# ASPECTS OF THE BREEDING BIOLOGY OF THE NEOTROPIC CORMORANT *PHALACROCORAX OLIVACEUS* AT GOLFO SAN JORGE, ARGENTINA

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**SUMMARY**

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We studied the breeding biology of Neotropic Cormorants *Phalacrocorax olivaceus* at Golfo San Jorge, Argentina, during 1999. A total of 104 nest platforms with signs of occupation was counted, at 66 (63.5%) of which eggs were laid. Nests were built on top of medium to large bushes located up to 50 m inland. Average height of nests was 0.53±0.13 m. Nest platforms were built of sticks and twigs, and occasionally lined with grass, sea-weed, feathers, shells, and seabird bones or carcasses. First eggs were found on 15 November. Egg laying continued for more than six weeks until the last week of December. Median date of laying was 2 December. Clutch size varied from one to five eggs, with a mean clutch size of 3.51±0.69 and modal clutch size of three eggs. Mean volume for all eggs was 35.9±3.2 $cm^3$. Egg volume was similar within eggs of a clutch. The length of the incubation period was estimated at 26.6±2.2 days. Of the 178 eggs laid, 54 (28.7%) were lost. Number of eggs hatched per nest averaged 2.6±1.2. Median hatching date of a-eggs was 20 December. Mean number of chicks alive per nests at 10 days of age was 2.1±1.1.

Keywords: Neotropic Cormorant, *Phalacrocorax olivaceus*, Patagonia, breeding biology

## INTRODUCTION

The Neotropic Cormorant *Phalacrocorax olivaceus*, also referred as *P. brasilianus* (Browning 1989), is widely distributed in the Neotropical Region. The species ranges from the southern United States of America to Cape Horn at the southern extreme of South America (Orta 1992, Telfair & Morrison 1995). The Neotropic Cormorant is one of the few cormorant species which occupies both freshwater and marine environments, breeding in inland wetlands, fast-flowing rivers, high-altitude lakes, and on marine shores and islands (Orta 1992).

In Argentina, the Neotropic Cormorant also inhabits both freshwater and marine habitats (Navas 1993). It is a widespread and abundant species, with colonies reaching up to several thousand individuals at some wetlands in northern and central Argentina (De la Peña 1980, Navas 1993). In coastal Patagonia it breeds at 12 localities from Complejo Islote Lobos (41°27'S), Río Negro, to Bahía San Julián (49°16'S), Santa Cruz, with a total breeding population estimated at 1200 pairs (Yorio *et al.* 1999). Despite its wide distribution and abundance, the Neotropic Cormorant has been poorly studied throughout its range (Telfair & Morrison 1995). In Argentina, only some general aspects of its breeding biology and behaviour have been described (Bo 1956, Daneri 1960, Aramburu & Bo 1961, de la Peña 1980, Mosqueira *et al.* 1987, Yorio *et al.* 1994). However, most of this information comes from studies conducted on freshwater populations and relatively little has been published from marine populations. This paper presents information on the biology of marine-breeding Neotropic Cormorants and compares results with previous studies at other sites in Argentina and the Americas.

## METHODS

Isla Vernacci Sudoeste (45°11'S, 66°31'W) is located near the mouth of Caleta Malaspina, Golfo San Jorge (Fig. 1). It is a low island of approximately 6.4 ha, 500 m long and less than 200 m wide. Vegetation consists mainly of bushes of *Atriplex* spp., *Suaeda divaricata* and *Lycium chilensis*, with the presence in some parts of herbaceous vegetation such as *Salicornia ambigua* and *Stipa tenuis*. Several other seabird and waterbird species breed at Isla Vernacci Sudoeste, such as Kelp Gull *Larus dominicanus*, Magellanic Penguin *Spheniscus magellanicus*, Subantarctic Skua *Catharacta antarctica*, Great White Egret *Casmerodius albus* and White-headed Steamer-Duck *Tachyeres leucocephalus* (Yorio *et al.* 1998a).

During late October 1999 we marked all Neotropic Cormorant nest platforms at Isla Vernacci Sudoeste. The nesting area was surveyed to detect new nests. All nests were subsequently visited every three to seven days from late October up to the onset of lay-

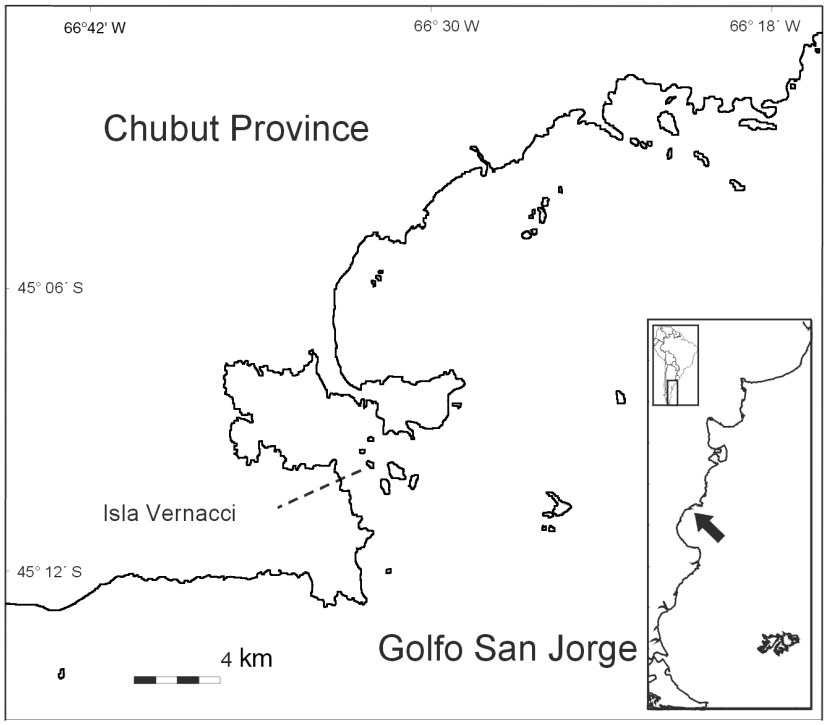


**Fig. 1.** Location of Isla Vernacci Sudoeste, Chubut, Argentina.

ing in mid-November, and then every one to five days (2.6±1.2) up to late December to record egg-laying dates, clutch size, egg measurements, egg losses, hatching dates and chick survival. We measured eggs with Vernier calipers to the nearest 0.1 mm. We calculated egg volumes (V) as: $V = \text{length} \times \text{width}^2 \times 0.0051$ (Hoyt 1979). When first recorded, we marked eggs with a felt-tip pen with the nest number and hatching order. The length of the incubation period was defined as the time elapsed between the laying of an egg and the hatching of the respective chick. We estimated chick survival to 10 days of age. During March 1999, we described and measured a sample of Neotropic Cormorant nests and bushes where these were built. We measured the width and height of nests to the nearest cm.

Means are presented together with standard deviation. Sample sizes of different variables analyzed may differ due to the loss of nests or to other nest-checking problems. Non-parametric statistics were used as underlying assumptions for parametric tests were not met.

## RESULTS

### Settlement and nesting

A total of 104 nest platforms with signs of occupation was counted at Isla Vernacci Sudoeste, in 66 (63.5%) of which eggs were laid. Nests were built on the tops of bushes, mostly medium to large-sized *Atriplex* spp. and *Suaeda divaricata*, located up to 50 m inland (Table 1). Average height at which nests were placed was 0.5±0.1 m (range 0.3–0.8 m, n = 40). Nest platforms were built of sticks and twigs, and occasionally lined with grass, sea-weed, feathers, shells and seabird bones or carcasses. Nest dimensions were variable (Table 2). Nearest-neighbour distance varied from 54 to 104 cm, with a mean of 71.3 cm (n = 37). Mean number of nests per bush was 3.5±2.4 (n = 44 bushes).

### Egg laying, incubation and hatching success

The first eggs were found on 15 November. Egg laying continued for more than six weeks, until the last week of December. Median date of laying was 2 December (n = 66). Seventy percent of eggs were laid within the first two weeks after the first egg was laid.

Clutch size varied from one to five eggs, with a mean clutch size of 3.5±0.7 (n = 63) and a modal clutch size of three eggs. Mean egg length for all eggs was 56.3±2.6 mm (range = 50.4–63.6 mm) while mean egg width was 35.3±1.3 mm (range = 32.1–39.0 mm; n = 219). Mean volume for all eggs was 35.9±3.2 $cm^3$ (range = 29.1–42.9 $cm^3$; n = 219). Egg volume was similar among eggs of the same clutch (Kruskal-Wallis $H = 5.6$, $P > 0.05$, n = 179; Table 3). The length of the incubation period in nests at which laying and hatching dates were known within 24 h was estimated as 26.6±2.2 days (n = 9).

Of the 178 eggs laid, 54 (28.7%) were lost: 85.2% of these disappeared from the nest so the cause of mortality could not be established, 1.9% were preyed upon, 5.6% were found broken at the nest and 7.4% were found whole outside the nest. Number of eggs hatched per nest averaged 2.6±1.1 (n = 50). A total of 124 eggs hatched from 178 eggs laid (69.7%).

### Chick survival

The first chicks were observed on 13 December, although given the nest-checking frequency they could have hatched on 10

**TABLE 1**

**Characteristics of bushes (n = 15) on top of which Neotropic Cormorants placed their nests at Isla Vernaci Sudoeste during 1999**

| | Mean±SD | Range |
|---|---|---|
| Height (m) | 0.9±0.2 | 0.7–1.5 |
| Maximum diameter (m) | 3.9±0.9 | 2.7–5.9 |
| Minimum diameter (m) | 3.2±0.7 | 2.3–4.5 |
| Area ($m^2$) | 10.4±4.5 | 5.0–20.8 |
| Volume ($m^3$) | 10.2±5.7 | 4.0–19.8 |
| Distance to water (m) | 30.4±15.5 | 8.5–50 |

December at the earliest. Median hatching date of a-eggs was 20 December (n = 32 nests). Fifty percent of eggs hatched within 10 days after the first egg hatched. Eggs hatched asynchronously and, except for one nest, eggs hatched in the order they were laid (n = 38).

Mean number of chicks alive per nests at seven days of age was 2.4±1.2 (n = 29 nests) and at 10 days was 2.1±1.1 (n = 20 nests). A total of 41 chicks survived to this latter age from 46 chicks hatched (89.1%). Of the five chicks lost, three had disappeared and two were found dead at the nest.

## DISCUSSION

The size of the Neotropic Cormorant colony at Isla Vernacci Sudoeste, estimated as 66 nests, differed from previous seasons. Information obtained at this same breeding site shows that colony size can vary widely between years. A total of 120 breeding pairs was counted in 1993 (Yorio *et al.* 1998a), whereas 154 pairs were recorded in 1998 (P. Yorio & F. Quintana unpubl. data). A similar variation in colony size has been observed at Punta León, northern Chubut, where the number of breeding pairs has fluctuated from 56 to 131 during a 10-year period (P. Yorio & F. Quintana unpubl. data). Colony sizes in coastal Patagonia vary between 30 and 356 nests (Yorio *et al.* 1999). Colonies located at

**TABLE 2**

**Nest dimensions of Neotropic Cormorants breeding at Isla Vernacci Sudoeste, Golfo San Jorge, during 1999**

| | Mean±SD | Range | N |
|---|---|---|---|
| External diameter (cm) | 39.9±5.1 | 29–51 | 40 |
| Internal diameter (cm) | 18.1±2.5 | 14–24 | 36 |
| Depth (cm) | 2.9±2.3 | <2–8 | 31 |

inland sites in Argentina, however, can be much larger, reaching several thousand breeding pairs (de la Peña 1980, Navas 1993). Over 35 nest platforms with signs of some use (e.g. fresh guano staining) and at which no eggs were laid were observed in the colony. In addition, at least another 50 abandoned platforms were recorded. A high number of unused platforms has also been reported at other colonies in Patagonia (Pagnoni *et al.* 1993, P. Yorio & F. Quintana, unpubl. data.). At Punta León, Neotropic Cormorants use three different breeding sites within the same locality, often changing among them between seasons and reusing the old nest platforms (Yorio *et al.* 1994).

Neotropic Cormorants at the study site nested on the tops of bushes. The species nests on bushes and trees throughout its range, although they can also nest on bare ground or rocks where such sites are lacking (Telfair & Morrison 1995). Along the Patagonian coast, for example, Neotropic Cormorants nest on the tops of bushes at all breeding sites except for a colony located at Península Valdés, Chubut, where nests are placed on gently sloping cliffs (Yorio *et al.* 1998a). Nest platforms were placed less than a metre high, although nests can be placed on bushes and trees at higher altitudes at other coastal localities (2 m; pers. obs.) and inland sites (3 m; Mosqueira *et al.* 1987, Navas 1993). In North America, Neotropic Cormorants also nest on trees or bushes, usually up to four metres high (Morrison *et al.* 1979, Telfair & Morrison 1995).

The Neotropic Cormorant is the only cormorant in coastal Argentina that builds its nest with sticks and which places them on top of vegetation. Rock shags, *Phalacrocorax magellanicus* and

**TABLE 3**

**Mean length, width and volume (±sd, with range in parentheses) of Neotropic Cormorant eggs in relation to laying sequence at Isla Vernacci Sudoeste, Chubut, during the 1999 breeding season**

| | a-egg (n = 54) | b-egg (n = 48) | c-egg (n = 49) | d-egg (n = 24) | e-egg (n = 4) |
|---|---|---|---|---|---|
| Length (mm) | 56.9±2.9 (51.7–3.6) | 56.4±2.5 (51.7–62.4) | 56.0±2.2 (51.6–60.8) | 55.9±2.5 (50.7–60.3) | 54.3±1.9 (52.0–56.6) |
| Width (mm) | 35.4±1.2 (32.9–37.6) | 35.2±1.4 (32.7–38.1) | 35.1±1.2 (32.5–38.0) | 35.1±1.3 (32.1–38.0) | 35.8±0.8 (34.8–36.5) |
| Volume ($cm^3$) | 36.4±3.3 (29.1–42.8) | 35.8±3.5 (29.1–42.9) | 35.1±2.9 (29.3–42.8) | 35.1±3.1 (29.5–41.3) | 35.5±1.5 (33.4–37.0) |

Imperial, Red-legged and Guanay Cormorants, *P. atriceps*, *P. gaimardi* and *P. bougainvilli* respectively, all build their nests with marine algae, feathers and small sticks cemented with guano, placing them on level ground or cliffs (de la Peña 1980, Malacalza & Navas 1993, Gandini & Frere 1995, Malacalza 1995, G. Punta & P. Yorio unpub. data). Therefore, there is little potential for spatial competition between Neotropic Cormorants and these congeneric species. However, waterbirds such as Great White Egrets, White-necked Herons, *Ardea cocoi*, and Black-crowned Herons *Nycticorax nycticorax* nest on the same bush species as do Neotropic Cormorants at several other localities in coastal Patagonia (Yorio *et al.* 1998a), so future studies should explore the way these species partition nesting habitat.

The timing of breeding observed at Isla Vernacci Sudoeste was similar to that recorded at other coastal sites in Patagonia. At Punta León, Neotropic Cormorants start laying during mid- to late October (Yorio *et al.* 1994), and at Isla de los Pájaros, Chubut, they were reported to lay in late October to early November (de la Peña 1980). At Complejo Islote Lobos, Río Negro, birds with eggs were already observed by mid-October (P. Yorio unpubl. data), although the onset of laying at this locality is unknown. Clutches in Isla de los Pájaros have been also observed as late as January (Arambru & Bo 1961), but these were likely replacement clutches. Whereas along the Patagonian coast Neotropic Cormorants breed mostly between October and November, in Salta (north-western Argentina) they lay between April and June (Mosqueira *et al.* 1987), and in the Paraná River delta (eastern Argentina) between July and September (Aramburu & Bo 1961). In Santa Fe, eggs have been reported in mid-April (de la Peña 1980).

Neotropic Cormorants at Isla Vernacci Sudoeste nested asynchronously, with new nests being started over a period of several weeks. Asynchronous breeding in this cormorant species has been also reported in other studies in Argentina, both at coastal (Daneri 1960) and inland sites (Navas 1993), and in the United States (Telfair & Morrison 1985). In North America, this cormorant has a prolonged breeding season, nesting from early February to mid-October, with some nestlings up to late December in some years (Oberholser 1974, Telfair & Morrison 1995). In contrast to the extended laying period observed both at colonies in the southern United States and those in central and northern Argentina, Neotropic Cormorants at Golfo San Jorge have a relatively more contracted breeding season, as shown for seabirds breeding at higher latitudes (Ashmole 1971).

Mean clutch size observed at Isla Vernacci Sudoeste was within the range of those reported for other localities in Argentina and the United states, where clutch size may vary between two to five eggs (Navas 1993, Telfair & Morrison 1995). Egg loss was the main cause of mortality at our study area. Eggs could have been lost to predation by Kelp Gulls and Subantarctic Skuas. Neotropic Cormorants nest within a Kelp Gull colony of over 8100 breeding pairs and, in addition, three pairs of Subantarctic Skuas defended breeding territories near the Neotropic Cormorant colony (pers. obs.). Both species have been recorded preying on other seabird eggs and chicks (Yorio *et al.* 1998b, Yorio & García Borboroglu 2002). Eggs may have also been dislodged as a result of stormy weather and the particularly high winds characteristic of the study area. Morrison *et al.* (1979) also reported a high percentage of eggs lost, and attributed this to severe storms with high winds. Although Neotropic Cormorants have been observed to leave nests when disturbed (Morrison *et al.* 1979, P. Yorio & F. Quintana pers. obs.), dislodging eggs from their nests and leaving eggs exposed to predators, few birds in our study left their nest sites when approached and no effects on nest contents were observed. However, undetected losses due to disturbance cannot be ruled out.

Morrison *et al.* (1979) reported that starvation and trampling were the main source of chick mortality, particularly of the smallest sibling in a brood soon after hatching. In contrast, chick mortality during the first few days was low in our study. Unfortunately, nests could not be followed for a longer period so the overall extent and sources of chick mortality could not be evaluated.

The variability observed in some of the previously discussed breeding parameters is very likely due to differences in feeding conditions between different environments and geographic localities. The foraging ecology of Neotropic Cormorants in coastal Patagonia is poorly known and research on this issue is needed to help understand the variability observed within and between localities in the breeding parameters of this wide-ranging cormorant.

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