Condor 85:50–52

HATCHING OF FORSTER'S TERNS

MARTIN K. McNICHOLL

ABSTRACT.—Forster's Terns (*Sterna forsteri*) hatch out at the large end of the egg and "peep" before hatching. The mean number of days between laying and commencement of hatching is 24.2. The breaking period varies from one to five days, longer periods involving mainly the Early Pip stage. Subsequent stages occur in less than one day. Eggs within a clutch generally hatch within one day of each other and in the order laid. In small groups of nests, hatching appears to be more closely synchronized than the onset of laying. Chicks have both upper and lower mandible egg-teeth, but lose them within five days after hatching.

Hatching is a critical process in the lives of birds, involving a series of physical and physiological adaptations (Portmann and Stingelin 1964, Hamburger and Oppenheim 1967, Oppenheim 1972, Drent 1975). The process is better known in gulls (Kirkman 1931, Drent 1970) than in terns (Jones 1906).

In 1968 and 1969, I studied the breeding biology and ecology of Forster's Tern (*Sterna forsteri*) at a colony in the Delta Marsh, Manitoba (McNicholl 1971). Since little had been published on the species, my project was designed as a general life history study of the species, including hatching. To my knowledge, the only published reference to hatching in this species is the vague comment by Harris (1933). Here I report on the hatching of these terns plus some information about the egg-teeth.

STUDY AREA AND METHODS

My study took place primarily on Forster's Bay, the first bay southwest of the University of Manitoba Field Station at Delta, Manitoba. Delta Marsh (15,000 ha) is vegetated with *Phragmites communis* and permeated by a maze of channels that open into bays, the larger of which are bordered by *Typha* spp. and *Scirpus acutis*. Forster's Bay, one of these open areas, contains stands of *Scirpus* that serve as nesting "islands" for terns, grebes, American Coots (*Fulica americana*), a few ducks, and Yellow-headed Blackbirds (*Xanthocephalus xanthocephalus*).

With few exceptions, I visited nests in the tern colony each morning during the nesting season (early May to mid-July) in 1968 and 1969, travelling to the bay and from one *Scirpus* island to another by canoe, and wading through each island from nest to nest. I numbered each egg in these nests as laid with a felt-tipped pen, and examined them at approximately the same time each day for signs of hatching. Occasionally, weather or other factors delayed my arrival at the colony, but none of these delays occurred on a day that would affect data in this note.

In both 1968 and 1969, the terns lost many eggs primarily owing to waves and other weather-related factors (McNicholl 1971, 1979). In both years, I noted the hatching of as many eggs as possible. This included 38 eggs that reached initial stages of hatching, and 33 that actually hatched. Since only two eggs hatched in 1969, most data are from 1968.

TERMINOLOGY

In the field, I classified hatching into four stages, by a scheme that Roger M. Evans and I devised:

Early Pip. The shell is slightly cracked at one end; often small bumps may be felt before cracks are visible. This stage is often termed "starring" or "cracking," and has been described in detail by Marples and Marples (1934). Hamburger and Oppenheim (1967) termed this "pipping."

Pip. A hole is present in the egg, and the tip of the beak can usually be seen through it.

Early Ring. The hole has been enlarged, usually in two directions.

Ring. The opening encircles most of one end of the egg and the bird could push up the cap of the eggshell without elongating the opening further.

Stages 1 through 4 correspond in total to Kirkman's (1931) phase 1, "the making of a break in the shell;" stages 1 through 4 plus actual emergence (Kirkman's phase 2) to the breaking or hatching period of Paludan (1951) and Ytreberg (1956); and stages 2 through 4 plus emergence to Hamburger and Oppenheim's (1967) "climax."

Stages 3 and 4 occurred rapidly in Forster's Terns, and I have combined them in my results.

RESULTS AND DISCUSSION

HATCHING PROCESS

Eggs of Forster's Tern pipped at the larger end, with the latter facing upwards, a pattern similar to that of other larids (Drent 1970; review in McNicholl 1971). Faint taps and "peeping" notes were heard at or before the Early Pip stage. Newly hatched downy young were wet and well developed. Chicks hatched during daylight hours. The two that I observed hatched at 10:59 and 11:30; I found 11 others still wet between 09:29 and 19:52. In this regard, Forster's Terns resembled Common (*S. hirundo*), Arctic (*S. paradisaea*) and Antarctic terns (*S. vittata*) (Palmer 1941, Hawksley 1950, Parmelee and Maxson 1974), but not always Least Terns (*S. albifrons*; Hardy 1957).

DURATION OF HATCHING

The number of days between laying of an egg and its Early Pip ranged from 19 to 27 ($\bar{x} \pm$ SD = 23.2 ± 2.57 days, $n = 27$); days between laying and the Pip ranged from 22 to 29 ($\bar{x} \pm$ SD = 24.4 ± 2.4 days, $n = 11$); and between laying and either the Early Ring or the Ring stage ranged from 26 to 28 ($\bar{x}$ ± SD = 27.0 ± 0.71 days, $n = 5$). The incubation period of 13 clutches (i.e., number of days between laying and emergence of the last egg in the clutch, *sensu* Drent 1970) ranged from 23 to 28 days ($\bar{x}$ ± SD = 25.3 ± 2.02 days, $n = 13$), and that of each egg ranged from 22 to 29 days ($\bar{x} \pm$ SD = 25.8 ± 2.09 days, $n = 33$). Bent (1921) reported an incubation period of 23 days in Forster's Terns; recent field guides have indicated 23 to 24 days (H. H. Harrison 1975, 1979) or 23 to 25 days (C. Harrison 1978).

Total hatching time. Hatching in 33 Forster's Tern eggs from the first appearance of the Early Pip to emergence of the young ("breaking period" of Paludan 1951 and Ytreberg 1956) ranged from one to five days ($\bar{x}$ = 2.82), with approximately half of the chicks taking two or three days. The duration of hatching was not consistently related to the position of the egg in the clutch. A one-to-five-day hatching period has also been found in Arctic Terns (Hawksley 1950, Cullen 1956, Evans and McNicholl, unpubl. observ.). Ashmole (1962) reported that the eggs of the Black Noddy (*Anous tenuirostris*) were "starred" three or four days before hatching.

Length of the hatching stages. I was able to determine the approximate duration of each hatching stage for about 38 tern eggs (Table 1). The sample sizes in the table differ because some eggs were lost between stages. In contrast to subsequent stages, Early Pip frequently lasted two to three days. Cullen's data (1956) indicate that this stage is about two days for Arctic Terns. The Pip, Early Ring, and Ring stages usually required less than one day (Table 1). In other terns, stages 2 through 4 last 8 to 36 h (Watson 1908, Bent 1921, Palmer 1941, Cullen 1956, Hardy 1957, Ashmole 1962).

TABLE 1. Duration of hatching stages for eggs of Forster's Tern.

Hatching stage	Total number of eggs	Days required to complete hatching stage[a]				
		<1	1	1–2	2–3	3–4
Early Pip	38	10	12	9	7	0
Pip	34	25	9	0	0	0
Early Ring	33	30	3	0	0	0
Ring	33	32	2	0	0	0
Total breaking period	33	3	12	8	6	4

[a] Values in the table are number of eggs. <1 refers to eggs in which the stage in question was passed through in less than a day, and thus not seen. 1 refers to eggs in which the stage was seen on one day only, and thus the egg remained in the stage a maximum of one day. Thus, <1 may not always differ from 1.

For the two eggs that I actually watched hatch, one took 29 min and the other 1 h from the Early Ring stage until emergence of the chick from the shell. Chicks of the Black Tern (*Chlidonias niger*) also reportedly emerge 1 h after the shell at the end of the egg is removed (Eddy 1961).

HATCHING INTERVALS, PATTERN, AND SYNCHRONY

In 13 nests with two- or three-egg clutches, the eggs hatched in the order laid or so soon after one another that the order could not be determined. Hatching onset (i.e., when the egg first showed signs of Early Pip) was also in the laying order, as is true of Common Terns (Jones 1906).

Eggs hatched on the same day or one day apart in most of the clutches. One two-egg clutch was exceptional in that the eggs hatched six days apart. In all other cases, the intervals were generally equal to or shorter than the egg-laying interval. Coulter (pers. comm.) found hatching intervals of 0.7 to 2.0 days between eggs in clutches of this species. Hatching intervals of Arctic Terns at Churchill (Evans and McNicholl, unpubl. data) varied from zero to four days (only one to two days in 85% of the clutches); the mean was 1.5 days between the first and second eggs in 32 clutches, and 1.4 days between the second and third eggs in five clutches. Comparable hatching intervals have been reported for several other species of terns (De Groot 1931, Palmer 1941, Cuthbert 1954, Baggerman et al. 1956, Swift 1960, Paige 1968).

One group of eight nests that I found on a muskrat (*Ondatra zibethicus*) house dramatically demonstrated the shortening of the hatching interval as compared with the onset of Early Pip. These nests were close together, suggesting that social influences, perhaps helped by the faint taps and peeping that accompany hatching, may promote synchronous hatching. In all eight nests, Early Pip started between 22 and 25 June, whereas the young emerged from the eggs on 25 or 26 June.

EGG-TOOTH

Newly hatched chicks invariably possessed egg-teeth on both mandibles; they lost these in three to five days. Lower mandible egg-teeth are also known in Black Terns (Clark 1961). Common (Marples and Marples 1934, LeCroy and Collins 1972), Arctic (Hawksley 1950), and Black terns (Eddy 1961, Dunn 1979) also lose their egg-teeth within five days of hatching, whereas Roseate (*S. dougallii*) and Least terns retain theirs somewhat longer (LeCroy and Collins 1972).

ACKNOWLEDGMENTS

I thank R. M. Evans, J. H. Gee, and R. W. Nero for constructive comments on my thesis, and M. Coulter, E. H. Dunn, M. D. Kern, and two anonymous reviewers for criticism on an earlier draft of this paper. Portage Country Club owns most of Forster's Bay and allowed me to work on its property. My research was supported by funds from the National Research Council of Canada, including grants to R. M. Evans. Accomodations, meals, and some equipment were provided by the University of Manitoba (Delta Marsh) Field Station, of which this paper constitutes Publication No. 27.

LITERATURE CITED

Ashmole, N. P. 1962. The Black Noddy *Anous tenuirostris* on Ascension Island. Part I. General biology. Ibis 103b:255–273.

Baggerman, B., G. P. Baerends, H. S. Keikem, and J. H. Mook. 1956. Observations on the behaviour of the Black Tern (*Chlidonias n. niger* (L.)) in the breeding area. Ardea 44:1–71.

Bent, A. C. 1921. Life histories of North American gulls and terns. U.S. Natl. Mus. Bull. 113.

Clark, G. A., Jr. 1961. Occurrence and timing of egg teeth in birds. Wilson Bull. 73:268–278.

Cullen, J. M. 1956. A study of the behaviour of the Arctic Tern (*Sterna macrura*). Ph.D. diss., Oxford Univ., Oxford.

Cuthbert, N. L. 1954. A nesting study of the Black Tern in Michigan. Auk 71:36–63.

De Groot, D. S. 1931. History of a nesting colony of Caspian Terns on San Francisco Bay. Condor 33:188–192.

Drent, R. H. 1970. Functional aspects of incubation in the Herring Gull. Behaviour, Suppl. 17:1–132.

Drent, R. 1975. Incubation, p. 333–420. *In* D. S. Farner and J. R. King [eds.], Avian biology. Vol. 5. Academic Press, New York.

Dunn, E. H. 1979. Nesting biology and development of young in Ontario Black Terns. Can. Field-Nat. 93: 276–281.

Eddy, J. 1961. Nesting habits of the Black Tern. Flicker 33:3–4, 14–15.

Hamburger, V., and R. Oppenheim. 1967. Prehatching motility and hatching behavior in the chick. J. Exp. Zool. 166:171–204.

Hardy, J. W. 1957. The Least Tern in the Mississippi Valley. Publ. Mus. Mich. State Univ., Biol. Ser. 1.

Harris, A. T. 1933. The Forster Tern. Oologist 50:31–32, 34.

Harrison, C. 1978. A field guide to the nests, eggs and nestlings of North American birds. Collins, London.

Harrison, H. H. 1975. A field guide to birds' nests in the United States east of the Mississippi River. Houghton Mifflin, Boston.

Harrison, H. H. 1979. A field guide to western birds' nests. Houghton Mifflin, Boston.

Hawksley, O. 1950. A study of the behavior and ecology of the Arctic Tern, *Sterna paradisaea* Brunnich. Ph.D. diss., Cornell Univ., Ithaca, NY.

Jones, L. 1906. A contribution to the life history of the Common (*Sterna hirundo*) and Roseate (*S. dougalli*) terns. Wilson Bull. 18:35–47.

Kirkman, F. B. 1931. The birth of a Black-headed Gull. Br. Birds 24:283–291.

LeCroy, M., and C. T. Collins. 1972. Growth and survival of Roseate and Common tern chicks. Bird-Banding 45:326–340.

Marples, G., and A. Marples. 1934. Sea terns or sea swallows. Country Life Press, London.

McNicholl, M. K. 1971. The breeding biology and ecology of Forster's Tern (*Sterna forsteri*) at Delta Marsh, Manitoba. M.Sci. thesis, Univ. Manitoba, Winnipeg.

McNicholl, M. K. 1979. Destruction to nesting birds on a marsh bay by a single storm. Prairie Nat. 11:60–62.

Oppenheim, R. W. 1972. Prehatching and hatching behavior in birds: a comparative study of altricial and precocial species. Anim. Behav. 20:644–655.

Paige, B. B. 1968. The Least Tern in Man's world. Fla. Nat. 41:14–16.

Palmer, R. S. 1941. A behavior study of the Common Tern (*Sterna hirundo hirundo* L.). Proc. Boston Soc. Nat. Hist. 42:1–119.

Paludan, K. 1951. Contributions to the breeding biology of *Larus argentatus* and *Larus fuscus*. Vidensk. Medd. Dan. Naturhist. Foren. 114:1–128.

Parmelee, D. F., and J. S. Maxson. 1974. The Antarctic Terns of Anvers Island. Living Bird 13:233–250.

Portmann, A. and W. Stingelin. 1964. Development, embryonic, p. 180–191. *In* A. L. Thomson [ed.], A new dictionary of birds. McGraw-Hill, New York.

Swift, J. J. 1960. Notes on the behaviour of Whiskered Terns. Br. Birds 53:557–572.

Watson, J. B. 1908. The behaviour of Noddy and Sooty terns. Pap. Tortugas Lab. Carnegie Inst. Washington 2:187–225.

Ytreberg, N. J. 1956. Contributions to the breeding biology of the Black-headed Gull (*Larus ridibundus* L.) in Norway. Nytt. Mag. Zool. (Oslo) 4:4–106.

Department of Zoology, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada. Present address: 21857 64th Avenue, R.R. 8, Langley, British Columbia V3A 6H4, Canada. Received 13 August 1980. Final acceptance 28 May 1982.