THE WEIGHT OF THE KIWI AND ITS EGG

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I. NORTH ISLAND BROWN KIWI *Apteryx australis mantelli*

It is believed widely that this bird lays an egg which, relative to its body size, is the largest known. Furthermore, the egg is stated to equal one-fourth (Romanoff and Romanoff, 1949; Welty, 1962) or even as much as one-third (Fisher and Peterson, 1964) of the adult body weight which is given as 1.8 kg (Van Tyne and Berger 1959; Welty 1962) or 2.0 kg (Romanoff and Romanoff, 1949). Falla (1964) weighed a female that was accidentally killed when on the point of laying. The specimen weighed nearly eight pounds (3.6 kg) but this included a fully developed one-pound (450 g) egg in the lower oviduct. In this particular example the egg was a little over one-seventh of the body weight and Falla cautioned that — " There have been speculative assertions that the egg is roughly one-quarter of the weight of an adult bird without due reference to the age and sex of the adult quoted." Although this example is cited in some more recent literature (Lack, 1968; Johns, 1970), the New Zealand Department of Education still reiterated the traditional view in a 1968 issue of its ' School Journal.'

In his first mention of the size of the brown kiwi and its egg, Lack (1968, p. 208) uses Falla's record (i.e. the egg is 14.3% of 3.2 kg); later (p. 286) he uses the same proportionate size (14.3% or one-seventh) but gives the adult weight as 1.8 kg. Along with age and sex, condition is also an important consideration. A female weighing 3.2 kg is carrying excessive fat while one weighing only 1.8 kg is quite emaciated. Data suggest that while a normal sized egg represents more than 14.3% of the weight of a female in average condition, it falls considerably short of the 25-33% mentioned in some accounts.

Weights of Adult Birds: Data are available from two sources; birds killed in the wild and birds retained in captivity.

Wild Birds: Seventy-one specimens sent to the Dominion Museum since 1958 include 54 adults (32 females, 22 males) that were weighed on arrival. The 22 males varied in weight from 1020 to 2590 (mean 1680) g. and the 32 females weighed from 1180 to 3270 (mean 2125) g. Many of these had either bled or starved to death in opossum traps. If emaciated or injured adults are excluded the sample decreases to 13 males with weights varying from 1820 to 2590 (mean 2080) g; and 21 females with weights ranging from 2090 to 3270 (mean 2490) g.

Captive Birds: Between August 1965 and December 1970, 27 of 42 birds held at Mt. Bruce were weighed on arrival; and more than 400 subsequent weighings provide additional information on 19 birds. Many weights record growth or performance of young or sick birds for, of the 42 kiwis held, 18 were either chicks or juveniles and more than half of the adults were injured. Only four (three females. one male) of the adults that were weighed several times (Table 1) were considered to be in good health.

Fairly broad fluctuations occurring in their weights coincided with periods of heavy or light feeding and are regarded as normal.

Weight records for both wild and captive adult kiwis in good condition show females average about 2490g (5 lb 8 oz) and males about 2080g. (4 lb 9 oz).

Egg Size and Weight: Data from two eggs of typical shape (elliptical, with blunt ends) permit calculations of weight for other eggs when the primary dimensions alone are known.

One egg, removed from the oviduct of an injured wild bird that died in captivity, measured 125.4 by 78.6 mm. and weighed 434.6g. The dry shell weighed 22.9g and had an internal volume of 400 ml., and the specific gravity of the mixed contents was 1.029.

The second egg was infertile, had been incubated for 30 days and weighed only 323.4g. The shell measured 121.0 by 71.7 mm., enclosed an internal volume of 323.5 ml. and, when dried, weighed 21.7g. The weight of this egg at laying can be determined by multiplying its internal volume by the relative density of fresh mixed contents and then adding the shell weight, i.e. $323.5 \times 1.029 + 21.7 = 354.6$g.

If the specific gravity of the fresh contents of kiwi eggs is assumed to be constant then, from the weights and measurements of these two eggs, it seems that the fresh weight of a typical egg may be fairly accurately determined from the expression:

$$W = 0.565\ ab^2$$

where a is the length and b is the maximum transverse diameter of the shell.

In both examples the error from this formula is less than one percent, (Table 2) and when the formula was used to determine the fresh weights of 15 measured eggs the following weights were obtained (Table 3).

Two eggs in this series (Nos. 13 and 14), from the Dominion Museum collection, were weighed by F. C. Kinsky. Number 13 weighed 470g., and number 14 weighed 465g. The first was 32g. and the second was 40g. below their calculated weights but both contained chicks — a featherless embryo in number 13 and a half-grown chick in number 14.

Egg Weight and Body Weight: Two females that weighed 3.25 kg (approximately the same weight as the bird discussed by Falla) were of average size but very fat. One of these birds fluctuated considerably and temporarily dropped to 2.15 kg after a fairly long period of light feeding. Fasting by kiwis in captivity is not unusual and this bird remained in good health. Its weight increased when it reverted to a greater food intake but a few months later this kiwi slowly declined and, at death, weighed 1.52 kg.

Body weight is very variable. While it may indicate real differences in overall size between different individuals, it frequently merely emphasises the condition of the bird and/or the fullness of its gut. In any comparison of egg size to body size, the condition, as well as the age and sex of the bird must be taken into account. Whereas an average-sized egg would weigh 28% of this kiwi's terminal weight, it would weigh only 13% of her maximum, very fat, weight.

Table 1. Weights of Healthy Birds in Good Condition at Mt. Bruce

Sex	Numer of Weighings	Weight in Grams Range	Mean
F	12	2130 - 3270	2610
F	3	2190 - 2580	2420
F	16	2210 - 2630	2440
M	6	1850 - 2180	2030

Table 2. Actual and Calculated Weights for Two Measured Eggs.

Egg	Weights (g) Actual	$.565ab^2$	Difference grams	percent
1	434.6	437.7	3.1	+0.71
2	354.6	351.5	.3.1	-0.87

Table 3. Calculated Fresh Weights of 15 A.australis Eggs.

No.	Dimensions (mm)	Weight $.565ab^2$	No.	Dimensions (mm)	Weight $.565ab^2$
1	116.0 x 71.0	330.5	9	122.0 x 81.0	452.0
2	121.0 x 71.7	351.5	10	119.5 x 82.5	459.5
3	127.7 x 73.7	392.0	11	130.4 x 79.0	460.0
4	125.0 x 75.0	397.0	12	127.0 x 83.3	498.0
5	120.5 x 76.5	398.5	13	129.3 x 82.9	502.0
6	123.1 x 77.8	421.0	14	129.6 x 83.1	505.5
7	126.0 x 77.5	427.5	15	135.0 x 82.5	519.0
8	125.4 x 78.6	437.5	*Mean*	125.2 x 78.4	434.8

Table 4. Measurements and Weights of A. oweni Eggs.

Dom.Mus. Number	Measurements (mm)	Internal Volume (ml)	Shell Weight (g)	Fresh Weight $.565ab^2$
6703	108.4 x 71.2	283.9	18.3	310.5
6704	109.5 x 70.9	283.1	19.2	311.0
6705	112.5 x 69.6	282.8	16.9	307.9

Table 5. Egg Weight and Body Weight, A.australis and A. oweni

	A.australis min.	max.	mean	A.oweni min.	max.	mean
Egg Weight	330	519	435	275	368	310
Female Weight	2090	3270	2490	1035	1345	1220
Male Weight	1820	2590	2080	815	1135	1000
Egg as % of:						
Female Weight	15.8	15.9	17.5	26.6	27.4	25.4
Male Weight	18.1	20.0	20.9	33.7	32.4	31.0
M as % of F	87.0	79.2	83.5	78.7	84.3	82.0

An average sized egg, it seems, weighs 435g (15¼ oz) while an average adult female weighs 2490 g (5 lb 8 oz) and an average adult male weighs 2080 g (4 lb 9 oz). Whereas the egg is approximately one-fifth (21%) of the male body weight, it is only one-sixth (17.5%) of the female body weight.

Information supplied recently by the National Zoological Park, Washington, supports this size relationship. A bird laid five eggs between August and December 1969. Three eggs were weighed and averaged 404 g (range: 400-407 g). Seven weighings of this female over an 11-month period gave her a mean weight of 2430 g (range: 2270-2490 g). This bird laid eggs that weighed about 17% of her body weight.

II. LITTLE GREY KIWI *Apteryx oweni*

Weights of Adult Birds: Weights are known for three birds. A male collected from the Rough River, Westland, in 1952, weighed 910 g; and a pair of birds transferred from Kapiti Island to Mt. Bruce in October 1969 are weighed every two weeks. Both birds have kept good health and the weight of the male, which was 910 g at capture, has varied from 815 to 1135 g (mean: 1000 g or 2 lb 3¼ oz) during his first 15 month at the Reserve. The female, who weighed 1305 g at capture, has since varied between 1035 and 1345 g (mean: 1220 g or 2 lb 11 oz).

Egg Size and Weight: The internal volumes of three typical shells from the Dominion Museum collection were obtained by filling these with water and their fresh weights calculated from the expression: $W = 0.565\ ab^2$ (Table 4).

Measurements and calculated fresh weights for nine eggs ranged from 105.4 x 68.0 mm (275 g) to 113.0 x 76.0 mm (369 g) and the mean dimensions of 108.6 x 71.1 mm give a calculated mean weight for the egg of the Little Grey Kiwi of 310 g (11 oz) which is about one-fourth (25.4%) of the mean weight of an adult female at Mt. Bruce.

DISCUSSION

Throughout the various families of birds, smaller species generally have proportionately larger eggs than do their bigger relations. Kiwis are in accord — *A. australis* lays an egg that is equivalent to 17.5 percent of the female body weight and *A. oweni*, which is only half the size, lays an egg that is equivalent to about 25 percent of the mean weight of an average sized female.

Data for both species is summarised in Table 5.

Data compiled by Lack (1968) show several birds weighing less than 400 g. lay eggs which, relative to their body size, equal or are proportionately larger than the egg of the 2500 g brown kiwi. A few species even have an egg:adult weight ratio comparable with that of the 1200 g. Little Grey Kiwi. These latter include some of the *smallest* procellariiformes (storm-petrels) and *smallest* terns weighing less than 100 g., some sandpipers weighing less than 75 g, and the 400 g crab plover *(Dromas)*.

No other birds of similar weight (i.e. between 1000 - 3000 g) lay eggs as large as the kiwis. Those Megapodiidae and Procellariiformes that occur within this size range come closest with eggs

weighing between 10 and 14% of their body weight. Next come the Cracidae (Curassows) with eggs weighing from 7 to 10%, then the Laridae (gulls and terns) with eggs weighing between 6 and 9% of the adult weight.

All Apterygiformes (Kiwis) lay exceptionally large eggs but only a few of the smallest-sized Procellariiformes and Charadriiformes lay eggs that are of comparable relative proportions.

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SHORT NOTE

A SANDERLING AT OPOUTERE

While checking waders on 8/1/71 at Opoutere, on the East Coast at the base of the Coromandel Peninsula, my husband and I found a Sanderling *Calidris alba,* feeding near a flock of Banded Dotterels *Charadrius bicinctus.* The bird was racing back and forth at the crest of the steep ocean beach and pecking rapidly along the line of weed thrown up by the rolling surf. Twice it was seen to run on the same spot, apparently using its feet to disturb sand-hoppers and small flies, and once to run down towards the water. It had a tip-toed look, no doubt because this species lacks a hind toe and moved at an accelerated pace when compared with the run-and-stop action of the Banded Dotterels. This bird was part way into breeding plumage with a brownish tone starting to show on the pale grey back. The dark shoulder patch was well marked and there was some brownish mottling descending from the shoulder area onto the breast. Underparts were white as was the face, particularly around the bill, with a few brownish feathers on the cheeks. The straight black bill and black legs were noted and the bird was put up. If it called we did not hear it over the roar of the surf but a short flight showed its strong white wing-bar and white sided dark tail.

A Sanderling seen at Taramaire, Firth of Thames, by South Auckland members on 11/4/70 was very well coloured with scaly patterned back, well spotted breast and "roughed" cheeks but retained the white ring around the bill. Another seen at Rangiputa Bank, Rangaunu Harbour, on 16/1/71, during the Far North Field Study Course, was completely pale and a perfect example of a bird in eclipse plumage. This bird, in calm conditions, fed at the edge of and just into the water and it was of great interest to me to see that this bird also ran about on the same spot, as the Opoutere bird had done.

— BETH BROWN