INFLUENCE OF DATE AND BODY MASS AT FLEDGING ON LONG-TERM SURVIVAL OF SOOTY TERNS *STERNA FUSCATA*

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The Sooty Tern *Sterna fuscata* is a pan-tropical seabird that nests typically on isolated oceanic islands. Sooty Terns nest always on the ground, generally amongst sparse herb vegetation and often in large dense colonies, sometimes numbering hundreds of thousands of pairs (Gochfeld & Burger 1996, Schreiber *at al.* 2002). In most colonies, laying is highly synchronised; e.g. on Bird Island, Seychelles, in 1973, 90% of eggs in a colony estimated at 395 000 pairs were laid in a nine-day period early in the laying season (Feare 1976) although the remaining eggs were laid over an approximate six-week period. In that study, time of laying appeared to be critical in terms of fledging success. Eggs laid during peak laying produced more chicks of fledging age, and chicks that were heavier at fledging and which fledged earlier, than chicks from later eggs. Despite being perhaps the world's most numerous tropical seabird (Schreiber *et al.* 2002), few aspects of its life history have been quantified (Hamer *et al.* 2001). Here, I analyse data from birds ringed as chicks on Bird Island, Seychelles in 1972–1973 and recaptured during searches for ringed birds in 1994–2001, in order to examine the relationship between long-term survival and (1) body mass at fledging, and (2) date of fledging.

In August–October 1972 and 1973, chicks on the point of fledging were ringed with monel rings in the colony on Bird Island, Seychelles (4°53'S, 55°12'E). In 1972, between 30 August and 20 September a cohort of 806 chicks on the point of fledging was ringed and weighed to the nearest g using a 300-g Pesola balance. In 1973 a similar cohort, of 321 chicks, was ringed and weighed between 13 August and 3 September. In addition, in 1973, 4430 chicks on the point of fledging were ringed, but not weighed, between 13 August and 11 October. Chicks were considered to be on the point of fledging on the basis of their plumage. Feare (1976) described stage of plumage development in chicks and the birds ringed for this study were 'short tail' or 'tail forked'. At these stages they had attained their asymptotic body mass and were acquiring flight capability.

Each year from 1994 to 2002, ringed Sooty Terns have been searched for on Bird Island during incubation by teams of two to four people who walked slowly through the colony. Ringed birds were caught using hand nets and ring numbers were recorded (Feare & Lesperance 2002). Recaptures during the 1990s and early 2000s show that the rings used have not deteriorated during the course of this study, indicating that no birds would have lost rings.

The fledging masses of birds that were recaptured in 1994–2002 did not differ significantly from the masses of chicks that were not found. For the birds ringed in 1972, the mean mass of chicks ringed but not found was 183.3±0.9 g (standard error), n = 794, whereas the mean fledging mass of birds that were recaptured was 191.5±5.7 g , n = 12 (t_{804} = 1.14, P = 0.26). For the 1973 cohort the mean mass of chicks ringed but not found was 178.9±1.4 g, n = 313, whereas the fledging mass of birds that were recaptured was 188.3±6.2 g, n = 8 (t_{319} = 1.48, P = 0.18).

The sample of chicks ringed, but not weighed, in August–October 1973 was broken down into four 15-day periods for analysis; this division was used in order to provide adequate numbers (n > 5) of the sub-sample of these birds recaptured in 1994–2002 in a contingency table. The proportions of birds recaptured from each period differed from the pattern of ringing in these periods (χ^2_3 = 11.7, P = 0.009). Paired comparisons between the time periods of ringing indicated that significantly more birds were recaptured from the 12–26 September cohort than from the first and last cohorts (Table 1).

In the two years, 1972 and 1973, for which samples of ringed Sooty Terns were available, subsequent recaptures of birds between 22 and 29 years later indicated that body mass at fledging did not influence post-fledging survival. On the other hand, the ringed birds recaptured in 1994–2002 suggested that birds that fledged in the middle of the fledging period in 1973 survived better than those that fledged earlier or later (Table 1).

These findings supplement the pre-fledging survival information reported by Feare (1976), where in 1973 more chicks fledged from eggs laid at the peak of laying in the colony, which occurred very early during the laying season, and chicks that fledged early in the season did so at a greater body mass and in a shorter time than did birds that fledged later. Higher survival of peak-season eggs and chicks was attributed to reduced predation and to reduced aggression/interference between neighbours that were all at the same stage of the breeding cycle. These factors would not apply once the birds had left the colony.

The greater body mass and early fledging of peak-season chicks was at least partly due to these birds experiencing better feeding conditions than did later-fledged birds in 1973, as was demonstrated by seasonal variations in growth rates (Feare 1976). Parents may have been more efficient when foraging at times when most other adults from the colony were also foraging, benefiting from local enhancement (Feare 1981).

Little is known about the life of juvenile Sooty Terns in the months after fledging or in the 4–10 years before they return to the colony to breed (Harrington 1974, Schreiber *et al.* 2002, C.J. Feare unpubl. data). They leave the colony, probably with only one

TABLE 1

The re-sighting of Sooty Tern fledglings in their natal colony from four cohorts ringed at different stages of the fledging period on Bird Island, Seychelles, in 1973. Significant differences: pairs of rows sharing the same letters indicate χ^2 tests showing $P < 0.05$

Dates ringed	No. ringed	No. recaptured	Proportion recaptured	Significant differences
13–27 August	3136	45	0.014	a
28 August–11 September	341	8	0.023	
12–26 September	457	15	0.033	a,b
27 September–11 October	443	3	0.007	b

parent (Schreiber *et al*. 2002), and the duration of parental care is unknown. During this time they are sometimes fed, in the air, by the parent (Feare 1975) and must learn to feed themselves. On leaving the colony, Sooty Tern fledglings are gull-like, with shorter wings and tails than adults, and they are also very different in colour. Their flight is less powerful and agile and they may feed in a different way from their parents (Feare 1975), but recently-fledged juveniles do not appear to have been seen feeding. At sea, the problems facing juveniles are food location and procurement, kleptoparasitism by frigatebirds *Fregata* spp., predation by birds (e.g. skuas *Catharacta* spp.) and predatory fish (Feare 1976), and storms. Without knowing how and where juvenile Sooty Terns from the Seychelles feed, it is not possible to speculate how their survival might be influenced in ways that produced the observed pattern of survival. Steinen & Brenninkmeijer (2002), however, reported that body-condition factors involved in pre-fledging mortality of Sandwich Terns *Sterna sandvicensis* similarly had no influence on post-fledging survival. They attributed the absence of a post-fledging effect of earlier poor growth to the parents' ability to take juveniles to rich food supplies, enabling these juveniles to overcome potential earlier disadvantages.

Few studies of seabirds have been sufficiently long term to determine the effects of chick condition at fledging on post-fledging survival. Steinen & Brenninkmeijer (2002) reviewed seven such studies and concluded that species with post-fledging parental care showed no relationship between these parameters, whereas chick body condition did influence subsequent survival in species in which parents did not care for young after fledging. This study of Sooty Terns supports Steinen & Brenninkmeijer's (2002) hypothesis that parental provisioning after fledging buffers juveniles against growth disadvantages that they experienced prior to leaving their colonies.

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