THE SEXUAL DIMORPHISM OF SNARES CAPE PIGEONS
*(Daption capense australe)**

By P. M. SAGAR

ABSTRACT

The males of Snares Cape Pigeons breeding at the Snares Islands are larger than females, especially in head plus bill length, mid-toe plus claw, bill length, bill depth, tarsus, and weight. By using the measurements head plus bill length and mid-toe plus claw, one can reliably sex about 82% of the Snares Islands birds. The amount of sexual dimorphism is similar in both races of cape pigeon. The importance of having a wide range of calls during breeding is favoured as the reason for dimorphism having developed in fulmarine petrels.

INTRODUCTION

Cape Pigeons are fulmarine petrels, a group which is sexually dimorphic e.g. Northern Fulmar *Fulmarus glacialis* (Dunnet & Anderson 1961), Antarctic Fulmar *F. glacialoides* (Mougin 1967), Cape Pigeon *Daption capense capense* (Pinder 1966), Snow Petrel *Pagodroma nivea* (Croxall 1982), and Northern and Southern Giant Petrels *Macronectes halli* and *M. giganteus* (Hunter 1984). Sexual dimorphism is evident in most petrels, males tending to be larger than females except in storm petrels, where they may be smaller (Bourne 1985).

The Snares Cape Pigeon *(D. c. australe)* breeds at the Snares, Antipodes, Bounty, Auckland, and Campbell Islands (Kinsky 1980). This race is smaller and darker than the nominate race (Watson 1975), which breeds at higher latitudes. Measurements of Snares Cape Pigeons are available from a small number of museum specimens (e.g. Oliver 1955) but not from live birds of known sex.

The easiest time to sex live petrels is during the laying season. Therefore, when my November 1985 visit to the Snares Islands coincided with the laying period of Snares Cape Pigeons, I took the opportunity to obtain some information from live birds. The objectives were to measure and weigh live Snares Cape Pigeons of known sex so as to study their sexual dimorphism and to compare these results with data for the nominate race.

METHODS

A sample of 95 breeding Snares Cape Pigeons was captured and measured at the North Promontory, North East Island, the Snares Islands (48°02'S,

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166°36'E) between 4 and 18 November 1985. All birds were caught at marked nest sites either just before egg-laying or during the first two incubation shifts. Because they were breeding I could assume that these birds were at least five years old (Beck 1969), which should eliminate any age-related size variation. Both birds of a pair were caught at 43 nests, but at nine nests only the male was caught.

Eight measurements were taken from each bird: head plus bill length (Nugent 1982), bill length, bill width,bill depth, tarsus, and mid-toe plus claw were measured to the nearest 0.1 mm with vernier calipers; wing length to the nearest 1.0 mm with a steel tape; and weight to the nearest 5 g with a 1000 g Pesola spring balance. I measured most birds; the rest were measured by Colin M. Miskelly.

Each bird was sexed by cloacal examination (Serventy 1956), a particularly reliable method because laying was at its peak.

The measurements were subjected to a stepwise discriminant function analysis (Nie *et al.* 1975). This analysis chooses the single measurement which is best for discriminating between the sexes and, by placing the other measurements in a series of decreasing value as discriminators, gives an optimal set of measurements. An index of sexual dimorphism (female/male x 100, see Croxall 1982) was calculated for each measurement. This index indicates the degree of sexual dimorphism, where a result of 100 shows no difference but lower and higher results show that males are larger or smaller respectively than females. Although the index is useful when comparing the degree of sexual dimorphism between species, it cannot be used to sex birds.

RESULTS

Males were significantly larger than females in all measurements (Table 1). Dimorphism was least marked between bill width and wing length. The best discriminators were head plus bill length (HB) and mid-toe plus claw (MTC) and are used for Figure 1. However, as there is some overlap a 2-variable analysis was completed to obtain a classification score:

$$(0.48568 \times \mathrm{HB}) + (0.2592 \times \mathrm{MTC}) - 53.17596.$$

A negative result for this equation indicates that the bird is a female and a positive result indicates a male. Use of this equation on birds of known sex resulted in 81.4% of females and 84.6% of males being correctly assigned to sex.

Males were significantly heavier than females ($P<0.001$) just before laying, even though each female was carrying an egg. The males were heavy before starting the long, first incubation shift. Straight after laying, mean female weight was 347 g ($n=47$) but by the time females started their first incubation shift their mean weight was 421 g ($n=21$). Males lost weight during their first incubation shift. Thus comparing the weight of birds at one colony from year to year or the weight of birds at different colonies has little value unless the birds are at the same stage of the breeding cycle.

Although wing length, the longest linear measurement, is the easiest to record, it was the least useful measurement in determining sex.

TABLE 1 — The relative sexual dimorphism in body measurements of live Snares Cape Pigeons

Measurement	Mean ± 1 standard deviation (Range)		F d.f.1 & 93
	Male (N = 52)	Female (N = 43)	
Head + bill length (mm)	78.47 ± 1.51 (74.6 - 81.8)	75.87 ± 1.67 (71.8 - 79.4)	63.74 ***
Bill length (mm)	31.22 ± 1.18 (27.8 - 34.9)	29.90 ± 1.05 (27.8 - 32.3)	32.18 ***
Bill width (mm)	15.32 ± 0.64 (13.8 - 17.0)	14.86 ± 0.72 (13.2 - 16.3)	10.52 **
Bill depth (mm)	12.97 ± 0.63 (11.8 - 14.4)	12.39 ± 0.60 (11.1 - 13.6)	21.29 ***
Wing length (mm)	267.08 ± 5.91 (254 - 276)	264.07 ± 7.24 (241 - 280)	4.97 *
Tarsus (mm)	45.07 ± 1.57 (41.7 - 48.6)	43.80 ± 1.82 (40.7 - 47.3)	13.31 ***
Mid-toe + claw (mm)	61.29 ± 1.58 (57.8 - 65.3)	59.11 ± 1.96 (54.0 - 63.1)	35.82 ***
Weight (g)	452.00 ± 40.00 (345 - 577)	419.00 ± 31.00 (342 - 476)	19.67 ***

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

The index of sexual dimorphism calculated for each measurement was 92.7 (weight), 95.5 (bill depth), 95.8 (bill length), 96.4 (mid-toe plus claw), 96.7 (head plus bill length), 97.0 (bill width), 97.2 (tarsus), and 98.9 (wing length). The mean index for all measurements was 96.3.

DISCUSSION

Snares Cape Pigeons, like other fulmarine petrels, have males larger than females. By using the measurements of head plus bill length and mid-toe plus claw, one can correctly sex about 82% of live birds. A similar degree of sexual dimorphism has been shown for Northern Fulmars (Dunnet & Anderson 1961) and Snow Petrels (Croxall 1982). The two species of giant petrels have a greater extent of dimorphism in weight than these species (Croxall 1982). Because of this sexual dimorphism one can correctly assign to sex a large proportion of the fulmarine petrels at their breeding colonies or on adjacent seas.

Both races of cape pigeon have a similar extent of sexual dimorphism, even though the southern race is slightly larger than the Snares Cape Pigeon. The index of sexual dimorphism in weight for breeding *D. c. capense* on Signy Island was 92.1 (Croxall 1982), which compares well with my 92.7for *D. c. australe.* Pinder (1966) showed that the bill length, wing length and

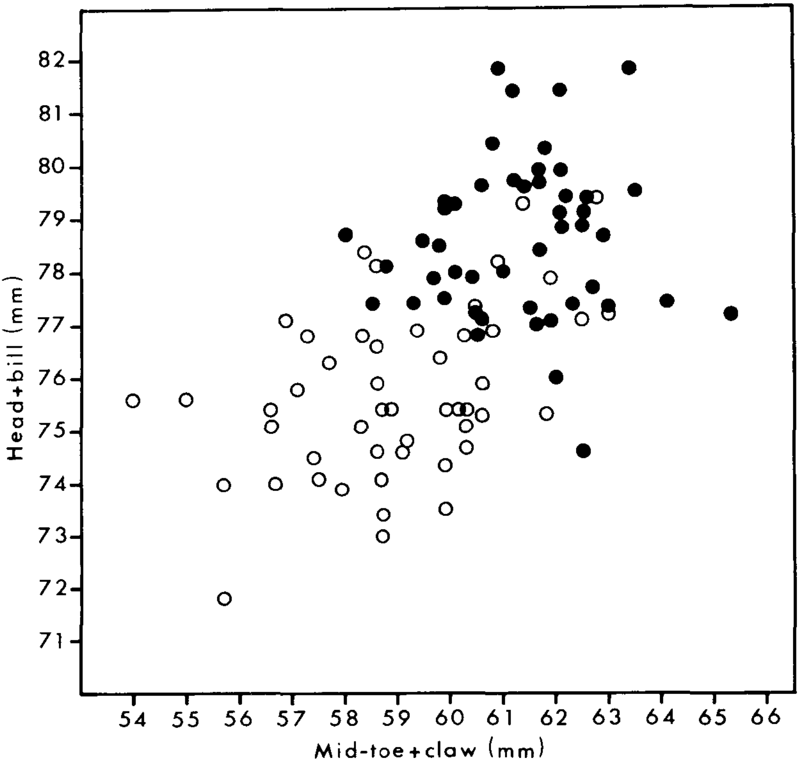

FIGURE 1 — Measurements for head plus bill length and mid-toe plus claw of live Snares Cape Pigeons of known sex from North East Island, the Snares Islands. O = females (n = 43); ● = males (n = 52)

tarsus of males were larger than those of females in *D. c. capense* breeding on Signy Island. Calculation of indices of sexual dimorphism from his data results in 95.5 (tarsus), 96.8 (bill length), and 99.6 (wing length). These indices are also similar to those obtained from Snares birds. Unfortunately measurements reported from birds at other breeding colonies do not distinguish between the sexes.

Several explanations have been proposed for the development of sexual dimorphism in fulmarine petrels. Hunter (1983) suggested, for giant petrels, that interspecific and intersexual competition at carcasses led to selection for larger males, their bill letting them feed more easily on carrion. However, this argument would apply equally to females and so could explain how larger males have gained an advantage only after sexual dimorphism had developed.

Males do more incubating and brooding than females in both species of giant petrels (Hunter 1984), in Cape Pigeons (Pinder 1966) and in Snow Petrels (Brown 1966). In the Wandering Albatross *(Diomedea exulans)*, which has similar sexual dimorphism, incubating males have a lower rate of weight loss than females, which offsets their longer incubation spans (Croxall &

Ricketts 1983). However, because fulmarine petrels have much shorter incubation periods than other procellariforms (Croxall 1984), different rates of weight loss are unlikely to explain sexual dimorphism in cape pigeons.

The most plausable explanation, suggested by Croxall (1982) for Snow Petrels, is that sexual dimorphism may be a simple way of increasing the range of calls the birds have. Guillotin & Jouventin (1980) showed that body weight was correlated with the sound frequency of the voice in Snow Petrels, and Isenmann (1970) showed that calls are important in the recognition of individuals. Calls seem to be just as important for cape pigeons, especially during courtship and when birds meet at the nest. These aspects of fulmarine petrel biology need special study.

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