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Short Communication

Diurnal Behaviour of the Greater Flamingo *Phoenicopterus roseus* during a Tidal Cycle on the Bandar Abbas Coast, Persian Gulf

ABOLGHASEM KHALEGHIZADEH
Ornithology Lab., Iranian Research Institute of Plant Protection, Tehran, IRAN.
Email: akhaleghizadeh@gmail.com

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Abstract: This study was conducted on 16 February 2010 using 10×40 binoculars and scan sampling of 136 individuals of the Greater Flamingo *Phoenicopterus roseus*. The behaviour of the birds was monitored every 15 minutes from sunrise to sunset in 10 different categories: feeding, drinking, walking, flying, resting, preening, scratching, aggression, showing alarm and loafing. The most important activity was feeding (over 50% of the time in both adult and juvenile individuals). Walking and resting were the two other main activities of the Greater Flamingos during the present study. Overall, the difference in behaviour between adults and juveniles was not statistically significant ($P>0.05$), but the juveniles spent more time feeding and less time walking and preening than adults, and the differences in time spent feeding and time spent preening were statistically significant ($P<0.05$).

Introduction

Although many studies have been carried out on the diet of the Greater Flamingo *Phoenicopterus roseus*, studies of its behaviour are scanty (Baldassarre & Espino-Barros 1989, Bildstein *et al.* 1991, 1993, Schmitz & Baldassare 1992), especially in the Middle East and Iran. The Greater Flamingo is a wintering species in the northern Persian Gulf region (Mansoori 2008). The aim of the present study was to estimate the proportion of time spent by Greater Flamingos in feeding and other diurnal activities during a complete tidal cycle in order to provide information on the behaviour patterns of the species essential for the conservation of the birds in their wintering areas on the Persian Gulf coast.

Study Area

The study area was about one sq km of sub-tidal flats in a coastal wetland (known as *Khoor* in Persian) on the Persian Gulf coast. The site comprised a strip of sandflats (to the west) and mudflats (to the east). Holes of fiddler crabs *Uca* sp. were present along the coast (A.K., pers. obs.). This area attracts many waterbird species, especially waders.

On the day of the visit, sunrise and sunset in Bandar Abbas were 06:21 and 17:37, respectively. The first low tide was at 05:48, the high tide at 11:29 and the second low tide at 17:55; there was a fluctuation of 257 cm in water depth on this day (Mobile Geographics 2010). Therefore, this study covered a complete diurnal tidal cycle from the first low tide to the second low tide.

Materials and Methods

The study was conducted using 10×40 binoculars on 16 February 2010. Observations were made every 15 minutes from sunrise to sunset, and then grouped within one-hour intervals. The scan sampling method (Altman 1974) was used for all individuals visible within identification range. During each scan, the behaviour of all individuals was recorded on a dictaphone. The plumage of the individuals was also noted during each scan. On the day of the study, a flock of 136 Greater Flamingos was present, comprising 40 adults (with pink bills, wings and legs), 36 immatures (with pinkish bills, wings and legs), 36 in their

second winter (with no pink on the legs or bill and a dark stripe on the wings) and 24 in their first winter (with grey feathers on the neck and back and no pink on the bill or legs). The first and second categories were grouped as adults, while the third and fourth categories were grouped as juveniles. During each scan, the behaviour of the birds was noted in the following ten categories: feeding (included searching for food resources), drinking, walking, flying, resting (including standing), preening, scratching (including shaking the head), aggression, showing alarm and loafing (when showing none of the previous nine types of behaviour). The frequency of each type of behaviour was then calculated for adults and juveniles separately (Fig. 1). The depth of the water in which the Greater Flamingos were observed was calculated by estimating the fraction of the tarsus and tibia that was submerged. These fractions were then compared with the tarsus length of the Greater Flamingo as given by Cramp & Simmons (1977; average 281 mm) and tibia length, which ranges between 220 and 250 mm (average 235 mm; Ali & Ripley 1968). The Wilcoxon matched-pairs test in SPSS 16.0 was used to compare the frequency of the different types of behaviour in adults and juveniles.

Results

Figure 1 shows the relative frequency of different types of behaviour in adult and juvenile Greater Flamingos. The three main activities of adults were feeding, walking and resting, respectively (Fig. 1). Over 60% of adults and juveniles were engaged in feeding at all times of the day except 08:00 and 09:00 when feeding activity was at its lowest (Fig. 1). Feeding activity was highest amongst adults at 15:00 and amongst juveniles at 06:00. Walking peaked at 08:00, when feeding activity was at its lowest (Fig. 1). Resting occurred throughout the day, with the highest rates in adults occurring at 09:00, 11:00 and 17:00 and in juveniles at 09:00, 10:00 and 12:00. The main time for flight was at 09:00 (Fig. 1).

Regarding other activities, drinking was observed between 08:00 and 10:00 and between 13:00 and 14:00, with adults spending more time drinking than juveniles (Fig. 1). Preening began at 07:45 and continued until 17:00, but at no time were more than 7% of individuals engaged in preening. However, on average adults showed most preening activity at 12:00 when the tide was at its highest (Fig. 1). Aggression amongst juveniles was seen only at 08:15, while amongst adults it was seen at 08:45 and 14:00, when there was relatively little feeding activity.

A statistical analysis revealed that adults and juveniles showed significant differences in the time spent feeding (Z= –2.589, P=0.01) and preening (Z= –2.134, P<0.05) (Table 1). Overall, however, the adults and juveniles showed similar behaviour patterns (Table 1, Fig. 2, Z= –0.678, P=0.498).

Table 1. Results of the Wilcoxon matched-pairs test for comparison of the proportion of adults and proportion of juveniles engaged in each type of behaviour at different times of the day. * No instances of birds showigng alarm behaviour were observed during the present study.

Behaviour	Feeding	Drinking	Walking	Flying	Resting	Preening	Scratching	Aggression	Alarm	Loafing	Overall
Z	–2.589	–0.734	–1.804	–1.000	–0.392	–2.134	–1.836	–1.342	*	–1.355	–0.678
Asym. Sign. (2-tailed)	0.01	0.463	0.071	0.317	0.695	0.033	0.066	0.180	*	0.176	0.498

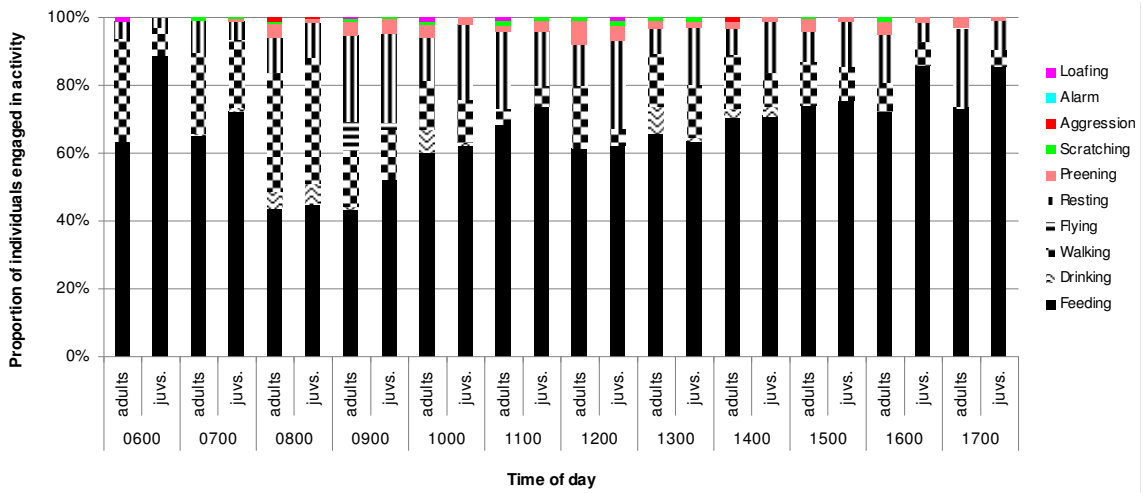

Figure 1. Relative frequency of different types of behaviour shown by adult and juvenile Greater Flamingos.

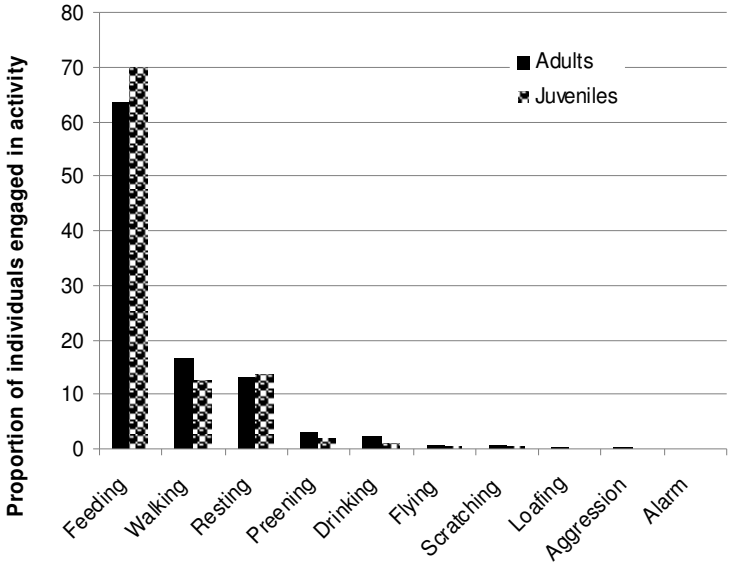

Figure 2. Overall comparison of the behaviour of adult and juvenile Greater Flamingos.

Discussion

The flock size and density of coastal birds depend on food supply, prey density and mobility, existence of competitors, the slope of the foraging land, and various other factors (Evans & Dugan 1984).

During the present study, 20 species of waterbirds were observed. No inter-specific competition was observed between Greater Flamingos and other waterbirds during the study period, and intra-specific aggression was low, being seen only at 08:15 and 14:00 and involving fewer than 5% of individuals (Fig. 3). Given the low frequency of intra-specific aggression observed during the present study (Fig. 1), it would seem that there is little intra-specific competition for food in this area.

The long legs and neck of the Greater Flamingo can help it to exploit food resources in a large area from the coast to some deep water bodies (*c.* 200 ha in the present study). However, a specific area can support food resources for a limited flock size. Daily intake can also affect flock size. For example, Lesser Flamingos *Phoenicopterus minor* eat an estimated 60 g (2.1 oz.) dry weight to fulfill their daily food requirements (Anonymous 2010b). Feeding time and aggression are correlated with changes in food abundance and availability (Schmitz & Baldassare 1992). However, flock size can also affect some forms of behaviour, in particular aggression.

It is worthwhile to mention that the bill morphology and structure of flamingos as filter-feeding birds is consistent with their feeding behaviour; the exceptional large bent bill with lamellae is designed to sort

small food items from mud and other soft material (Anonymous 2010a). It is probably because of the small size of their prey items that Greater Flamingos are forced to spend more time on feeding than on other forms of behaviour (Fig. 1). One other important reason for the high frequency of feeding is that in the present study, searching for food items could not be treated as separate behaviour and hence is included in the category feeding.

While adults spent less time on feeding than juveniles, they spent more time walking (Fig. 2). One clear reason for the difference was that during the study period the adults were more inclined to move up and down with the rising and falling tide, while the juveniles tended to stay longer in the same place, even when the water level was rising. Some juvenile individuals remained in deep water as the water rose and moved only when they had to. It is probable that these juveniles were feeding on swimming food items and that their feeding activity was less efficient than that of the adults. Juveniles spent more time feeding than adults during the present study while adults spent more walking and preening (Fig. 2). However, Bildstein *et al.* (1991) calculated that the food-intake rate of juveniles was, at most, 82% that of adults. In Venezuela, juveniles were more often involved in aggression, especially as recipients, than were adults, and aggressive encounters significantly affected the amount of time the flamingos spent feeding (Bildstein *et al.* 1991). No such pattern was observed in the present study because very little aggression was observed either amongst juveniles or adults (Figs. 1–2).

It has been stated that feeding activity is highest at dawn and dusk (Cramp & Simmons 1977). However, during the present study three peaks in feeding activity were observed: in the early morning (low tide), at noon (high tide) and in the evening (low tide). In a study in Venezuela, the feeding activity of flamingos reached a peak in the early morning; the birds roosted in the middle of the day and resumed feeding in the late afternoon-early evening (Bildstein *et al.* 1991). Although the rate of feeding was similarly higher in the morning and afternoon in the present study, the rate of resting was highest between 09:00 and 12:00 and in the late afternoon (Fig. 1). Walking occurred most frequently as the tide was rising in the morning when there was reduced feeding activity. Arengo & Baldassarre (1999) have also reported patch choice and seasonal differences in the number of feeding Greater Flamingos according to water level fluctuation and its influence on food variability. In contrast, Baldassarre & Espino-Barros (1989) found that feeding activity did not change throughout a normal day, suggesting that flamingo feeding is not affected by wind and tides. More studies are necessary to determine the relationship between feeding activity and tidal cycles in the Greater Flamingo and seasonal variations in its behaviour.

At no time during the present study did birds behave as though they were alarmed, suggesting that there are no serious threats to the Greater Flamingos on the Bandar Abbas coast. However, many tourists visit the Bandar Abbas shore every day, in particular when the tide is low. The Greater Flamingos were not sensitive to people passing nearby unless they came within a radius of 50 m. The birds showed no reaction to passing airplanes, but are known, from observations at other times, to react with alarm calls to the sound of gunshot, even at a distance of more than 500 m. Local fishermen build tidal fishing nets called ‘moshta’ at the lowest points along the coast. At low tide, these fishing nets attract Little Egrets *Egretta garzetta*, Western Reef Herons *Egretta gularis* and Great White Egrets *Casmerodius albus*, while at high tide they attract Great Cormorants *Phalacrocorax carbo* (M. Ghasemi, pers. comm.; A.K. pers. obs.). It seems that the presence of the local fishermen and their nets has no significant effect on the activities of the Greater Flamingos.

The development of the study area as a Flamingo Park for the citizens of Bandar Abbas and tourists under the management of the Bandar Abbas Municipality could

help to protect the wintering population of Greater Flamingos and other waterbirds visiting the area. The existence of an inter-city bus terminal with many passengers arriving and departing every day could increase this value. The municipality should introduce measures to minimize human disturbance in the area and should prohibit rubbish disposal and other forms of pollution. The Flamingo Park could become a popular bird-watching site and could serve as a model for other nature parks in and around urban areas elsewhere in Iran.

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