Weight changes and reproduction in female Blue-billed and Musk Ducks, compared with North American Ruddy Ducks

S.V. BRIGGS

Introduction

Tome (1984) has recently published details of weight changes in North American Ruddy Ducks *Oxyura jamaicensis* in relation to their breeding status. Prior to this, Siegfried *et al.* (1976) published some limited data for Maccoa Ducks *O. maccoa*. In the present paper data on female weight changes in two Australian oxyurids, Blue-billed Ducks *O. australis* and Musk Ducks *Biziura lobata*, are summarised. The question is asked – does female body weight increase prior to laying, and if so, by how much? Body weight changes in Blue-billed and Musk Ducks are then compared with those in related North American Ruddy Ducks and Maccoa Ducks.

Study area and methods

The Blue-billed and Musk Ducks were collected at Barrenbox Swamp (34°10'S; 145°50'E), an irrigation water storage lake in inland south-eastern Australia. A full habitat description of Barrenbox Swamp is given in Braithwaite and Frith (1969a). A sample of ducks was collected by shooting each month they were present between September 1962 and April 1967 (Braithwaite and Frith 1969b). Musk Ducks were present at Barrenbox Swamp all year while Blue-billed Ducks were absent or less abundant between March and May (autumn). Each duck specimen was assigned to 1 of 6 reproductive categories modified from Tome (1984):-

Pre-breeding: Corresponds to Tome's "Arrival" stage. Largest follicle <8 mm. Collected between June and November (breeding period).

Pre-laying: Identical with Tome's category.

Laying: Identical with Tome's category.

Incubation: Collected with brood patch, on nest incubating, or with regressing follicles.

Brood rearing: Collected with downy young.

Non-breeding: Largest follicle <8 mm. Collected between December and May (non-breeding period).

Wing area of female Blue-billed Ducks was obtained from three captive yearling birds (other wing clipped, second generation in captivity), measured according to Raikow (1973). The average wing length of these captive ducks was the same as in wild birds (Frith 1977).

No identifiably incubating or brood rearing Blue-billed Ducks were collected. The collection period spanned 4 1/2 breeding seasons.

Results

Female Blue-billed and Musk Ducks both gained weight prior to laying (Table 1). Blue-billed Ducks increased in body weight by an average of 212 g between pre-breeding and pre-laying and by a further 157 g between pre-laying and laying (total increase of 46% from pre-breeding to laying). Their body weight had increased by 28% between non-breeding and pre-breeding, giving a total increase of 87% between non-breeding and laying ((73% when corrected for egg mass in laying birds – Table 3). There were no data on weights

Table 1. Body weights in female Blue-billed and Musk Ducks in relation to breeding status (means ± s.e.).

Breeding stage	Blue-billed Duck	Musk Duck
Pre-breeding	798±16.8	1338±16.8
n	47	144
Pre-laying	1010±45.0	1665±43.8
n	11	21
Laying	1167±27.6	1641±33.4
n	10	13
Incubation	–	1397±87.6
n		4
Brood rearing	–	1223±22.1
n		21
Non-breeding	624±16.4	1346±22.6
n	26	98

Wildfowl 39 (1988): 98–101

of incubating and brood-rearing Blue-billed Ducks.

Musk Ducks increased in weight by an average of 327 g (24%) between pre-breeding and pre-laying (Table 1). Mean pre-laying weight was not significantly different from mean laying weight. Females of this species lost weight during incubation (244 g) and brood rearing (a further 174 g). This total weight loss was greater than that gained prior to laying.

Females of both species had relatively low body masses during the non-breeding period (Table 1). They differed in that average Musk Duck weight did not increase during the pre-breeding period, whereas Blue-billed Duck pre-breeding weight was higher (174 g) than for non-breeding.

Discussion

The percentage weight change in Blue-billed Ducks prior to laying is amongst the highest recorded in waterfowl to date. It compares with the large weight increases in breeding geese and eider ducks. For example, Cackling Geese *Branta canadensis minima* increase their weight by 46% from spring migration to pre-laying, and 57% from midwinter to pre-laying (Raveling 1979). Common Eiders *Somateria mollissima* increase by 25% between winter and pre-laying, and American Eiders *S.m. dresseri* by 32% between pre-breeding and laying (Milne 1976; Korschen 1977).

The large percentage and absolute weight gain in breeding Blue-billed Ducks and the large absolute gain in Musk Ducks contrast with the much smaller weight gain in North American Ruddy Ducks. When laying these last increase by only 123 g or 21% of their body weight (Tome 1984). Maccoa Ducks, closely related to Blue-billed Ducks, may also substantially increase in body weight prior to laying. Seigried *et al.* (1976) report a weight difference of 307 g (51%) between three non-breeding (= pre-breeding) females and one laying individual.

Why is there this difference between Ruddy Ducks and Blue-billed, Musk and Maccoa Ducks? Two factors related to body mass in ducks may be important. Firstly, flying imposes a constraint on weight gain in birds. As Tome (1984) has highlighted, North American Ruddy Ducks have a low wing area to body weight ratio (buoyancy index) compared with waterfowl in other tribes. He suggested that this factor prevents them from increasing their breeding body weight. Large weight gains in Blue-billed and Musk Ducks might thus be possible if they have higher wing areas relative to body weight than North American Ruddy Ducks.

Relations between body weight and wing size in Blue-billed, Musk, Maccoa and North American Ruddy Ducks are shown in Table 2. Breeding Musk and Maccoa Ducks have slightly greater wing length to body weight ratios than Blue-billed and North American Ruddy Ducks. But breeding Blue-billed Ducks have similar wing lengths relative to body weight as breeding North American Ruddy Ducks, and lower wing area to body weight ratios (buoyance index) (Table 2). Consequently, breeding female Blue-billed Ducks have no advantage in wing size and this factor cannot explain their marked increase in reproductive body weight compared with North American Ruddy Ducks.

A second factor which could be related to

Table 2. Maximum (breeding) and minimum (pre-breeding or non-breeding) body weight (g), wing length (mm), wing length divided by cube root of body weight, wing area (cm^2) and Bouyancy Index[a] (Hartman 1961) in female oxyurids. Data from Siegfried *et al.* (1976), Johnsgard (1978) and Tome (1984).

Species	Body weights max	Body weights min	Wing length	Wing ÷ $\sqrt[3]{\text{weight}}$ max	Wing ÷ $\sqrt[3]{\text{weight}}$ min	Wing area	Buoyancy Index[a] max	Buoyancy Index[a] min
Blue-billed Duck	1167	624	153	26.2	30.6	360	1.80	2.22
Musk Duck	1165	1138	185	29.0	30.6	–	–	–
N.A. Ruddy Duck	739	582	139	26.7	28.3	326	2.00[b]	2.16[b]
Maccoa Duck	907	600	169	30.5	34.1	–	–	–

[a]square root of wing area divided by cube root of body weight
[b]calculated from wing area in Raikow (1973) and body weights in Tome (1984)

breeding body weight is clutch mass. All oxyurids have large eggs and consequently large clutch masses relative to their body mass, compared with other waterfowl (Lack 1967). A large pre-laying increase in body mass might enhance clutch mass, since stored reserves can influence clutch size in anatids (Ankney and MacInnes 1978; Drent and Daan 1980). However, North American Ruddy Ducks have a larger clutch mass than Blue-billed, Musk or Maccoa Ducks (Table 3), so that clutch mass and body weight increase are not positively related in these four species.

It is suggested that the answer to the question lies in the different movement patterns of the species. North American Ruddy Ducks are migrants (Johnsgard 1978), and fly several hundred kilometres between their wintering and breeding grounds. Good flying ability is hence essential for breeding and survival in this species, as suggested by Tome (1984). Blue-billed, Musk and Maccoa Ducks have no such constraints. Blue-billed Ducks make local seasonal movements, but do not regularly migrate long distances prior to breeding, and Musk Ducks are mainly sedentary (Blakers *et al.* 1984). Maccoa Ducks are also sedentary or move locally (Siegfried *et al.* 1976; Johnsgard 1978). Differences in breeding habitat may additionally contribute to the species' differences in weight gain. North American Ruddy Ducks often breed in relatively small, discrete wetlands between which they must fly to find nest sites (Tome 1984). Conversely, Blue-billed and Musk Ducks usually breed in interconnected or larger waterbodies (Frith 1977) in which they can move largely by swimming.

I therefore suggest that low breeding weight gain in North American Ruddy Ducks compared with Musk, Maccoa, and especially Blue-billed Ducks can be attributed to this difference in their movement patterns. The sedentary or locally mobile species consequently can store more reserves for breeding. These data thus support Tome's (1984) conclusions concerning the constraining effect of wing area on weight increase prior to breeding in female North American Ruddy Ducks.

Further investigations of this subject await accurate information on movement patterns and weight changes in other oxyurid species, and details of carcass composition changes relative to breeding in Blue-billed and Musk Ducks.

Table 3. Average egg mass (g), clutch size and clutch mass as a percentage of laying body mass in female oxyurids. Data from Siegfried *et al.* (1976), Frith (1977), Johnsgard (1978) and Tome (1984).

Species	Egg mass	Clutch size	Clutch mass %
Blue-billed Duck	90	5.5	42%
Musk Duck	128	2.8	22%
N.A. Ruddy Duck	73	7.6	75%
Maccoa Duck	88	5	49%

Acknowledgements

Dr L.W. Braithwaite most kindly allowed me to use his data on body weights and follicle sizes of Blue-billed and Musk Ducks for this paper. These measurements were collected by Dr Braithwaite, Dr H. Frith, K. Gamble, J. McKean, J. Burt, P. Hanisch and B. Brown. B. Lambie at Tidbinbilla Nature Reserve supplied the Blue-billed Ducks for wing measurement. The manuscript was read by Dr L.W. Braithwaite, Dr A. Cockburn, Dr R. Kingsford and L. MacLean. I remain grateful to the Division of Wildlife and Rangelands Research, CSIRO for the provision of facilities.

Summary

Female Blue-billed and Musk Ducks both increase in body weight prior to breeding. Blue-billed Ducks increase by 369 g (46%) and Musk Ducks by 327 g (24%) between pre-breeding and breeding. These weight gains, especially in Blue-billed Ducks, are high compared with those in related North American Ruddy Ducks. It is suggested that this difference is because North American Ruddy Ducks have to migrate long distances to breed whereas Blue-billed and Musk Ducks do not.

References

Ankney, C.D. and MacInnes, C.D. 1978. Nutrient reserves and reproductive performance of female Lesser Snow Geese. *Auk* 95:459–471.

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. 1984. *The atlas of Australian birds*. Melbourne University Press, Melbourne.

Braithwaite, L.W. and Frith, H.J. 1969a. Waterfowl in an inland swamp in New South Wales. I. Habitat. *CSIRO Wildl. Res.* 14:1–16.

Braithwaite, L.W. and Frith, H.J. 1969b. Waterfowl in an inland swamp in New South Wales. III. Breeding. *CSIRO Wildl. Res.* 14:65–109.

Drent, R.H. and Daan, S. 1980. The prudent parent: energetic adjustments in avian breeding. *Ardea* 68:225–252.

Frith, H.J. 1977. *Waterfowl in Australia*. Reed, Sydney.

Hartman, F.A. 1961. Locomotor mechanisms of birds. *Smithsonian Misc. Coll.* 143:1–91.

Johnsgard, P.A. 1978. *Ducks, geese and swans of the world*. Indiana University Press, Bloomington.

Korschen, C.E. 1977. Breeding stress of female Eiders in Maine. *J. Wildl. Manage.* 41:360–373.

Lack, D. The significance of clutch size in waterfowl. *The Wildfowl Trust Eighteenth Annual Report*:125–128.

Milne, H. 1976. Body weights and carcass composition of the Common Eider. *Wildfowl* 27:115–122.

Raikow, R.J. 1973. Locomotor mechanisms in North American Ducks. *Wilson Bull.* 85:295–307.

Raveling, D.G. 1979. The annual cycle of body composition of Canada Geese with special reference to control of reproduction. *Auk* 96:234–252.

Siegfried, W.R. 1969. The proportion of yolk in the egg of the Maccoa Duck. *Wildfowl* 20:78.

Siegfried, W.R., Burger, A.E. and Frost, P.G.H. 1976. Energy requirements for breeding in the Maccoa Duck. *Ardea* 64:171–191.

Tome, M.W. 1984. Changes in nutrient reserves and organ size of female Ruddy Ducks breeding in Manitoba. *Auk* 101:830–837.

S.V. Briggs, C/– Division of Wildlife and Rangelands Research, CSIRO, P.O. Box 84, Lyneham, A.C.T. 2602, Australia.