

Nest site selection by Cormorants *Phalacrocorax carbo* at the colony of Val Campotto, NE Italy

FABRIZIO GRIECO

Via Gorizia 17 - 27036 Mortara (PV), Italy

Abstract - The phenology and structure of the nest-sites of a Cormorant colony in dead trees, during 1992-1993, are described. Sites were classified using three criteria: (1) topography of the colony; (2) density of breeding trees; (3) structure of breeding trees. Photographs were used to mark the nests during the breeding period. The number of nests increased to a peak in early May and then declined; many nest sites were used successfully by more than one pair. The structure of nest sites was more important than their position. The percentage of sites reaching the nest stage decreased during the breeding season. Adult birds showing much white on the head are more frequent in the centre of the colony. Sites taken by breeding immature-plumaged birds are like those taken by adults, but immatures seem to succeed in building nests and breeding only on sites of lower quality. Beginning from 1992 some breeding attempts occurred on sites outside the present colony. Current level of competition between Cormorants and Grey Herons which breed in the same area is low. Differences between this and a similar German colony are discussed.

Introduction

The recent establishment of the Cormorant colonies in continental Italy is probably linked with the spectacular increase in the number of breeding pairs in Central and Northern Europe and a consequent growth of the wintering population in the Mediterranean in the last 15 years (Cramp and Simmons 1977, van Eerden and Zijlstra 1991). As ringed breeding birds were observed in the colonies of Val Campotto (Po Delta, N-E Italy) and Oldenico (Piemonte, N-W Italy), the breeding populations of Cormorants in Northern Italy are thought to originate mainly from the colonies of Denmark, Germany and Sweden (Baccetti and Brichetti 1992). Cormorants are regular wintering birds at Val Campotto since the last '70s (Santucci 1978). In the past the Cormorant was almost absent as a breeding species, the first sure reference for the region of the Po Delta being the tree colony of Malalbergo in the 17th century (Aldrovandi 1603). For the 19th century information on breeding in the region is doubtful (Giglioli 1886). In 1986 the Cormorant returned to breed in trees close to freshwater marshes at Val Campotto: the colony place had been flooded only three years before (Spina et al. 1986). Artificial reservoirs also revealed their importance for providing isolated islands and flooded trees as nesting substrate for the

related *Ph. auritus*, which has shown similar recent population trends in the interior of the United States (Findholt 1988). The protection of the area guaranteed since 1976 and the characteristics of the site favoured the establishment by the early pairs.

Val Campotto is currently the most important Cormorant colony in Italy: it grew from 12 nests in 1986 to 270 in 1993. Population size, breeding success, plumage and behaviour of nesting pairs has been investigated there in recent years (Nicosia 1991, Grieco 1994), most of the data indicating continuous growth of the colony, but in the last years many nest sites disappeared because the collapse of the breeding trees, nests becoming more and more dispersed. Recent changes in nest site choice due to the lack of sites have been recorded in many colonies in central and northern Europe as well as the foundation of colonies right from the beginning and sometimes the use of artificial structures like old lighthouses (van Eerden and Gregersen 1995, Lindel *et al.* 1995). In view of the necessity to develop a management plan for the Nature Reserve and in order to evaluate the response of this population to such environmental changes, the phenology, location and structure of nest sites taken by both adult- and immature-plumaged breeding birds were investigated by means of direct counts and checks using photographs in 1992 and 1993. As reported by

Kortlandt (1942) for Dutch colonies, two year-old cormorants may pair and build nests but rarely lay eggs. At Val Campotto, nesting immatures have been seen since the establishment of the colony (Baccetti and Brichetti 1992).

Methods

Since 1986, Cormorants have nested in dead trees some 10-20 m high (*Populus sp.* and *Salix alba*). The nests are surrounded by water within a basin 130 ha wide called "Bassarone", contiguous to the semi-natural marshes of Valle Campotto and Vallesanta, which are 1600 ha wide (Santucci 1978, Piccoli 1979). The nests are 1-15 m above the water level. Breeding trees are mainly located at the centre of the basin but several birds nest in trees close to the banks. Most trees occur in rows and form groups of variable density. 30-45 pairs of Grey Herons *Ardea cinerea* breed in a scattered heronry in the reedbed of Bassarone; the nests are not placed at less than 10 m from the trees.

The colony was visited approximately every three weeks during February-July in both 1992 and 1993. Nesting sites were counted from the banks of Bassarone, over distances ranging from 80 to 400m, with 10x40x binoculars and a 20-60x zoom telescope. Each nest site was categorized as follows: (a) active nest (well built with a breeding bird or brood of young present); (b) trace nest (platform or a few fragments of material guarded by one or both adults); (c) bare site (site without nest material, guarded by a pair or a male advertising by wing-waving); or (d) empty nest (nest deserted after failure or fledging of chicks). Part of the colony, forming about 80-90% of the overall sites, was photographed 7 times during 1992 and 6 during 1993. Nesting sites were classified according to: (1) the topography of the colony and resulting in 3 areas being defined (Figure 1) - N (centre of the colony, with over 50% of the total nests), E1 (trees close to the banks) and E2 (trees farther from banks than some E1 trees); (2) the density of trees, classified as isolated, thin rows (trees not in contact with each other) and thick rows (trees in closer contact); (3) the structure of nest sites, classified as (I) primary and (II) secondary branches, sloping (III) and horizontal (IV) broken trunks, or stumps (V) at a very short height above water level (1-2 m). Type-V site is the last possibility of using trees after they have fallen down.

The proportion of sites reaching the nest stage could be estimated by comparing bare sites mapped on the photographs with nests on the following check. As birds were not individually recognizable, some unsuccessful pairs moved from site to site without being identified, so this method will not consider pairs

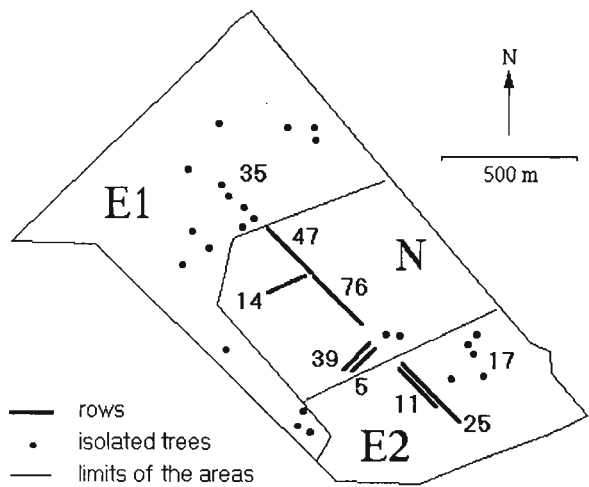


Figure 1 - Characteristics of the colony area. Numbers: active nests in 1993.

occupying a site during the period between two surveys. In this paper the term "phenotype *sinensis*" refers to adult birds showing a great amount of white elongated feathers on the crown and the neck, as in type-4 and -5 birds described by van Eerden and Munsterman (1986).

Results

Nest phenology

At Val Campotto, the earliest pairs occupying sites were seen in mid-January, but the highest rate of occupancy was in February and March (Figure 2). A few isolated trees in E1, with several type-I and -II sites, were colonized earlier than several central trees. During 1992, the number of active nests increased by

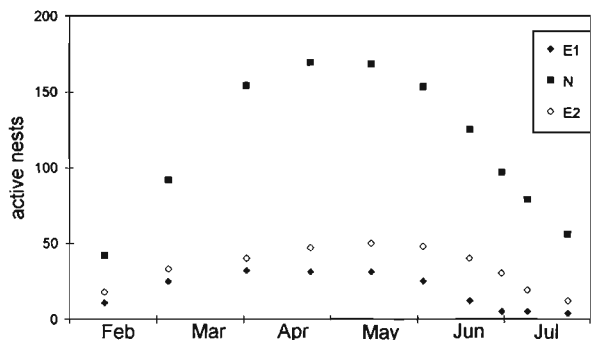


Figure 2 - Counts of active nests within 3 areas of the colony as in Fig. 1, 1992.

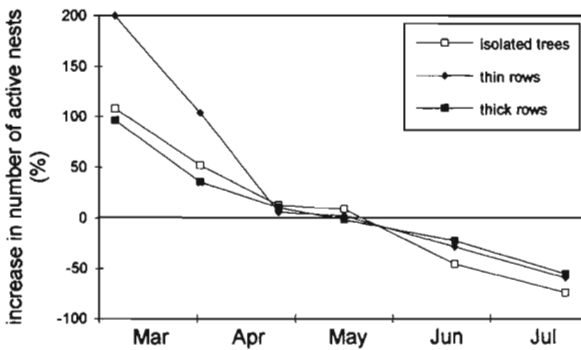


Figure 3 - Percentage variation of the number of nests in 3 clusters of trees, 1992.

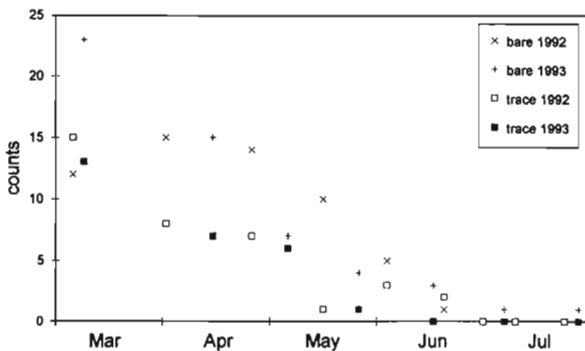


Figure 4 - Counts of bare sites and trace nests, 1992-93.

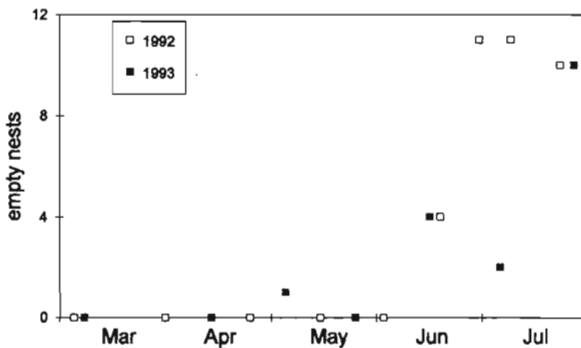


Figure 5 - Counts of empty nests, 1992-93.

127% in E1, 119% in N and 83% in E2 in February; by 28%, 67% and 21% in March; by -3%, 9% and 17% in April respectively. In early May, only E2 showed further increases, though by 6% only (test on absolute increases in March, April and early May: $\chi^2 = 16.0$, $df = 4$, $p < 0.01$). Between 9 March and 14 April 1993, active nests increased by 42%, 83.3% and 92.6% respectively; data before March are lacking. In March

and early April 1992, thin rows showed twice the increase of the other categories (Figure 3). Although the difference was not statistically significant (test on absolute increases: $\chi^2 = 6.53$, $df = 4$, $p = 0.05$ for 1992; $\chi^2 = 3.62$, $df = 2$, $p = 0.05$ for 1993), it was recorded in both years. The overall number of active nests increased to a peak in early May and then declined strongly before August (Figure 2). Most of nests were re-occupied by May: sometimes pairs having bred successfully in spring took their site again when chicks had reached the fledging stage (Grieco 1994). From June onwards new nests were not seen, as in Figure 4 showing bare sites and trace nests (a more advanced nesting stage). Breeding was completed in mid-September.

Nests were both started and disappeared throughout the breeding season, the material being stolen by neighbouring pairs or both adult and immature intruders. Thus empty nests were seen in the last period of the season (Figure 5). Empty nests as considered in the overall season were more frequent in E1 than in other areas ($\chi^2 = 36.9$, $df = 2$, $p < 0.01$ for 1992; $\chi^2 = 10.1$, $df = 2$, $p < 0.01$ for 1993).

Nest-site choice

Table 1 shows the results of the counts of nest sites during the two seasons. Active nests are obviously a measure of the size of a certain part of the colony; trace nests and bare sites also indicate whether a part or group of trees is preferred or not by nesting birds. Empty nests are usually visible where the competition for obtaining nest-material is low, as they are not destroyed by birds collecting material.

Cumulative counts of bare sites and trace nests were compared with the maximum counts of active nests (early May). The 3 areas defined within the colony showed proportions of active nests, trace nests and bare sites similar to each other (Table 1) ($\chi^2 = 0.62$ for 1992, $\chi^2 = 2.67$ for 1993, $df = 2$, $p = 0.05$). These proportions did not vary between the two years ($\chi^2 = 0.07$ for active nests; $\chi^2 = 0.37$ for trace nests; $\chi^2 = 0.64$ for bare sites, $df = 2$, $p = 0.05$).

Similarly, thick rows, thin rows and isolated trees showed proportions of active nests, trace nests and bare sites similar to each other (Table 1. $\chi^2 = 1.76$ for 1992, $\chi^2 = 3.24$ for 1993, $p = 0.05$); no yearly variations were found ($\chi^2 = 3.52$ for active nests; $\chi^2 = 0.91$ for trace nests; $\chi^2 = 2.41$ for bare sites, $df = 2$, $p = 0.05$). The difference in the number of nests in thin rows between 1992 and 1993 is due to a high number of available, not previously used, type-V sites within a central tree row.

Figure 6 shows the proportion of types of site for nests started before particular dates in 1992 and 1993,

Table 1. Counts in 3 areas of the colony and in 3 clusters of trees of different density, 1992-93. Numbers of active nests refer to the maximum counts; the others are cumulative counts for each season.

Area	Active nests		Empty nests		Trace nests		Bare sites	
	1992	1993	1992	1993	1992	1993	1992	1993
E1	31	35	15	7	4	5	3	1
N	168	182	7	8	23	20	40	43
E2	50	52	3	2	9	2	13	11
Cluster	1992	1993	1992	1993	1992	1993	1992	1993
isolated trees	50	52	18	7	4	6	11	8
thin rows	62	77	-	4	9	10	14	21
thick rows	137	140	7	6	23	11	31	26

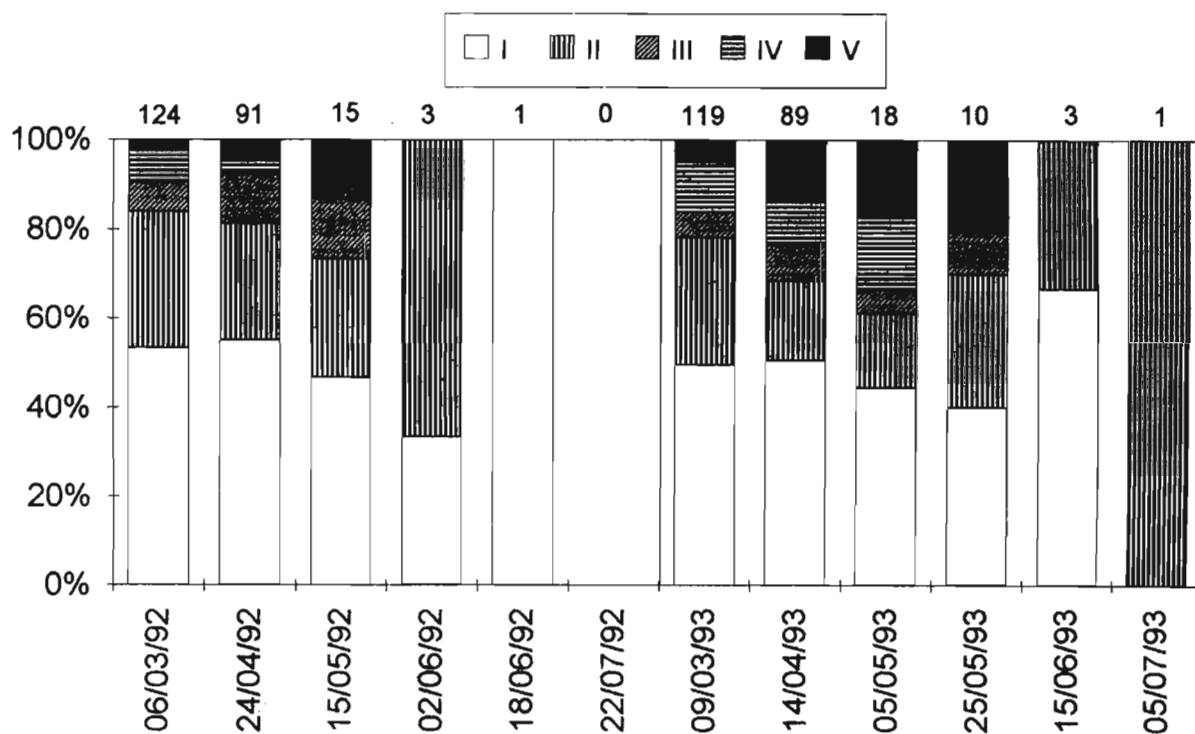


Figure 6 - Distribution of the 5 nest-site types in nests started at each date, 1992-93. Data refer to over 80% of the colony.

respectively. The proportion of each type did not vary significantly through the season; however, from May 1992 to May 1993 the colony showed a decline of type-II sites and a greater frequency of type-III, -IV and -V sites ($\chi^2 = 9.75$, $p < 0.05$).

Sites reaching the nest stage

Of 54 bare sites taken by males or pairs and marked on photographs in 1992, 30 (55.5%) reached the active nest stage. In 1993 of 46 bare sites, 25 (54.3%)

reached the nest stage. This ratio ranges from 30.0% (early June 1992) to 69.6% (early April 1993): early occupancy was more likely to result in an active nest ($r_s = -0.857$, $p < 0.05$, $n = 7$).

Nest site selection in relation to plumage characters

Adult birds with a great amount of white feathers on the head and birds almost entirely black were observed nesting early in the season (February) and in the same peripheral tree. In the first decade of March, birds

showing phenotype *sinensis* were 25% in a peripheral tree of E1 (n = 20 in 1992, n = 14 in 1993), 37% in N (n = 124 in 1994; E. Veronesi pers. comm.) and 49% in the thickest row of N and of the entire colony (n = 41 in 1993).

In 1992 and 1993 several sites were occupied by a single immature, a pair comprising of one immature and one adult or two immatures that were paired; some of the pairs also bred. As birds were not ringed, the exact age of immatures was unknown.

Immatures occupying sites were seen from April until July, the highest sighting rate being in May (Table 2) while the highest sighting rate of bare sites taken by adults occur earlier (see Figure 4). Overall, 12 and 17 bare sites were occupied by immatures and 4 (3 successful) and 6 (5 successful) nests in 1992 and 1993, respectively. Differences between distribution of bare sites occupied by normal adult pairs and "immature + adult" pairs in different areas and in different groups of trees were not significant ($\chi^2 = 2.81$ and $\chi^2 = 0.87$ respectively, $df = 2$, $p = 0.05$, data of both years added; see Table 3). In 1992 and 1993 only a few "immature + adult" pairs bred; however, out of 10 nests observed, 4 were in isolated trees, 4 in

thin rows and only 2 in thick rows (see Table 1 for comparison with distribution of active nests). Three nests were located in E1, 6 in N and one in E2. Of these nests, 4 were the type-V sites within N.

Discussion

As showed in Figure 2, the number of nests decreases by 70% before August, thus estimates at the end of the season would differ greatly to those of a large Dutch colony on trees, where winter counts provided an estimate of at least 80% of the number of breeding pairs in the summer before (van Eerden and Zijlstra 1985). Counts of nests and trace nests in early May provide the most accurate index of population size, similarly to counts in the Polish colonies (Przybysz 1991), while counts in mid-June provide a good estimate of summer breeding pairs. Counts of sites used, obtained from photographs (283 sites in 1992 season and 300 in 1993: Grieco *et al.* in press), give a ratio of 1.13 sites per pair for 1992 and 1.09 for 1993 (pairs were estimated by counts of active and trace nests in early May). Nevertheless, a lot of sites are successfully used twice during a season. If individuals from any pairs lay eggs twice, the sites/pairs ratio is likely to be <1.

The breeding season start earlier than in the colony of Ismaning (Bavaria, Germany) founded in 1980, in which nests start at the 3rd decade of February (at Val Campotto most of nests are already at the egg stage). The nest occupation lasts until early May while at Ismaning it terms in mid-April (Hashmi 1988). These two populations should be definitively independent from their probable originary cohorts, latitude and environmental conditions affecting directly their breeding cycle. The growth rate at Val Campotto in early years ($N_t = 20.49 e^{0.38t}$, based on the years 1986-1992) was like that at Ismaning, but the S-curve model ($N_t = 376 e^{-3.54t}$, based on the years 1986-1994) indicates a carrying capacity much higher (111 pairs at Ismaning calculated 7 years after foundation) resulting probably from a more favourable structure and productivity of the ponds surrounding the colony (Comacchio lagoon is about 20 km from Val Campotto). The medians of nest occupation are placed in the same period of the season (2nd half of March) but at Val Campotto the time of highest percentage of breeding plumage adults falls earlier (20/1/94: 51%; 11/3: 93%; 4/4: 61%; 7/5: 44%, $n > 100$ for each count, E. Veronesi pers. comm.). This may be induced by differences in daylength between regions in late winter (see van Eerden and Munsterman 1986 for wintering birds).

Failure of bare sites is in accordance with failure of active nests: during both 1992 and 1993, frequency of

Table 2. Counts of bare sites occupied by immatures advertising or pairs comprising of at least one immature-plumaged bird, 1992-93. In brackets: number of surveys.

Month	1992		1993	
	birds advertising	pairs	birds advertising	pairs
March (1)	0	0	0	0
April (1)	2	2	1	1
May (2)	5	1	6	4
June (2)	1	0	2	2
July (2)	1	0	1	0

Table 3. Distribution of bare sites occupied by adult males or pairs and immatures or "immature + adult" pairs, 1992-93.

	1992		1993	
	adult	immature	adult	immature
E1	2	1	-	1
N	36	4	32	11
E2	9	4	7	4
thick rows	24	7	19	7
thin rows	13	1	16	5
isolated trees	10	1	4	4

failure of nests started in May-June was higher than that of the early ones. Failure of broods might occur at various stages, and it is also due to the falling of breeding trees (13 records in 1992 and 19 in 1993, Grieco *et al.* in press).

Part of nest-sites is replaced each year. About 18% of sites used in 1992 were deserted in 1993, and the new sites used in 1993 compensated exactly for those deserted or lost with the collapse of trees in 1992. In the last 3 years more and more pairs have nested in peripheral trees (Grieco *et al.* in press). The intensive and early use of peripheral trees shows the importance of nest-site quality, irrespective of the topography of the colony. Cormorants are able to exploit new areas both in wintering (Suter 1989, van Eerden and Zijlstra 1991, Geroudet 1991, Martucci and Consiglio 1991, Debout 1992) and in establishing new settlements (Brichetti 1982, van Eerden and Zijlstra 1985, Commecy 1989, Ibañez 1992, Kotlarz 1993), even for the more sedentary *Ph. c. carbo* (Cramp and Simmons 1977, Debout 1988). Social factors affecting site-selection are not so strong as in other colonial seabirds (see Nelson 1967 and Nelson 1978 for *Sula bassana*). From a topographical point of view, Cormorants choose their sites rather regularly. Peripheral areas and the centre are occupied in the same phase of the season, trees close to the banks are also used by pairs nesting late in summer. Density of sites appears to be not very important: if tree groups of intermediate density are really occupied later than others, it may be due to a relatively low number of sites of best quality (type-I and -II). However, a small number of nests are usually built very late in the season (June) in not previously used type-I and II sites in central rows. So sites located in the upper part of trees are not necessarily occupied early in the season.

Percentage of birds showing *sinensis* phenotype is higher in the centre of the colony; difficulties in understanding the role of nuptial signals are from: 1) age affecting or not the amount of white feathers on the head; 2) possible polymorphism in the species (black specimens nesting in February did not become white in the weeks later, Marion 1995); 3) lack of sites and consequent competition probably conceals any hierarchy if really existing.

Like at Ismaning, immatures build nests late in the season even though success is not verified there (Hashmi 1988). The quality of sites chosen by pairs comprising of an immature does not differ from that of the others. Nevertheless they seem to succeed in building nests on sites of low quality even though within the central area. This is probably because pairs nesting late in the season cannot obtain sites of better quality at the centre of the colony (see also Kortlandt

1942, Lack 1954, Coulson 1968, Ryder 1980, Marion 1983).

Interactions between Cormorants and Grey Herons are not so strong as at Ismaning: Herons did not nest in dead trees in any year, and Cormorants deserted reedbeds until 1994 when some pairs bred there (Grieco and Veronesi in press). In the last 5 years Heron number have not decreased, although in the future competition for obtaining nest sites in reedbeds might occur between the two species.

Data collected hitherto at Val Campotto indicate that the only limiting factor for this population is likely to be the availability of trees surrounded by water. In the future, it will be more and more difficult to distinguish between central and peripheral groups within the colony. Rows will become thinner, and large groups of peripheral nests might become more important than some central zones lacking of tipe-V sites and form real subcolonies. The proportion of sites used twice during a season should increase, as trees fall down, and in light of the growing breeding population. Moreover, Cormorants will use more and more Type-IV and -V sites: nevertheless these sites are not only few, but they might be easily flooded by rising water. Most of the banks of the marshes are too disturbed to support nesting Cormorants, and trees within the marsh of Valle Campotto are scarce. The first breeding attempt outside Bassarone was recorded in 1992: in mid-April a pair occupied unsuccessfully the top of a disused iron framework surrounded by water, about 1 Km S-W of the centre of the colony. In April 1993 a pair nested in a willow on the southern bank of Bassarone. The nest (type-II site) was about 12 m above ground, as far as possible from the footpath on the bank. Two young fledged in mid-June. Cormorants might soon form new settlements in the area: (a) on iron frameworks over water within Bassarone and Valle Campotto (these are now being used as resting sites); and/or (b) in the wet wood of Traversante, about 2 km south of the present breeding place. Nests in frameworks would be greatly dispersed and regular replacement of nest-sites would be more difficult; the unsuccessful "experiment" of 1992 was not repeated. On the other hand, in the wood of Traversante, a number of high and aged poplars could be good sites for Cormorants, and presence of visitors walking there is extremely lower than at Bassarone. However, the wood, except its parts close to the pond called "Cavone", is not surrounded by water, hence it is probably not a so good breeding place.

Acknowledgments - I wish to thank the Consorzio per la Bonifica Renana and Prof. Sergio Frugis, Bird Observatory of Val Campotto, for assistance and logistic support. I also thank Eva Veronesi and Dr. Christian Migliorati who helped with the

fieldwork, Fabrizio Varese and Fabrizio Borsani who prepared the figures, two anonymous referees for comments to the manuscript and for the improvement of the English.

Riassunto - Sono state studiate la fenologia e la struttura dei siti di nidificazione in una colonia di Cormorani su alberi, negli anni 1992 e 1993. I siti sono stati classificati secondo: (1) la topografia della colonia; (2) la densità degli alberi; (3) la struttura degli alberi. Mediante fotografie sono stati marcati i siti durante la stagione riproduttiva. Il numero di nidi aumenta fino alla prima metà di maggio per poi diminuire; molti nidi vengono usati con successo da più di una coppia. La struttura dei siti si rivela più importante della loro posizione. La percentuale di siti che raggiungono lo stadio del nido diminuisce durante la stagione. Gli adulti molto bianchi sul capo sono più frequenti nel centro della colonia. I siti occupati da immaturi sono simili a quelli occupati da adulti, ma gli immaturi hanno successo solo in siti di qualità minore. A partire dal 1992 si sono avuti tentativi di nidificazione all'esterno dell'attuale colonia. L'attuale competizione tra Cormorani e Aironi cenerini che nidificano nella stessa area è scarsa. Vengono discusse le differenze tra questa e una simile colonia su alberi in Germania.

References

- Aldrovandi U. 1603. Ornitologia, sive avium Historia. Bononiae, liber XX, t. III: 368.
- Baccetti N. and Brichetti P. 1992. Cormorano *Phalacrocorax carbo*. In: Brichetti P., P. De Franceschi and N. Baccetti (eds). Fauna d'Italia XXIX Aves. Calderini, Bologna: pp.99-112.
- Brichetti P. 1982. Tentativo di nidificazione di Cormorano *Phalacrocorax carbo* nelle Valli di Comacchio (Emilia Romagna, Italia). Riv. It. Orn. 52: 61-64.
- Commeçy X. 1989. Le Grand Cormoran *Phalacrocorax carbo* nicheur en Picardie continentale. L'Oiseau et R.F.O. 59: 197-200.
- Coulson J.C. 1968. Differences in the quality of birds nesting in the center and on the edge of a colony. Nature 217: 211-227.
- Cramp S. and Simmons K.E.L. (Eds.). 1977. Birds of Western Palearctic. Vol. I. Oxford Univ. Press, Oxford.
- Debout G. 1988. La biologie de reproduction du Grand Cormoran en Normandie. L'Oiseau et R.F.O. 58: 1-17.
- Debout G. 1992. L'utilisation des repaires et des dortoirs en période internuptiale par le Grand Cormoran *Phalacrocorax carbo*. L'Oiseau et R.F.O. 62: 37-51.
- Eerden M.R. van and Zijlstra M. 1985. Aalscholvers *Phalacrocorax carbo* in de Oostvaardersplassen, 1970-85. Limosa 58: 137-143.
- Eerden M.R. van and Munsterman M.J. 1986. Importance of the Mediterranean for wintering Cormorants *Phalacrocorax carbo sinensis*. NATO ASI Series, Vol. G 12 Mediterranean Marine Avifauna. Springer-Verlag, Berlin Heidelberg: 123-141.
- Eerden M.R. van and Zijlstra M. (Eds.). 1991. Proceedings workshop 1989 on Cormorants *Phalacrocorax carbo*. Rijkswaterstaat, Directorate Flevoland, Lelystad.
- Eerden M.R. van and Gregersen J. 1995. Long-term changes in the northwest European population of Cormorants *Phalacrocorax carbo sinensis*. Ardea 83: 61-78.
- Findholt S.L. 1988. Status, distribution and habitat affinities of Double-crested Cormorant nesting colonies in Wyoming. Colonial Waterbirds 11: 245-251.
- Géroutet P. 1991. Le système hivernal du Grand Cormoran (*Phalacrocorax carbo*) dans le haut bassin du Rhône. Nos Oiseaux 41: 145-164.
- Giglioli E. H. 1886. Avifauna Italica. Le Monnier, Firenze.
- Grieco F. 1994. Fledging rate in the Cormorant *Phalacrocorax carbo* at the colony of Val Campotto (Po Delta, N-E Italy). Avocetta 18: 57-61.
- Grieco F., Frugis S. and Groppali R. in press. Studio della colonia di Cormorani *Phalacrocorax carbo* nidificanti in Val Campotto: una proposta metodologica. Suppl. Ric. Biol. Selv. 22, Ozzano Emilia.
- Grieco F. and Veronesi E. in press. Accertata nidificazione di Cormorano *Phalacrocorax carbo* in canneto a Val Campotto (Emilia-Romagna). Riv. It. Orn. 64: 168-170.
- Hashmi D. 1988. Ökologie und Verhalten des Kormorans *Phalacrocorax carbo sinensis* im Ismaninger Teichgebiet. Anz. orn. Ges. Bayern 27: 1-44.
- Ibañez F. 1992. Nidification du Grand Cormoran, *Phalacrocorax carbo*, dans le Marais Breton. Alauda 60: 113.
- Kortlandt A. 1942. Levensloop, samenstelling en structuur der Nederlandse aalscholverbevolking. Ardea 31: 175-280.
- Kotlarz B. 1993. Kolejna naziemna kolonia kormoranów (*Phalacrocorax carbo*) w Polsce. Notatki Ornitol. 34: 169-171.
- Lack D. 1954. The natural regulation of animal numbers. Oxford Clarendon.
- Lindell L., Mellin M., Musil P., Przybysz J. and H. Zimmerman 1995. Status and population development of breeding cormorants *Phalacrocorax carbo sinensis* of the central European flyway. Ardea 83: 81-92.
- Marion L. 1983. Problèmes biogéographiques, écologiques et taxonomiques posés par le Grand Cormoran *Phalacrocorax carbo*. Rev. Ecol. (Terre Vie) 38: 65-99.
- Marion L. 1995. Where two subspecies meet: origin, habitat choice and niche segregation of Cormorant *Phalacrocorax c. carbo* and *P.c. sinensis* in the common wintering area (France), in relation to breeding isolation in Europe. Ardea 83: 103-114.
- Martucci O. and Consiglio C. 1991. Activity rhythm and food choice of cormorants (*Phalacrocorax carbo sinensis*) wintering near Rome, Italy. Le Gerfaut 81: 151-160.
- Nelson B. 1967. Cliff nesting in the Gannet. Ardea 55: 60-90.
- Nelson B. 1978. The Gannet. Berkhamsted.
- Nicosia E. 1991. Indagine sull'ecologia del Cormorano in Valle Campotto (FE) durante il periodo riproduttivo. In: AA.VV. "Delta del Po. Relazione conclusiva". Università di Parma, Dip. Biol. e Fisiol. Gen. (non pubbl.).
- Piccoli F. 1979. Flora e vegetazione delle Casse di Campotto e Vallesanta. Lavori S.I.B. Nuova serie, 6: 231-263.
- Przybysz J. 1991. Uwagi do metodyki badan liczebności kormoranów (*Phalacrocorax carbo*). Notatki Ornitol. 32: 115-118.
- Ryder J.P. 1980. The influence of age on the breeding biology of colonial nesting seabirds. In: Burger J., B.L. Olla and H.E. Winn (Eds.) Behavior of marine animals, vol. 4: marine birds, pp. 153-168.
- Santucci D. 1978. Le Valli di Argenta e Marmorta. Oasi di protezione della fauna e della flora. Natura e montagna 4: 13-25.
- Spina F., Bolognesi F., Frugis S. and Piacentini D. 1986. Il Cormorano, *Phalacrocorax carbo sinensis*, torna a riprodursi nell'Italia continentale: accertata nidificazione in Val Campotto (Ferrara). Riv. It. Orn. 56: 127-129.
- Suter W. 1989. Bestand und Verbreitung in der Schweiz überwinternder Kormorane *Phalacrocorax carbo*. Orn. Beob. 86: 25-52.