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CRECHING BEHAVIOR OF BRANDT'S CORMORANT CHICKS[1]

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Abstract. Creching behavior of Brandt's Cormorant (*Phalacrocorax penicillatus*) chicks was studied at Southeast Farallon Island, California, in July and August 1984. Three stages of creching were described: (1) nest-site creches involved small chicks (10 to 25 days old) from adjacent nests huddling on nest sites before and just after parents stopped continuous attendance of chicks; (2) subcolony creches involved medium-sized chicks (over 20 days old) standing together between nest sites and on the periphery of natal subcolonies; and (3) fledgling creches involved large chicks (over 25 days old) from several subcolonies standing together outside of subcolonies and nearer to the ocean. Nest-site creches occurred mainly at night and probably have a thermoregulatory function. Fledgling creches occurred throughout the day and night and may facilitate fledging behaviors. Chicks in fledgling creches entered the ocean, swam, dove, bathed, and returned to these creches where they were fed by adults up to and beyond the time when they could fly.

Key words: Creche; Brandt's Cormorant; Phalacrocorax penicillatus; *thermoregulation; fledgling; roost.*

INTRODUCTION

Creching (the formation of groups of chicks from two or more broods in or adjacent to the breeding colony) occurs in most penguins, all ground-nesting pelicans, several gulls and terns (reviews in Evans 1980, 1984a; Davis 1982), and in several species of waterfowl (reviews in Gorman and Milne 1972, Munro and Bedard 1977). Adaptive functions advanced for creching include thermoregulation and protection from predation, permitting chicks to be left unattended while both parents forage. Other explanations consider creching to be accidental outcomes of crowding or aggressive territorial encounters. Although creching is well-known in the Pelecanidae, it has not been studied in the Phalacrocoracidae. Nevertheless, this behavior may be widespread in cormorants. For example, Shag (*Phalacrocorax aristotelis*) and Crowned Cormorant (*P. coronatus*) chicks are known to form creches in the late chick period (Snow 1963, Williams and Cooper 1983) and Double-crested Cormorant (*P. auritus*) chicks are known to form creches in response to disturbances (Lewis 1929, Mendall 1936, Brechtel 1983). In this paper, we describe creching behavior in Brandt's Cormorant (*P. penicillatus*) chicks on Southeast Farallon Island (SEFI), California.

METHODS

From 28 July to 29 August 1984, we observed creching behavior from a blind overlooking a colony of Brandt's Cormorants (composed of 10 spatially distinct subcolonies) on a rocky peninsula on the northwest side of SEFI (Fig. 1). Most nests were placed on rocky or dirt substrates with little or no slope, although some nests were placed on flat areas within steeper slopes (subcolonies 3, 5, 6, 9, and 10). We monitored chick locations and activities daily from 28 July to 9 August (Period 1) and every second day from 11 to 29 August (Period 2). In Period 1 (early chick period), we observed chicks in 1-hr sessions every other hour from 05:30 to 20:30 (PDT) for nine full days and on two other days where the first session was missed. During Period 2 (late chick period), we observed chicks in 2-hr sessions twice per day (10:30 to 12:30 and 18:00 to 20:00) on every second day. The durations of creches at nest sites were determined during Period 1. If they were present during the first 30 min of an hourly session but broke up before the end of the hour they were classed as being 0.1 to 1.0 hr long. Those still present at the same site at the start of the next session were classed as

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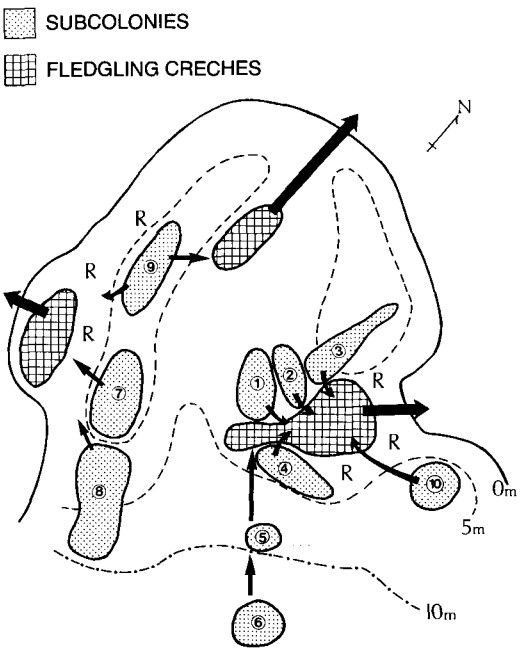

FIGURE 1. Schematic map of the Brandt's Cormorant colony showing locations of 10 subcolonies (see Table 1) and three large fledgling creches on a peninsula on the northwest side of SEFI. Small arrows indicate directions of movement of banded chicks from nests to fledgling creches. Large arrows indicate directions of movement from fledgling creches to the ocean. Letter R indicates night roosting areas used by AHY birds. Dashed lines indicate approximate elevations.

being at least 2.1 to 3.0 hr long. Those not present were classed as being 1.1 to 2.0 hr long, and so on. We disregarded creches that lasted less than 5 min. We defined overnight creches as those present at the same site during the last evening count (20:30) and at least during the first morning count of the following day (05:30). We counted all after-hatching-year (AHY) birds present in and near subcolonies during each session. Ambient weather conditions at SEFI, including wind speed and direction, air temperature, and cloud cover were monitored daily at 08:00, 12:00, 16:00, and 20:00. We considered chicks to be fledglings between the time that they first entered the water to when they left the colony area. During this period, chicks developed the ability to fly.

On 25 July, we banded 149 chicks with individually color-taped color bands, another color band indicating hatching year, and an incoloy USFWS band. On 16 August, we banded another 63 chicks (without the color-taped bands). Banding was performed at night (00:45 to 03:00) in order to reduce disturbance and to minimize predation of eggs and small chicks by Western Gulls (*Larus occidentalis*). Chicks were banded at a slightly earlier age than usual (see Boekelheide et al., in press), enabling us to band many chicks on natal nests. We searched for individual chicks between 25 and 27 July and confirmed the location of many natal nest sites. On 25 July (after the first banding), we counted the number of well-built nests, chicks, and eggs visible from the blind in each of nine subcolonies (Table 1). During the first banding, we found about 50 to 60 chicks in areas out of view of the blind (including subcolony 10 and part of subcolony 8) and about 20 chicks were mobile enough to escape our capture attempts.

TABLE 1. Numbers of active nest sites and nest-site creches of Brandt's Cormorants at nine subcolonies on SEFI in 1984.

Subcolony[1]	25 July census[2]			Nest-site creches[3]		
	Nest sites	Number chicks	Number eggs	Number observed	% sites used	% attended by adult(s)
1	18	24	3	37	55.6	81.1
2	7	9	0	10	71.4	60.0
3	37	53	5	—	—	—
4	4	8	0	20	75.0	90.0
5	3	5	0	9	66.7	88.9
6	14	20	0	39	50.0	53.8
7	35	56	7	119	62.9	72.3
8	19	13	0	4	15.8	75.0
9	23	27	7	—	—	—
Total	160	215	22	238	52.0	72.3

[1] See Figure 1 for locations.
[2] Well-built nests with eggs or chicks.
[3] During Period 1 (28 July to 9 August). Subcolonies 3, 9, and 10 were not followed (see text).

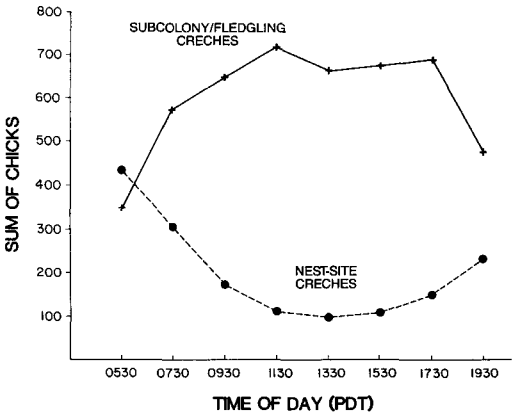

FIGURE 2. Number of Brandt's Cormorant chicks present in nest-site and other creches at 2-hr intervals through the day, expressed as the total sum of chicks participating between 28 July and 9 August.

RESULTS

NEST-SITE CRECHES

Nest-site creches were the first indication of creching behavior. These creches were composed of small, relatively immobile chicks (about 10 to 25 days old) from adjacent nests (confirmed with banded chicks) which huddled closely while sitting or lying down together on and about a nest bowl. Nest-site creches occurred before and just after parents stopped continuous attendance of chicks at nest sites (when parents returned only to feed chicks). Attending parents, which stood beside the nest or on the edge of the nest bowl, only rarely interfered with neighboring chicks as they joined a nest-site creche. During Period 1, we recorded 238 nest-site creches at 52 nest sites in the seven subcolonies we observed (Table 1). They occurred at 52.0% of the 100 nest sites followed, ranging between 15.8 and 75.0% of sites in each subcolony. They often occurred at the same sites (mean [±SD] number of creches/site = 4.6 ± 3.8, range = 1–15), up to three times/day, and over several days (mean [±SD] days site used = 3.4 ± 2.2, range = 1–8). In 334 counts of the 238 nest-site creches on 11 days, creche size ranged from two to 14 chicks, averaging 4.5 ± 1.9 (SD) chicks. Most (72.3%) of the 238 nest-site creches were attended by adult(s) when first recorded (within 1 hr of initiation), ranging between 53.8 and 90.0% in different subcolonies (Table 1). Creche sites occurred widely in each subcolony, although several adjacent sites were used interchangeably by the same banded chicks. Nest-site creches tended to occur wherever at least two nests with similar-aged chicks were close together (≤2 m). Banded chicks did not move more than 2 to 3 m from their natal site, so there was no interchange of chicks between subcolonies.

During Period 1, the number of chicks in nest-site creches changed significantly throughout the day (One-Way ANOVA: $F = 9.23$, df = 8, $P < 0.001$; Fig. 2). More birds were involved in nest-site creches at the 05:30 count than at other times of day (Tukey's range test, $P < 0.05$). From 11:30 to 15:30, numbers of birds in nest-site creches were similar ($P > 0.05$). Nest-site creches thus occurred mainly at dawn and dusk; presumably many formed throughout the night. We recorded 21 overnight creches at 13 sites. These had a mean duration of 14.4 ± 2.1 (SD) hr. Diurnal nest-site creches averaged 1.9 ± 1.3 (SD) hr and ranged from 5 min to at least 9 hr ($n = 181$ nest-site creches over nine full days). They frequently broke up during late morning and early afternoon when adults returned to feed their chicks and drove other chicks from the nest. In addition, nest-site creches not attended by adults often were disrupted by subadult birds wandering through the colony stealing nest material or attempting to usurp nest sites (see Boekelheide et al., in press). When disbanded by AHY birds, nest-site creches usually reformed nearby. Chicks also left these groups to beg from parents and often returned to nest-site creches after being fed.

During Period 1, the number of chicks in nest-site creches was negatively correlated with ambient temperature ($r = -0.45$, $n = 45$, $P < 0.01$). Strong negative correlations occurred on 6 August ($r = -0.98$, $n = 4$, $P < 0.05$) and 7 August ($r = -0.94$, $n = 5$, $P < 0.05$). On these days, temperatures ranged from 12.3° to 15.5°C and 12.1° to 15.8°C, respectively. The number of chicks in nest-site creches was not correlated with wind speed ($r = 0.01$, $n = 51$, $P > 0.05$) or cloud cover ($r = 0.09$, $n = 49$, $P > 0.05$), despite the study colony being located on the most exposed part of SEFI. However, these variables did not show a marked diel pattern as did temperature.

SUBCOLONY AND FLEDGLING CRECHES

Subcolony and fledgling creches were composed of medium- to large-sized chicks (over about 20 days old). Smaller subcolony creches formed first in large spaces between nests within subcolonies and around subcolony edges after parents had

stopped continuous attendance of chicks and involved chicks from the same subcolony standing in loose associations (or rarely huddled). Larger fledgling creches formed outside subcolonies shortly after subcolony creches had become common, and involved chicks from several subcolonies. During Period 1, we recorded 128 subcolony (mainly) and fledgling creches. Since chicks in small subcolony creches were fairly mobile, creche locations shifted continuously, making it difficult to determine their durations. In 510 counts of the 128 subcolony and fledgling creches on 11 days, these creches ranged in size from two to 34 chicks, averaging 9.3 ± 5.7 (SD) chicks/creche. Larger fledgling creches (up to 78 chicks) formed later in Period 2 when chicks from several subcolonies grouped farther from subcolonies and nearer to ocean access points at three permanent locations (Fig. 1). Chicks were relatively inactive in subcolony creches, spending most of the time walking, preening, sleeping, and picking up pebbles and displaced bits of nesting material. Chicks not yet able to fly were observed entering the ocean, swimming, diving, bathing, and returning to fledgling creches. They often were observed preening and using spread-wing postures after being in the water.

During Period 1, numbers of chicks participating in subcolony (mainly) and fledgling creches tended to increase during the day and decrease toward dusk (Fig. 2), although differences were not significant (One-Way ANOVA: $F = 0.62$, $df = 8$, $P > 0.05$). This resulted partly from temporary breakups of nest-site creches during the day when these chicks sometimes formed subcolony creches for short periods. After parents stopped continuous attendance of chicks, chicks began to spend all day and night in fledgling creches outside subcolonies. This resulted in little interchange of chicks between nest-site and other creches (confirmed with banded chicks). It appeared that subcolony creches were part of a transitional stage between nest-site and fledgling creches. For a few days during this transition, chicks would return to nest sites at dusk and then return to fledgling creches shortly after dawn. Adults fed chicks during the day, often leading (or being chased by) medium-sized chicks part or all the way back to their nest sites before feeding them. However, older chicks and fledglings were fed within or on the periphery of fledgling creches. Often several chicks would approach and beg weakly from an adult returning to feed chicks

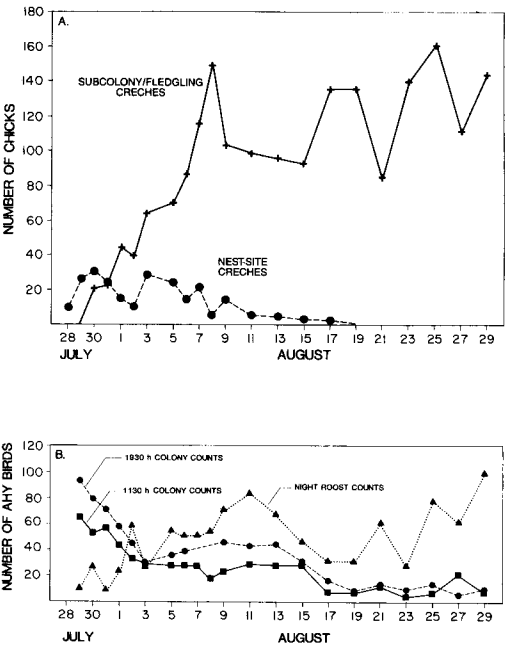

FIGURE 3. A. Numbers of Brandt's Cormorant chicks participating in nest-site creches (19:30) and other creches (11:30) on each day examined between 28 July and 29 August. B. Number of AHY Brandt's Cormorants present in the colony and in night roosts (19:30) between 28 July and 29 August.

but we observed banded parents feeding only their own chicks. Siblings begged vigorously and incessantly once their parent had arrived.

No correlations were found between the numbers of chicks in subcolony and fledgling creches and ambient temperature ($r = 0.03$, $n = 44$, $P > 0.05$), wind speed ($r = 0.19$, $n = 45$, $P > 0.05$), or cloud cover ($r = 0.34$, $n = 43$, $P > 0.05$). We never observed Western Gulls attacking creche-aged chicks whether adults were present or not. On only a few occasions, gulls stole food by harassing adults as they fed chicks, causing them to regurgitate onto the ground. Few chicks died between the time parents stopped continuous attendance of chicks and when chicks permanently left the colony (also see Boekelheide et al., in press).

Numbers of chicks in subcolony and fledgling creches increased throughout Period 1 but oscillated in Period 2 (Fig. 3A). Three peaks in numbers occurred on 8, 17 to 29, and 25 August and corresponded with changes in the sizes of large fledgling creches as chicks joined from subcolonies with different breeding chronologies.

These peaks roughly mirrored three earlier peaks of the numbers of chicks in nest-site creches on 30 July and 3 and 9 August (Fig. 3A). Numbers of chicks in fledgling creches fell between peaks because some chicks permanently left this colony earlier than others (determined by observations of banded chicks elsewhere on SEFI). Others remained and received feedings in fledgling creches between swimming and diving bouts nearby. Several birds developed the ability to fly during this period (including wing exercising on land and water) and were observed flying and landing in or near creches, then being fed by parents. Once chicks joined a fledgling creche, most did not leave it before being able to fly except to be fed or to enter the ocean. Only a few instances of banded chicks temporarily wandering from one fledgling creche to another were noted but none were ever observed returning to natal nest sites.

Numbers of adult and subadult birds in subcolonies during midday (11:30) and before dusk (19:30) fell in three steps between 28 July and 29 August (Fig. 3B), as parents stopped continuous attendance of chicks in different subcolonies. During this same period, however, the numbers of AHY birds in night roosts increased (Fig. 3B). The two major roosts were adjacent to the two largest fledgling creches (Fig. 1) but little intermingling was observed. Once parents stopped roosting at nest sites, they joined these nearby roosts (confirmed with banded adults) which grew rapidly just before dusk and dispersed rapidly just after dawn. Thus, adults roosted near (but not beside) their chicks in fledgling creches. Such roosts were never present during the day.

DISCUSSION

The formation of nest-site creches coincided with the presumed delayed onset of thermoregulation and completion of growth of the dense coat of natal down (see Dunn 1976; Evans 1980, 1984b). Brandt's Cormorant chicks are brooded continuously for 5 to 10 days after hatch and attended continuously by adults for an average of 25 to 57 days, depending on the year (Table 2). In 1984, cold northwest winds continued into late summer (often warm and foggy at SEFI) and Brandt's Cormorants bred later, had smaller clutch sizes and smaller brood sizes, and parents stopped continuous attendance of chicks earlier than usual (Table 2). Nest-site creches may compensate for reduced thermal properties of chicks under suboptimal conditions, especially when cold stressed as appeared to occur in 1984. In 1985 and 1986, nest-site creches were apparently much less prevalent (S. Johnston and J. P. Feldman, pers. comm.). Since chicks were characteristically huddled in nest-site creches primarily at the coldest times of day (evening, night, early morning) and just after the period of continuous parental brooding, this strongly suggested a primarily thermoregulatory role for nest-site creches (see Evans 1984a, 1984b; Vickery and Millar 1984). In addition, chicks left nests and formed small groups on nearby nests during night banding so it appeared that nest-site creches may also provide protection from predation. Similarly, Williams and Cooper (1983) noted that, by 15 days of age, Crowned Cormorant chicks joined other chicks on the nest farthest from the observer when disturbed. Shaw (1985) also noted that, at 28 days of age, Blue-eyed Shag (*P. atriceps*) chicks moved onto neighboring nests for brief periods when approached by an observer. Brandt's Cormorants differ from other creching species with altricial young (Evans 1980) in that nondisturbed chicks creched at nest sites even before parents stopped continuous attendance of chicks. Toleration of such behavior by attending adults presumably reflects the development of at least adequate parent-chick recognition by the time nest-site creches occur (10 to 25 days after hatch; review in Evans 1980). Snow (1963) noted several instances of Shag chicks over 25 days old occurring in neighboring nests but she did not mention if adults or neighboring chicks were present.

All Brandt's Cormorant chicks (in the colony we observed) participated in fledgling creches (for varying periods of time); thus, creching was characteristic of the late chick period. In 1985 and 1986, even larger fledgling creches formed in the same locations as in 1984 (Fig. 1). This behavior shows strong social attractions between chicks, as found in other creching studies (see Evans 1980, 1984a; Davis 1982), but the locations of creches apparently were influenced by proximity to ocean access points. Although breeding adults were freed of attending chicks during the day in the later part of the creching period, they still roosted near these creches at night. These roosts did not appear to confer any protection to chicks (see Davis 1982). By occurring nearer to the ocean than nest sites (Fig. 1), fledgling creches may fa-

TABLE 2. Comparison of breeding biology characteristics of Brandt's Cormorants at the study colony on SEFI in 1984 compared to previous years.

Breeding biology characteristic	1971–1983[1] Overall $\bar{x}$ ± SD (*n*)	1971–1983[1] Range of annual means	1984[2] $\bar{x}$ ± SD (*n*)
Clutch initiation date	14 May ± 9.8 (282)	3–31 May	27 May ± 9.9 (8)
Clutch size	3.1 ± 0.7 (286)	2.5–3.8	2.7 ± 0.8 (24)
No. chicks leaving nest/successful site[3]	2.0 ± 0.7 (234)	1.1–2.9	1.7 ± 0.7 (19)
No. days chicks attended continuously by adults[4]	35.4 ± 6.1 (192)	25.1–56.9	29.9 ± 7.4 (16)

[1] Data obtained exclusively from subcolonies 5 and 6 (Boekelheide et al., in press).
[2] Data for clutch initiation from subcolonies 5 and 6 only; data for other characteristics from all subcolonies (PRBO, unpubl. data).
[3] Includes sites where at least one chick left the site.
[4] Number of days from when first egg hatched to when site first unattended by adults.

cilitate fledging behaviors (i.e., diving, bathing, preening, flying, etc.) as well as the development of roosting behaviors in chicks dependent on parental feedings. Similarly, Shag chicks sometimes form creches at colonies or on nearby rocks where they are fed by parents up to and beyond the time when they can fly (Snow 1963). The tendency for cormorant chicks to form fledgling (and other) creches likely depends to a great extent on nesting habitat. Creching is most feasible in flat or gently sloping ground-nesting habitats (like those used by Brandt's Cormorants on SEFI), whereas prefledging movement of chicks from nests located in cliff- or tree-nesting habitats are less feasible.

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