginea*), including an important colony of Greater Flamingo *Phoenicopterus roseus* (Samraoui *et al.* 2006a), currently known only as wintering species, were recorded in this survey as breeding in the area (Samraoui, Boulekhssaïm, Houhamdi & Saheb, unpubl. data). One way to overcome this difficulty, and to avoid protracted and sometimes dangerous fieldwork, is to carry out aerial surveys; this is probably the best option for monitoring these special wetlands in the future.

An alternative non-exclusive explanation for the increase in the number of Shelduck recorded stems from the effective conservation steps taken in Europe in the second half of the 20th century (Walmsley 1986). The demographic increase of Shelduck in both the Northwest European population (300,000) and in the Black Sea/ Mediterranean population (75,000), over the past decades (Scott & Rose 1996), may have contributed to its expansion in North Africa.

A third possible explanation is based on the favourable climatic conditions (three exceptionally wet years) that coincided with the study. This could have attracted more birds and enhanced local breeding conditions. The availability of food for the Shelduck in local salt lakes appears to be highly variable, with abundant food resources (especially large branchiopods such as the Fairy Shrimp *Branchinella spinosa*, Fairy Shrimp *Branchinectella media* and Brine Shrimp *Artemia salina*; Samraoui *et al.* 2006b) becoming available to the birds following intermittent heavy rains. Fluctuating conditions at the lakes, and the alternation of resource-rich and resource-poor phases (Davis *et al.* 2000; Sher *et al.* 2004), may explain the unusually large number of waterbirds present during favourable periods. A combination of all three factors could account for the currently high number of wintering Shelduck in the region. Explorations have begun at other sites in the western parts of the Hauts Plateaux and northern parts of the Sahara, and these also suggest that previous reports may have underestimated the true total number of Shelduck in the region. The results highlight the role of Algeria as one of the most important wintering quarters for the Shelduck in the western Palearctic and, if no evidence of bird relocation from other areas is uncovered, total population estimates of the Shelduck in the Black Sea/ Mediterranean population should be revised substantially upwards.

Previous studies on the time budgets of Shelduck were carried out in tidal areas (Great Britain), where diurnal feeding times of 55% (Evans & Pienkowski 1982) and 45% (Thompson 1981) were noted. The higher value recorded at G. Guelif (67.7%) might indicate lower food availability (Patterson

1982) but data should be interpreted with caution as two distinct habitats are involved, and nocturnal feeding could presumably be more important in tidal areas during the short winter day lengths of higher-latitude sites. Cold conditions appeared to depress feeding activity during the study period, perhaps because of stress, but it is unlikely that adverse weather, episodic in nature, could have affected seasonal trends. More rigorous monitoring of weather conditions would help to provide further insight into the effect of cold snaps on Shelduck behaviour in Algeria.

The seasonal pattern of feeding displayed by Shelduck during the present study did not appear to be consistent with the usual trend exhibited by wintering waterfowl, with a peak in feeding activity in autumn followed by a decline in winter and an increase in feeding corresponding to the premigratory 'fattening' period of early spring (Paulus 1988; Tamisier & Dehorter 1999). The reasons for such a discrepancy are unclear, but unfortunately information on the nocturnal behaviour of Shelduck is currently lacking.

The large variation in the pattern of diel activities exhibited by waterfowl remains a vexed question with many hypotheses put forward to account for diurnal or nocturnal feeding: visual selection of food, food density and availability, predation risk, thermoregulation and competition (Jorde & Owen 1988; Tamisier & Dehorter 1999). Foraging efficiency through social interactions might also be enhanced in many bird species (Krebs 1974). Possibly because of their size, Shelduck may not benefit greatly from nocturnal feeding, being often resilient to attack from predators active in the day (Tamisier 1974). Geographic variation within the same species can also occur (Bredin *et al.* 1986; Houhamdi & Samraoui 2003), and the plasticity of the Shelduck's behaviour is such that in intertidal estuaries the birds adapt their feeding activities to tidal rhythms, feeding by day as well as by night (Bryant & Leng 1975; Buxton 1981).

Flexibility in foraging behaviour in dabbling ducks is well documented (Eadie *et al.* 1979; Danell & Sjöberg 1982; Pöysä 1989) and shifts in feeding methods probably reflect differences in depth profiles, trophic resources between lakes and/or years, and competition (Thomas 1982; Pöysä 1986; Stephens & Krebs 1986). Depending on the type of prey and water depth, Shelduck, in estuarine habitats, have been found to use a wide range of feeding techniques (sieving while wading at low tide, pecking, head dipping or upending in deeper water at high tide) (Bryant & Leng 1975; Buxton 1981; Patterson 1982). In the present study, upending was thought to be linked to depth of water in both years. Although water depth was not measured, Shelduck appeared to rely more heavily on surface feeding and wading as the water receded. Upending is energetically costly and Shelduck may resort to it only when high-nutrient food is plentiful at lower depths. This was the case at G. Guelif (2002/03), which harboured a high density of gastropods, Fairy Shrimp *B. spinosa* and dipteran larvae, whereas copepods and anuran larvae (*Bufo viridis*) were abundant in Tazougart in 2003/04. The energetic constraint of upending may be lessened as it may be more cost effective for Shelduck and large dabbling ducks to upend as they can remain submerged for longer bouts (Pöysä

1983; Nudds 1992) and exploit, comparatively, a greater portion of the water column (Green 1998).

The timing and amount of rainfall may vary significantly and unpredictably from year to year in the Algerian Hauts Plateaux and this, in turn, may influence food availability. Waterfowl are known for their opportunism and often select food based on its availability (Paulus 1982; Euliss & Harris 1987). Inasmuch as the present study is limited by the lack of systematic data on food resources and accurate information on water depth, further studies aimed at exploring the link between trophic resources, habitat use and behaviour are needed in order to provide a greater insight into the Shelduck's ecological requirements in this area.

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