collected and is now at the Western Foundation (#11,250). The specimen is dull white with a heavily pitted, almost corrugated surface. The rough shell bears numerous small rounded granulations and excrescences. The egg is oval in shape and measures 75.71 x 57.45 mm. The empty shell weighs 11.251 g with a blowhole 4.6 mm in diameter. According to Sheffler's notes, the egg contained a half-developed embryo. To our knowledge, it is the only egg known for the species.

In the spring of 1959, it was learned that the Tablas Mountain site was again being used by a pair of Solitary Black Eagles. R. G. Hannum was sent from Los Angeles to investigate the report, but by the time he reached the remote locality, the nesting attempt had already met with failure. Local residents, who were able to look down into the nest from a nearby cliff, told him that ravens (*Corvus corax*) had broken and eaten the single egg which the nest had originally contained.

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Western Foundation of Vertebrate Zoology, 1100 Glendon Avenue, Los Angeles, California 90024. Accepted for publication 21 September 1976.

THE EGG OF THE CROWNED SOLITARY EAGLE, *HARPYHALIAETUS CORONATUS*

HELMUT SICK
AND
DANTE MARTINS TEIXEIRA

The Crowned Solitary Eagle (*Harpyhaliaetus coronatus*) formerly was seldom seen in captivity. Since the construction of Brasília and the exploration of the surrounding region, however, the bird is now seen regularly in Brazilian zoos, where it is brought from the State of Goiás. One such eagle in the zoo at Belo Horizonte, Minas Gerais, laid an egg in early October, 1974. This egg, acquired by the junior author for the Museu Nacional in Rio de Janeiro, seems to be the first well-documented one for the species.

The egg is a rounded oval with the ends similar in shape; it is unmarked, white, rough in texture, and without gloss; one end bears a wart-like bump. Held against the light, the inside of the shell is blue-green, which is the normal inside color of accipitrid eggs (Schönwetter, Handb. der Oologie I:138, 1967). The egg measures 65.0 $\times$ 52.6 mm; its full weight was 100 g; the empty shell weighs 10.3 g.

An egg in the Nehrkorn collection from São Paulo, Brazil, possibly of this eagle (see Schönwetter, p. 145), differs from the present one in being larger (69.3 $\times$ 60.0 mm) and having some gloss. A larger bird of prey which may occur in São Paulo is the Harpy Eagle (*Harpia harpyja*). Its eggs are unmarked, but sometimes are so heavily nest-stained that they appear spotted (Bond, Auk 44:562, 1927).

We thank D. Amadon, H. Pelzl, E. O. Willis, and P. Stettenheim for their suggestions, and Antônio Caixetos, Director of the zoo in Belo Horizonte, for presenting the egg to our Museum.

Museu Nacional, Quinta da Boa Vista, Rio de Janeiro, RJ, Brazil. Accepted for publication 4 October 1976.

TEMPORAL PATTERNS IN LAYING, HATCHING AND INCUBATION OF SOOTY TERNS AND BROWN NODDIES

WILLIAM Y. BROWN

Temporal patterns in laying, hatching and incubation of wild birds are rarely studied in detail, probably because they are difficult to observe. However, these attributes are reasonably accessible for study in colonial sea birds, because such birds often lay near each other in the open and are tolerant of people.

In 1971 and 1972, I studied temporal patterns in laying, hatching and incubation of two species of colonial sea birds, the Sooty Tern (*Sterna fuscata*) and the Brown Noddy (*Anous stolidus*), on Manana Island, a 25-ha volcanic islet about 1 km north of the eastern tip of Oahu, Hawaii.

METHODS

In 1971, I painted a fluorescent line around a segment, roughly 100 m $\times$ 1 to 10 m, of the inner crater rim of Manana where Brown Noddies nest. During laying, I searched this area at 4-hr intervals for 48 hr. Each newly discovered egg was numbered and the same number painted by the nest. Beginning about one month later, I checked the marked eggs at 4-hr intervals from before any had hatched until after the last hatched. I moved rapidly, and the Brown Noddies nearly always returned to their nests within a few seconds after I passed. I followed a similar procedure in 1972 except that I searched an area about twice as long and checked for new eggs for 96 hr instead of 48 hr.

In 1972, I laid out 16 contiguous 18.9-m^2 plots in a sandy area of the Sooty Tern colony by tying 0.6-cm rope close to the ground between stakes. I checked for laying and hatching as previously described for the Brown Noddy, except that I placed a numbered rock beside each egg when discovered.

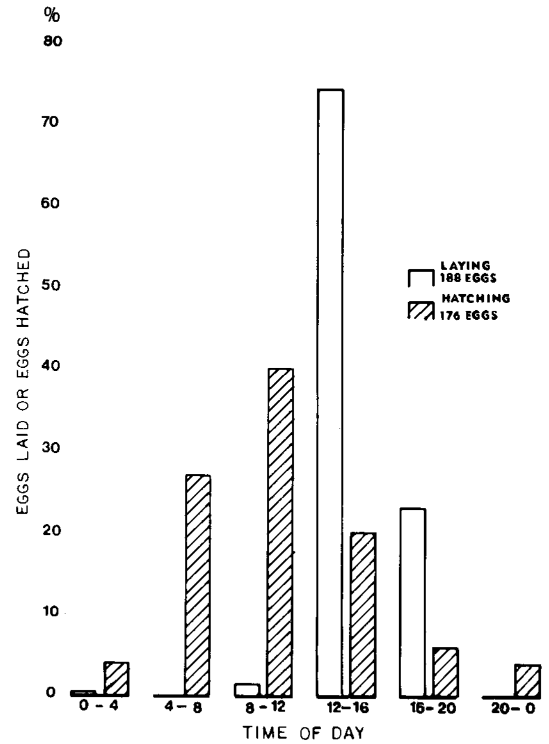

FIGURE 1. Distribution of Sooty Tern egg-laying and hatching by time of day.

During laying, I checked for new eggs at 4-hr intervals for 168 hr. The terns, like the noddies, returned quickly to their nests after I passed; in fact, many did not leave the nest.

I recorded the time of "starring" (appearance on the egg of a small crack made by the chick) and "pipping" (a definite hole) for a sample of the eggs of each species.

I determined the diurnal variation in temperature of one incubated egg of each species. All temperature readings were made with a YSI Tele-Thermometer, probes, and extension leads. The sensor was held near the center of the egg (Howell and Bartholomew 1962), and about 0.61 m of the probe lead nearest the egg was buried. Readings were taken periodically over 48 hr for the Sooty Tern egg and over 30 hr for the Brown Noddy egg. The tern parent was not observed continuously but was incubating quietly at each temperature check. The noddy parent was observed continuously during daylight hours.

RESULTS

Sooty Terns on Manana laid primarily in the afternoon and rarely at night (fig. 1). The time of hatching (emergence) was less discrete than the time of laying, the mode falling between 08:00 and noon. The eggs first starred on the blunt end of the egg an average of 109 hr before hatching ($N = 25$, $SD = 8.7$ hr, $R = 92–128$ hr), and the chicks extended this fissure around the egg leaving gaps of uncracked shell. A "pip" appeared an average of 31 hr before hatching ($N = 25$, $SD = 12.4$ hr, $R = 4–52$ hr), and the chicks extended this hole around the egg. The incubation period for the Sooty Tern is the time from egg-laying to hatching, and on Manana averaged 686 hr ($N = 175$, $SD = 14.2$ hr, $R = 660–736$ hr) with distinct 24-hr modes (fig. 2).

Brown Noddies on Manana laid both day and night with a single mode from 08:00 to noon (fig. 3). The eggs also hatched day and night, but the day was favored even for eggs laid at night. The eggs first starred an average of 136 hr before hatching ($N = 19$, $SD = 24.3$ hr, $R = 76–184$ hr). The chicks extended the crack around the blunt end of

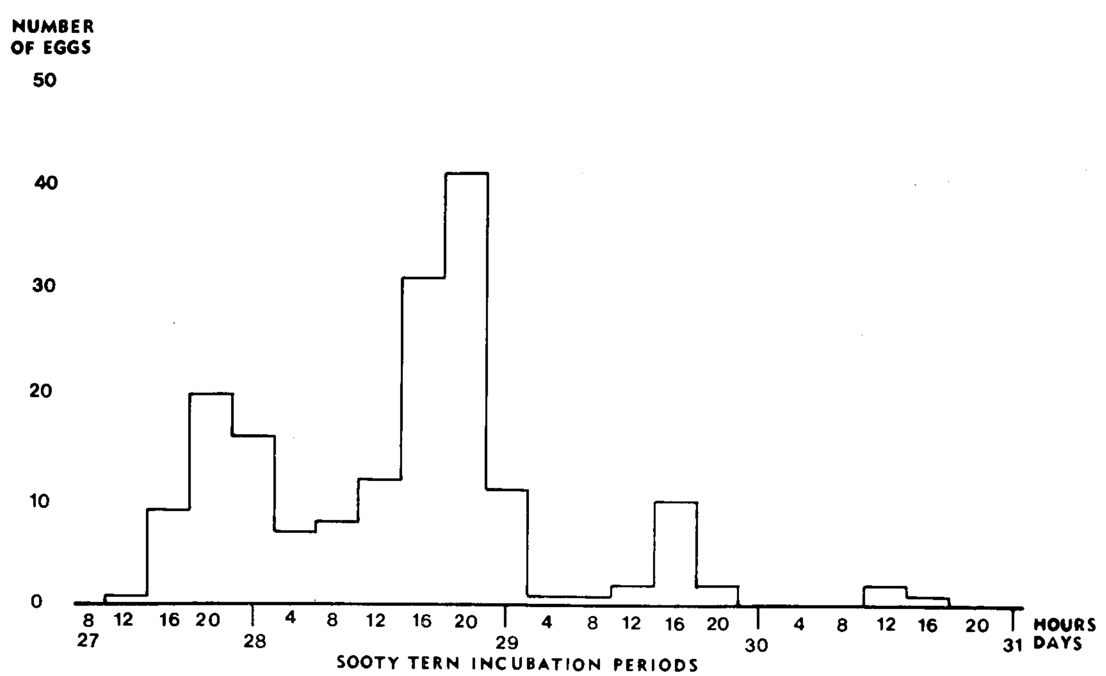

FIGURE 2. Frequency distribution of lengths of Sooty Tern incubation periods.

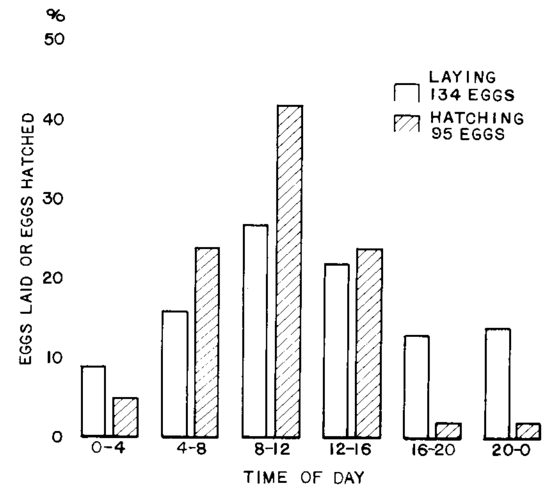

FIGURE 3. Distribution of Brown Noddy egg-laying and hatching by time of day.

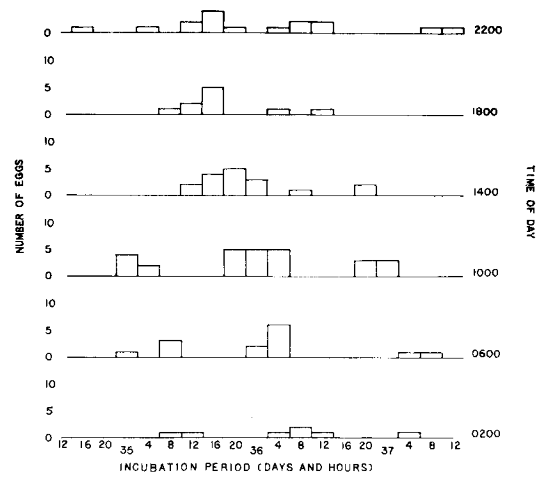

FIGURE 4. Frequency distribution of lengths of Brown Noddy incubation periods for eggs laid at different times of the day. Modes are separated by approximately 24 hr regardless of laying time, but shift with different laying times. Only 1972 data are presented because observations in 1971 were at different hours of the day.

the egg, and the pip appeared an average of 31.7 hr before hatching (N = 19, SD = 16.4 hr, R = 4–68 hr). The incubation period of the Brown Noddy averaged 864 hr (N = 121, SD = 13.3 hr, R = 832–900 hr), and was distinctly modal when plotted according to the time of day when the eggs were laid (fig. 4).

DISCUSSION

Sooty Tern. The Sooty Tern lays primarily in the afternoon not only on Manana, but also on the Seychelles (Ridley and Percy 1958), the Dry Tortugas (Dinsmore 1972), and Ascension Island. Ashmole (1963) found that 21 of 33 eggs on Ascension hatched between 06:00 and noon although all but one of the eggs had been laid after noon. The incubation periods of the 33 eggs had a bimodal frequency distribution with a 24-hr separation. Ashmole suggested that the bimodality arose from the failure of eggs to hatch at night which, in turn, was related to diurnal variation in temperature of the incubated eggs. This hypothesis is corroborated by my finding that an incubated Sooty Tern egg on Manana was cooler at night than during the day (fig. 5). Egg temperature appeared to follow air temperature, which peaked at about 32° C from 12:00 to 14:00 each day of observation. Ashmole's hypothesis could be tested experimentally in incubators with controlled temperatures and light intensities.

The mean incubation period of 33 Sooty Tern eggs on Ascension was 29.5 days, significantly longer than the 28.6 days on Manana ($t = 4.63$, $P < 0.001$). This may be because the eggs are larger, although other factors such as climate may be involved. Parsons (1972) found egg volume and incubation period to be directly related in the Herring Gull (*Larus argentatus*). Stonehouse (1963) gave dimensions of Sooty Tern eggs on Ascension Island during Ashmole's study; the eggs averaged 1 mm longer than those on Manana ($t = 5.14$, $P < 0.001$). Thus, the Ascension eggs probably averaged about 0.5 cm^3 greater in volume than the Manana eggs (Brown 1976).

The incubation period of the Sooty Tern has been reported as 26 to 29 days on the Seychelles (Ridley and Percy 1958), "Just under 28 days" on Christmas Island in the Pacific (Gallagher 1960), 26 days (Watson 1908), 31 days (Watson and Lashley 1915), and 29 days 12 hr (Dinsmore 1972) on the Dry Tortugas, and 28.1 days on Kure Atoll (Woodward 1972). Extraordinarily long incubation periods may occur in the Sooty Tern. Ashmole (1963) reported at least one egg on Ascension incubated 31 to 32 days before hatching. He suggested that this occurs when eggs are left unattended for long periods. One Sooty Tern egg on Manana hatched 38.7 days after laying; the egg was alternately warm and cold during at least the last week of incubation, indicating irregular attendance.

Brown Noddy. Regardless of when a Brown Noddy egg was laid on Manana, it was most likely to hatch between 08:00 and noon. This restriction on hatching time coupled with variation in the rate of chick development apparently causes the multi-modal frequency distributions observed in the incubation period (fig. 4). I found that the temperature of an incubated noddy egg varied over the day on Manana, roughly following air temperature (fig. 5). Although a parent sat quietly during the early morning and late afternoon, from about 09:00 to 15:00 it rose repeatedly from the egg, providing shade, then settled. Each time the parent rose, the temperature of the egg dropped; when the parent settled, the temperature rose. The cue to hatching may be temperature change, as Ashmole suggested for the Sooty Tern.

Watson (1908) reported a 32–35 day incubation period of Brown Noddy eggs on the Dry Tortugas although Watson and Lashley (1915), presumably using the same data, gave the period as 35 or 36 days. Gibson-Hill (1951) found that the incubation period of eight eggs varied from 33 to 35 days on Christmas Island in the Indian Ocean, and Woodward (1972) reported a mean period of 36.1 days for 76 eggs on Kure Atoll.

Exceptionally long incubation periods occur in the Brown Noddy. The mean incubation period of three

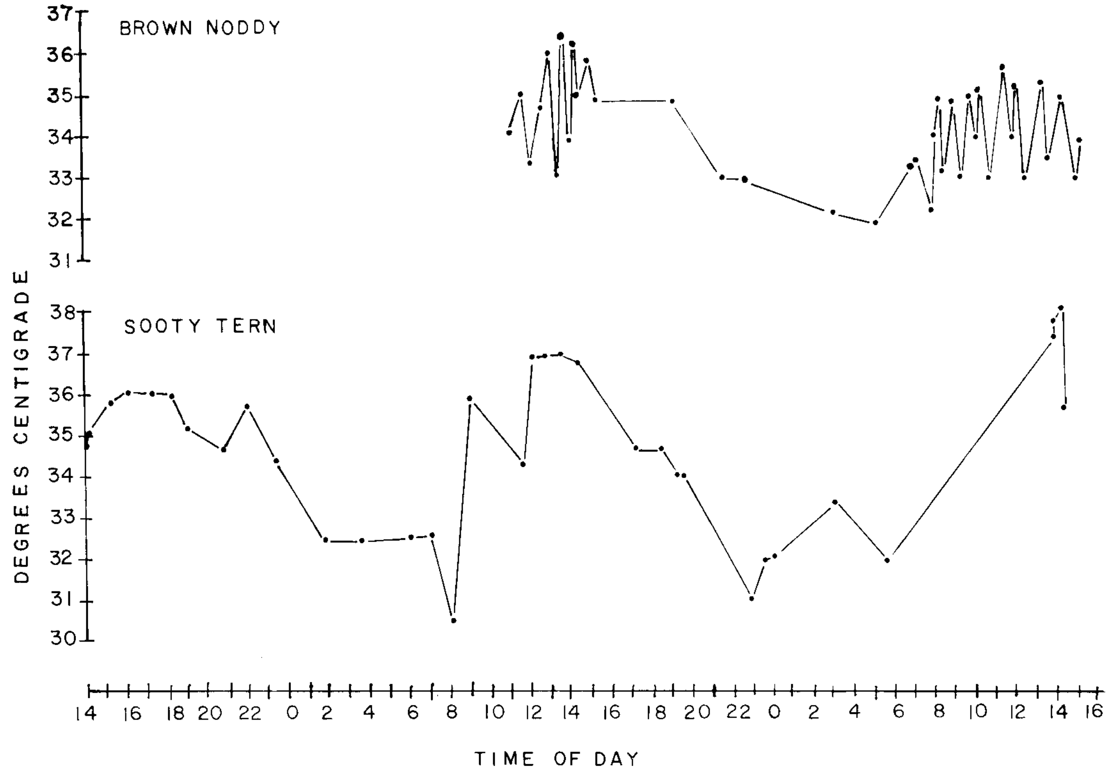

FIGURE 5. Diurnal variation in temperature of single freshly-laid incubated Sooty Tern and Brown Noddy eggs.

noddy eggs on Manana was 39.6 days, more than 3.5 days longer than the incubation period of 92 single-egg clutches laid the same year ($t = 9.1$, $P < 0.001$). These eggs were part of "two-egg" clutches for at least the last week of incubation, the second eggs apparently rolling into the sites of these original eggs or being laid in them by different females (Brown 1975). Parents with "two-egg" clutches sometimes incubate only one egg at a time, apparently causing the long incubation period.

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LITERATURE CITED

Ashmole, N. P. 1963. The biology of the Wideawake or Sooty Tern *Sterna fuscata* on Ascension Island. Ibis 103b:297–364.

Brown, W. Y. 1976. Egg specific gravity and incubation in the Sooty Tern and Brown Noddy. Auk 93:371–374.

Brown, W. Y. 1975. Artifactual clutch size in Sooty Terns and Brown Noddies. Wilson Bull. 87: 115–116.

Dinsmore, J. J. 1972. Sooty Tern behavior. Bull. Florida State Mus., Biol. Sci. 16:129–179.

Gallagher, M. D. 1960. Bird notes from Christmas Island, Pacific Ocean. Ibis 102:489–502.

Gibson-Hill, C. A. 1951. Notes on the nesting habits of seven representative tropical sea birds. J. Bombay Nat. Hist. Soc. 48:214–235.

Howell, T. R., and G. A. Bartholomew. 1962. Temperature regulation in the Sooty Tern *Sterna fuscata*. Ibis 104:98–105.

Parsons, J. 1972. Egg size, laying date and incubation period in the Herring Gull. Ibis 114: 536–541.

Ridley, M. W., and R. Percy. 1958. The exploitation of sea birds in Seychelles. Colon. Res. Stud. 25:1–78.

Stonehouse, B. 1963. Egg dimensions of some Ascension Island sea-birds. Ibis 103b:474–479.

Watson, J. B. 1908. The behavior of Noddy and Sooty Terns. Carnegie Inst. Washington, Pap. Tortugas Lab. 2:187–255.

Watson, J. B., and K. S. Lashley. 1915. An historical and experimental study of homing. Carnegie Inst. Washington, Pap. Dept. Marine Biol. 7:7–60.

Woodward, P. W. 1972. The natural history of Kure Atoll, Northwestern Hawaiian Island. Atoll Res. Bull. 164:252,272.

U.S. Fish and Wildlife Service, AFA, Interior Building, Washington, D.C. 20240. Accepted for publication 14 August 1975.