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# THE COMPOSITION OF ANCIENT MURRELET EGGS[1]

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The murrelets in the genus *Synthliboramphus* are unique among seabirds, in that their chicks leave the nest site and are taken to sea by their parents when only 2 days old. They are not fed prior to their departure (Sealy 1976, Murray et al. 1983). Other alcids are either semi-precocial, leaving the nest site after several weeks, when close to adult mass, or intermediate (*Uria* and *Alca*) and leave the breeding site when only 25% of adult mass, flightless and aged 16–30 days, and are cared for at sea by their male parent (Sealy 1973, Birkhead 1977, Gaston and Nettleship 1981).

The eggs of murrelets (adult mass circa 160–230 g: Sealy 1975, 1976; Murray et al. 1983; A. J. Gaston, unpubl.) weigh 20–25% adult mass, and are among the largest relative to body mass of any birds. The relative size and composition of birds' eggs are related both to the mode of posthatching development (Romanoff and Romanoff 1949, Carey et al. 1980) and to the interval between hatching and the first feeding by the adult (Williams et al. 1982). The eggs of precocial birds and those of pelagic seabirds, which may have a protracted period between hatching and first feeding, tend to be large with relatively large yolks (Carey et al. 1980, Williams et al. 1982). On both these counts we would expect the eggs of the precocial alcids to have high yolk : albumen ratios.

Here we present information on the composition of eggs of the Ancient Murrelet (*S. antiquus*) and compare this with information for the eggs of semiprecocial and intermediate alcid species. Twenty-four newly laid eggs were collected (under permit) from Reef Island, Queen Charlotte Islands, British Columbia, Canada in May 1985 ($n = 9$) and May 1987 ($n = 15$). Interyear differences in fresh weight, linear dimensions, and absolute amounts of yolk and albumen were small and not statistically significant, so data were pooled for analysis. Eggs were hard-boiled and the yolk, white, and shell separated and weighed. Ancient Murrelets produce two eggs 7–11 days apart (Sealy 1973, 1976; A. J. Gaston, unpubl.). First and second eggs did not differ in weight (A. J. Gaston, unpubl.). The components of the boiled eggs were fixed in 4% formalin and later processed. We recorded the dry weights of yolk, white, and shell, and determined the lipid contents of yolk using chloroform as a solvent in a soxhlet apparatus (Birkhead and Nettleship 1984). No lipid was detected in albumen. Details of the size and composition of eggs are presented in Table 1.

Yolk, white, and shell wet weights were positively correlated with fresh egg weight (yolk: $r = +0.705$, df 22, $P < 0.001$; white: $r = +0.747$, $P < 0.001$; shell: $r = +0.783$, $P < 0.001$), and the amounts of all three components appeared to vary in proportion to fresh egg weight, i.e., the slopes ($b$) of log-log relationships did not differ significantly from 1 (yolk: $b = 0.88$, $t = 0.59$, n.s., white: $b = 1.09$, $t = 0.44$, ns., shell: b = 0.82, $t = 0.68$, ns).

Ancient Murrelet eggs have relatively large yolks (46.6% of fresh egg weight, or 50.7% of fresh egg weight minus shell wet weight) (Table 1). These values are high relative to all birds (range for percent of fresh egg weight: 14–57% [excluding megapodes and kiwis]; Carey et al. 1980), and higher than any alcid eggs previously examined. This is most clearly seen from the yolk : albumen ratios (wet weight). For the Ancient

TABLE 1. Size and composition of 24 Ancient Murrelet eggs.

| | $\bar{x}$ | SD | CV |
|---|---|---|---|
| Fresh egg weight (g) (FEW) | 44.91 | 3.29 | 7.32 |
| Length (mm) | 59.40 | 1.82 | 3.06 |
| Breadth (mm) | 37.49 | 1.04 | 2.77 |
| Volume index ($1 \times b^2$) | 83.59 | 5.95 | 7.12 |
| Shell wet weight (g) | 3.44 | 0.27 | 7.94 |
| Shell wet weight as % FEW | 7.67 | 0.39 | 5.14 |
| Shell dry weight (g) | 2.65 | 0.21 | 7.92 |
| Shell dry weight as % FEW | 5.91 | 0.28 | 4.73 |
| Yolk wet weight (g) | 20.93 | 1.92 | 9.17 |
| Yolk wet weight as % FEW | 46.64 | 3.10 | 6.66 |
| Albumen wet weight (g) | 20.32 | 2.10 | 10.33 |
| Albumen wet weight as % FEW | 45.23 | 3.18 | 7.04 |
| Yolk dry weight (g) | 10.58 | 1.04 | 9.89 |
| Yolk dry weight as % FEW | 23.58 | 1.94 | 8.21 |
| Albumen dry weight (g) | 2.60 | 0.52 | 20.00 |
| Albumen dry weight as % FEW | 5.80 | 1.08 | 18.66 |
| Yolk: % water | 49.14 | 3.37 | 6.86 |
| % lipid | 32.61 | 1.74 | 5.33 |
| % nonlipid dry matter | 18.25 | 2.39 | 13.12 |
| Albumen: % water | 87.20 | 2.08 | 2.39 |
| Yolk : albumen ratio | 1.03 | | |

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Murrelet this value is 1.03; values for intermediate alcid species are, Razorbill, *Alca torda,* 0.66; Common Murre, *Uria aalge,* 0.59 (Birkhead and Nettleship 1984); Thick-billed Murre, *U. lomvia,* 0.65 (Uspenski 1956); and semiprecocial species, Atlantic Puffin, *Fratercula arctica,* 0.59 (Birkhead and Nettleship 1984); Black Guillemot, *Cepphus grylle,* 0.59 (Petersen 1981) and Rhinoceros Auklet, *Cerorhinca monocerata,* 0.52 (Kuroda, *in* Williams et al. 1982).

The composition of Ancient Murrelet yolk (49% water, 33% lipid, and 18% nonlipid dry matter), was similar to that of Razorbill, Common Murre, and Atlantic Puffin; 47–48% water, 33–34% lipid, and 18–19% nonlipid dry matter (Birkhead and Nettleship 1984). The energy content of Ancient Murrelet eggs was estimated to be 101 kcal (or 2.25 kcal/g) (assuming 9.5 kcal/g lipid, and 5.65 kcal/gr for dry albumen, and nonlipid dry matter; Ricklefs 1974). Equivalent values for the Razorbill were 178 kcal (1.85 kcal/g), Common Murre 190 kcal (1.75 kcal/g), and Atlantic Puffin 136 kcal (1.93 kcal/g). Yolk provides the nutrients for the developing embryo and in precocial species may also provide an important food reserve after hatching (Kear 1965, Ankney 1980, Birkhead and Nettleship 1982). In Common Murre chicks from pipped eggs, for example, the yolk sac weighs about 18g (24% of chick weight), which is about half the fresh egg yolk mass (Birkhead and Nettleship 1984). The lipid content of Ancient Murrelet chicks at hatching was found to be greater than that of four nonprecocial alcid species (Duncan and Gaston 1988).

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