

SIZE DISCREPANCY BETWEEN EGGS OF WILD AND CAPTIVE BROWN KIWI (*Apteryx australis mantelli*)

By BRIAN REID

ABSTRACT

Kiwi eggs laid in captivity are significantly smaller than eggs laid in the wild (mean weights, 360 g and 431 g respectively). The reason is not known but is believed to be related to diet.

INTRODUCTION

The 33 eggs used to confirm the reliability of the expression $0.565 ab^2$ for calculating the weights of Brown Kiwi eggs (Reid, elsewhere in this issue) consisted of 26 'Zoo' eggs averaging 115.4 x 72.4 mm and 346.4 g (calculated mean, 344.5 g), and seven 'wild' eggs averaging 125.4 x 77.9 mm and 428.2 g (calculated mean, 430.5 g). In this limited sample the 'average' wild egg was about 80 g (23.5%) heavier than the 'average' Zoo egg.

These data suggest that eggs laid in captivity are much smaller than eggs laid by 'wild' (free-living) birds, and to investigate this anomaly I have applied the expression $0.565 ab^2$ to all eggs for which measurements are available.

In addition to the 33 eggs mentioned above, measurements alone are available for a further 149 eggs and fresh weights alone for three eggs. The material includes 107 eggs laid in the wild by 86 females and 78 eggs laid in captivity by 19 females.

SIZE, SHAPE AND WEIGHT

Size: Measurements for 182 eggs are plotted in Figure 1. Wild eggs have a mean size of 125 x 78 mm, range 104-135 mm and 66-86 mm. The mean for Zoo eggs is 118 x 73 mm, range 95-132 mm and 64-82 mm.

Shape: Inconsistencies in shape occur in both wild and Zoo eggs. In both samples most eggs are elliptical or oval, but some are conical with pronounced blunt and pointed ends and others have little taper, both ends being similarly rounded. Some eggs are broad and others elongated. The length : diameter ratio varies from 1 : 0.52 to 1 : 0.71 (mean 1 : 0.625). Relative to their lengths, eggs laid in the wild generally have a greater diameter than eggs laid in captivity, and in both groups the L : D ratio tends to alter with size with smaller eggs being proportionately wider (Table 1).

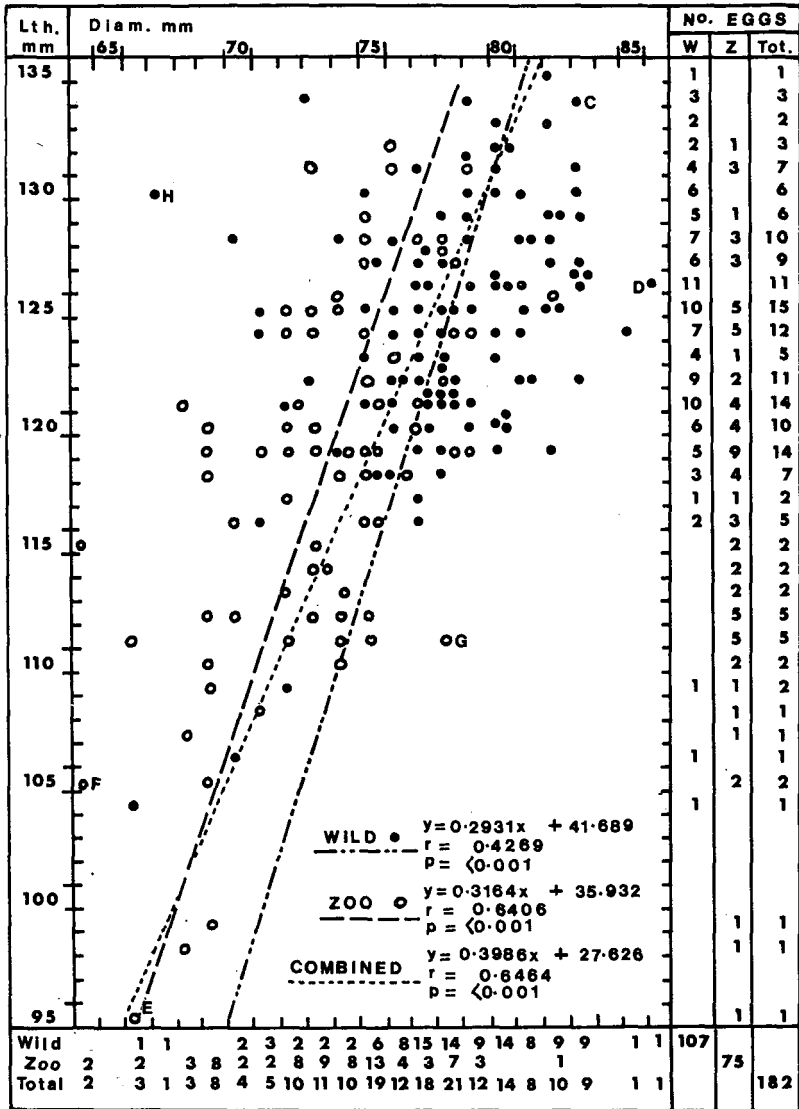


FIGURE 1 — Length and diameter of North Island Brown Kiwi eggs. Six eggs (with letters C-H) are illustrated in Fig. 2.

TABLE 1 — Length:diameter ratio of wild and Zoo kiwi eggs

Length Class mm	Wild Eggs		Zoo Eggs	
	N	L:D Ratio	N	L:D Ratio
131 - 135	12	1: 0.60	4	1: 0.58
126 - 130	35	1: 0.62	7	1: 0.60
121 - 125	40	1: 0.63	17	1: 0.61
116 - 120	17	1: 0.65	21	1: 0.62
111 - 115	-	-	16	1: 0.64
106 - 110	2	1: 0.66	5	1: 0.65
95 - 104	-		5	1: 0.67

Variations in size and shape are shown in Figure 2.

Weight: When the fresh weights for 152 eggs, most calculated from measurements, are included with the original 33, the difference between the means of wild and Zoo eggs is reduced (107 wild eggs, 431 g, SD 48.8; 78 Zoo eggs, 360 g, SD 53.0). The wild eggs are heavier by an average of 71 g (19.7%). An analysis of variance of the enlarged sample showed that the difference in weight between wild and Zoo eggs is statistically highly significant ($F_{1, 183} = 10.8$, $p < 0.001$).

Figure 3 shows the percentage of wild and Zoo eggs in each 20-g weight class.

DISCUSSION

There are no obvious explanations why kiwis in captivity lay smaller eggs than kiwis in the wild. In the domestic fowl a reduction in egg size can result from several causes or circumstances (Romanoff & Romanoff 1949). The bird's age, body size and condition, health and diet are those most likely to apply to captive kiwis.

Age: Domestic fowls produce their largest eggs when 2-4 years old. Thereafter, egg size decreases with increasing age, and eggs laid by a hen during her last year or two of production may be 8-16% (average 11-12%) lighter than those laid during her prime.

As all Zoo eggs in the sample were laid by kiwis that were adults of unknown age when taken from the wild, it is reasonable to assume that the captive group is biased in favour of older birds. Data from two birds at Otorohanga, however, appear to annul the

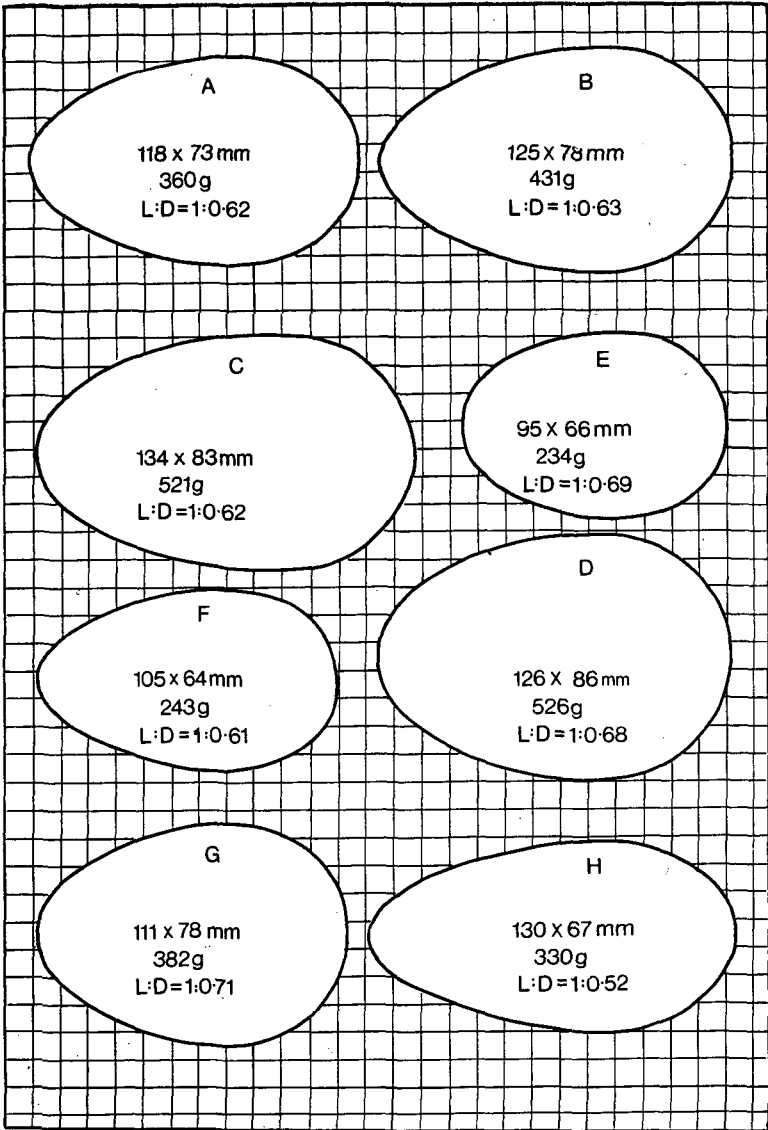


FIGURE 2 — Extremes in shape and size of North Island Brown Kiwi eggs (drawn to scale on 1 cm grid). Eggs A & B represent the 'average size' Zoo and wild egg. Eggs C & D are the heaviest and eggs E & F the smallest eggs in the sample. Eggs G & H are proportionately the broadest and the most elongated in the sample.

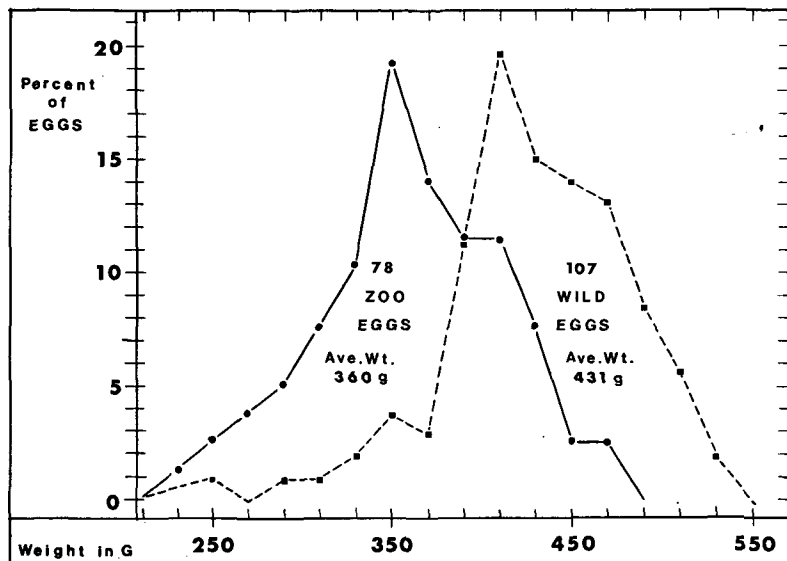


FIGURE 3 — Weight distribution of Zoo and wild North Island Brown Kiwi eggs plotted in 20-g weight classes.

supposition that the smaller size of these eggs is age-related. Both have laid regularly since coming into captivity — one producing 26 eggs in seven years, the other 32 eggs in six years, and the eggs have not decreased in size with increasing age of the hens.

Free-living kiwis lay one or two eggs a year, and so an annual production of four, five or sometimes six eggs by Zoo birds is incongruous. In domestic poultry the laying rate decreases with age; annual egg production by old birds drops to about 40% of their peak production. It would indeed be a unique biological adaptation if ageing kiwis increased egg production threefold in response to a benign habitat, while simultaneously decreasing egg size for other reasons. The effect of age on egg size in kiwis is not known but is assumed to be little or none.

Size: Egg size is broadly related to body size and, within a species, larger hens tend to lay larger eggs. Size is difficult to measure in living birds and precise data on the sizes of kiwis are lacking. Size can be obtained only from skeletal measurements and the usual method (weighing) gives a bird's weight without indicating the relative contributions of linear dimensions and condition (fat deposits, gut content) to a bird's weight.

As the range in weights (from emaciated to obese) obtained from Zoo birds duplicates that obtained from wild birds, there is no evidence that the smaller eggs indicate a disproportionately large number of small adults in captivity.

Health: Over the years some laying birds in captivity have been debilitated. However, although in one or two instances egg size may, perhaps, have been influenced by the health of the hen, there is no evidence that stress or any pathological condition has coincided with oögenesis and resulted in small eggs.

Diet: In the wild, kiwis eat earthworms, a wide variety of insects and other invertebrates, and some vegetable matter. In captivity an approximately uniform diet is fed at all institutions. The basic ration, which includes beef (ox-heart or skirt steak), rolled oats or equivalent cereals, wheat germ, soya or corn oil and a calcium-based mineral-vitamin additive, contains (dry weight) 54-55% protein, 16-17% fat and oil, 25% carbohydrate and 4% ash. This provides each bird with approximately 1380 kJ (330 Kcal) daily, and the premix ensures that essential micronutrients are available at levels matching the known requirements for breeding domestic poultry. A limited quantity of natural food is also available in the open-air enclosures.

For many years, there have been no nutrition-related deaths or diseases of Zoo birds fed this diet, and the long life, well-fleshed condition and high egg production in captivity all indicate a satisfactory ration. If dietary inadequacies are likely to influence breeding performance, limitations are typically manifested by either a reduction in the number of eggs or an increase in embryonic mortality, rather than by a decrease in egg size. In captivity most of the few embryonic deaths have resulted from artificial incubation experiments.

Although experiments have related a decrease in egg size in domestic poultry to either inadequate dietary linoleic acid (Calvert 1967, Menge 1968, Weatherup 1974) or insufficient protein (Romanoff & Romanoff 1949; Akayama *et al.* 1978), the resultant decreases were small; for example, in one study the average egg weight dropped by 1.7% when the protein content of the diet was reduced by 43%. Protein and linoleic acid are both well represented in the kiwi diet, and so some other nutrient imbalance (rather than age, size or health of Zoo birds) may be the primary cause of the smaller eggs.

It is questionable whether the total characteristics of a diet based on invertebrates can be duplicated in a mixture of mainly beef and oats and also whether a species that has evolved to utilise nutrients from one source can fully utilise the same (or substitute) nutrients from another source. Although the artificial diet seems adequate, it may differ in some way from the natural diet enough to inhibit the development of normal-sized eggs. Biochemists are still groping with 'unidentified factors' that stimulate growth or affect reproduction in domestic animals, and insects, which are lacking in the Zoo diet, may provide substances that enhance the full development of kiwi eggs.

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SHORT NOTE

A NORTH ISLAND BROWN KIWI AND HER EGG

X-ray photograph of a captive North Island Brown Kiwi (*Apteryx australis mantelli*) taken 16-24 hours before she laid her 23rd egg in 50 months at Otorohanga. The egg (126 x 76 mm, 415 g) occupied a large portion of the body cavity, extending anteriorly to within 40-45 mm of the sternum and lying immediately dorsal to the gizzard. This egg was 19.3% of the hen's post-laying weight of 2.155 kg. Her other eggs have ranged in weight between 360 and 440 g.



Photo: Copyright, Otorohanga Zoological Society

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