ANALYSIS OF MEASUREMENTS, WEIGHTS, AND COMPOSITION OF COMMON AND ROSEATE TERN EGGS

CHARLES T. COLLINS AND MARY LECROY

An abundance of data has been presented on various aspects of the eggs of birds. Most studies have been concerned with intraclutch, intraspecific, and interspecific variations in egg color and dimensions (Coulson, 1963; Preston, 1953, 1957; Preston and Preston, 1953; and others) with little information being given on egg weights and almost none on the proportions of the various egg components. Data of all sorts are particularly incomplete for semiprecocial species as skuas, gulls, and terns. In this light it seemed worthwhile to gather information on this aspect of the annual cycle of the Common Tern (*Sterna hirundo*) and Roseate Tern (*Sterna dougallii*) as a part of a wider study of the reproductive biology of these species nesting on Great Gull Island, Suffolk County, New York. Further information on this colony and the growth and development of chicks of both tern species is presented elsewhere (Cooper, Hays, and Pessino, 1970; Hays, 1970; LeCroy and Collins, 1972).

METHODS

For this analysis 20 freshly laid eggs of each species were collected at random on Great Gull Island in early June 1967, at which time egg laying was just beginning. To insure freshness, eggs were only taken from areas which were checked daily for new nests and from nests containing but a single egg. In most cases this would be the first egg of a multi-egg clutch but some cases may have represented single egg clutches. It was expected that removal of eggs this early in the reproductive cycle would result in renesting by the pair and thus minimize any losses to the colony. A larger sample size was not considered necessary and might in fact have interfered with other studies being conducted in the colony. Weights were taken to the nearest tenth of a gram on a triple beam balance. Linear measurements were made to the nearest tenth of a millimeter by means of dial calipers. The data collected in this study are presented as a mean ($\bar{x}$) accompanied by the range and $\pm$ twice the standard error of the mean ($S_{\bar{x}}$) which for large samples closely approximates the 95 per cent confidence interval. When these intervals are nearly equal in length and nonoverlapping, the difference between the samples can be considered significant at the 5 per cent level (Simpson, Roe, and Lewontin, 1960:353).

EGG SIZE

The data on the size of Common and Roseate Tern eggs are presented in Table 1. Roseate eggs were significantly narrower than those of Common Terns, leading to an also significantly lower shape index. This difference in shape did not, however, appreciably affect the overall weight of the eggs, which was similar in both species (Table 1.). It should be remembered that

TABLE 1

SIZE OF COMMON AND ROSEATE TERN EGGS

	Mean ($\bar{x}$)	Twice Standard Error ($\pm 2S_{\bar{x}}$)	(Range)
Common Tern (N = 20)			
Length (mm)	42.94	±0.642	(40.4–45.9)
Width (mm)	30.49	±0.316	(29.2–31.9)
Shape Index[a]	72.91	±1.378	(67.3–78.4)
Weight (g)	21.01	±0.540	(18.7–23.8)
Roseate Tern (N = 20)			
Length (mm)	43.90	±0.890	(40.5–48.5)
Width (mm)	29.90	±0.272	(28.8–31.0)
Shape Index[a]	69.82	±1.470	(64.5–76.8)
Weight (g)	20.56	±0.540	(19.2–23.7)

[a] 100 × width/length.

these samples represented only the first egg of multi-egg clutches or in some cases single egg clutches. As there is a great deal of intraclutch variation in linear measurements (Gemperle and Preston, 1955; LeCroy, unpubl.) these apparent specific differences may not hold true when the full scope of egg sizes in the colony are considered. Such interspecific differences were not found for the remaining data collected on the eggs of these terns. Thus it is unlikely that the conclusions based on these data would be altered by larger sample sizes or analysis of intraclutch variation.

EGG SIZE RELATIVE TO BODY WEIGHT

No body weights for adult Common and Roseate Terns are available for a period when eggs were being laid or when eggs used in this study were collected. Adult body weights for both species for the period 29 June–2 July 1968 are as follows: Common Tern (N = 56) 116.1 ± 1.646 g (range, 103–129 g); Roseate Tern (N = 46) 107.7 ± 1.898 g (range, 92–125 g). Using these values, the eggs of Common and Roseate Terns are respectively 18.1 per cent and 19.3 per cent of adult body weight. Such high values seem typical of many terns and other semiprecocial birds while those for most altricial species are appreciably lower, frequently less than 10 per cent (Lack, 1968). The larger bird species in nearly all taxa show a pronounced decrease in the egg weight/body weight ratio which is independent of developmental pattern (Lack, op. cit.).

TABLE 2

COMPOSITION OF COMMON AND ROSEATE TERN EGGS

	Shell	Albumen	Yolk
Common Tern (N = 20)	2.22 ± 0.094[a] (10.6%)	12.87 ± 0.422 (61.2%)	5.94 ± 0.256 (28.2%)
Roseate Tern (N = 20)	2.21 ± 0.086 (10.7%)	12.26 ± 0.416 (59.6%)	6.10 ± 0.248 (29.7%)

[a] Mean weight in grams ± 2 standard errors of the mean.

COMPOSITION OF THE EGG

The composition by weight and on a per cent basis are highly similar in both species as shown in Table 2. The egg contents were poured from one half-shell to the other until the albumen had been separated from the yolk. The weight of the remaining shell and yolk was subtracted from the whole egg weight to determine the weight of albumen removed. The shell (including shell membrane) was then weighed separately and the yolk weight determined by subtraction. As the weighing was done in the field at the colony no attempt was made to determine dry weights for any of these components as has been done by some other workers (Reid, 1965).

DISCUSSION

Newly hatched young birds have long been assigned to one or the other of two categories by their degree of maturity at hatching, e.g., precocial or altricial. Analysis of egg sizes associated with these categories has shown that species producing precocial young tend to lay large eggs relative to their body weight, and ones in which the yolk makes up 30 to 40 per cent of the total egg weight. On the other hand, those species producing altricial young tend to produce smaller eggs relative to their body weight and ones containing only 15 to 25 per cent yolk. As noted earlier, the eggs of larger birds in most taxa are smaller, relative to body weight, and they also tend to contain relatively less yolk than those of closely related but smaller species.

The wide variation in developmental regimes makes the separation into but two categories extremely difficult and misleading. The expanded classification of Nice (1962:18) recognizes eight categories of maturity at hatching based on the manner of getting food, amount of down, activity, and development of sight at hatching. In addition to making it possible to categorize newly hatched young in a more realistic manner, this classification sequence serves to point out the existence of a gradual transition in developmental patterns from that of the highly precocial species which are nearly indepen-

TABLE 3

COMPARISON OF EGG CHARACTERISTICS IN PRECOCIAL, SEMIPRECOCIAL, AND ALTRICIAL SPECIES

	Egg Components (percentage by weight)			Yolk/Albumen Index
	Shell	Albumen	Yolk	
Precocial Birds				
Average of 10 species[a]	11.9	52.9	35.2	.665
Average of 5 species[b]	10.5	56.4	33.1	.586
Semiprecocial Birds				
Common Tern	10.6	61.2	28.2	.470
Roseate Tern	10.7	59.6	29.7	.506
South Polar Skua[c]	8.6	65.2	26.2	.409
Altricial Species				
Average of 10 species[a]	7.0	73.2	19.8	.276
Average of 4 species[b]	7.7	70.9	21.4	.305

[a] From: Romanoff and Romanoff, 1949.
[b] From: Asmundson, Baker, and Emlen, 1943.
[c] From: Reid, unpublished, in Reid, 1965.

dent at hatching to that of the extremely helpless altricials requiring great amounts of parental care at the other. Semiprecocial birds, as skuas, gulls, and terns, fall near the middle of this sequence in that at hatching they are down covered, their eyes are open, yet they stay in or near the nest and are fed by the adults for several weeks.

The available information suggests that there has also been a gradual shift in the relative amount of the components of bird eggs which goes along with this transition in developmental pattern. The species with the more precocial young tend to produce larger eggs with relatively more yolk. The extremely precocial species of megapodes have eggs containing in excess of 60 per cent yolk, while the eggs of most precocial species have 30–40 per cent and most altricials 15–25 per cent yolk (Nice, 1962:25). Our data for Common and Roseate Terns and that of Reid (1965) for the South Polar Skua (*Catharacta maccormicki*) along with that previously available for other species (Nice, 1962:25) indicate that the intermediacy of semiprecocial species extends to the component characteristics of their eggs as well (Table 3). Eggs of semiprecocial species usually contain between 25–30 per cent yolk which is more than is found for the altricial and semialtricial groups but less than for the eggs of precocial species. Table 3 also shows that the relative amount of albumen increases during the transition from the precocial to altricial mode of development. Shell weight is believed to be more a product of the size of the bird and the incubation regime to which it is subjected (Welty,

1962). The yolk/albumen index (Table 3) incorporates the relative changes of both of these components with the different levels of maturity at hatching and thus may be more helpful in indicating the changes in the components of eggs associated with the several developmental patterns utilized by birds. Further study is needed before the relative role of these components can be determined for the different developmental patterns. Laboratory analysis of the chemical composition of these components in species with different developmental patterns would also seem a fruitful area for further work.

SUMMARY

Eggs of Common (*Sterna hirundo*) and Roseate (*Sterna dougallii*) Terns, were collected on Great Gull Island in June 1967. Roseate Tern eggs were significantly narrower than those of Common Terns and had a significantly lower shape index. Such specific differences were only found for the linear measurements and even these differences may not be consistent when the full range of interclutch and intraclutch variation is considered. Egg weight of Common and Roseate Terns was 18.1 per cent and 19.3 per cent respectively of adult weight, which is typical of values recorded for other species of terns. The weights of egg shell, yolk and albumen were highly similar for both species with yolk making up 28–30 per cent. This is appreciably higher than in the eggs of altricial species and less than for precocials. These data point out the correlation between the changes in egg component proportions and the several developmental patterns of birds.

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DEPARTMENT OF ORNITHOLOGY, AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, NEW YORK 10024. (PRESENT ADDRESS: (C.T.C.) DEPARTMENT OF BIOLOGY, CALIFORNIA STATE COLLEGE, LONG BEACH, CALIFORNIA 90801),
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