

and Sutton (1979) in that the incubating terns failed to recognize the turnstone as a predator in most cases, no matter how closely they were approached by the turnstones. Mobbing behavior was elicited only when Canada Geese (*Branta canadensis*) and Ring-billed Gulls were passing. Turnstones in the area at this time would also be mobbed.

Contrary to Parkes et al. (1971), our observations were not confined to a single turnstone, rather they concur with Bent (1929) in that many were involved. The impact of turnstones was higher at the Headland than at the Common Tern colony on Great Gull Island (Parkes et al. 1971), yet it did not result in total destruction of the colony, as was reported for Royal Terns near Florida in 1978 (Loftin and Sutton 1979).

There have been no further reports of egg-eating by turnstones in well-studied Common Tern colonies since that of Parkes et al. (1971). Neither have there been any previous observations recorded at our study site since research began here in 1976. Similarly, at the Royal Tern colony studied by Loftin and Sutton (1979), the investigators did not notice egg predation by turnstones until the fourth year of their study. However, it is difficult to say whether this form of egg predation is a new, expanding,

or just a hitherto unnoticed behavior. Further efforts should be made in other tern colonies being studied to document the frequency of occurrence and the impact of egg predation by Ruddy Turnstones.

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LITERATURE CITED

- BENT, A. C. 1929. Life Histories of North American Shorebirds (Part II). U.S. Natl. Mus. Bull. 146.
 BEVEN, G., AND M. D. ENGLAND. 1977. Studies of less familiar birds, 181, Turnstone. Br. Birds 70:23-32.
 CROSSIN, R. S., AND L. N. HUBER. 1970. Sooty Tern egg predation by Ruddy Turnstones. Condor 72:372-373.
 LOFTIN, R. W., AND S. SUTTON. 1979. Ruddy Turnstones destroy Royal Tern colony. Wilson Bull. 91:133-135.
 PARKES, K. C., A. POOLE, AND H. LAPHAM. 1971. The Ruddy Turnstone as an egg predator. Wilson Bull. 83:306-308.

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VARIATION IN SIZE SPECIFIC COMPOSITION OF BLACK-BILLED MAGPIE EGGS WITHIN AND AMONG CLUTCHES¹

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Key words: *Black-billed Magpie*; *Pica pica*; egg composition.

In recent years, descriptive data on egg composition of a number of altricial species have been published, e.g., Great Tit, *Parus major* and Pied Flycatcher, *Ficedula hypoleuca* (Ojanen 1983), European Starling, *Sturnus vulgaris* (Ricklefs 1984), and Boat-tailed Grackle, *Quiscalus major* (Bancroft 1985). One possible application of these data is to relate egg composition to life history characteristics of a species. For example, one could examine Howe's (1978) suggestion that variation in egg composition could influence brood reduction. As brood reduction is proximately the result of events within a single nest and appears to be related to intraclutch variation in egg size (e.g., Howe 1976), one needs to know how egg composition varies with egg size within nests. However, most detailed descriptions of variation in egg composition with egg size are comparisons among clutches (e.g., Bancroft 1985), or combine interclutch and intraclutch variation (e.g., Ricklefs 1984). Only Ankney and Johnson (1985) presented separate analyses of variation within and among clutches, although only one

set of eggs was analyzed for intraclutch variation in Brown-headed Cowbirds (*Molothrus ater*). Thus, it is unclear whether size-dependent variation in egg composition follows the same pattern within a clutch as among clutches. The purpose of this note is to examine whether size-dependent variation in egg composition within a clutch can be predicted on the basis of patterns observed among clutches.

METHODS

As part of a study of Black-billed Magpie (*Pica pica*) reproductive ecology, eight complete clutches of eggs were collected in the city of Edmonton, Alberta, Canada, in 1984. Clutches were collected on the day on which the last egg was laid, or on the following day. Within 2 hr of collection, eggs were brought into the laboratory, weighed, and measured (length and breadth at largest diameter to 0.1 mm with dial calipers). Eggs were then separated into albumen, yolk, and shell plus membrane, and wet masses of all components determined. All components were dried to constant weight at 60°C in a drying oven, and dry masses were measured; water content was calculated as the difference between total wet and dry mass of eggs. Yolks were ground up and placed in Soxhlet apparatus, and neutral lipids were extracted for a 2-hr period with petroleum ether solvent. Mass of extracted lipids was found after evaporating the solvent over a steam bath; lean yolk mass was calculated as the difference between total dry yolk and yolk lipid masses. The above procedure did not apply to one clutch in which incubation had apparently begun before

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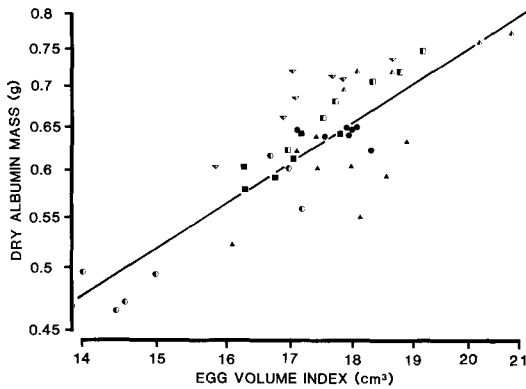


FIGURE 1. Variation in dry albumen mass with egg size. All points represent individual eggs, and all eggs denoted by the same symbol came from the same clutch. The line through the points is from a regression through clutch mean values ($r^2 = 0.69$), and describes interclutch variation.

eggs were collected, and it proved impossible to separate yolk from albumen in these eggs; only lipid and shell masses were found for eggs in this clutch. All masses were determined to 1 mg on a Mettler balance. The numbers of eggs in clutches were: 5 (one clutch), 6 (two to three clutches, depending on the egg component), 7 (three clutches), and 8 (one clutch).

RESULTS AND DISCUSSION

Conventionally, allometric regressions (dependent and independent variables log transformed) have been used to describe variation in egg composition with size. I used the same procedure in analyzing my data. The variable used as egg size was an index of volume (length \times breadth² at largest diameter; Hoyt 1979). For each egg component, a separate regression was done on the data from each clutch (describing the relationship between component mass and egg size within clutches); mean values of component mass and egg volume were found for each clutch, and these mean values were used as the data set in other regressions (describing egg size-component mass relationships among clutches). Thus, exactly the same data were used to describe interclutch and intraclutch patterns.

A number of the regressions were not statistically significant. For the regressions describing variation among clutches, the only nonsignificant regression was that of lean yolk mass on egg size. However, for the regressions conducted within clutches, the following numbers of regressions were not significant: dry albumen (2 of 7), lean yolk (5 of 7), yolk lipid (5 of 8), and dry shell (6 of 8). All regressions involving water content of eggs were statistically significant. These results suggest that although egg size may be a good indicator of the average composition

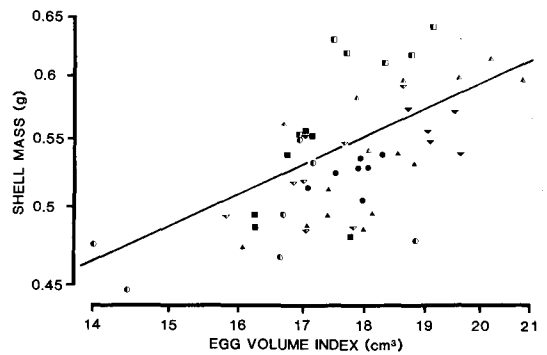


FIGURE 2. Variation in mass of dry shell and membranes with egg size. All points represent individual eggs, and all eggs denoted by the same symbol came from the same clutch. The line through the points is from a regression through the clutch mean values ($r^2 = 0.51$), and describes interclutch variation.

of eggs in a clutch (among-clutch regressions were significant), the same does not usually hold within a clutch (Figs. 1, 2).

Although nonsignificant, regressions within clutches still represent the best guess as to the relationship between egg size and component mass within those clutches. Thus, it is of interest to see whether the lines predicted by regressions within clutches agree with the line based on clutch-mean values, for a given egg component. This was tested with a one-sample Wilcoxon's signed-ranks test, with differences being calculated between all within-clutch regression slopes, and the among-clutch slope. If the egg size to component mass relationship is the same within as among clutches, the slope of the among-clutch regression should fall within the distribution of the within-clutch slope values. Within clutches, slopes of dry albumen and dry shell regressions were significantly lower than the slopes found among clutches (Table 1, Figs. 1, 2). Hence, the relationship egg size did bear with albumen or shell mass within a clutch was not that predicted on the basis of regressions describing the pattern found among clutches. This is particularly interesting for dry albumen, where most of the regressions within clutches were statistically significant. Ankney and Johnson (1985) found something similar when they compared dry yolk and yolk lipid variation among and within clutches: slopes within the one clutch tested were higher than among clutches. However, they suggested that their result may have been an artifact of an outlier in the within-clutch regressions, or the fact that the eggs of the one female did not span the entire size range observed in the population.

The above statistical analyses show something about the way in which egg composition varied within clutches. A clearer picture can be gained by inspecting the raw data. The data are presented here only for dry albumen (Fig. 1)

TABLE 1. Slopes of allometric regressions of egg component mass on egg volume index. For each egg component, comparison is made between the slopes found for regressions within clutches, and the slope calculated from clutch mean values of component mass and egg size ("Among clutches"). n is the number of clutches represented in the analyses. Probabilities (two-tailed) are for one-sample Wilcoxon's signed-ranks tests.

	Slope			Among clutches	n	Probability
	Within clutch					
	Min.	Max.	Median			
Dry albumen	-0.26	1.37	1.06	1.23	7	$P = 0.05$
Lean yolk	-0.46	1.92	0.83	0.83	7	$P > 0.20$
Yolk lipid	-0.73	2.49	1.31	1.33	8	$P > 0.20$
Dry shell	-0.28	0.93	0.52	0.80	8	$P < 0.05$
Total water	0.69	1.08	0.87	0.99	7	$P > 0.20$

and shell mass (Fig. 2). I will briefly note some of the patterns found in the data presented in these figures. First, there is a wide variation in the range of egg sizes found in the clutches (contrast the half- and fully-shaded circles). Second, egg size to component mass relationships can vary from log-linear to apparently random (in Fig. 1, contrast half-shaded squares with fully-shaded triangles). Third, a linear egg size to component mass relationship for one component does not necessitate a similar relationship for other components (contrast the half-shaded squares in Figs. 1 and 2). In short, there was no consistency in the way egg composition varied with egg size within a clutch.

These data suggest that it may be incorrect to infer the pattern of variation in egg composition within clutches from data describing variation among clutches. Although allometric relationships between egg size and component masses may exist when populations are considered as a whole, this was not consistently found in all separate clutches. Only water content was consistently predicted by egg size within clutches and bore a similar relationship with egg size both within and among clutches (Table 1). Thus it appears that egg size is generally a poor predictor of egg composition within a clutch. Unfortunately, clutch sizes of many species are too small for adequate regression analysis, as was the case here, and it would be difficult to test the generality of my findings. The data suggest that if egg composition has an effect on whether a chick is likely to die, this effect is not correlated with egg size. Laying sequence was not known for the eggs in this study. Egg composition may still function in brood reduction. Potentially, egg composition could vary in some systematic way through the laying sequence, which would indicate that laying sequence within a clutch is more important than egg size in determining which chicks are likely to die.

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LITERATURE CITED

- ANKNEY, C. D., AND S. L. JOHNSON. 1985. Variation in weight and composition of Brown-headed Cowbird eggs. *Condor* 87:296-299.
- BANCROFT, G. T. 1985. Nutrient content of eggs and the energetics of clutch formation in the Boat-tailed Grackle. *Auk* 102:43-48.
- HOWE, H. F. 1976. Egg size, hatching asynchrony, sex, and brood reduction in the Common Grackle. *Ecology* 57:1195-1207.
- HOWE, H. F. 1978. Initial investment, clutch size, and brood reduction in the Common Grackle (*Quiscalus quiscula* L.). *Ecology* 59:1109-1122.
- HOYT, D. F. 1979. Practical methods of estimating volume and fresh weight of bird eggs. *Auk* 96:73-77.
- OJANEN, M. 1983. Composition of the eggs of the Great Tit (*Parus major*) and the Pied Flycatcher (*Ficedula hypoleuca*). *Ann. Zool. Fenn.* 20:57-63.
- RICKLEFS, R. E. 1984. Variation in the size and composition of eggs of the European Starling. *Condor* 86:1-6.

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SLEEPING BEHAVIOR OF BLACK-BILLED MAGPIES UNDER A WIDE RANGE OF TEMPERATURES¹

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Key words: Sleep; thermoregulation; Black-billed Magpies; *Pica pica*.

Many bird species are reported to sleep with their bills tucked under their scapular feathers (Goodwin 1976; Amlaner and Ball 1983). This sleep posture probably offers thermoregulatory advantages because covering the bill in feathers is a likely means of preventing heat loss. In this context, it would be interesting to know whether nonmigratory birds adopt this posture more readily during the coldest nights of winter than during milder nights, and conversely whether they still sleep in that posture under summer temperatures that are within their thermoneutral

zone. In an attempt to provide such information, I report here on my observations of Black-billed Magpies (*Pica pica*) sleeping under temperatures varying between -30°C and 23°C. I also give a brief description of their sleep posture and night behavior since these, to my knowledge, have never been reported for any single species under such a wide range of temperatures.

MATERIAL AND METHODS

The Black-billed Magpie is a medium-sized corvid whose distribution range extends from Alaska to central California and western Texas (Linsdale 1937). It is typically nonmigratory and is therefore present during the winter in central Alberta, where this study was undertaken. Here (Reebs 1985) as in other places (Mugaas and King 1981), magpies roost communally from July to April, in dense thickets of deciduous trees in the fall, and dense thickets of conifers in winter. In central Alberta, they must face average minimum night temperatures of -19°C in January and 12°C in July.

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