Avocetta N-18: 57-61 (1994)

Fledging rate in the Cormorant *Phalacrocorax carbo* at the colony of Val Campotto (Po Delta, N-E Italy)

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Abstract – Cormorants *Phalacrocorax carbo* nesting at the Val Campotto colony occupied 270 nests in 1993. In 1992 and 1993, the number of fledglings from 190 successful broods was recorded. Each brood was assigned to one of 3 laying periods defined within the breeding season (February-March, April-early May, late May-July). The mean number of fledglings per nest was 2.81 ± 0.08 (SE) in 1992 and 2.80 ± 0.06 (SE) in 1993. In 1993 the fledgling production in late broods was lower than in early ones; no difference was found between nests at the centre and those at the edge of the colony, nor among clusters of trees of different density. No cases of predation were observed. Data indicate a further growth of the colony. Some second brood attempts are also reported.

Introduction

Val Campotto is presently the largest Cormorant colony in Italy. Its establishment in 1985 (Spina et al. 1986) is linked with a strong increase in the number of breeding pairs in Central and Northern Europe as well as in the wintering population in the Mediterranean area in the last 15 years (Cramp and Simmons 1977, van Eerden and Zijlstra 1991, Baccetti e Brichetti 1992). The colony has grown from 12 nests in 1986 to 270 nests in 1993.

At Val Campotto breeding occurs from February until September, with the main peak in spring and a secondary one in summer. Most birds breeding in summer use nests built by other pairs in spring. It is possible that some of the late broods are really second broods; thus the exact number of breeding pairs is still unknown (Grieco *et al.*, in press).

In this paper the fledging rate of the Cormorant in 1992 and in 1993 is analysed. Some attempts to breed twice are also reported. The second brood was supposed since very late broods (July) have occurred for the North-Atlantic subspecies *P. c. carbo* and eggs have been recorded over a period of seven months for the continental subspecies *P. c. sinensis*. Several late broods may refer to replacement broods (Haverschmidt 1933, Witherby et al. 1940, Cramp & Simmons 1977).

Study area and methods

Since 1986 Cormorants have nested on dead trees 10-20 m high (poplars *Populus sp.* and willows *Salix alba*) surrounded by water in a 130 hectare basin called "Bassarone" contiguous to the 1600 hectare semi-natural marshes of Valle Campotto and Vallesanta; nests are 1-15 m above the water level. The breeding trees are mainly located at the centre of the basin but several birds nest on trees close to its banks. Many trees are in rows and form groups of different density. Peripheral trees are often isolated.

In 1992 and 1993 I recorded the number of chicks at fledging in 190 successful broods. Unsuccessful broods (37 in both years, approximately 10% of the total number of broods: see Grieco *et al.* in press) were not considered since the nest position, laying period and stage that they had reached were unknown. Out of the unsuccessful nests, 32 were lost because the respective trees fell down and thus the stage of those broods is unknown. Nests were checked a few days before the young started to leave the nest temporarily, about 35-40 days after hatching. Surveys of the colony were made about every three weeks between February and July, at various times of the day. Nests were monitored from the banks of Bassarone with a zoom 20-60x telescope, the distance of the observer from nests ranging from 80 to 350 m. The shortest distance refers to peripheral trees, for which the problem of investigator influence might have occurred.

Each brood was assigned to one of the three laying periods fixed within the breeding season; samples refer only to the total number of broods started in each period (Figure 4):

Period 1 (P1) - February and March; the number of nests strongly increasing. Sample: 42 (18.6% of the nesting population) in 1992 and 59 (26.5%) in 1993.

Accepted 16 March 1994

Period 2 (P2) - April-early May; nesting population slowly growing to a peak. Sample: 20 (87% of new nests) in 1992 and 37 (78.7%) in 1993.
Period 3 (P3) - late May-July; the number of nests decreasing. Many sites are taken again after fledging by the young. Sample: 13 (18.1%) in 1992 and 19 (23.0%) in 1993.
The position of nests was classified according to two criteria. In relation to the density of trees, I defined isolated trees, thin rows (trees with branches not touching each other) and thick rows (trees with branches in closer contact). With regard to the simple location of trees, the colony was divided into the centre (almost all trees in rows, over 70% of the total sites) and the periphery (trees closer to the banks).
Chick loss was only verified for broods regularly monitored for the entire rearing period, beginning from the stage when the presence of chicks could be checked (about 8-10 days after hatching).
Data were entered on a Statgraphics worksheet. The mean fledging rate is given in the text with the standard error (S.E).

Results

As depicted in Figure 1, the nesting population of Val Campotto has strongly grown since 1985 when nesting by a founder pair is assumed. Figure 2 shows the phenology of 240 nests in the 1993 breeding season. A massive occupation of sites occurred between February and April, but in early May some nestings were already finished. As indicated in Figure 3, the proportion of nests with chicks had two peaks, hence Cormorants laid eggs in summer as well. Many nests were used twice within the same season.
First data collected in 1991 revealed a mean rate of 2.78 ± 0.15 (n= 9) fledglings per nest. The fledging rate for the three laying periods in 1992 and 1993 is shown in Table 1. The number of fledglings was recorded in 75 successful broods in 1992 and 115 in 1993 (22.9% and 31.9% of the total successful broods, respectively: Grieco et al. in press).
No differences were found between the two years, nor between corresponding periods of the two years. The mean was similar among the periods of 1992, but not in 1993 (Table 2). In both years, the proportion of pairs rearing 3 or 4 chicks decreased as the season progressed (Figure 5). Most of the summer broods (laying period 3) were in previously used nests: 11 out of 13 broods in 1992 and 13 out of 19 in 1993; the others, in new nests, did not differ substantially from their own sample: 3 or 4 chicks per nest (n= 2) in 1992 and 2.33 ± 0.33 (n= 6) in 1993.
Data from laying periods 1 and 2, 1993 (n= 96) were assigned to one of three groups of trees differing in density and to one of the two areas defined in the colony. No significant differences were found among fledging rates in thick rows (2.84 ±0.08, n= 57), thin rows (3.14 ± 0.17, n= 21) and isolated trees (2.72 ± 0.11, n= 18) (Kruskal-Wallis one-way analysis, p>

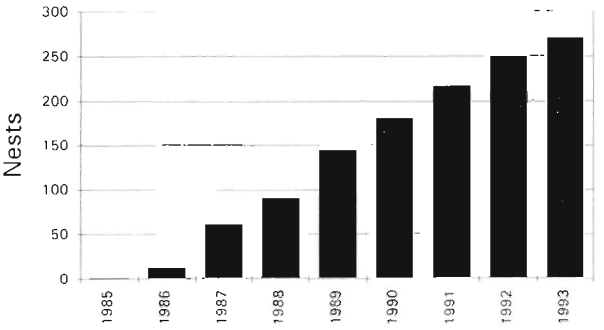

Figure 1. Maximum counts of nests at the colony of Val Campotto, 1985-1993. (From Spina et al. 1986 (1985 and 1986) and Baccetti & Brichetti 1992 (1987-1989).

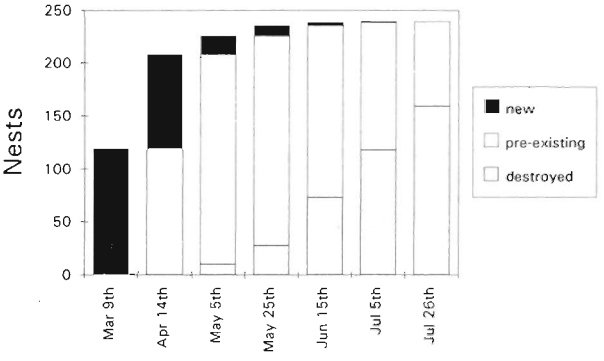

Figure 2. Phenology of nests in part of the colony (n= 240, 80% of total sites) in 1993.

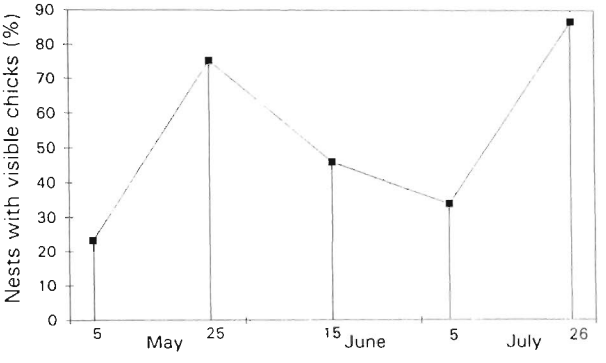

Figure 3. Percentage of nests with visible chicks in 1993. 6 May, n=224; 25 May, n= 158; 15 June, n=181; 5 July, n= 118; 26 July, n= 83.

Table 1. Mean fledgling production of 190 pairs of Cormorant, in relation to the laying periods, 1992-1993.

Year	Period	Number of nests	Mean	SE
1992	P1	42	2.86	0.12
	P2	20	2.85	0.15
	P3	13	2.62	0.21
	total	75	2.81	0.08
1993	P1	59	3.00	0.08
	P2	37	2.72	0.11
	P3	19	2.32	0.15
	total	115	2.80	0.06

Table 2. Comparison bet-ween fledgling production in broods of the different laying periods. *= p< 0.05; **= p< 0.001, Wilcoxon test.

Year	Period	p	Year	Period	p
1992-93	P1	NS	1992-93		NS
	P2-P2	NS			
	P3-P3	NS			
1992	P1-P2	NS	1993	P1-P2	*
	P2-P3	NS		P2-P3	*
	P1-P3	NS		P1-P3	**

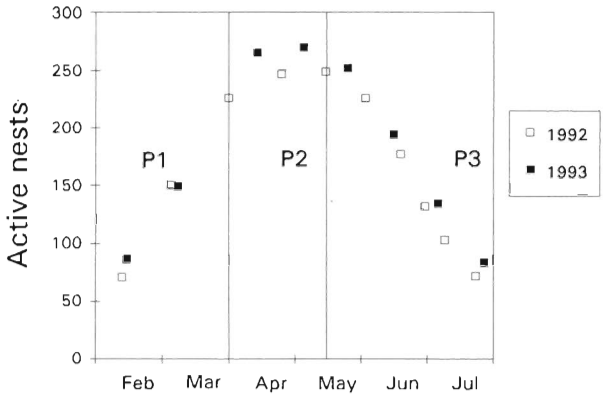

Figure 4. Active nests in 1992-93 and laying periods as defined in the text.

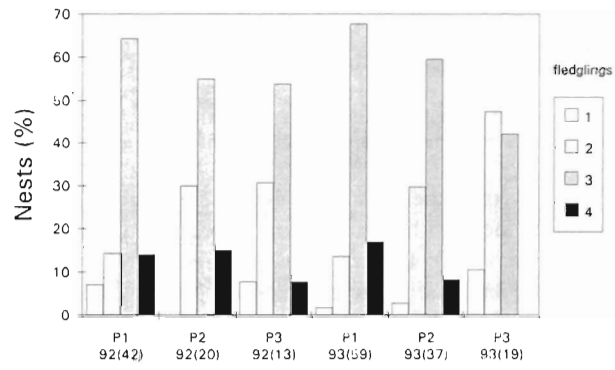

Figure 5. Fledgling production (percentage of each sample) in relation to the laying periods within the breeding seasons 1992 and 1993 (in brackets: sample size).

0.05). Similarly, no difference was found between the periphery (2.72 ± 0.11, n=18) and the centre of the colony (2.92 ± 0.08, n=78) (z= -1.33, p> 0.1, Wilcoxon test).

Loss of chicks. Predation pressure.

As most successful broods were not monitored for the whole rearing period, data on chick mortality are incomplete. However, in 1992, 17 nests belonging to laying period 1 were observed from hatching to fledging: two pairs lost one of 4 chicks observed after hatching, but the cause of loss is unknown.

During observations in the breeding seasons 1991, 1992 and 1993, no cases of egg or chick loss by predation were recorded (36 broods monitored from laying to fledging in the period February-July for a total of 1626 hours, mean 45h 10' per nest, SD= 15h 45'). Defensive behaviours against potential flying or

resting predators, Hooded Crows *Corvus corone cornix* and Herring Gulls *Larus cachinnans*, were not observed.

Further breeding attempts after successful breeding.

During surveys in 1992 and 1993, I observed adults holding the nest, as in a normal occupation of a site, while full-feathered chicks were not yet definitively fledged. Adults held sites without reacting against young in the nest and sometimes fed them. These observations suggested that some birds, having successfully bred, occupied their site and bred again. In 1992 this situation was recorded in 4 nests and in one of them the second brood was successful: three young left the nest in August. Nesting birds were not individually recognizable, as they were not ringed, so one could not verify whether the pair, or at least one of the birds, had really bred twice. In May 1992 a pair occupied its nest again when one of the chicks had not yet reached the fledging stage (eggs were probably laid in February). As both adults were sitting in the nest for a few minutes, the occupying stage was not so advanced as for other breeding pairs. One of the birds claimed the site by Wing-waving more than once. Moreover, the parents fed the young regularly and fetched a lot of nest-material. On 4 June a copulation was observed; ten days later the pair left the nest. None of the adults re-occupying nests after rearing chicks had white patches on the thighs or white elongated feathers on the crown and neck.

Discussion

The 2.8 young per nest recorded in this study is very close to the 2.95 reported from Val Campotto in 1989 (Nicosia 1991): these values suggest a rather high hatching success, as the mean clutch size is thought to be about 3-4 (Cramp and Simmons 1977, Røv 1984). Such a result is much more evident if compared with the proportion of successful broods: 328 out of 365 started in 1992, 360 out of 397 started in 1993 (Grieco et al. in press). As the survival rate of young Cormorants is unknown, it is not possible to say whether local population growth is self-sustaining. For comparison, we can consider data collected in a newly-established population of the related Double-crested Cormorant *Phalacrocorax auritus* in South Carolina. The breeding colony is inland and the number of nesting pairs and the population growth are similar to those of Val Campotto. The average of 2.2 fledglings per nest is thought to be sufficient to allow local self-sustaining population growth (Post & Seals 1991). At Val Campotto the fledging rate in 1992 was as high as in 1993, but in the latter year it decreased through the breeding season, as recorded previously for this and other species (Kortlandt 1942, Nelson 1978, Ryder 1980, Debout 1988). As most late clutches were in previously used, successful nests (initiated in late winter-early spring), lower success should not be due to nest-site quality. Moreover, the fledging rate in late nests in sites not previously used was about the same as in the others in that period. Further, no differences were found in nest success among clusters of different density, nor between central and peripheral nests. In several nesting colonies of certain Phalacrocoracidae and of other species, late nesting was thought to be by young inexperienced birds that have lower success and use the periphery of the colony (Kortlandt 1942, Nelson 1978, Potts et al. 1980, McNeil and Léger 1987, Sæther 1990). The Val Campotto colony shows a wave of summer broods as soon as the winter and spring nests are left by the young, thus summer broods are in re-occupied sites. It is possible that late nesting by inexperienced birds really occurs in this colony, as suggested by immature birds occupying sites (Baccetti & Brichetti 1992): in 1992 and 1993, 8 pairs with at least one immature mate bred successfully and many others made attempts. All these broods refer to laying periods 2 and 3 (immature birds occupied sites and formed pairs as from the middle of April). Nevertheless, the number of summer broods (71 pairs in 1992 and 85 in the following year: Grieco et al. in press) and some recorded breeding attempts after successful nesting by the same pair induce one to think that a significant proportion of the summer nestings are by experienced breeders. The very few records of summer broods with 4 chicks in the early development stage suggest that the lower fledging rate, if it really exists, might simply be due to a smaller clutch size rather than a higher mortality rate of chicks.

High fledging rates obtained in this and previous studies are also probably due to a low predation rate. Moreover, the type of predator is limited to other birds as nests are on trees over water.

The loss of chicks, also recorded in 1989 (Nicosia 1991), is not sufficient to indicate a frequent offspring-reduction strategy, as identified in the related species *Phalacrocorax aristotelis* (Snow 1960), *P. atriceps* (Williams and Burger 1979), and *P. coronatus* (Williams and Cooper 1983), which is an adjustment of breeding to food availability.

The increase of the number of breeders, verified since the establishment of the colony (Baccetti and Brichetti

1992), and the breeding success are even more significant because of the progressive falling of dead trees and the consequent lack of nesting sites: this has determined the dispersion of nests and the use of isolated trees near the banks. However, the ability of Cormorants in utilizing sites not previously used, even those made with broken trunks, has been described (Grieco et al. in press). Data from Val Campotto show the potential capability of expansion of a species whose continental European population has grown strongly in recent years.

Acknowledgments - I wish to thank the Consorzio per la Bonifica Renana, the Museo delle Valli d'Argenta and Prof. S. Frugis, Director of the Bird Observatory C.I.S.O. of Val Campotto, for assistance and logistic support during the study. I also thank E. Veronesi who helped with the fieldwork, F. Varese who prepared the figures, Dr. G. Bogliani and Prof. M. Fasola for helpful advice, Dr. M. Cucco and another referee for constructive comments on the manuscript.

Riassunto – La colonia di Cormorani *Phalacrocorax carbo* di Val Campotto (Ferrara) ha raggiunto le 270 coppie nel 1993. Nel 1992 e 1993, si è rivelato il numero di pulli involati da 190 covate. Ogni coppia è stata associata ad uno dei 3 periodi di deposizione definiti (febbraio-marzo; aprile-inizio maggio; fine maggio-luglio). Il numero medio di pulli involati per nido è stato di 2,81±0,08 (ES) nel 1992, 2,80±0,06 (ES) nel 1993. Nel 1993 il successo fu più basso per le covate tardive rispetto a quelle primaverili, ma fu simile in nidi a diversa collocazione spaziale. Nessun caso di predazione è stato osservato. I dati indicano un'ulteriore crescita della colonia. Vengono inoltre descritti alcuni tentativi di seconda covata.

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