

EGG SIZE OF MURRELETS

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Egg size is characteristic for each species, the main species differences in both the absolute and proportionate egg sizes being presumably hereditary and having evolved through natural selection (Lack 1968). Heinroth (1922) was the first to study comprehensively the weights of birds' eggs; his work was extended by Huxley (1927). Egg size varies among bird species from 1.5–27% of adult weight, and is inversely related to body weight (Lack 1968). Lack's data showed that in seven species of alcids, eggs range from about 12–19% of adult weight.

I obtained data on egg size of murrelets (table 1) during my studies of the breeding ecology of these and other alcids (Sealy 1972, 1973, 1974, 1975a). The Ancient Murrelet (*Synthliboramphus antiquus*) and Xantus' Murrelet (*Endomychura hypoleuca*) lay particularly large eggs (21.9% and 23.7% of adult weight, respectively). In fact, their eggs are the heaviest in proportion to adult weight in the family (fig. 1).

The large eggs of *Synthliboramphus* and *Endomychura* are undoubtedly associated with their precocial mode of posthatching development (Bent 1919, Sealy 1973, 1975b). Lack (1967a, b, 1968) stated that, in waterfowl, a relatively larger egg has been evolved at the expense of a large clutch. Thus, the large egg probably provides the newly hatched duckling, and also probably the precocial murrelets, with a relatively large fat reserve, initially concentrated in the yolk sac, but rapidly transferred to the liver and under the skin soon after hatching (Kear 1965). The advantage of this fat reserve in precocial birds was demonstrated by Märcstrom (1966) to permit the young to withstand temporary food shortages and regulate their body temperatures.

In a physiological sense, egg-laying affects only

TABLE 1. Egg weights of murrelets.

Species	Adult body wt (g)	Egg wt (g)	Egg wt as % of body wt
Marbled Murrelet ^a (<i>Brachyramphus marmoratus</i>)	222(76) ^b	36(1) ^c	16.2
Kittlitz's Murrelet ^d (<i>B. brevirostris</i>)	224(14)	34(1)	15.2
Xantus' Murrelet (<i>Endomychura hypoleuca</i>)	156(7) ^e	37 ^f	23.7
Craveri's Murrelet (<i>E. craveri</i>)	?	35 ^f	—
Ancient Murrelet ^a (<i>Synthliboramphus antiquus</i>)	205(154)	44.9(15)	21.9
Japanese Murrelet (<i>S. uumizusume</i>)	?	36 ^f	—

^a Unpublished data from Sealy.

^b Sample size in parentheses.

^c Egg weight calculated by adding weight of unshelled egg (33.1 g) removed from oviduct (Sealy 1972) and weight of eggshell (2.9 g) presented by Schönwetter (1963).

^d Unpublished data supplied by J. Bédard. The egg weight is for a soft-shelled egg removed from the oviduct of a female.

^e Data from Bédard (1969).

^f Data from Schönwetter (1963).

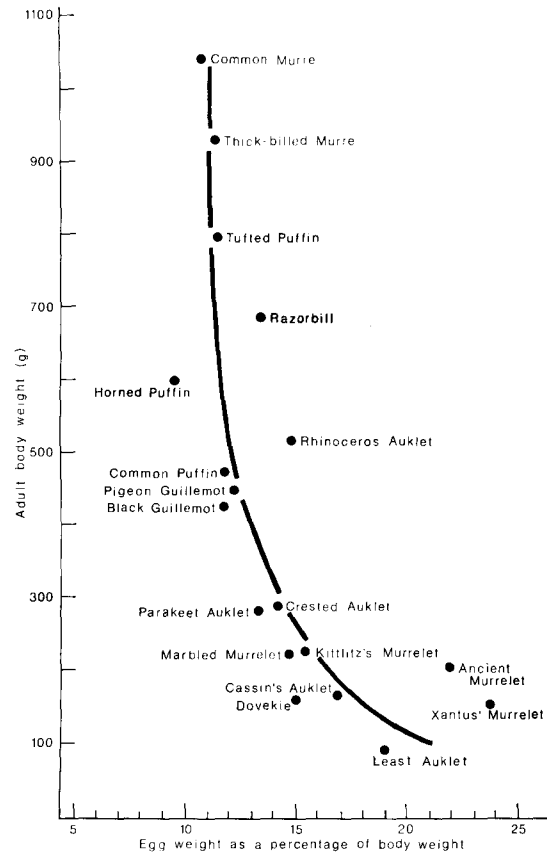


FIGURE 1. Proportionate egg weight in the Alcidae. Marbled Murrelet proportionate egg weight based on weight of unshelled egg. Line fitted by eye. Sources of data cited in Sealy (1972).

females and its importance from the energetic point of view has been stressed by Siivonen (1957), King (1973) and Ricklefs (1974). Siivonen demonstrated that the feeding conditions prior to egg-laying have a profound effect on the size of the egg or eggs and on the clutch. Lack (1966) pointed out that certain procellariiforms leave their colonies for up to three weeks immediately prior to egg-laying; he assumed, probably correctly, that the females require at least this time to produce their large eggs. This feeding period has been called the "honeymoon" period by several workers (e.g., Marshall and Serenty 1956, Tickell 1962, Harris 1966, Ashmole 1971). Such a period also exists in the Ancient Murrelet (see Sealy 1975b). About one week before the eggs are laid (in colonies on Langara Island, British Columbia), the individual pairs cease visiting the nesting slopes until the night when the first egg is to be laid. The egg is then left unattended in the burrow for about seven days until the female returns to lay the second egg.

In commenting on the long intervals between the laying of the proportionately small eggs of penguins and boobies, Lack (1968) suggested that food may be sparse when the females are producing and laying eggs, but may be comparatively easy to obtain during chick-rearing. In the Ancient Murrelet, the food supply, although possibly abundant, is apparently patchy in distribution and much time is spent finding it (Sealy 1975b). The long period of egg production in this species hence is not surprising.

Williams (1966) assumed that there is a functionally related cost to the parent for effort channelled into the production of young. The evidence for the existence of such a cost is, in fact, fairly substantial (see Cody 1971, Trivers 1972, King 1973, Ricklefs 1974); egg production requires energy that must be obtained through feeding by the female. Lack (1968) stated that since proportionately larger eggs require more parental material in their formation, they represent a greater reproductive effort. In the Ancient Murrelet, the reproductive effort or cost is apparently spent only in egg production as the newly fledged young feed at sea with the adults.

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SHADOWS AND DETECTION OF MOVEMENT BY A BURROWING OWL (*SPEOTYTO CUNICULARIA*)

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Several nocturnal rodent species are known to avoid surface activity during moonlight (Wiley, Southwest

Nat. 16:43-54, 1971; O'Farrell, *J. Mamm.* 55:809-823, 1974); this behavior probably reduces their vulnerability to visually hunting predators such as owls. However, activity is also known to reach its peak during evening twilight when illumination is brighter than moonlight (Lockard and Owings, *Anim. Behav.* 22:262-273, 1974). This suggests that increased illumination itself is not the critical determinant of moonlight avoidance. Lockard and Owings proposed that shadows, which are cast in moonlight but not in twilight, may constitute a more important cause of increased conspicuousness to predators. The purpose of our study was to test this hypothesis by comparing the responsiveness of a Burrowing Owl