

- recently developed recorders for monitoring diving activity of marine birds and mammals. In: *Experimental Biology at Sea*, MacDonald A.G. & I.G. Priede (Eds.). London: Academic Press.
- LISHMAN, G.S. & J.P. CROXALL. 1983. Diving depths of the Chinstrap Penguin *Pygoscelis antarctica*. British Antarctic Survey Bulletin. 61: 21-26.
- SKIRA, I. 1979. Underwater feeding by Short-tailed Shearwaters. *Emu* 79: 43.
- WILSON R.P. & C.A.R. BAIN. In press. An inexpensive depth gauge for penguins. *J. Wildl. Management*

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## MORTALITY AND GROUP COHESION IN MIGRATING RAINBOW BEE-EATERS

Rainbow Bee-eaters *Merops ornatus* migrate annually between Australia and New Guinea (Blakers *et al.* 1984). Two aspects of this migration are of particular interest: the high mortality on waterless islands in Torres Strait during the southern migration (Anon 1975; Draffan *et al.* 1983) and their social organization in transit.

The high mortality appears to be from starvation and/or dehydration (Draffan *et al.* 1983). Bee-eaters caught during migration at Booby Island in Torres Strait weighed only 22.2 g (18-25,  $n = 30$ , R.D.W. Draffan pers. comm.) whereas the mean weight of all Bee-eaters banded in southern Australia between October and March is 29.3 g (24-33,  $n = 96$  Australian Bird Banding Scheme) and of Bee-eaters wintering in northern New Guinea is 28.2 g (25-32,  $n = 9$ , Diamond & LeCroy 1979). Fry (1984) has suggested that the condition of birds dying in Torres Strait would indicate a continuous flight of 1,000 km from islands around the Banda Sea rather than from nearby New Guinea. Such mortality has not been noted among migrant European Bee-eaters *M. apiaster* and Blue-cheeked Bee-eaters *M. persicus*, which travel much greater distances than the Rainbow Bee-eater, although less over water.

Rainbow Bee-eaters are communal breeders (Filewood *et al.* 1978). In all but a few communally breeding species social groups are cohesive throughout the year. The high mortality Bee-eaters reported from Torres Strait would appear to act against such social cohesion since the probability of mating with the same individual in successive years would be so much reduced. It has been suggested that the sexual dimorphism of Rainbow Bee-eaters, the only bee-eater species exhibiting differences in both plumage and weight (males  $30.0 \pm 1.5$ , females  $28.4 \pm 1.7$ ,  $t = 3.65$ ,  $P < 0.001$ , ABBS), is due to a need to re-establish social bonds annually (Fry 1984). Sexual dimorphism is lacking in the migratory White-throated Bee-eater *M. albicollis* and is almost absent from the European Bee-eater, both of which have perennial pair-bonds (C.H. Fry pers. comm.) as do all sedentary species that have been studied (Fry 1984). However the only strong evidence

for social cohesion among bee-eaters during migration is of adult European Bee-eaters feeding young on their non-breeding grounds (Robinson & Robinson 1975). There is no information on the structure of migratory flocks of any bee-eater species.

I visited Booby Island from 28 August to 4 September 1984, which coincided with the early stages of the Rainbow Bee-eater migration. Booby Island is a rock of 6.3 ha 35 km west of Thursday Island with no surface water and only 1 ha of vegetation. The Bee-eaters on Booby Island fell into two categories: those that stayed for a single night, or less if they arrived before 1700 hrs, and those that remained for longer periods. The former were heavier: males 27.0 g (24.8-29.2,  $n = 15$ ), females 25.1 g (23.8-26.9,  $n = 8$ ). Only one, a bird which was regrowing its entire tail, was moulting its flight feathers, while none had more than a few body feathers in sheaths. Birds in the group that stayed were much lighter (19.9 g, 17.4-25.7,  $n = 9$ , 6 males, 3 females, sexes similar) and, of seven birds examined, five were in heavy body moult. Four of these also had growing feathers in the wing and tail. The only one weighing more than 22 g was among those in heaviest moult. Seven of these emaciated birds were present when I arrived. Of these, four died the following day and only one survived the full week of my stay, declining in weight from 21.2 to 19.1 g over that period. Two birds that arrived with migrating flocks did not continue and also lost weight on the island: 20.8 to 16.2 g, 25.7 to 20.7 g, both over two days. None gained weight in contrast to some of those that remained at Booby Island during their northward migration (R.D.W. Draffan pers. comm.). Dissection of the four that died revealed no pathology but neither was there any fat around the neck or viscera. Their gizzards were lined with black viscous material, lacking solid contents, although all Bee-eaters were observed feeding sporadically on the flying insects available.

Bee-eaters dying on Booby Island were either underweight or in heavy moult. Of the 135 birds seen to arrive or pass by during my stay only two remained and died. While this may have been a function of the

unusually light winds for that time of year, the majority of Bee-eaters must pass Booby Island successfully. The astonishing mortality that has been witnessed (Anon. 1975; Draffan *et al.* 1983) is probably a function of the vast numbers using this migratory pathway. The mortality of the Bee-eaters was sufficiently low, and the weight of those that continued sufficiently high, to suggest that they came from nearby New Guinea. Those over-wintering on Islands around the Banda Sea are more likely to migrate along the Wessel Islands north-east of Arnhem Land, where the movement of Bee-eaters is said to be as spectacular as that across Torres Strait (C.O'Neill pers. comm.).

The arrival time of the migrating Bee-eaters would suggest that they had flown the 170 km from New Guinea in a morning. The earliest arrivals at Booby Island were at 1200 hrs. Assuming they left New Guinea at 0600 hrs, ground speed would have been just under 30 km/hr, a speed comparable with that of the European Bee-eater, which can travel 520 km in a single day (Fry 1984), given the more rounded wing of the Rainbow Bee-eater (Fry 1984) and the prevailing headwind. The strength of the headwind also appeared to influence the time of arrival. On a day of constant south-east winds of between 20 and 30 km/hr the first arrivals were at 1500 while on the days with least wind no Bee-eaters were seen at all although further to the east, at Thursday Island, Bee-eaters were passing continuously (G.J. Malone pers. comm.). Since Booby Island is to the west of the main island chain across Torres Strait it may be that only on windy days does the Bee-eater's route cross the island at all.

Several of the observations point to social cohesion among migrating flocks. First, one evening a group of over fifty arrived at sunset and roosted on the island. Roosting was in clusters of three to seven and two groups seen by spotlight were both of two males and one female. Secondly, when birds were caught during the day the rest of their flock perched nearby and waited,

usually until the captured bird was released. Most migrating flocks passed over the island without breaking their flight. Thirdly, all three members captured out of a flock of four had blue on the throat, a feature lacking in all others examined and suggesting a genetic relationship. Two in this group also had extensive areas of turquoise blue in the crown, a feature not noted by Fry (1984). These observations are circumstantial evidence that social groupings observed during breeding are maintained during migration. Such facets of Bee-eater biology, however, can only be confirmed by marking many more migrating Bee-eaters and recapturing them at breeding grounds or *vice versa*.

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#### REFERENCES

- ANONYMOUS. 1975. The birds of Booby Island. Transport Australia 13: 12-14.
- BLAKERS, M., S.J.J.F. DAVIES & P.N. REILLY. 1984. The Atlas of Australian Birds. Melbourne: RAOU.
- DIAMOND, J.M. & M. LECROY. 1979. Birds of Karkar and Bagabag Islands, New Guinea. Bull. Amer. Mus. Nat. Hist. 164: 469-531.
- DRAFFAN, R.D.W., S.T. GARNETT & G.J. MALONE. 1983. Birds of the Torres Strait: an annotated list and biogeographical analysis. Emu 83: 207-234.
- FILEWOOD, L.W.C., K. HOUGH, I.C. MORRIS & D.E. PETERS. 1978. Helpers at the nest of the Rainbow Bee-eater. Emu 78: 43-44.
- FRY, C.H. 1984. The Bee-eaters. Calton: Poyser.
- ROBINSON, G.B. & J.M. ROBINSON. 1975. European Bee-eaters feeding young in Zambia. Bull. Zambian Orn. Soc. 7: 107.

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