OBSERVATIONS ON THE RED-FOOTED BOOBY ON MABUALAU ISLAND, FIJI

By N. P. LANGHAM

ABSTRACT

The Red-footed Booby *(Sula sula)* colony on Mabualau Island, Fiji, was visited from 1980 to 1982. Eggs were recorded throughout the year, and young were found in seven of the nine months of the year considered. The two peaks of nesting recorded were about 7-8 months apart. Only unsuccessful birds were likely to nest twice in the same year. Fledging success was low in both 1980 (55%) and 1981 (24%). Climatic factors rather than food supply or predators caused most mortality. The diet comprised flying fish and squid. Growth was similar to that on Aldabra Atoll, but fledging weight was higher. The timing of the breeding seasons is discussed.

The ecology of seabirds breeding in the Fijian Islands is poorly known, as is shown by the accounts in King (1967) and Watling (1982). The most informative recent account is that of Tarburton (1978), who visited the main seabird islands in 1974-76. Further information is in the marine survey by Barritt (1979/80) and in Clunie *et al* (1978), although the latter is principally concerned with new records. Other observations relate to short accounts (Shorthouse 1967, Lovegrove 1978) or unpublished reports by other mariners (J. A. F. Jenkins, pers. comm.). During 1980-1982, I made a series of brief visits to the colony of Red-footed Boobies *(Sula sūla)* on Mabualau Island (178°46'E, 17°58'S) in Bau waters close to the south-east coast of Viti Levu, Fiji. The island consists of highly eroded coral limestone surrounded by an extensive shallow reef flat, making it inaccessible except at high water. At the north end is a small beach and at the south end is a *Rhizophora* mangrove swamp. That part above high water is covered with trees such as *Cerbera manghas, Pisonia grandis, Morinda citrifolia,* and other strand species. These trees provide the site for the nests of the Red-footed Booby on the leeward side of the island.

On each visit, I noted the number of nests and the contents of accessible or visible nests (Table 1). I could not visit the island in January, September and December, but eggs were recorded in all other months. Young were recorded in all these months except March and April 1981. On a visit to Vatu-i-Ra Island, 80 km north, on 14/8/82, I counted 190 nests, including 41 birds presumably incubating, three small chicks (<500 g) and 14 large chicks (≥500 g).

TABLE 1 — Red-footed Booby census details

Date	No. of occupied nests	Eggs	Young
3/ 7/80	246	✓	✓*
24/ 8/80	-	-	✓*
12/10/80	-	✓	✓*
26/10/80	173	✓	✓*
23/11/80	118	✓	✓*
15/ 2/81	5+	✓(4)	✓(1)
17/ 3/81	394	✓	0
7/ 4/81	-	✓	0
5/ 5/81	-	✓	✓*
26-27/ 5/81	-	✓	✓*
7/ 7/81	-	✓	✓*
7-8/ 8/81	c.300	✓	✓*
23/ 8/81	340	✓	✓ large only
18/10/81	397	✓	✓*
17/ 2/82	17	✓	✓ large only
22/ 6/82	263	✓	✓*

* Young at all stages; - no record; large young > 500 g

The predominance of large to small chicks suggests that the previous breeding period was tailing off and that the sitting birds represented the start of a new period of laying. A similar situation was found on Mabualau in the same month, and again in February 1982.

On Mabualau, the peak nest counts were made in March and October 1981, and the number was rising in June 1982 when counts ceased. These counts seem to show that the laying peaks were 7-8 months apart, that is, that the breeding cycle was over less than annual intervals. This presumption needs confirmation. If adults had a successful breeding season, the long incubation period (45 days) and nestling stage (91-105 days), together with at least 1 and perhaps 3 months of post-fledging care, made it very unlikely that such birds could breed more than once a year (Nelson 1969). Moult, courtship and nestbuilding would preclude successful breeders from laying at the next peak. However, unsuccessful birds could profit by not having to wait a year before attempting to breed again. Individual colour

banding of adults is necessary to show definitely whether only unsuccessful birds breed more than once a year.

Breeding success was hard to measure accurately because marked nests and eggs might be destroyed and replaced between visits and the origin of dead and starving chicks found on the ground was often uncertain. In 1980, a sample of 20 labelled nests with chicks produced 11 young (55%) to the fledging stage. In 1981, only six young (24%) definitely fledged from a sample of 29 nests. High mortality has been noted in other Red-footed Booby colonies (Nelson 1978), but in the Galapagos Islands, the cause seemed to be erratic food supply, resulting in starvation. On Mabualau, starvation was seen only in chicks that had fallen out of nests, when the chicks would generally be ignored by their parents. However, unless nests were watched continuously to record feeding rates and weight gains, starvation is hard to detect. Circumstantial evidence from weighings and measurements did not suggest that starvation was prevalent during the period of observation at Mabualau. In ten regurgitation samples from chicks were about equal amounts by weight of flying fish (Exocoetidae) and squid, a feeding bolus weighing 35-50 g. Regurgitation samples from two breeding adults, probably intended for their respective chicks, weighed 70 g and 90 g.

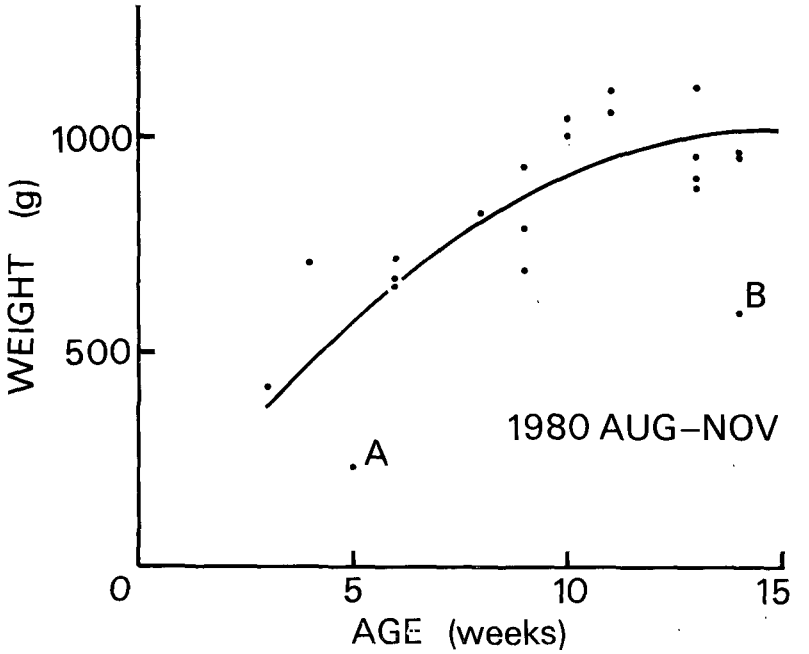

FIGURE 1 — A = Fallen chick; B = Underweight fledgling on ground

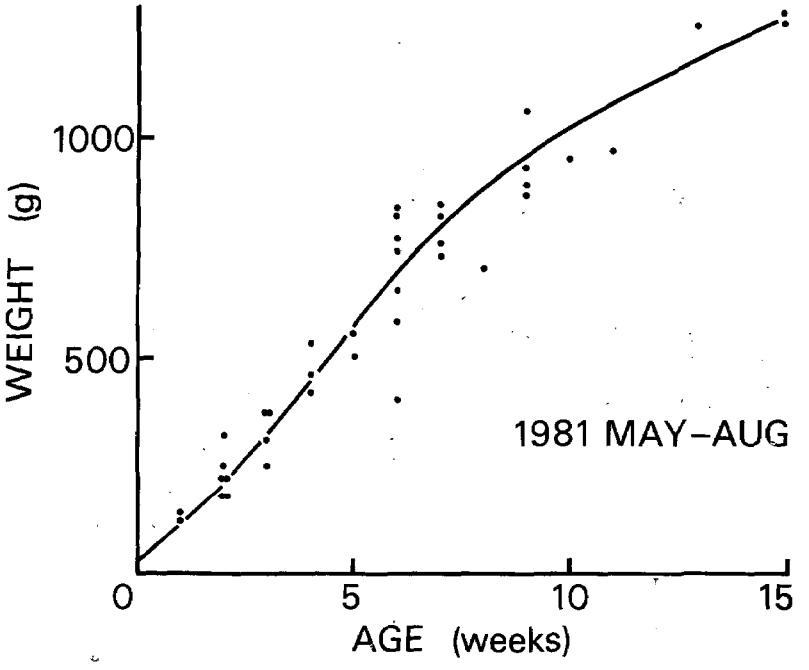

FIGURE 2

On Mabualau, climatic factors caused the main mortality of chicks and, to a lesser extent, of eggs. The cyclone season is normally from November to March, which may explain the low numbers nesting during that period and the absence of young in March and April 1981. In strong winds, branches were broken and eggs and young were knocked out. Any chicks not dead from the fall died from starvation as parents feed only young that are in or close to the nest. Large young were particularly vulnerable as they cannot be covered by adults and their down soon loses its insulating power in rain storms. The prevailing easterly trade winds account for the nests being sited on the western leeward side of the island.

The growth rate of chicks in accessible nests was examined. To estimate the age of chicks, I used the culmen and wing length of birds of known age measured on Aldabra Atoll (Diamond 1974) and in the Galapagos Islands (Nelson 1969, 1978). The growth in terms of weight is shown in Figures 1 and 2. The growth rate in 1980 was lower than in 1981 and resembled that recorded in Aldabra. In 1981, the growth rate was such that birds fledged at over 1.2 kg, higher than any fledglings in Aldabra or Galapagos (Nelson 1978). The growth rate was slowest in the Galapagos, where starvation,

probably related to current change, was prevalent. Growth rate, particularly feather development, determines fledging date, which was 91-105 days on Mabualau, 100-110 days on Aldabra, but 135 or more days on Galapagos. The Red-footed Booby lays one egg, which means that during a shortage of food the chick can survive only by reducing its growth rate (Ricklefs 1968).

Predation did not seem important on Mabualau. Rats *(Rattus exulans)* and a Swamp Harrier *(Circus approximans)* were only seen scavenging on dead chicks that had fallen to the ground. Lesser Frigate Birds *(Fregata ariel)*, which were often in small groups above the colony, were seen only to chase incoming boobies and terns, trying to force them to disgorge their food.

The phenomenon of non-seasonal breeding with laying peaks less than a year apart, as on Mabualau, has also been reported on Christmas Island (Pacific Ocean), where laying occurred in April-May and December-January (Schreiber & Ashmole 1970). Most other colonies apparently have an annual cycle: Christmas Island, Indian Ocean (Nelson 1969); British Honduras (Verner 1961); Aldabra Atoll (Diamond 1974); Kure Atoll, Hawaii (Woodward 1972). Nelson (1978) reported that, in the Galapagos, the main peak occurs in September-October and a less marked one occurs in February-April but that great annual variation occurs as a result of an erratic food supply.

The timing of breeding seasons is usually considered in terms of ultimate and proximate factors (Baker 1938), the former of survival value and acted on by natural selection and the latter being the bird's environmental cue or cues. In polar and temperate climates, increasing daylength or temperature provides a suitable proximate factor, anticipating an increase in food, the ultimate factor determining breeding success (Lack 1954). In tropical and subtropical regions, changes in daylength and temperature are not so obvious, and so birds tend to use other cues as proximate factors that anticipate food abundance. In Fiji, for example, most terrestrial insectivorous species start breeding in the rainy season, when vegetative growth generally leads to an abundance of insects. In tropical oceanic conditions, where rainfall is not a likely cue for anticipating fish or squid abundance, the breeding seasons of seabirds are not precise. The largest breeding colonies of tropical seabirds are in those areas where cold upwelling currents bring an abundance of nutrients and associated food organisms, but at certain times these currents diverge from their normal course and widespread starvation occurs, as among the Red-footed Boobies on the Galapagos. Under these conditions, food abundance may be both a proximate and an ultimate factor for tropical seabirds. In Fiji, knowledge of seasonal abundance of suitable food organisms is inadequate, especially for a pelagic-feeding species such as the Red-footed Booby, which may take 1 to 3 days to collect food for its chick.

Schreiber & Ashmole (1970) suggested that an internal rhythm or "clock" could explain the synchrony in species breeding at less than annual intervals such as the 9½ month interval of the Sooty Tern *(Sterna fuscata)* on Ascension Island in the tropical Atlantic Ocean (Ashmole 1963). Where seasonal effects occur such as the period of cyclones in Fiji, any internal rhythm must be modified to reduce mortality during breeding.

In birds such as the Red-footed Booby, where a successful breeding cycle needs more than 12 months, a non-annual breeding peak occurs (Nelson 1969). A non-annual peak allows unsuccessful birds to make a second attempt without having to wait a year, provided food conditions are relatively stable and adverse weather is unpredictable. In Fiji, breeding can be attempted twice in less than two years, but these periods tend to avoid those seasons when adverse weather is most likely to occur. Before any firm conclusions can be drawn a more prolonged investigation is needed with enough birds colour-marked for the relaying of both successful and unsuccessful breeders to be followed.

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APPENDIX I

(a) **Other breeding species on Mabualau Island**

Reef Egret **(Egretta sacra)** — mainly nesting in mangrove, but some in crevices beneath booby colony

Slaty Flycatcher **(Mayrornis lessoni)** — one pair present on all visits and probably bred

(b) **Non-breeding species on Mabualau Island**

Lesser Frigate-bird **(Fregata ariel)** — regular attendant over booby colony

Brown Booby **(Sula leucogaster)** — a few roosted regularly on island

Swamp Harrier **(Circus approximans)** — one record

White-capped Noddy **(Anous tenuirostris)** — roosted on island during non-breeding season (26/5/81 and 8/8/81). In poor light, I estimated that 5000 birds roosted on the island. Probably from Vatu-i-Ra.

Barn Owl **(Tyto alba)** — one record

White-collared Kingfisher **(Halcyon chloris)** — one record

Fiji Shrikebill **(Clytorhynchus vitiensis)** — one record

Vanikoro Broadbill **(Myiagra vanikorensis)** — several records, all males

Jungle Myna **(Acridotheres fuscus)** — several records

Orange-breasted Honeyeater **(Myzomela jugularis)** — several records

Grey-backed White-eye **(Zosterops lateralis)** — several records

N. P. LANGHAM, *School of Natural Resources, University of the South Pacific, Fiji.* Present address: *Ecology Division, DSIR, Havelock North, New Zealand*

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SHORT NOTE

NEST OF THE GIANT FOREST HONEYEATER

Neither the breeding nor the nest of the endemic Giant Forest Honeyeater *(Gymnomyza viridis)* of Fiji, nor that of the related Mao *(G. samoensis)*, endemic to Samoa, have been described (Watling 1982). In Fiji, *G. viridis is* frequently heard where sufficient areas of mature rainforest remain. The call is a loud ringing sound, often in duet (Diamond 1972) with another bird and often answered by duets given by other birds in the forest which can be heard for at least a kilometre. Despite its conspicuous call, the bird itself is relatively timid, preferring the dense foliage of the rainforest canopy, where it drinks nectar and forages for insects.

On 29 August 1982, while walking along a bulldozed track through the catchment forest of Wailoku near Suva, I noticed two *G. viridis* near the top of a tall tree, one of which was displaying by fanning and raising and lowering its tail. A few minutes later, I saw one bird carrying a dead leaf of a small palm in its bill. The next day, at about 1500 h, I again saw a bird in the vicinity and could discern a nest among the foliage of a tree, *Heritiera ornithocephala,* distinguished by the copper colour of the undersurface of the leaves. The nest was estimated to be about 18-20 m above ground with a diameter of about 20-25 cm. It was like a basket formed of rootlets