

EGG-SIZE AND CLUTCH-SIZE OF THE BROWN BOOBY, *Sula leucogaster*, AT SWAIN REEFS, GREAT BARRIER REEF

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Received 27 December, 1988

INTRODUCTION

There is intrapopulation variation in the number of eggs in clutches of the Brown Booby, *Sula leucogaster*, the recorded clutch size being from one to four eggs (Nelson 1978). Rarely, however, does more than one chick survive to the fledging stage. This raises the question of the reproductive strategy involved. Multiple egg-laying may improve the chances of at least one young surviving nest depredation by gulls and hence be selected for. On the other hand if parents can't adequately feed more than one large chick, there would be selection against large clutch size (Lack 1968). Consequently, clutch sizes within a population may represent a balance between these opposing forces.

Clutch size may in turn affect egg size, and hence quality of resources for developing chicks. If only one egg were laid the bird might be able to put a greater energetic or nutrient investment into it than into individual eggs of a multiple clutch. One might predict, then, that egg size would be greater in single-egg clutches than in two-egg, or larger clutches.

The present study was undertaken in order to test this prediction and to assess the frequency of different clutch sizes in the population of Brown Boobies at Swain Reefs, Great Barrier Reef.

METHODS

Seven cays in the Swain Reefs (Bell, Bacchi, Thomas, Frigate, Price, Bylund and Gannet) were visited at six-monthly to yearly intervals from 1979 to 1988. The number of eggs in each nest was counted at each visit. Some clutch sizes may have been underestimated by the extent that laying hadn't been finished at the time of the counts.

On one visit to Gannet Cay (28 January 1987) dimensions of eggs in 40 nests were measured with dial calipers. The nests were selected by starting at one end of the island and obtaining data from every nest encountered while proceeding toward the other end until the predetermined number of 40 nests had been studied.

RESULTS

Egg size

Before statistical comparisons between clutches were made it was desirable to ascertain whether the eggs within two-egg clutches differed in size. Consequently, the null hypothesis that mean differences in egg-length within clutches did not differ from zero was tested and accepted (\bar{x} difference = 0.308 mm; $t = 0.41$; $P > 0.50$). Thus, there was no significant difference in length between eggs in two-egg clutches. The same was not true

TABLE 1

Characteristics of eggs in different clutch sizes of the Brown Booby, *Sula leucogaster* at Gannet Cay, Swain Reefs.

Clutch size	Number of clutches	Egg length (mm)		Egg width (mm)	
		Mean \pm S.E.	Range	Mean \pm S.E.	Range
1 egg	20	61.2 \pm 0.72	54.5-66.2	42.3 \pm 0.46	37.7-45.1
2 eggs	19	61.1 \pm 0.57	53.9-68.9	42.2 \pm 0.28	38.9-45.1
3 eggs	1	56.9 \pm 1.33	55.0-59.5	38.4 \pm 0.84	36.7-39.5

for maximum egg-width. The mean difference in maximum width between eggs was significantly different from zero (\bar{x} difference = 0.606 mm; $t=2.54$; $P<0.05$). Thus, although both eggs in two-egg clutches are the same length on average, one is larger in diameter than the other.

The mean lengths of eggs from single-egg clutches and two-egg clutches did not differ significantly ($t<1.0$; $P>0.50$; 95% confidence limits 59.971–62.495 mm), nor did the width of eggs from single-egg clutches differ significantly from those of two-egg clutches (ignoring the within clutch differences in two-egg clutches) ($t<1.0$; $P>0.50$; 95% confidence limits 41.692–43.174 mm) (Table 1).

The eggs in the only three-egg clutch observed on the island did appear to be smaller than those of other clutches (Table 1). Their mean length was 56.88 mm, well short of the 95% confidence limits of one-egg and two-egg clutches. Their mean width was 38.37 mm, again lower than the 95% confidence limits for one-egg and two-egg clutches.

Clutch size

Three-egg clutches are rare (less than 1%) among the Brown Boobies of the Swain Reefs (Table 2).

DISCUSSION

Our data do not permit assessment as to whether the first-laid or the second-laid is the larger in Brown Boobies although Nelson (1978) reported the second egg to be slightly smaller in this species, and the same is true of Kittiwakes (Braun and Hunt 1983).

Nelson (1978) reviewed seven studies ($N=24-93$ clutches, for a total of 338 clutches) of clutch size in this species from widely scattered localities. Values were 7.5–81%, 17.0–86.3% and 0.8–6% for one-egg, two-egg and three-egg clutches respectively. He noted that some error could be involved, as sometimes eggs get moved from one nest to another. He concluded that not enough data were available to interpret regional differences. Only two of those studies, Christmas Island (Indian Ocean) (57%; 42%; 1%) and Bedout (53%; 47%, 0%) were close to the values of the present observations. These localities are widely separated from Swain Reefs and there are

TABLE 2

Clutch-size frequencies of the Brown Booby on seven islands of the Swain Reefs, 1979–1988*.

Clutch size	Number of clutches	%
1	762	41.9
2	1 049	57.7
3	6	0.3
Mean Clutch Size \pm S.E.	1.58 \pm 0.01	
Total number of nests	1 817	

*Data were pooled over years and islands.

no consistent geographical patterns to clutch size. Thus, local, rather than regional conditions may be of most importance. Nelson listed only one report of clutch size larger than 3; Desnoue Island was reported to have mostly clutches of three and a few with four.

Lack (1968) suggested that a large egg is advantageous because it provides the newly hatched young with a large food reserve. If that is so, hatchlings from three-egg clutches of the Brown Booby would seem to be disadvantaged relative to those from small clutches.

The mean egg widths and lengths of our three-egg clutch were lower than those reported by Nelson (1978) from one-egg and two-egg clutches from any locality.

It can be concluded that three-egg clutches are rare in *Sula leucogaster* at Swain Reefs and that when three eggs are laid they are smaller than those of one-egg or two-egg clutches.

ACKNOWLEDGMENTS

We are grateful for financial support from the Australian Research Grants Scheme and Marine Sciences and Technologies Grants, and to Dr Stuart Cairns for assistance with statistical and computer techniques.

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