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Preliminary Survey of the Breeding Biology of the Purple Swamphen *Porphyrio porphyrio* in Anzali wetland, Southwest Caspian Sea

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Abstract
The Purple Swamphen *Porphyrio porphyrio* is a resident waterbird in Iran. It has a very small population in Anzali wetland which is one of the main breeding areas of this species in Gilan Province. The present study was conducted to study the breeding biology and ecology of the Purple Swamphen in Anzali wetland during the breeding seasons of 2011 and 2012. In this study, nine nests, including four active nests with 16 eggs, were found and studied in Jahadbekandeh Ab-bandan, 236 ha, in the central section of Anzali wetland. The nests had shallow cups constructed within reed clusters. The average maximum and minimum diameters of the nest-cups were 44.7 and 34.9 cm, respectively, and the average external height of the nest-cups was 28.2 cm (*N*=9). The clutch size was 3 to 5 (*N*=4). The average length and width of the eggs were 52.2 and 40.7 mm (*N*=16), respectively. Eight of 16 eggs were successfully hatched.

1. Introduction

In the breeding season, monitoring and the gathering of data on reproductive functions such as breeding biology, clutch size, nesting success, number of nests and number of fledged broods are important ways to evaluate breeding habitat and conserve and protect the populations of species, especially vulnerable and endangered species (Robinson *et al.* 2005). The importance of monitoring programs is frequently stressed in many international and national agreements relating to nature conservation (Straub 2006).

The Purple Swamphen *Porphyrio porphyrio* is a resident breeding species in Iran. Its habitats are wetlands with vast reed-beds and the edges of lakes with dense vegetation. Large tracts of suitable habitat are found in the wetlands of northern Iran, at the Hamoun Lake in Seistan & Baluchestan Province, and in Fars Province (Mansoori 2008). In recent years, because of the destruction of reed-bed habitats and irregular hunting, the population of the Purple Swamphen in Iran has been declining (Mansoori 2008).

The Purple Swamphen is a tropical and subtropical species that occurs from southern Europe to eastern Asia, and in Africa, New Zealand and Australia. Within this extensive range, at least 13 subspecies have been described, based mainly on differences in size and plumage (Doss *et al.* 2009).

Many studies have been conducted on the breeding biology and nesting ecology on different subspecies of the Purple Swamphen throughout

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the world, e.g. in New Zealand (1980), Spain (1993, 1998, 2004), Italy (1999, 2010), India (2009) and China (2009) (Doss *et al.* 2009).

Two subspecies of the Purple Swamphen occur in Iran; *P. p. seistanicus* extending from Iraq through southern and eastern Iran to Afghanistan, Pakistan and northwest India, and *P. p. caspius* extending from the northern coasts of the Caspian Sea in Russia to northwestern Iran and Turkey. These subspecies are very similar to one another, but differ slightly in size, with *P. p. caspius* being the larger of the two (Lok & Subaraj 2008, BirdLife International 1999). Although the Purple Swamphen is a resident waterbird in Iran, its breeding biology has not been well documented in the country. The objectives of the present study were: 1) to determine the breeding season, 2) to determine the choice of nesting site, 3) to determine the size, shape and structure of the nest, 4) to describe the characteristics of the eggs and chicks, and 5) to estimate breeding success in two breeding seasons.

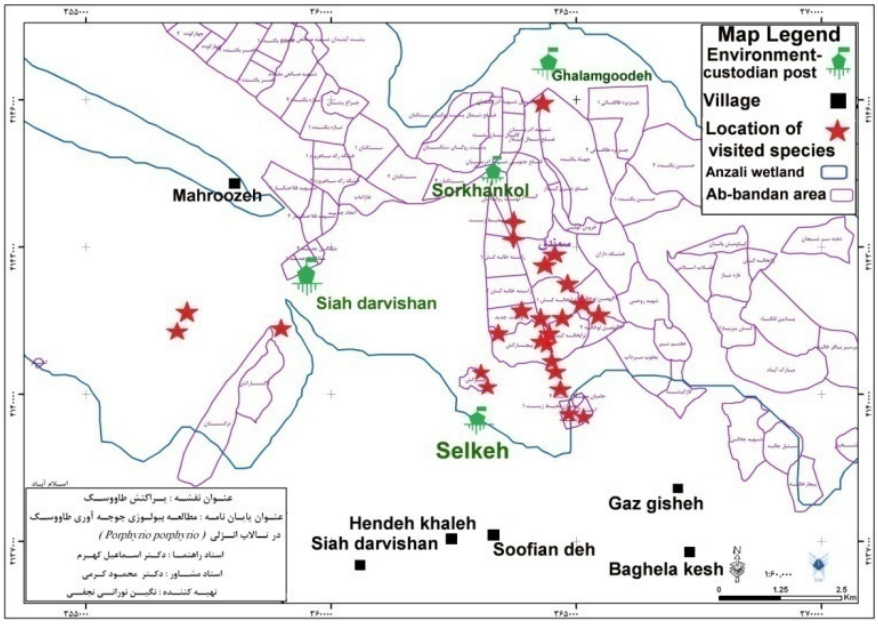

Fig. 1a. Location of 25 observations of Purple Swamphens in the study area during the breeding season in 2011 & 2012 © N. Nourani Najafi.

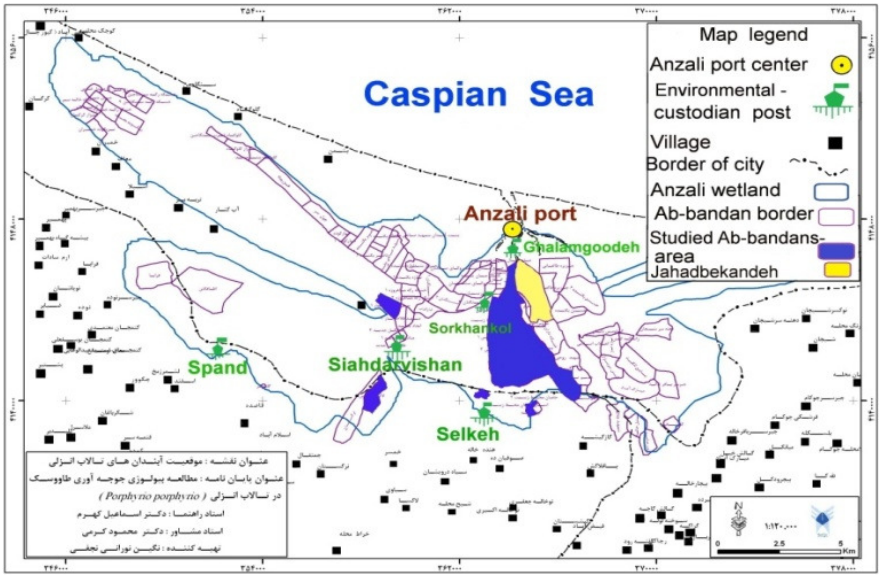

Fig. 1b. Location of the ab-bandans investigated during the breeding season in 2011 & 2012 © N. Nourani Najafi.

2. Study Areas and Methods

2.1. Study areas

Anzali wetland is located south of the city of Bandar Anzali in Gilan Province, Iran (37°29'13''N, 49°18'41''E), and covers an area of about 14,000 ha (Behrouzi-Rad 2008). Its flora includes more than 30 species but most parts of the wetland are covered with the reed *Phragmites australis*. The Anzali Wetland Complex was designated as a Ramsar site in 1975 and has also been identified as an Important Bird Area by BirdLife International (Evans 1994).

The water body of Anzali wetland is divided into four interconnected sections: eastern, central,

western and southwestern (Siahkeshim Protected Area) (Beheshti 1998). According to a satellite map of Anzali wetland, the eastern and southwestern sections are relatively dry with soft mud, especially in spring and summer when they are completely inaccessible by boat. The western and central sections are readily accessible by boat because of the relatively deep water. However, the western section of Anzali Mordab was not thoroughly surveyed during the present breeding study of the Purple Swamphen because of its physical characteristics (mostly deep water with vegetation cover restricted to the edges of the wetland, except in one extremely small section) (Beheshti 1998). The present study was conducted in the accessible sections in the central basin and 14 adjacent ab-bandans covering more than 890 ha (Fig. 1).

2.2. Material and Methods

The field work of this survey was carried out during two breeding seasons from 23 May to 10 July 2011 and from 29 March to 30 June 2012. In Anzali wetland, the Purple Swamphen is a rare species with an extremely small population. Furthermore, it is a secretive species. Therefore, at the beginning of the field work during the 2011 breeding season, the bird's distribution was surveyed by registering the geographical location of all individuals observed using a handheld Global Positioning System (GPS), recording the number of individuals in each location, and recording the habitat characteristics of each location. A distribution map was then created using ArcMap software version 9.3.1. These areas were then searched for nests during the 2012 breeding season. The geographical location of each nest was carefully recorded. For each nest, three groups of parameters were measured and recorded. Firstly, we measured parameters relating to the nest-site, focusing on habitat quality which could have an effect on breeding success (Sanchez *et al.* 1993), including water depth under the nest-cup, the height from the edge of the nest-cup to the water level, the closest distance from the edge of the nest-cup to the edge of the ab-bandan, the closest distance from the edge of the nest-cup to open water or an open area with sparse vegetation cover, and the closest distance from the edge of the nest-cup to an area with motorboat traffic. Secondly, we measured parameters relating to the shape and structure of the nest-cup, including the length (largest diameter) and width (smallest diameter) of the nest-cup, the external height of the nest-cup from the top edge of the nest-cup to the nest-cup bottom, the shape and structure of the nest, and the materials used for building the nest. Thirdly, at active nests we measured parameters relating to egg measurements and morphological characteristics, including the length, width and mass of the eggs, the clutch size, and the colour and shape of the eggs. The following formula was used to calculate egg mass: $V(cc) = K \times L(cm) \times B^2(cm)$ where L indicates maximum length, B is maximum breadth and K is a constant (0.51) (Ashoori 2009). The software Excel 2010 was used for statistical calculations. Data were presented as means ± SD. Active nests were monitored to the end of the incubation period. Once the eggs had hatched, the broods were monitored three days per week. In order to minimize disturbance at the nest, only the morphological characteristics of the chicks were recorded. All parameters relating to measurement of the height, length and width of the nest structure and nest site were measured with a metal measuring tape and a yardstick 170 cm in height. Parameters relating to the measurement of distances were measured with GPS. A Vernier Caliper (0.01 mm in accuracy) was used for the egg measurements. Both a motorboat and a rowing boat were used to reach the nests in the study area.

3. Results

In the breeding season of 2011, approximately 35–40 individuals were recorded at 25 locations dispersed within 14 ab-bandans, covering an area of about 890 ha in the central section of Anzali Wetland (Fig. 1). In the breeding season of 2012, nine nests of the Purple Swamphen were located and studied in Jahadbekandeh ab-bandan, 236 ha (Fig. 1). This represents a density of 0.038 nests per hectare.

Table 1. Mean ± SD of parameters relating to nesting site, nest and eggs of the Purple Swamphen at Jahadbekandeh Ab-bandan.

Variables	N	Min – Max	Mean ± SD
Average large diameter of the nest–cups (cm)	9	37.92–51.52	44.72±6.80
Average small diameter of the nest-cups (cm)	9	30.07–39.81	34.94±4.87
Average height from the edge of the nest-cups to the water surface (cm)	9	14.56–41.88	28.22±13.66
Average water depth under the nest-cups (cm)	9	1.78–15.44	8.61±6.83
Average closest distance from the edge of the nest-cups to the edge of open water or open area (cm)	9	49.08–134.02	91.55±42.47
Average closest distance from the edge of the nest-cups to an area with motorboat traffic (m)	9	193.12–597.54	395.33±202.21
Average closest distance from the edge of the nest-cups to the edge of the ab-bandan (m)	9	45.61–133.71	89.66±44.05
Average length of eggs (mm)	16	39.52–64.98	52.25 ±12.73
Average width of eggs (mm)	16	37.77–45.65	40.71±2.94
Average volume of eggs (mm^3)	16	37.47 – 50.31	43.89 ± 6.42

3.1. Nesting site

Nests were located within patches of reed vegetation in which there were small areas of open water. These patches of reed vegetation were situated far from the edge of the ab-bandan and were surrounded by open water. The nest-cups were concealed by the stems of the reed vegetation. The average closest distance from the edge of the nest-cups to an area with motorboat traffic was 395.3±202.2 m (193.1–597.5), but the closest distance to the edge of the ab-bandan was 89.7±44.0m (45.6–133.7). The average closest distance from the edge of the nest cups to an open area was 91.5±42.5 cm. The average depth of the water under the nest-cups was 8.61±6.83 cm (1.78–15.44) (Table 1).

3.2. Nest

In Anzali wetland, the nests of the Purple Swamphen were, in most cases, constructed within reed clusters and were hidden from view by reed stems. The nests had shallow cups and were placed at the bottom of reed clusters, just on water level or on muddy sediments. Four active nests with clutches of eggs were located. The average large diameter of the nest-cups was 44.72–6.80 cm (37.92–51.52), the average small diameter of the nest-cups was 34.94–4.87 cm (30.07–39.81), and the average external height of the nest-cups was 28.22±13.66 cm (14.56–41.88) (Table 1).

3.3. Eggs

The first nest with a clutch of three eggs was located on 4 May 2012. During the study, 16 eggs were recorded in four nests. The clutch size varied from three to five. Two nests had clutches of three eggs and two nests had clutches of five eggs. The eggs were oval, smooth and glossy, dirty white to dirty cream and in some cases very pale green, and variably spotted and blotched with maroon, pale violet or grey. In the early days of the incubation period, the egg colour tended to be creamy-white, while in the final days of incubation, they were darker and relatively bronze in colour. The average length of the eggs was 52.2±12.73 mm (39.52–64.98), the average width was 40.71±2.94 mm (37.77–45.65), and the average volume was 43.89±6.42 mm^3 (37.47–50.31) (Table 1). Some differences in egg diameter and volume were recorded even within a clutch.

3.4. Chicks

The eggs hatched between 29 May and 1 June. The chicks were precocial and nidifugous. The newly hatched chicks were covered with a coat of black down feathers (Fig. 2) with some silver down dispersed on the back, around the neck and at the end of the wings. The skin of the head was bare and dark red, and there was some dark red bare skin at the ends of the primitive wings. The chicks had black irises, dark red eyelids, dark

pink feet and noticeably long legs. The bill was white with a dark red spot, and there was an extensive white shield on the forehead. It is believed that eight chicks were produced from the 16 eggs found in the ab-bandan.

Fig. 2. Chicks of the Purple Swamphen.

4. Discussion

4.1. Nesting site

It is stated that the Purple Swamphen builds its nests inside thick vegetation in swampy areas with shallow water of c.12–30 cm in depth (Cramp & Simmons 1998). The nesting area in Jahadbekandeh ab-bandan was shallow throughout, with thick soft sediments. The depth of the water under the nest-cups was on average 8.6 cm. In this study, the average closest distance from the edge of the nest-cups to an area with motorboat traffic was 395.3 m. The negative impact of human disturbance on the suitability of breeding habitat has frequently been emphasized (Junhua *et al.* 2010). The average closest distance between the edge of the nest-cups and the edge of the ab-bandan was 89.7 m in this study, which is in contrast to the results of a breeding study on Purple Swamphens in India, where the average distance between the nest and the edge of the lake was only 2.95 $\pm$ 0.91 m, N= 25 (Doss *et al.* 2009). At a wetland in China that is under pressure from a prosperous aquaculture industry, the average distance of the nests of Purple Swamphens from the nearest road was 75.67 ± 7.42 m, N= 15) (Junhua *et al.* 2010). In Anzali wetland, it seems that although the Purple Swamphens choose the dry verges of the wetland for feeding and resting, they prefer to build their nests over water, perhaps for greater security and escape from predators such as Wild Boars *Sus scrofa* and Golden Jackals *Canis aureus*. However, it would not provide protection from Otters *Lutra lutra*. Also in this study, the average closest distance from the edge of the nest cups to an open area was 91.5 cm, while in China this distance was 12.33 $\pm$ 1.67m (Junhua *et al.* 2010). It seems that in Anzali wetland, the onset of breeding activities in this subspecies coincides with the beginning of re-growth of reeds and reduction in water level. Both these factors influence the risk of predation. Presumably, re-growth of reeds reduces the risk of predation while a reduction in water level increases the risk of predation.

4.2. Nests

In the present study, the nest-cups were oval in shape except in two cases where the nests were relatively large and triangular in shape. In Anzali wetland, the nests of the Purple Swamphens were constructed within reed clusters. No woven structures were observed in the nest-cups, and there was no evidence that the Purple Swamphens were passing leaves between reed stems in the construction of their nests. The external surface of the nest-cups formed a relatively deep cup. The upper surface was completely flat and open, and in most cases, the distance from the top edge of the cup to the water level was the same as the external height of the nest-cup above the base of the reeds, i.e. on average 28.2 cm. When the nests were built over deep water, the height of the top edge of the nest-cup above the water surface was also high, presumably to ensure that the eggs remained safe from waves and fluctuations in water level during periods of strong wind and heavy rainfall. In China, this measurement was lower than in the present study (17.7 cm, Junhua *et al.* 2010). In all nest-cups that had been abandoned after hatching, structural changes were visible. In all cases, a ramp of reed leaves and stems had been made from the top edge of the cup to the surface of the water, and this ended at a pile of reed leaves and stems which formed a carpet on the sediment. It seems that the Purple Swamphens were providing easy access for chicks entering and exiting the nest. This

provision of access ramps at Purple Swamphen nests has been reported in other studies (Cramp & Simmons 1998).

In the present study, the average large diameter, small diameter and external height of the nest-cups were 44.7 cm, 34.94 cm and 28.2 cm respectively. In comparison, these measurements in China were 38.57 cm, 18.57 cm and 18.17 cm (Junhua *et al.* 2010), while in India they were 37.7 cm, 31.6 cm and 4.7 cm (Doss *et al.* 2009). Thus, it seems that the nests in this study in Anzali wetland were larger than those in previous studies.

4.3. Eggs

As in our study of *P. p. caspius*, studies of *P. p. porphyrio* in Europe have indicated that clutch size varies from 3 to 5 (range 2–7) (Cramp & Simmons 1998), while studies of another subspecies in southern India have indicated a variation in clutch size from 3 to 7 (average 4.5) (Doss *et al.* 2009). In each clutch, there was an interval of 1-2 days between the hatching of each egg. It has been reported in the literature that the hatching of Purple Swamphen eggs may be either synchronous or staggered over several days (Cramp & Simmons 1998). In our study, in nests not attacked by predators (or in which no eggs were lost or disappeared), one egg failed to hatch in each clutch.

In our study, the average length and width of the eggs was 52.25 mm and 40.71 mm, respectively, and the average volume was 43.89 mm^3. The length, width and volume of the eggs were different from each other even within a clutch. The eggs were slightly larger than those of the European subspecies (average length 55 mm, average width 37 mm) (Cramp & Simmons1998) and those of the subspecies in southern India (average length 52.5 mm, average width 32.3 mm) (Doss *et al.* 2009).

4.4. Chicks

When the newly hatched chicks were first seen, they were very active and mobile, hiding themselves on our approach, although they were not more than 10 hours old. It seems that the chicks leave the nest soon after the last egg has hatched (usually after one or two days and always within a week). In nesting waders and waterfowl, low rates of hatching success caused by nest destruction have frequently been recorded (Opermanis *et al.* 2001). In the present study, eight of the 16 eggs in four nests hatched successfully. One clutch of five eggs was destroyed by a bird of prey (Fig. 3), and one clutch of three eggs disappeared. The disappearance of clutches was also reported in a study of Purple Swamphens in southern India in 2005 and 2006. The reasons were uncertain, but it was supposed that strong winds and water currents were responsible for the disappearance of whole clutches from some nests (Doss *et al.* 2009). The disappearance of whole clutches without a trace was also reported in a study of nest-site selection in the Purple Swamphen in Spain, but here it was thought that avian predators were the most important reason (Sanchez *et al.* 1993). It seems that the survival rate of Purple Swamphen chicks from fledging to maturity is very low, given the low number of individuals of this species in Anzali wetland. The low density of the Purple Swamphen at Anzali could be as the result of other factors relating to habitat suitability, foraging potential, predation, winter climate etc. However, the vegetation cover is so dense in Anzali wetland that it was not possible to monitor the chicks after fledging or to estimate their survival rate and the overall breeding success.

Fig. 3. Nest and eggs of Purple Swamphen predated by a raptor.

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