ORGANIC MATERIAL AND CALORIES IN LAUGHING GULL EGGS

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PRESTON and Preston (1953) demonstrated that in three-egg clutches of the Laughing Gull (*Larus atricilla*) the third egg was significantly smaller in diameter than the first two eggs. Vermeer (1969) found this to be the case for two other gulls (*Larus californicus* and *L. delawarensis*) and, from a compilation of data from the literature, concluded that the phenomenon was common in the larids. Almost all analysis of bird eggs rely on measurements of size (weight or linear dimensions). Collins and LeCroy (1972) introduced a yolk/white index calculated from wet weights to categorize eggs of various bird species with different development types. Lawrence and Schreiber (1974) showed that the index for the egg of the "altricial" Brown Pelican (*Pelecanus occidentalis*) did not fit into the appropriate category of development type proposed by Collins and LeCroy (1972). Lawrence and Schreiber further suggested that representation of the egg in terms of organic material or calories was more meaningful than wet or dry weights in interpreting the amount of nutrient and energy drain on the female and the amount available to the young.

In this paper we investigate the proportions of yolk, egg white, and eggshell in terms of wet weight, organic composition, and energy content as related to diameter and position of the egg in the clutch of the Laughing Gull. We also investigate the relationship between the yolk/egg-white index of the Laughing Gull to see how this "semiprecocial" species fits into the scheme of Collins and LeCroy.

MATERIAL AND METHODS

Six three-egg clutches were collected from the large Laughing Gull colony on the bayway, Boca Ciega Bay, Pinellas County, Florida (27° 40′ W, 80° 30′ N) on 14 June 1973 (see Dinsmore and Schreiber 1974 for a description of this colony). The age of the egg, and thus its position in the clutch, was inferred by measuring the length and weight of the developing embryos. The eggs were analyzed by the procedures given by Lawrence and Schreiber (1974).

RESULTS

The position of the egg in the clutch could be determined in five of the six clutches. Four of these clutches showed a decline in egg wet

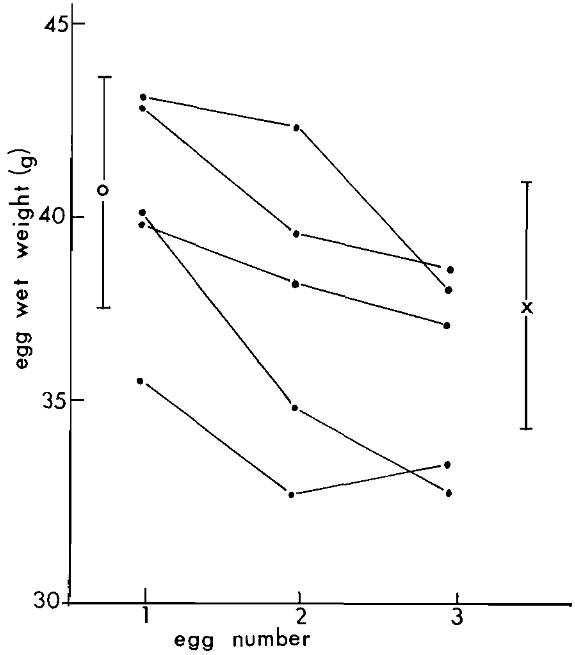

Fig. 1. Weights of the eggs within a clutch of the Laughing Gull (*Larus atricilla*). The average weights ± SD of the first eggs (o, n = 5) and all eggs (x, n = 18) are indicated.

weight from the first to the third egg (Fig. 1). The wet weight of the five known first eggs was 40.3 ± 3.0 g and the wet weight of all 18 eggs was 37.7 ± 3.2 g (Table 1). We found no relation between the position of the egg in the clutch and the relative proprotions of shell, yolk, or egg white, or the relative proportion of lipid, carbohydrate, or protein (Tables 1 and 2).

The eggs of clutches 1 and 2 (Tables 1 and 2), in which either the embryo could not be seen or was too small to measure, were used to provide a representation of a standard undeveloped egg (Fig. 2). The proportion of yolk in the undeveloped egg is least in terms of wet weight and greatest in terms of kcals. This difference results from a lower water level and higher lipid level in the composition of yolk than in egg white.

The embryos were composed primarily of protein although considerable lipid was present (Table 2). Carbohydrate levels were very low. The levels of organic material found varied greatly, and no relation between levels and age of embryo was evident.

TABLE 1

PHYSICAL CHARACTERISTICS OF THE EGG OF *LARUS ATRICILLA*

	Clutch 1 Egg position			Clutch 2 Egg position			Clutch 3 Egg position			Clutch 4 Egg position			Clutch 5 Egg position			Clutch 6 Egg position		
	*[1]	*	*	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Length (mm)	51.4	53.6	51.9	56.0	54.1	53.1	56.7	55.7	55.3	56.1	52.6	50.2	50.2	50.6	51.0	52.1	50.1	49.7
Width (mm)	35.6	37.5	36.9	38.9	38.9	36.8	38.2	37.8	37.8	39.0	38.5	38.2	38.5	37.6	37.5	39.6	38.2	36.8
Wet weight (g)																		
Shell	3.1	3.0	3.2	3.8	4.0	3.3	3.4	3.2	3.2	3.7	3.7	3.6	2.9	2.8	2.7	3.3	3.3	3.2
Yolk	10.9	19.0	17.6	16.0	15.8	13.5	11.9	13.9	12.7	10.8	11.1	10.8	9.6	11.4	9.2	11.5	11.3	10.7
Egg white	16.4	14.7	15.4	23.5	22.3	22.0	5.4	4.2	12.6	25.5	22.9	23.7	1.2	2.7	12.8	5.4	6.2	15.6
Embryo	*	*	*	+[2]	+	*	19.2	16.4	8.8	+	+	*	22.0	15.9	8.9	18.8	14.2	4.1
Dry weight (% of wet weight)																		
Yolk	40	30	–[3]	41	40	44	50	48	42	36	40	48	49	49	44	44	47	45
Egg white	17	23	24	22	27	14	–	–	33	28	24	13	–	–	28	–	–	36
Embryo	*	*	*	+	+	*	2.9	2.3	1.0	+	+	*	4.5	3.7	2.4	4.1	3.4	1.7
Indexes																		
Shell	9	8	9	9	9	9	9	8	9	9	9	9	8	9	8	8	9	10
Yolk	32	51	49	37	37	36	30	36	34	27	28	28	27	35	27	29	32	33
Egg white	49	40	43	54	53	58	14	11	34	60	58	61	3	8	37	13	18	47

[1] * = embryo not present. [2] + = embryo too small to measure. [3] – = sample lost or not measured.

TABLE 2

ORGANIC CHARACTERISTICS[1] OF THE EGG OF *LARUS ATRICILLA*

	Clutch 1 Egg position			Clutch 2 Egg position			Clutch 3 Egg position			Clutch 4 Egg position			Clutch 5 Egg position			Clutch 6 Egg position		
	*[2]	*	*	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Yolk																		
Lipid	62	67	–[3]	58	57	61	60	53	72	61	61	70	59	63	65	61	61	68
Carbohydrate	0.4	0.2	–	0.4	0.4	0.4	0.8	1.1	0.7	0.3	0.6	0.4	–	1.8	0.7	1.6	0.6	0.7
Protein	21	14	–	25	39	30	16	36	23	31	34	22	36	33	15	39	21	21
White																		
Lipid	2.3	0.4	1.9	1.1	–	1.3	–	–	0.8	3.0	–	0.7	–	–	0.9	–	–	0.7
Carbohydrate	1.7	1.8	1.4	1.8	–	1.4	–	–	1.5	1.6	2.4	2.0	–	–	1.5	–	–	1.4
Protein	55	58	56	59	–	57	–	–	62	53	55	56	–	–	56	–	–	58
Embryo																		
Lipid	*	*	*	+[4]	+	*	17	13	13	+	+	*	20	12	13	11	9	17
Carbohydrate	*	*	*	+	+	*	3.3	3.3	2.9	+	+	*	2.8	3.1	3.1	2.6	3.2	2.7
Protein	*	*	*	+	+	*	48	48	46	+	+	*	44	56	47	51	53	36

[1] Levels of lipid, carbohydrate, and protein in % of dry weight. [2] * = embryo not present. [3] – = sample lost or not measured. [4] + = embryo too small to measure.

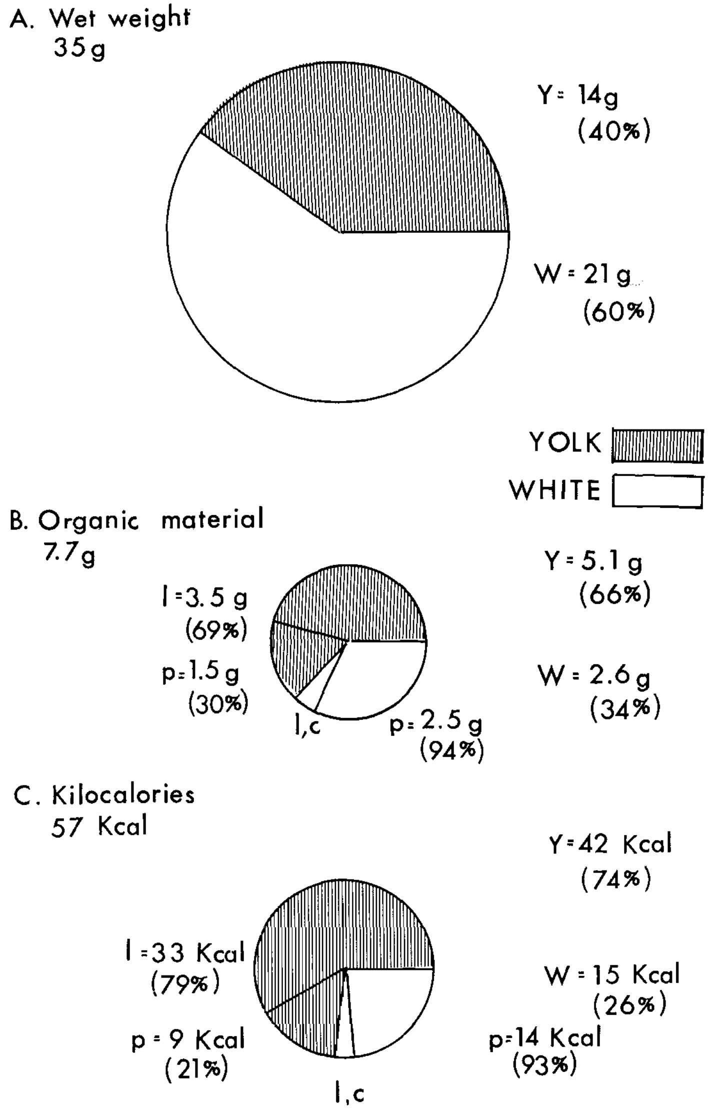

Fig. 2. Reconstruction of the shell-less undeveloped egg (i.e. the yolk and egg white) of *Larus atricilla* in terms of (A) g wet weight, (B) g organic material, and (C) kcal organic material. For the wet weight and organic material representations, the radius of the circle is proportional to the amount present. The relative proportions of the total due to the yolk (Y) and the egg white (W) of the shell-less egg are indicated by the areas of the sectors. The relative proportions of the yolk and egg white contributed by lipid (l), carbohydrate (c), and protein (p) are indicated by the areas of the sectors. Values for both absolute amount (in g or kcal) and percentages are given beside the appropriate portion of the circle.

Discussion

The relationship between position in the clutch and egg size as measured by diameter (Preston and Preston 1953, Vermeer 1969) apparently also holds for the wet weight of the egg of *Larus atricilla* in most cases. We found the relationship involving position in the clutch and wet weight even between the first two eggs of the clutch, whereas those other workers found the relationship involving egg diameter only between the first two and the third eggs. Wet weight measurements may be more sensitive to variations in position in the clutch than are linear dimensional measurements. The one clutch in which the third egg was slightly larger than the second does not concern us particularly. We believe the weight of the egg reflects the capacity of the female to deposit material and energy into the gametogenic process. This may be due to varying time available for feeding as a result of incubation, or to some other physiological phenomena. An improved nutritional condition of the female probably was involved in the laying of the one larger third egg in our sample and is simply another expression of the variability that can be expected in wild populations. Kendeigh et al. (1956) also hypothesized that the physical characteristics of the egg of the House Wren (*Troglodytes aedon*) were influenced by the energy resources of the female during the time immediately preceding laying. In the House Wren the last two eggs laid in clutches are larger than the first eggs.

The great variation in the size of the first eggs, and of all eggs, could reflect a number of variables that are uncontrolled in field collections: i.e. age, experience, and size of the female; food availability; and genetic and nutritional differences in individuals. The lack of correlation between the position of the egg in the clutch and its proportion of yolk and white or the proportions of lipid, carbohydrate, and protein present in these eggs or embryos cannot be explained to date.

While the total energy content of the "altricial" Brown Pelican egg (Lawrence and Schreiber 1974) is greater, the proportion of the yolk within the egg of the Laughing Gull is considerably greater, and thus the energy per 100 g of egg is greater. The energy level of bird eggs is often compared in terms of kcal/100 g of egg contents. On this basis, the egg of the Laughing Gull contains 162 kcal/100 g. This level is similar to that of the eggs of many domestic birds (158–162 kcal/100 g), but below that of the egg of the domestic duck (190–200 kcal/100 g) (see Lawrence and Schreiber 1974 for summary and references). The pelican egg contained only 149 kcal/100 g. At present data are insufficient to permit generalizing on the significance of energy richness in the egg to variables such as clutch size and reproductive success.

The yolk/egg-white index for the egg of the Laughing Gull is 0.679.

This value is much higher than those Collins and LeCroy (1972) listed for their category "other semiprecocial birds" that includes two terns and a skua. In fact, it is even higher than the average index figure for precocial species, which Collins and LeCroy indicate have the highest indexes of all birds.

As this is another instance in which the scheme proposed by Collins and LeCroy (1972) has proven inapplicable, it appears that egg component proportions may be affected significantly by some factor other than developmental pattern. Further, the proportions of egg components may not be appropriate characteristics to consider when discussing developmental patterns in birds.

SUMMARY

The wet weights of the eggs of *Larus atricilla* decrease progressively with the positions of the eggs in the clutch. This progression probably reflects the nutritional condition of the female. There is no correlation between the position of the egg in the clutch and its proportion of lipid, carbohydrate, or protein in the eggs or embryos. The energy level of the egg of the Laughing Gull is similar to that of domestic birds. The yolk/egg-white index of the egg of the Laughing Gull is much higher than the indexes found by Collins and LeCroy (1972) for other semiprecocial birds. The scheme of Collins and LeCroy (1972) relating yolk/egg-white indexes to development type may not be valid, as this is the second instance in which the scheme has not been found applicable.

LITERATURE CITED

COLLINS, C. T., AND M. LECROY. 1972. Analysis of measurements, weights, and composition of Common and Roseate Tern eggs. Wilson Bull. 84: 187–192.

DINSMORE, J. J., AND R. W. SCHREIBER. 1974. Breeding and annual cycle of Laughing Gulls in Tampa Bay, Florida. Wilson Bull. 86: 419–427.

KENDEIGH, S. C., KRAMER, T. C., AND F. HAMERSTROM. 1956. Variations in egg characteristics of the House Wren. Auk 73: 42–65.

LAWRENCE, J. M., AND R. W. SCHREIBER. 1974. Organic material and calories in the egg of the Brown Pelican, *Pelecanus occidentalis*. Comp. Biochem. Physiol. 47A: 435–440.

PRESTON, F. W., AND E. J. PRESTON. 1953. Variations of the shapes of birds' eggs within the clutch. Ann. Carnegie Mus. 33: 129–139.

VERMEER, K. 1969. Egg measurements of California and Ring-billed Gull eggs at Miquelon Lake, Alberta, in 1965. Wilson Bull. 81: 102–103.

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