The proportion of yolk in the eggs of waterfowl

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In an earlier publication (Lack 1967), I showed that the weight of the egg proportionate to body-weight differs greatly in different species of ducks, from 2½ per cent in the White-winged Wood Duck *Cairina scutulata* to a little over 20 per cent in two stiff-tails *Oxyura maccoa* and *O. dominica*. Subsequent investigations have shown that these two latter figures, derived from published sources, were wrong, and the highest figures are around 15 per cent, in the stiff-tails *O. vittata* and *O. dominica*. Even so, this represents a considerable range of variation.

I also showed, following Heinroth (1922), that the proportionate egg-weight in relation to body-weight is higher the smaller the species, and included graphs to demonstrate this relationship within each tribe of the waterfowl. (Note that the two right-hand points in this graph, for figures over 20 per cent, are wrong, as just noted.) I then compared the point for each species on the graph with the mean curve for the points for all the species of Anatidae (this curve not being shown on the graph) and thus determined the 'relative' egg-weight of each species after allowing for the regular variation in proportionate egg-weight with body-weight. (Note that the 'proportionate' egg-weight is the weight of the egg expressed as a percentage of the body-weight, while the 'relative' egg-weight is the weight of the egg relative to that of other species of similar body-weight.)

It was suggested that the disadvantage of a larger egg may be that it necessitates a smaller clutch, and the compensating advantage that it enables the chick to hatch at a relatively advanced stage or with a proportionately large food reserve derived from the yolk sac. The next step, therefore, was to determine whether the proportion of yolk in the egg varies with its proportionate or relative size. For this, fresh, infertile eggs laid at Slimbridge were weighed, and then hard-boiled, which enables the yolk to be separated easily from the white, after which the yolk, white and shell were weighed separately.

There was a very small change in weight after boiling, but this did not appear to affect the weight of the yolk or the shell. After this, the yolk was dried in an oven, weighed again and analysed for its fat content. Since most of the eggs could not be treated in this way at once, they were placed in deep-freeze.

Table I. Weights of fresh eggs of Anatidae from Slimbridge.

Species	*Number weighed*	*Mean weight in grams*	*Percentage of weight formed by*	
			shell	*yolk*
		(a) by author		
Dendrocygna bicolor	3	42.4	14	45
Cygnus atratus	3	235	14	49
Anser anser	8	158	14	43
A. c. caerulescens	3	119	12	40
A. c. atlanticus	4	113	13	36
Branta c. canadensis	1	198	11	42
Alopochen aegyptiacus	1	82.6	11	43
Anas platyrhynchos	5	55.7	11	39
A. undulata	2	49.1	11	42
Somateria mollissima	5	108	9	44
Netta rufina	2	49.1	14	41
Aix sponsa	3	43.5	9	41
A. galericulata	1	44.9	10	42
Cairina moschata	8	68.4	12	42
Plectropterus gambensis	7	115	14	40
Bucephala clangula	7	65.4	11	44
		(b) by J. Kear		
Cygnus olor	2	312	13	34
Anser anser	3	182	—	41
Branta sandvicensis	1	140.5	9	37
Anas platyrhynchos	10	53.1	—	37
A. specularis	3	69.4	11	42
A. chlorotis	1	52.5	8	44
Marmaronetta angustirostris	1	31.9	—	41
Aix sponsa	14	37.5	—	39

Some had to be kept there for several months, and were often found to have lost about 5 per cent in weight, and occasionally 7 or even 10 per cent. A comparison of eggs from the same clutch, some of which were wrapped and lost hardly any weight, while others were not wrapped and lost much, showed that virtually the whole loss was due to loss of water from the albumen, which accumulated as ice outside the shell. In eggs to which this had happened, the yolk and shell were weighed in the usual way, while the weight of the albumen was calculated from the difference between these two figures and the total fresh weight of the egg.

The average fresh weight and the average proportionate weight of the yolk and shell have been set out for each species that I weighed in Table I, together with some further measurements obtained by Dr. J. Kear. In Table II these figures, with those published earlier by Heinroth (1922, 1928) and Härms (1929-30), have been set out for each species grouped according to its relative egg-weight. Heinroth's figures are a little lower than those obtained by others, and his for the Mallard *Anas platyrhynchos*

Table II. Proportion of egg consisting of yolk (all sources).

Species	*Source*	*Yolk*	*egg/body wt. category*
Relatively large eggs			
Cygnus atratus	Lack	49%	C
C. olor	Heinroth	40%	A
C. olor	Kear	34%	A
C. cygnus	Heinroth	37%	A
Branta sandvicensis	Kear	41%	C
Relatively fairly large eggs			
Anser anser	Lack	43%	B
A. anser	Kear	41%	B
A. c. caerulescens	Lack	40%	C
A. c. caerulescens	Heinroth	35%	C
A. c. atlanticus	Lack	36%	C
Tadorna tadorna	Härms	39%	D
T. tadorna	Heinroth	43%	D
Anas specularis	Kear	42%	D
A. chlorotis	Kear	44%	E
Melanitta fusca	Härms	40%	E
Bucephala c. clangula	Heinroth	40%	E
B. c. americana	Lack	44%	E
Mergus serrator	Härms	40%	D
Relatively medium eggs			
Dendrocygna bicolor	Lack	45%	C
Branta canadensis	Lack	42%	A
Cereopsis novae-hollandiae	Heinroth	34%	A
Alopochen aegyptiacus	Lack	43%	B
Tadorna ferruginea	Heinroth	35%	C
Anas undulata	Lack	42%	C
A. clypeata	Härms	38%	D
A. clypeata	(Heinroth	50%)	D
Somateria mollissima	Lack	44%	B
S. mollissima	Härms	43%	B
Aythya nyroca	Heinroth	40%	D
A. fuligula	Härms	38%	E
Aix sponsa	Lack	41%	D
A. sponsa	Kear	39%	D
A. galericulata	Lack	42%	E
A. galericulata	Heinroth	38%	E
Plectropterus gambensis	Lack	40%	A
Relatively fairly small eggs			
Anas platyrhynchos	Lack	39%	B
A. platyrhynchos	Kear	37%	B
A. platyrhynchos	(Heinroth	33%)	B
Netta rufina	Lack	41%	B
Cairina moschata	Lack	42%	A
C. moschata	(Heinroth	32-35%)	A
Relatively small egg			
Marmaronetta angustirostris	Kear	41%	C

and Muscovy Duck *Cairina moschata* are so low, and for the Shoveler *Anas clypeata* so high, that they have been excluded from the following analysis. My own abnormally high figure for the Black Swan *Cygnus atratus*, though genuine, may relate to an abnormal individual.

I have then averaged the figures for each species grouped according to relative egg-weight in Table III and according to proportionate egg-weight in Table IV, which show that the proportion of yolk in the egg does not vary significantly with either factor. Hence the idea that the chicks of species with relatively or proportionately large eggs might hatch with proportionately large yolk sacs, and hence food reserves, has presumably to be discarded. It may be added that neither the dry weight of the yolk (around 50 per cent) nor the proportion of fat in it, appeared to vary significantly in different species.

Table III. Mean proportion of yolk in eggs of different relative size.

Relative size of egg	*Number of species in Table II*	*Mean percentage of yolk*
Large	4	41
Fairly large	10	41
Medium	13	40
Fairly small	3	40
Small	1	41

Table IV. Mean proportion of yolk in eggs of different size proportionate to body-weight.

Egg-weight in proportion to body-weight	*Number of species*	*Mean percentage of yolk*
A under 5.0%	6	38
B 5.0 - 5.9%	5	42
C 6.0 - 6.9%	8	41
D 7.0 - 7.9%	6	40
E 8 and over	6	41

Notes: The species composing each group for egg-weight in proportion to body-weight are indicated by A-E in Table II. Where two figures were available for one species, they were averaged before taking the average for each group (but the figures bracketed in Table II were ignored). In the totals subspecies are treated as full species.

Table I shows that there are rather large differences in the proportionate weight of the shell. Since the eggs were from captive birds, and the thickness of the shell is known to vary greatly with diet in poultry, these variations might have been due to diet. It is possible, on the other hand, that hereditary differences between species are involved. The unusually thin shell of the Eider *Somateria mollissima*, despite a large egg, is remarkable.

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Summary

The yolk forms about two-fifths of the weight of the egg in waterfowl. This proportion does not differ significantly in species with eggs of different size proportionate to body-weight.

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