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Breeding Biology of the Great Cormorant *Phalacrocorax carbo sinensis* in Southern Coasts of The Caspian Sea, Iran

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ABSTRACT: Breeding biology of the Great Cormorants Phalacrocorax carbo sinensis is assessed in the southern coasts of the Caspian Sea, Iran during the years 2008-2010. About 84 nests located on 63 trees were examined. Nests were built on large trees located in Abbas abad marsh, Gilan Province. Initially, eggs were found on first week of April and egg laying continued until the last week of May. Clutch size varied from 2 to 5 eggs, with a mean clutch size of 2.8±0.69. Mean shape index for all eggs were 1.68±0.035 and 1.706±0.048, respectively. The length of the incubation period was estimated at 26.6±2.2 days. in 2010 of the 84 eggs laid, 26.6% were lost. In 2009 of 92 eggs laid, 62% were lost. Number of eggs hatched per nest averaged at 1.57±0.57 in small ones and 1.8±1.6 in large nest. Mean weight of eggs was estimated at 46.8±1.28g (N=10, mean =48.9, min=45.2).

Key words: Great Cormorant, *Phalacrocorax carbo sinensies*, Breeding biology, Caspian Sea,Gilan Province, Abbas Abad marsh

INTRODUCTION

Lots of studies have discussed the population change of different species all around the world (Spanou *et al.*, 2012; Graham and Hudak, 2011; Pei *et al.*, 2011; Hayatgheib *et al.*, 2011). The Great cormorant *Phalacrocorax carbo sinensis* is one of the five species belonging to the Phalacrocoracidae. (Zydlis *et al.*, 2002). This Species is a migratory large diving waterbird, Specialized fish- eaters foraging mainly in large or medium sized aquatic habitats (Frederixson *et al.*, 2001; Casaux and Barrena- oro, 2006;Ceeh *et al* ., 2008;Goutner *et al.*, 2011;Misztal *et al.*, 2011;Nam *et al.*, 2005;Emmrich and Duttmann ;2011;Cramp and Simpsons, 1977; Zillstra and Van een, 1995). Great Cormorants occur on all the world's continents (Porter *et al.*, 1996;Gremillet *et al.*, et al.1995, Cormorants are monogamous and breed in colonies ranging from several pairs to a few thousands pairs (Shorring *et al.*, 1999).

The P.c .sinensis is distributed throughout Iran but breeds Only in the south of the Caspian Sea in Gilan and Mazandran Provinces (Mansoori, 2008; Mansoori, 2009;Firoouz,2000). This species inhabit Coastal areas as well as inland wetlands and are opportunistic feeder (Maxwell ,1970;Ashmol,1971;Urbar,1979;Childress,and Bennun,2000; BehrouziRad, 2007).

The decline of breeding population of P.c.sinensis in south of the Caspian Sea has received considerable recent attention. The status of its population, however has received far less attention., In the 1970 s, 5 colonies were reported in this region; Amir Kalayeh wetland, Abbas Abad marsh,and Jokandan in Gilan province, and Khoskehdaran and Ramsar Airport site in Mazandran Province (Monavari, 1988; Barati and Balmaki, 2005;Brati *et al.*, 2007). Numbers of breeding pairs seem to be affected by human interferences in area around and inside the colonies. Breeding population in some of the colonies declined due to destruction of trees within these colonies (Barati, 2003). In recent years, this species has been observed in Gilan Province in all seasons; and bred in mixed colonies with other species of Herons and Egrets (Scott and Adhami, 2006., Rands *et al.*, 1982; Scott; 1989. Scott, 2007)in Amir Kalayeh wetland which is protected area, and Abbas Abad marsh.

The breeding success in waterbirds such as P.c.sinensis changes remarkably depending on the

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inter- and intra species relationship in the colony, food resources and predator pressure (Ashoori, 2010). Indeed, studies on reproductive biology and ecology are of fundamental importance, not only in assessing the population dynamics of a species, but also in constructing population models for management purposes (Bager *et al.*, 2007;Zhang *et al.*, 2007). Breeding biology of P.c.sinensis such as other species of Cormorants is well know, and many data are available on its breeding biology (Inoue *et al.*, 2010 ;Newson *et al.*, 2005. ;Liordos and Goutner, 2003 ;Grieco, 1999), but it is insufficient in Iran.

The aim of this paper is to present the materials about the biology of P.c.sinensis population with emphasis the measurement of biological parameters such as volume of the clutch and nesting rate for evaluating population fitness in south of the Caspian Sea coast in Iran.

MATERIALS & METHODS

Abbas Abad marsh is situated about 2.5 km away from south of Astara city in Gilan province in the southern coasts of the Caspian Sea (38° 22′ 13″ N., 48° 50′ 59″ E.,- 13m a.s.l.) and cover an area of about 138 ha. This wetland is 2 km far from Lavandevill wildlife sanctuary, and has an ecological interaction with this site. About 60.1% of recorded rainfall occurs in summer and autumn, 27.9 % in winter and 12% in spring. The mean annual temperature is 16.7 C°, and the annual mean precipitation is 1725 mm. The study area is under protection of Department of the Environment. About 20% of this wetland is covered by Alder *Alnus glotinusa* trees in north section, 10% by aquatic plants such as *Carex sp.*, *Cyperus sp*. *Agrostistis sp*., etc; and the rest is open water. The alder trees are between 4.5 to 8 m in height. The water depth of this marsh in breeding season is about 70 cm to 1.5 m in margins and 1 to 2.25 m amongst the trees. Its waterbird breeding community includes Black-Crowned Night heron *Nycticorax nycticorax*, Cattle egret *Bubulcus ibis*,Little egret *Egretta grazetta*, Grey heron *Ardea Cinerea*, Little bittern *Ixobrychus minutes*, and Squacco heron *Ardeola rolloides*. *Emys orbicularis*, *Mauremys caspica caspica, Natix tesselata tesselata, Cyprinus carpio , Lutra lutra and* Myocastor Coypus are the main wildlife in the study area. Fig. 1 shows the map of Abbas abad marsh and surrounding areas.

Surveys of breeding cormorants were generally carried out by counting nests(Delany and Scott,2006;Olsen *et al.*,1994). It took placed from 2008 to 2010, which implies a very reliable estimate of the total breeding population throughout recent years.(Svagelj and Quintana ,2011;Coulson et al .,1996;Azar ,1999).Breeding population was assessed through direct counts of "a parental occupied nests", defined as substantial or well constructed nests capable of holding eggs and occupied by at least one bird on or within touching distance of the nest (Narayana and Vijayana, 2007).

The geographic positions of the colony were obtained with a GPS. Information on Abbas Abad marsh surface and distance were derived from aerial photographs and maps. Nesting characteristics of P.c.sinensis were observed from observation were

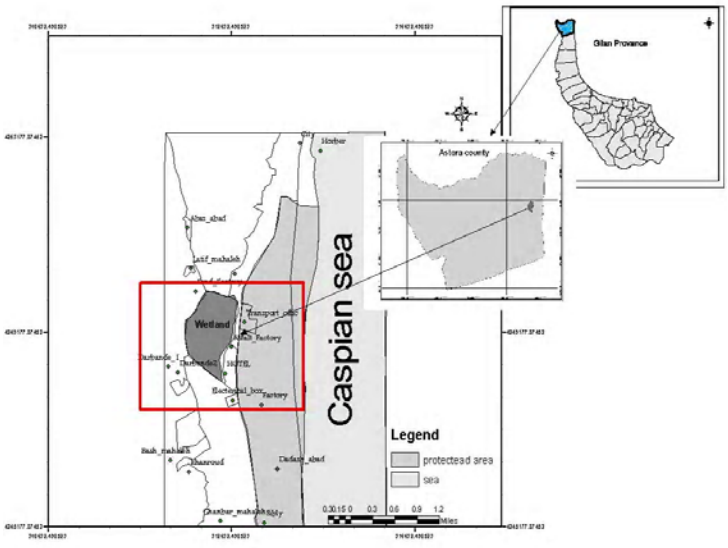

Fig.1. Map showing Abbas Abad breeding colony of the Great Cormorant in Iran

aided by 7×33 binoculars and a 15X spotting scope. A 9m ladder was utilized to reach the nests.

Observations of egg-laying and hatching were facilitated by the use of a $4^3 \times 6^3$ mirror secured at right angles to the end of a 40 cm pole. With this pole mirror and binoculars, reflection of the nest's interior was easily discernable.

The egg description was derived from observations made on eggs observed in the Abbas Abad colony.Observations were made five hours per day six days per week with the off day randomized and continued until 25 November, when all nestlings had fledged. Each day, the number of nestlings observed in each sample nest was recorded.

The formula of Hoyt (1979), V= 0.51 LB the ratio L/B were used for estimating egg volume and shape index respectively. The measurements of maximum length (L) and breadth (B) were used for the calculation of egg volume and shape index. One-way Analysis of Variance (AVOVA) and the T-test were used for statistical analysis.

RESULTS & DISCUSSION

At the Abbas Abad colony adults can be seen collecting nest materials in early March and the first eggs are usually laid in the first of April and the last hatch in late May Breeding populations of the Great Cormorant in the Abbas Aabad breeding colony was recorded in 3 years. A great increasing numbers in colony was noted. It is not certain what has caused such an increase, but appropriate protection of area by Gilan Environment Office in recent years, is the most possible explanation. The overall breeding of Great Cormorant population evolved from 98 pairs in 2008 and 86 pairs in 2009 to 139 in 2010. In other words about 41% increase is noticed during 3 years.

The maximum length and breadth of the eggs of nine complete clutches in the study area was measured (Table 1). One-way Analysis of Variance (ANOVA) and the T- test were used for statistical analyses. Clutch size was found between 2 and 5 eggs in all the studied years. In Abbas Abad colony the mean clutch size in 2008, 2009 and 2010 was regularly 3.36±0.56, 3.40±0.69 and 2.8 ±0.92 eggs. Analysis show there is not any significant difference (ANOVA one way: $F_{2.79}$= 4.78, P= 0.010).

The comparison of data showed no significant difference in mean egg length ($t_{14.732}$=0.350), but in breadth was $t_{14.586}$=0.557 (Table 2). In 2010 The shape index was 1.67±0.048 and mean egg volume was 437.66 mm^3. It was expected for the breeding populations to display similar clutch sizes since they are determined mostly by heredity (Welty, 1975). Nevertheless, variation in clutch size within a species may occur due to several reasons, such as: age, food availability, season, and genetic differences between individuals (Gill, 1994). Clutch size did vary among studied populations, but not significantly so. Shape index deviates strongly from 1 (sphere) in all the areas (Table 2), indicating that the shape of the eggs is elongate. Egg size is considered highly heritable and can serve as an index of body size (Olsen and Marples ,1993).

Table 1.Egg and clutch volume of the Great Cormorant in Abbas Abad colony (means are given with standard errors, n is the number of clutches)

Parameters	(n=9) Abbas Abad 2009		(n=7) Abbas Abad 2010	
	Mean	Range	Mean	Range
Length(mm)	(60.1-65.7)	62.9 ± 1.56	(60.8-65.9)	62.64 ± 1.77
Breadth(mm)	(35-40)	37.26 ± 1.58	(34.8-39.65)	36.75 ± 1.98
Volume(mm^3)	443.92		431.4	
Shape index	(1.64-1.73)	1.68 ± 0.035	(1.63-1.74)	1.70 ± 0.048

Table 2. Means of measurements and calculations of Great Cormorant clutch size parameters (with 95% Confidence Intervals) at their breeding colony in Abbas Abad

Years	Clutch size					Mean	SD	CV	Number
	2	3	4	5	6				
2008	1	14	10	0	0	3.36	0.56	16%	25
2009	2	13	11	1	0	3.40	0.69	20%	27
2010	14	10	4	2	0	2.8	0.92	32%	30

Variation in egg volume is indicative of variation in body size and may be evidence of subspecies of differing body size. *Such sub specific separation does occur in the Great Cormorant (P. c. carbo larger than P.c. sinensis) and the significantly larger eggs could suggest sub speciation. Nevertheless, safe conclusions cannot be drawn since population age structure (adult birds lay larger eggs) and other factors that may contribute to egg volume variability have not been examined. will help to assess the levels of differentiation between the breeding populations in different colonies. Some reports show difference in the mean clutch volume was not detected although mean egg volume was found significantly larger in Lake Kerkini than the Axios Delta* in Greece(Liordus and Goutner ,2003). This happened because clutch volume also depends on clutch size and within-clutch egg size variation.

The reproductive parameters of Great Cormorant colonies among different areas is difficult because many factors may influence hatching and fledging success (Van Eerden *et al.*, 1991; Boudewiyin and Dirksen, 1995; Van Eerden and Ziylstra, 1995) and differences in the estimated values from different studies may result from different methodologies . For example, hatching success in Northern Italy ranged between 72% and 91%, while total nest success was between 67% and 86% (Volponi, 1999). Other studies show this bird typically lay 3 to 4 eggs, but clutches of 5 are not uncommon and 6, or even 7, egg clutches have been recorded (Haftorn, 1971; Cramp and Simmon, 1977; Rov, 1984). Nests with 1 and 2 eggs are also common many which are likely to be complete clutches or the result of predation on larger clutches, but some genuine 1 and 2 egg clutches are undoubtedly produced. Mean clutch sizes determined at, or shortly before, hatching vary between about 2.4 and 3.7 eggs per nest. These figures exclude nests with no eggs, which typically account for 5% of nests(Gerard *et al.*,1995).

CONCLUSION

In this paper we have attempted to provide updated information on the breeding abundance of great cormorants along south of the Caspian Sea coasts in Gilan Province which has been a largest colony of this bird in whole country.

All the nests had eggs on them. Nests were built on top of the medium to large trees. Nests platforms were built by sticks and twigs and occasionally lined with dry grass. Initially, eggs were found on 4th to 10th April . Egg laying continued until the last week of May. Clutch size varied from two to five eggs, with a mean clutch size of 2.8±0.69 and modal clutch size of three eggs. Mean shape index for all eggs were 1.68±0.035 and 1.706±0.048 in the years 2008 to 2010, respectively. The length of the incubation period was estimated at 26.6±2.2 days. in 2010 of the 84 eggs laid, 8(26.6%) were lost. In 2009 of 92 eggs laid, 9(62%) were lost. Number of eggs hatched per nest averaged at 1.57±0.57 in small ones and 1.8±1.6 in large nest. Mean weight of eggs was estimated at 46.8±1.28g (N=10, mean =48.9, min=45.2). The overall breeding of Great Cormorant population evolved from 98 pairs in 2008 and 86 pairs in 2009 to 139 in 2010. In other words about 41% increase is noticed during 3 years.

Our discovery of nesting site of great cormorant, for instance, suggests that other seabird along the south of Caspian Sea coasts, because of lack of adequate searching need further comprehensive ornithological surveys so as to improve the picture of the cormorants populations.

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