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Breeding Population, Clutch and Egg Size of the Great Cormorant *Phalacrocorax carbo* in Greece

Vasilios Liordos & Vassilis Goutner

Liordos V. & V. Goutner 2002: Brutpopulation, Gelege- und Eigröße des Kormorans *Phalacrocorax carbo* in Griechenland. Vogelwelt 124, Suppl., 139-142.

In den letzten 30 Jahren hat sich der Bestand des Kormorans (*Phalacrocorax carbo*) in Europa erheblich vergrößert. Dies führte zu einer recht negativen Einstellung der Fischzüchter und der Freizeitangler und es hat die Aufmerksamkeit sowohl der Öffentlichkeit als auch der wissenschaftlichen Gemeinde auf sich gezogen. Auch im griechischen Bestand wurde eine wachsende Tendenz festgestellt, doch da ausreichende Informationen über die Anzahl, die Biologie der Arterhaltung, die Nahrung und die Ökologie der Ernährung und die genetischen Fakten dieser Vogelart fehlen, wird die erforderliche Untersuchung durchgeführt. Hier werden Fakten in Bezug auf die Anzahl der sich fortpflanzenden Tiere, die Eier und die Geburt angegeben. Während der Brutzeit in den Jahren 1999 und 2000 wurden die vier Brutgebiete der Kormorane untersucht, und zwar die Seen Kerkini und Mikri Prespa, und die Delta der Flüsse Axios und Ewros. Im See Kerkini und im Delta des Flusses Axios war der Bestand gleich, wogegen er sich im See Mikri Prespa im Jahre 2000 stark verringerte (auf 172 Paare statt der 472 Paare 1999), vielleicht durch die Abwertung der Brutbäume. Der gesamte, sich fortpflanzende Bestand wuchs 1971 von 540 auf 570 Paare, zu Beginn der 90er Jahre auf circa 600 Paare und 1999 auf 3,432 Paare. Die durchschnittliche Größe einer Eierlegung war im See Kerkini und in den Delta Axios und Ewros 3,8 Eier und im See Mikri Prespa nur wenig höher (3,95 Eier). Bei der durchschnittlichen Länge der Eier, der durchschnittlichen Form und der Menge bei der Eierlegung, konnten zwischen den Brutgebieten keine wesentlichen Unterschiede festgestellt werden. Die durchschnittliche Breite und das Volumen der Eier weist beträchtliche Unterschiede auf. Die Eier in Kerkini waren breiter und größer (3,98 cm und 50,63 cm^3) als in Axios (3,89 cm und 47,69 cm^3).

1. Introduction

The Great Cormorant (*Phalacrocorax carbo*) is the most widespread of all cormorant species and eats almost entirely fish (JOHNSGARD 1993). It has also adopted solitary as well as social foraging strategies, depending on prey availability and habitat conditions (VAN EERDEN & VOSLAMBER 1995, VOSLAMBER *et al*. 1995). Great Cormorant population status has changed rapidly throughout Europe in recent years, from threatened and protected to thriving. This change, along with the bird's food

preferences and feeding behaviour have caused considerable conflicts with the fisheries industry and angling interests in many countries (e.g. IM & HAFNER 1984, RUSSELL *et al*. 1996). Therefore, much research has been conducted and management and control plans formulated (e.g. KIRBY *et al*. 1996, VAN DAM & ASBIRK 1997, BILDSØE *et al*. 1998).

In Greece, there has also been an increasing trend in Great Cormorant numbers. This situation led to fishermen's complaints and demands for help and advice. Since there is lack of sound scientific information, research on this piscivorous species' population size, breeding biology, diet and feeding ecology, and genetic identity has been undertaken. Part of this research, concerning the breeding population, clutch and egg size, is presented, analysed, and discussed here.

2. Study Sites and Methods

The study sites, four Great Cormorant breeding colonies, are located in Northern Greece: at lakes Kerkini and Mikri Prespa and in the Axios and Evros Deltas (Fig. 1). All of them are designated as Wetlands of International Importance, under the Ramsar Convention.

Kerkini is an artificial lake, relatively shallow and rich in vegetation with flooded and riverine forests of Willow *Salix alba* x *fragilis* hybrids, Common Alder *Alnus glutinosa*, Oriental Plane *Platanus orientalis*, and Tamarisk *Tamarix parviflora*. Great Cormorants make their nests over water, in Willow trees found in the north and northeast part of the lake. Lake Mikri Prespa is also relatively shallow with two small islands; cormorants breed on the smaller of them (Vidronissi). A stand of ancient Juniper *Juniperus foetidissima*, in which the birds are nesting, occurs on the island. The Axios Delta is part of a large wetland complex and includes a variety of habitats: salt and freshwater marshes, riverine forests, lagoons, and open seas. The breeding colony is found on an island, in a narrow riverine forest of Tamarisk *Tamarix hampaena*, Common Alder, and Willow *Salix* spp. Here cormorants nest in association with Black-crowned Night Herons *Nycticorax nycticorax*, Squacco Herons *Ardeola ralloides*, Spoonbills *Platalea leucorodia*, and Little Egrets *Egretta garzetta* (KAZANTZIDIS *et al*. 1997). The Evros Delta also contains a variety of habitats (GOUTNER & KAZANTZIDIS 1989) and the colony is located in a seasonally flooded area with Tamarisk *Tamarix smyrnensis*.

The four breeding colonies were visited during the breeding seasons of 1999 and 2000 (from April to mid-June) and the active nests counted. The size of twenty complete clutches was also recorded and then the maximum length (L) and breadth (B) of the eggs in each clutch were measured, using digital callipers with 0.01 mm accuracy. These measurements were used for the calculation of egg volume and shape index. The formula of HOYT (1979), $V = 0.51 * L * B^2$, and the ratio L/B were used for estimating egg volume and shape index respectively. One-way Analysis of

Variance (ANOVA) was used to test the null hypotheses that the means of measurements (clutch size, egg dimensions, egg volume, etc.) were equal among breeding sites. If the null hypothesis was rejected, the Tukey test was used to detect which population means were different (ZAR 1999).

3. Results

Great Cormorants first recorded to breed, in Greece, in 1944, when a 6-pair colony was found (in the Axios Delta; HANDRINOS & AKRIOTIS (1997)). Since then, their total breeding population increased but changed little between 1971 and the early 1990s, being 550 (at two colonies: the lake Mikri Prespa and Evros Delta) and 660 (at four colonies: the lakes Mikri Prespa and Kerkini and the Axios and Evros Deltas) pairs, respectively (HANDRINOS & AKRIOTIS 1997). However, by 1999 the breeding population had increased to 3,422 pairs. Nesting pairs for the 1999 and 2000 breeding seasons were 360 and 400, respectively, for the Axios Delta, 472 and 172 for lake Mikri Prespa, and 2,300 in each year at lake Kerkini. The Evros Delta colony held 300 pairs in 1999 but no count was made in 2000 because the colony was inaccessible due to the destruction of a dirt dam made to flood the area during the summer. After this incident, mud made it impossible to approach the colony.

Clutch size was 3 - 5 eggs in all the areas (Tab. 1). In lake Mikri Prespa the mean clutch size was 3.95 eggs being slightly, but not significantly, higher than in the other breeding colonies (3.8) ($F_{3,76}$ = 0.26, P = 0.85, Tab. 1).

There were no significant differences in mean egg length ($F_{3,303}$ = 2.6, P = 0.52) and shape index ($F_{3,303}$ = 1.4, P = 0.24) between the four study colonies whereas significant differences were detected in mean egg breadth ($F_{3,303}$ = 4.5, P = 0.004) and mean egg volume ($F_{3,303}$ = 4, P = 0.0082, Tab. 1 and 2). Further statistical analysis (Tukey test) showed that the eggs were significantly broader ($q_{303,4}$ = 5.17) and larger ($q_{303,4}$ = 4.75) in samples from lake Kerkini (mean egg breadth, 3.98 cm; mean egg volume, 50.63 cm^3) than in those from the Axios Delta (mean egg breadth, 3.89 cm; mean egg volume, 47.69 cm^3). Overall, no differences among clutch volume means were found ($F_{3,76}$ = 0.4, P = 0.74, Tab. 1).

4. Discussion

The Kerkini and Axios breeding populations were practically stable during 1999 and 2000, whereas the Mikri Prespa colony showed a stark decrease from 472 to 172 pairs. It is not clear what caused this decline, but severe deterioration of the quality of nesting trees, due to the birds' faeces, is the most plausible explanation. The overall breeding population in Greece has shown a great increase of over 570 % since the 1970s, especially in the last decades. A number of factors may have

contributed to this: protection of breeding sites, increase of food availability, and increasing number of fisheries. All four breeding colonies are designated under the Ramsar Convention thus protected by law. The fish biomass in the lakes Mikri and Megali Prespa has increased in the last decade and the main reasons are thought to be: a) reduced number of fishermen due to socio-economic reasons, b) application of management measures such as longer fishery closed season and prohibition of the use of net mesh smaller than 45 mm, c) increased eutrophication due to increased use of fertilisers, and d) introduction of exotic species such as the highly adaptable Pumpkinseed *Lepomis gibbosus* (CRIVELLI *et al.* 1997). Application of appropriate fishery management, increased eutrophication, and the introduction of Pumpkinseed have also been identified as the main reasons for increased food availability at lake Kerkini. The number of farms of commercially valuable fish species, especially Gilthead *Sparus auratus* and Sea Bass *Dicentrarchus labrax* have also increased after securing proper funds by the European Community. Some of these farms are located in the vicinity of the Great Cormorant breeding colonies and therefore favoured feeding sites.

Clutch size is determined mostly by heredity (WELTY 1975) although, within a species, variation may occur for several reasons such as: age, food availability, season, genetic differences between individuals and populations (GILL 1994), adult body size (O'CONNOR 1985), body physiological condition (RICKLEFS 1977). Clutch sizes recorded in the present study were within the range of 3-4 (max. 6) given by CRAMP & SIMMONS (1977), while mean clutch size did not significantly vary among the studied populations. Since there is no data available, further research is needed in order to determine the factors affecting clutch size variation between and within the concerned populations.

Several factors may affect egg size (as for clutch size in the previous paragraph), however, parental body size has been identified as one of the most important by investigators. RAHN *et al.* (1975) and SAETHER (1987) found that egg size is positively correlated with female body size. OLSEN *et al.* (1994) shown that female as well as male body size are positively correlated with egg size. Variation in egg volume is indicative of variation in body size and may be evidence of subspecies of differing body size (OLSEN & MARPLES 1993). Since such subspecific separation does occur in the Great Cormorant (e.g. *P. c. carbo* is larger than *P. c. sinensis*; CRAMP & SIMMONS (1977)), the significantly larger eggs in lake Kerkini than the Axios Delta could suggest subspeciation. However strong these indications are, safe conclusions cannot be drawn before the other factors that may contribute to egg volume variability are examined. Population age structure (adult birds lay larger eggs; OLSEN *et al.* (1994)) and food availability (HIOM *et al.* 1991) are also considered important. In addition, blood and tissue samples have been collected and subsequent genetic analysis will help to assess the levels of differentiation between the four breeding

populations. Difference in the mean clutch volume was not detected although mean egg volume was found significantly larger in lake Kerkini than the Axios Delta. This happened because clutch volume also depends on clutch size and within-clutch egg size variation (WELTY 1975).

5. Abstract

Liordos V. & V. Goutner 2002: Breeding Population, Clutch and Egg Size of the Great Cormorant *Phalacrocorax carbo* in Greece. Vogelwelt 124, Suppl., 139-142.

The rapid increase of the Great Cormorant population has drawn the attention of the public and scientific community alike. Research at this fish-eating species' breeding sites: the lakes Kerkini and Mikri Prespa, and the Axios and Evros Deltas, during the 1999 and 2000 breeding seasons, has shown a stabilisation of numbers, except for the Mikri Prespa colony. There, the breeding pairs dropped from 472 in 1999 to 172 in 2000, possibly due to nesting trees deterioration. The overall breeding population increased from c. 600 pairs in the early 1990s to 3,432 pairs in 1999, showing an increase of over 570 %. Mean clutch size was found identical for three sites (3.8 eggs) and slightly but not significantly larger for Mikri Prespa (3.95 eggs), whereas differences were detected in mean egg breadth and mean egg volume. In lake Kerkini the eggs were significantly broader and larger (3.98 cm & 50.63 cm^3 respectively) than in the Axios Delta (3.89 cm & 47.69 cm^3 respectively).

Key words: Breeding season, population size, Great Cormorant, clutch size, egg breadth, egg length

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