VARIATION OF SHAPE IN THE EGGS OF THE COMMON TERN IN THE CLUTCH-SEQUENCE

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A METHOD of describing with precision the shape of any egg was given previously by one of us (Preston, 1953). In an investigation of the eggs of the Laughing Gull (*Larus atricilla*), it was found (Preston and Preston, 1953) that there were three significant statistical differences between the first two eggs and the last egg of a clutch of three: (1) the last egg tended to be smaller in maximum diameter, (2) the radius of curvature of the big end tended to be less in the last egg, and (3) the parameter c_1, that measures the asymmetry of the egg, i.e., the extent to which the big end is bigger than the small end, is less in the third egg. No other parameter or measurement seemed to differ significantly with position in the clutch-sequence, nor was there any significant difference between the first and second egg in any of these particulars.

The question naturally arises whether the findings apply only to the Laughing Gull, or whether they are of much wider application. The present report concerns one additional species, the Common Tern (*Sterna hirundo*). We felt it desirable to sample a different genus in the same family (Laridae). The decision to work with this species was based on the same considerations as applied to the Laughing Gull, viz., the species breeds colonially, nests on the ground, normally lays three eggs and no more, and lays eggs of a convenient size.

The colony used was on an extensive sand and shell flat, just south of Stone Harbor, New Jersey, and the nests were the first of the season. (In the case of the Laughing Gull in 1952, the early nests were destroyed by high tides, and the clutches used probably represented re-nestings in all cases.) The field work was done in May of 1953 by Mr. and Mrs. F. W. Preston, with assistance from Mr. Herbert Mills of Bridgeton, New Jersey.

The method used was similar to that used with the Laughing Gull. Each morning, a visit was made to the sand-flat, where the birds were nesting in fair numbers in the little tussocks of grass. When a nest having only one egg was found, a cane was pushed into the sand nearby, and the date was written in pencil at two or three places on the egg. This was found just as satisfactory as using a colored crayon as was done with the Laughing Gull. The pencil marks did not rub or wash off, in spite of numerous torrential thunderstorms, especially if it was placed on the small end of the egg, which suffers

no attrition. The nests were revisited daily, and additional eggs were marked with the date on which they were first found. When three eggs were laid it was assumed the clutch was complete, and if all the eggs had been marked, the clutch was collected. The field work took about a week, May 18 to May 24. In the end we collected twenty-two clutches comprising sixty-six eggs, and this is the material reported on here.

Measurements of the eggs are by Preston, statistical work by Gemperle. Actual measurements were made only on length, maximum breadth, and curvature of the big end. All of these measurements were made on a special spherometer, described later in this paper, the spherometer becoming a simple "height" or "distance" gage when used with the circular plate described below. Length, when subjected to statistical analysis, was found to be without significance as in the case of Laughing Gull eggs. It was necessarily measured in the process of obtaining the "sink" which defines the curvature of the big end, and since it was measured it is here recorded. It may have some advantage as indicating the normality of this particular colony at this particular time, but plays no important part in this report. The breadth and the curvature of the blunt end were measured, because it was suspected, on the basis of the Laughing Gull work, that they might be "significant" variables.

The parameter c_1 was not measured. Even in the field it was obvious that it was significant, for as a rule the last egg could be detected from a distance by its shape. Therefore, instead of contouring the egg, computing c_1, and obtaining quantitative data on it, a few qualitative experiments were made on the ability of observers to recognize the shape of the terminal egg. These experiments are described below.

Field and Laboratory Data.—Table 1 lists the sixty-six eggs by clutches (A, B, C, etc.) and by sequence in the clutch. It gives the date on which the egg was first observed in the nest. As a rule this was within twenty-four hours of its being laid, but those first seen on May 22 may have been laid somewhat longer, since no nests were visited on May 21. It gives also the length (l or $2a$), maximum breadth (B), and the "sink" (δ_B) for the large end when the three steel balls were a half-inch in diameter. The first two of these three quantities are the figures commonly listed in ornithological works as "length" and "breadth," and are all that are commonly listed in such works.

Average Values of the Parameters.—In table 2 are listed the average values of length, breadth, "sink," and radius of curvature of the big

TABLE 1

MEASUREMENTS OF COMMON TERN EGGS BY CLUTCHES

Egg number	Date marked	*l* or *2a* Length (*inches*)	*B* Maximum breadth (*inches*)	δ_B "Sink"	R_B Radius of curvature
A1	May 18	1.5077	1.194	0.0525	0.5698
A2	19	1.6029	1.189	0.0565	0.5157
A3	20	1.6430	1.189	0.0625	0.4479
B1	19	1.7011	1.267	0.0506	0.5987
B2	20	1.7295	1.266	0.0504	0.6019
B3	22	1.7390	1.206	0.0631	0.4419
C1	19	1.5905	1.185	0.0520	0.5772
C2	20	1.6003	1.212	0.0583	0.4939
C3	22	1.6097	1.214	0.0536	0.5542
D1	19	1.6560	1.216	0.0597	0.4777
D2	20	1.6396	1.227	0.0548	0.5377
D3	22	1.7190	1.209	0.0570	0.5095
E1	19	1.6487	1.212	0.0535	0.5556
E2	20	1.5989	1.190	0.0574	0.5046
E3	22	1.6694	1.147	0.0632	0.4409
F1	19	1.5645	1.171	0.0484	0.6351
F2	20	1.5264	1.201	0.0526	0.5684
F3	22	1.5502	1.178	0.0551	0.5338
G1	19	1.7352	1.220	0.0623	0.4500
G2	20	1.7558	1.236	0.0563	0.5183
G3	22	1.7880	1.198	0.0611	0.4625
H1	19	1.6127	1.181	0.0585	0.4914
H2	20	1.6440	1.203	0.0525	0.5698
H3	22	1.6468	1.185	0.0588	0.4880
I1	18	1.6796	1.275	0.0454	0.6905
I2	20	1.6731	1.232	0.0593	0.4822
I3	22	1.7043	1.227	0.0662	0.4125
J1	20	1.6624	1.199	0.0556	0.5272
J2	22	1.5851	1.198	0.0565	0.5157
J3	23	1.6702	1.179	0.0601	0.4733
K1	20	1.7031	1.207	0.0582	0.4950
K2	22	1.6342	1.188	0.0585	0.4914
K3	23	1.6566	1.183	0.0637	0.4359
L1	20	1.7759	1.208	0.0583	0.4939
L2	22	1.7369	1.207	0.0558	0.5246
L3	23	1.7838	1.192	0.0613	0.4603
M1	20	1.6700	1.203	0.0530	0.5627
M2	22	1.6708	1.246	0.0544	0.5431
M3	23	1.6862	1.253	0.0577	0.5009
N1	18	1.6198	1.281	0.0519	0.5788
N2	20	1.6235	1.264	0.0505	0.6003
N3	23	1.6925	1.253	0.0579	0.4986
P1	20	1.5018	1.147	0.0549	0.5364
P2	22	1.5419	1.200	0.0539	0.5500
P3	23	1.5651	1.136	0.0611	0.4625
Q1	20	1.6548	1.201	0.0495	0.6166
Q2	22	1.7129	1.197	0.0573	0.5058
Q3	24	1.6629	1.139	0.0639	0.4341
R1	22	1.5745	1.222	0.0632	0.4409
R2	23	1.5924	1.214	0.0593	0.4822
R3	24	1.5686	1.178	0.0633	0.4398
S1	20	1.5916	1.189	0.0593	0.4822
S2	22	1.5808	1.198	0.0553	0.5311
S3	24	1.6000	1.212	0.0572	0.5070
T1	20	1.8146	1.223	0.0576	0.5022

TABLE 1   (Continued)

Egg number	Date marked	l or $2a$ Length (inches)	B Maximum breadth (inches)	δ_B "Sink"	R_B Radius of curvature
T2	22	1.7037	1.206	0.0584	0.4927
T3	24	1.6978	1.194	0.0599	0.4756
U1	18	1.7485	1.216	0.0581	0.4962
U2	22	1.6766	1.199	0.0571	0.5083
U3	23*	1.6587	1.198	0.0567	0.5133
V1	20	1.7037	1.206	0.0538	0.5514
V2	22	1.5958	1.165	0.0582	0.4950
V3	24	1.6331	1.148	0.0664	0.4107
W1	20	1.6841	1.199	0.0553	0.5311
W2	22	1.6980	1.236	0.0563	0.5183
W3	24	1.7687	1.214	0.0628	0.4449

* This may be an error: the correct date might be May 24.

Bent (1921: 240) says categorically of the Common Tern, "one egg is laid each day until the set is complete." We did not find this to be invariably the case, and therefore in this table we have included the dates of laying, or, more accurately, the dates when the eggs were first observed. As previously reported, all nests were examined every day except on May 21. It will be seen, for example, that birds Q, S, T, U, V, and W allowed four days to elapse between first and third eggs, not two days as indicated by Bent. Clutch N was even slower in reaching completion, requiring five days. The question naturally arises whether clutches that proceed slowly to completion show differences in egg-shape which do not parallel those in which completion is prompt. That question is not examined here, but the dates of laying are recorded in case other workers may some day find them useful.

Witherby *et al.* (1944: 32) says of the British colonies, "eggs sometimes laid on consecutive days, sometimes at intervals of at least two days." This agrees with the behavior of birds in our New Jersey colony.

end, together with their standard deviations computed on the assumption that the various parameters or variables have a Gaussian or normal distribution.

It will be obvious at once that, just as was the case with the Laughing Gull, there is no possibility of distinguishing between first and second eggs, but the third egg may be significantly different.

TABLE 2

AVERAGE VALUES OF THE VARIOUS PARAMETERS AND THEIR STANDARD DEVIATIONS

	First egg	Second egg	Third egg	All eggs together
l	1.6546 ± 0.0802	1.6420 ± 0.0627	1.6688 ± 0.0669	1.6551 ± 0.0703
B	1.210 ± 0.0317	1.212 ± 0.0254	1.192 ± 0.0318	1.205 ± 0.0307
δ_B	0.0551 ± 0.0045	0.0559 ± 0.0026	0.0606 ± 0.0035	0.0572 ± 0.0043
R_B	0.5391 ± 0.0621	0.5250 ± 0.0349	0.4704 ± 0.0386	0.5115 ± 0.0549

Partition of Variance.—We now proceed, as we did with the Laughing Gull, to assume that the egg may have measurements affected by three causes: (1) its parentage, i.e., it may vary according to the bird that laid it, (2) its sequence number, i.e., whether it is the first, second, or third egg of a clutch, and (3) all other causes combined, hereinafter called the "error." The methods of making the computations were described in the Laughing Gull paper and are standard

practice.   Table 3 reports the results of the computations for the quantities l, B, δ_B, and R_B.

This table shows that in the last three of these quantities there are significant differences correlated with the sequence in the clutch. It is obvious that the difference is between the last egg and the first, or between the last egg and the second, and not between the first and second eggs.   These results all agree with what was found for the Laughing Gull.

TABLE 3

COMMON TERN EGGS

		l	B	δ_B	R_B
No. clutches analyzed		22	22	22	22
Computed variance ratio	Sequence:	3.18	7.57	16.25	14.45
	Parentage:	10.10	5.60	1.25	1.26
F value for one per cent level	Sequence:	5.15	5.15	5.15	5.15
	Parentage:	2.37	2.37	2.37	2.37
F value for five per cent level	Sequence:	3.22	3.22	3.22	3.22
	Parentage:	1.81	1.81	1.81	1.81
Significance	Sequence:	no	yes	yes	yes
	Parentage:	yes	yes	no	no
Variability	Sequence:	0.0009	0.000766	0.000061	0.00901
	Parentage:	0.0005	0.000073	—	0.00002
	Error:	0.0013	0.000350	0.000012	0.00201
	Total:	0.0027	0.001189	0.000073	0.01104
Partition of variability (per cent)	Sequence:	33.3	64.4	83.6	81.6
	Parentage:	18.5	6.1	—	0.2
	Error:	48.1	29.4	16.4	18.2
Coefficient of variation (per cent)	Sequence:	1.8	2.3	13.7	18.6
	Parentage:	1.4	0.7	0.6	1.0
	Error:	2.2	1.6	6.1	8.7
Mean value of characteristic for	First egg:	1.6546	1.210	0.0551	0.5391
	Second egg:	1.6420	1.212	0.0559	0.5250
	Third egg:	1.6688	1.192	0.0606	0.4704
	All eggs:	1.6551	1.205	0.0572	0.5115

Sources of Error.—In the field, the assumption was made that when a nest contained three eggs, the clutch was complete.   Pough (1951: 286–287) states that three is a full clutch and seems not to give the bird any option of laying less or more, except possibly if it is immature. In conversation, however, he tells me that all he meant to imply was that three was the "normal" full clutch.   Witherby *et al.* (1944: 32) report, "Eggs.—Generally 3, but often 2 and fairly frequently 4; higher numbers (5, 6, 9, 10 recorded) due to two or more females," while E. S. Thomas, in conversation, reports that he has frequently found two and four eggs in apparently authentic complete clutches on the shores of Lake Erie.   Our assumption, therefore, that a clutch was complete when it contained three eggs, will presumably have a high probability

of being correct, but no absolute certainty. Out of our collection of twenty-two clutches, it is possible that one or more may have been incomplete. Some of the clutches that we marked (dated) never progressed beyond two eggs, but these we abandoned and did not collect. There was some predation, apparently by Herring Gulls, and eggs were sometimes removed from a nest and broken: such nests also we abandoned.

There is also the possibility that the birds parasitize each other, as Witherby above reports. Thus all eggs in one nest, even though three in number and laid at reasonably appropriate intervals, might not be laid by the same bird. There is a suspicion, on the basis of pigmentation, that this may have happened once, perhaps twice, in our collection of twenty-two clutches, and this suspicion is increased by the results of the tests described below.

It is our belief, none the less, that some ninety per cent of our clutches may safely be said to be both complete and unparasitized.

Before proceeding to the qualitative tests, it may be well to insert here a description of the spherometer. In a typical spherometer, a knife-edged ring sits on the spherical surface, and the height, to which a convex sphere projects above the plane of the ring, is measured. This height is known as the "sagitta." Sometimes, in fact often, the ring is reduced to a three-point contact on three needle-like "legs," or it may be reduced to two legs if the sphere is a very long-radius one and the operator can make a good guess at keeping the two legs in the diametral plane of the sphere.

We tried this arrangement, using the complete ring, but found that the eggs would not seat themselves firmly in it. The sharp edge "bit" into the egg shell and prevented it from moving smoothly and accurately into true position. We found it necessary to modify the seat, and this we did by substituting three hard steel "bicycle" balls for the ring. The three balls were of equal size, each touching the other two, and hence arranged, in plan view, in an equilateral triangle. They were held tightly together by being pressed gently into a recess that just accommodated them, as shown in figure 1. The balls were not free to rotate; they merely provided very smooth, highly polished, and very hard surfaces on which the egg shell slipped very easily. The points of contact, three of them—one for each ball, between ball and egg—depend on the curvature of the egg. It is not at the top surface of the balls, nor at the mid-plane thereof, and it varies when the size of the egg varies.

The reference plane of the apparatus, however, is taken as the top surface of the three balls. Let us now conduct an imaginary experi-
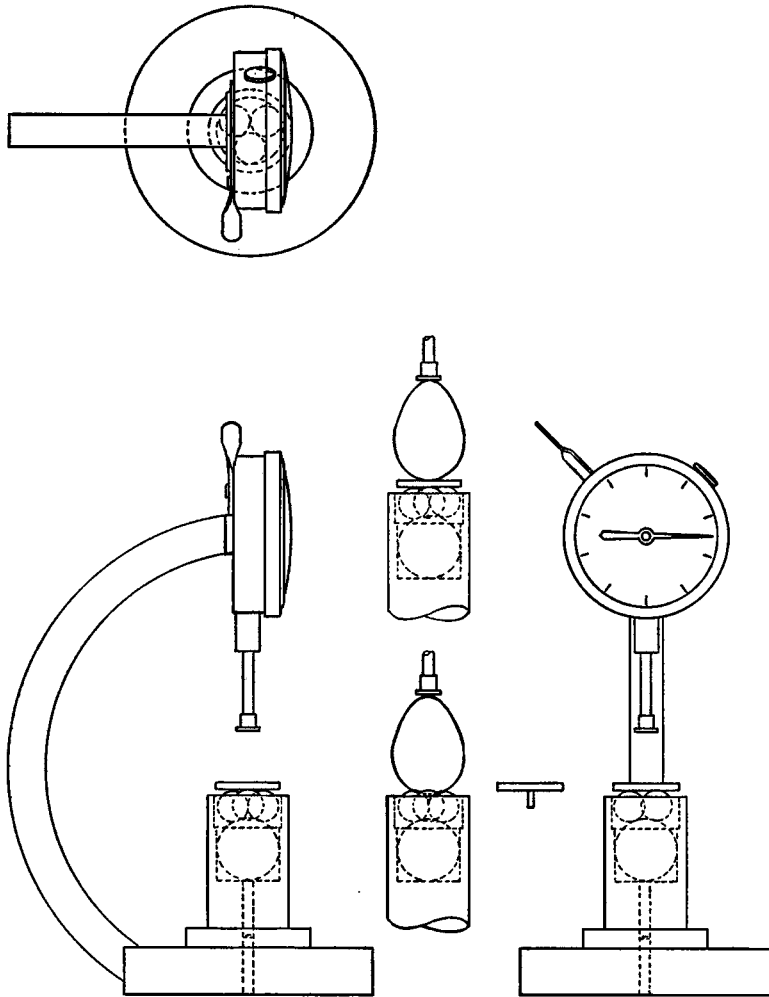
FIGURE 1. Special Spherometer. *Left,* side elevation; *right,* front elevation; *above,* plan view; *left center,* egg in the two positions for measuring curvature of big end; *right center,* one-tenth inch supporting disc.

ment. Set the egg on the imaginary reference plane, and measure its length. Then permit the egg to "sink" through the plane until it comes to rest on the actual steel balls. Take the reading of the dial gage again, and the difference of the two measurements is equal to the "sink" or "sinking-in," a quantity that replaces the "sagitta" of ordinary spherometer measurements.

Let the "sink" be δ, and let the radius (semi-diameter) of each steel ball be r: then the radius of curvature (R) of the end of the egg,

assuming that the part we measure is nearly enough a true spherical surface, is given by the formula:

$$R = \frac{2}{3} \cdot \frac{r^2}{\delta} + \frac{\delta}{2} - r \tag{1}$$

Since in practice the egg cannot be set for its first measurement upon an imaginary plane, it is actually set upon a little circular flat plate of thickness 0.1000″. This plate has a little pin projecting from its lower side, of such a diameter that it can pass through the small triangular space left between the three balls. It is a loose fit in this space, with a very small amount of "play," but positions the circular plate with adequate accuracy and prevents it from sliding bodily away. The plate is removed for the second measurement, and the "sink" is then one-tenth of an inch less than the difference of the two dial-gage measurements.

To measure eggs of different sizes, it is convenient to have several different pedestals and balls of different sizes. The typical machinists' dial-gage reads only over a range of one inch. We have found it convenient to have pedestals increasing in height by half-inch intervals, and to provide, for each size of bicycle ball, two pedestals differing in height by half an inch. The tallest pedestals hold the smallest balls, of course, since they are used for measuring the smallest eggs. It is convenient to have a different circular plate for each size of ball, since the pin should "fit," although only loosely, between the balls.

A typical gage "reads" to one-thousandth of an inch, and can be "estimated" to a ten-thousandth. With eggs, we find we can estimate somewhat more closely than the thousandth, but not to the ten-thousandth.

Since there is a simple one-to-one relationship between the radius of curvature and the "sink," the statistical work can be done just as well on the sink as on the radius.

For purposes of comparison, it may be noted that the formula for the ordinary, unsatisfactory, spherometer is

$$R = \frac{D^2}{8\delta} + \frac{\delta}{2}$$

where δ is the sagitta and D is the diameter of the knife-edged ring or the "pitch-circle" of the three legs. In many spherometer measurements, it is close enough to write $R = D^2/8$.

Experiments on Picking out the Terminal Egg on Sight.—These tests involve no measurement; a person is merely asked to judge by in-

spection.   Two kinds of tests were made: the first, and by far the more difficult, denied the experimenter access to any material for comparison; the second let him compare the three eggs of a clutch.

(a) *Attempt to guess terminal eggs when seen separately.*—A random sequence of Common Tern eggs was prepared with the aid of a table of random numbers, and the eggs were given to one of us (F.W.P.) one at a time.   The observer was to say "yes," if he thought an egg to be terminal, or "no," if he thought it was either first or second egg of a clutch.   He did not know how many tests were in the sequence, nor the exact proportion of terminal eggs.   He *did* know that it ought to be roughly one-third, but made no conscious use of the fact.   On this basis, when in doubt he ought to have said "no," but did not do so, trying each time to make an honest estimate.   He could not, however, divest himself of the knowledge that terminal eggs sometimes had characteristic arrangements of pigmentation, so that this additional source of knowledge must be assumed to have been present in his estimates.   On the other hand, when eggs are seen separately, one at a time, there is *no* knowledge available from maximum width. It is known that in a clutch of three eggs, that egg which has the least maximum diameter is likely to be the terminal egg, but no use can be made of this knowledge in the present test.   Hence, he must be assumed to have operated consciously only on *the shape of the blunt end of the egg* and subconsciously on the distribution of pigment.

It can be shown that if an experimenter is presented with $(a + b)$ opportunities to guess, a being the number of normal eggs presented and b the number of terminal eggs, and if the experimenter says "yes" m times and "no" n times, then his expectation of success is

$$(an + bm) \,/\, (a + b)^2 \,. \tag{2}$$

In the present test $(a + b)$ was 31: a was 19, b was 12: m was 15, n was 16: hence the expectation of success, if the guesses had been absolute guesses, was

$$(19 \times 16 + 12 \times 15) \,/\, (31)^2 = 484 \,/\, 961 = 0.503 \,, \tag{3}$$

or in other words, mere random guessing should have produced 50.3 per cent success.

Actually he "guessed" correctly on 19 eggs out of the 31, or 61.3 per cent.

He guessed correctly 7 out of 12 terminals, and 12 out of 19 non-terminals.

We are not quite sure how to calculate the likelihood of a 61.3 per cent success, on a 50.3 per cent probable success basis, in the

present instance. Nor are we sure that it is worth doing. The next experiment to be described is more revealing.

It should be added, however, that at the time of the test, the observer had not seen any of the eggs for several weeks, and it is unlikely that he remembered any of the eggs individually. They were presented to him in such a way that he could not see the pencil identifications on the back, near the blow-hole.

It seems likely that if he could not do better than 61.3 per cent, others who know less of the subject would not be strikingly successful at identifying an egg as terminal or non-terminal in the absence of companion eggs from the same clutch. See, however, below, under the heading "Reconsideration."

(b) *Picking out the terminal egg of a clutch by its shape.*—Operating again with the twenty-two clutches of the Common Tern, marked Clutch A, Clutch B, . . . Clutch W (but Clutch O being non-existent, no clutch was so marked), the experimenter was required to pick out the last egg of each clutch. His success or failure was unknown to him till all clutches had been reported. In each clutch there are three eggs, and random guessing will produce success 33-1/3 per cent of the time.

The first experimentalist was F. W. P., and the eggs were examined and success recorded by Mrs. Preston. The important difference now is that the experimenter can compare all eggs of a clutch and see the *difference* in shape, which is impossible when one egg at a time is examined.

All twenty-two clutches were examined and only a few seconds were allowed per clutch. Nineteen came out correctly, the exceptions being D, R, and U. The criterion was the shape of the blunt end, undoubtedly, however, taking subconscious note of pigmentation-arrangement.

To get over this last difficulty, we now tested Mrs. Preston. She had not seen the eggs for more than three months, and then only in the field. She did not know about the pigmentation. We explained that the third egg was the least blunt at the blunt end, and this had the effect of putting the "equator" further "south." She said she preferred to use this latter criterion, and immediately diagnosed correctly eighteen clutches out of twenty-two, being in error on D, K, T, and U. Note that D and U are clutches on which the previous observer was mistaken.

We therefore tested her again on these four clutches. She remained wrong on D, T, and U, but this time was correct on K.

The previous observer was now tested on D, R, and U. He remained wrong on D and U, but corrected R.

It is thus clear that D and U are abnormal, both observers being persistently wrong on these clutches. The probable reasons are discussed later, following table 4.

If, then, we omit Clutches D and U as being possibly abnormal on other evidence, we have almost 100 per cent success in picking out the terminal egg; and this is true whether done by an experimenter with some considerable background of observing these points, or by one with no background at all. Seeing that "chance" methods of picking out the third egg give only a 33 per cent success, while our success ran between 82 per cent and 100 per cent (the latter only if D and U are omitted as abnormal and suspect), it is clear that *without measurement*, but with the other eggs of the clutch available for *comparison*, the last egg is visually different.

(c) *Reconsideration of the previous experiment.*—It so happens that in the previous experiment, where, out of sixty-six eggs available, only thirty-one came up in the random series, U_3 came up for diagnosis once, and D_3 came up twice, and each time the experimenter (F. W. P.) gave a wrong answer. (U_1, U_2, D_1, and D_2 did not come up at all.) It is obvious, therefore, that the random series was loaded with an abnormal number of dubious choices.

If we reject tests of D_3 and U_3, the total number of tests was ($a + b$) = 28: $a = 19$, $b = 9$: $m = 15$, $n = 13$: so the expected success was $(19 \times 13 + 9 \times 15) / (28)^2 = 382 / 784 = 0.487$ or 48.7 per cent. Actually we had correct answers in nineteen cases out of twenty-eight, or 68 per cent.

This is sufficiently above the normal, "chance," expectation, that it means that terminal eggs can often be identified in the absence of companion specimens. However, the two experiments together show the great advantage of having the comparison eggs from the same clutch.

Table 4 shows the clutches in which the terminal egg would be correctly identified if the criterion were (a) that it has the least maximum-breadth in its clutch, (b) that it has the least radius of curvature, or maximum "sink," at the big end, (c) that it appears to Mrs. Preston to have its bulge most nearly at the mid-point or equator, and (d) that it appears to one of us (F.W.P.) to be the terminal egg by reason of a low value of R_B or of having "terminal pigmentation." We include also the possibility of identifying it as being the egg of greatest length.

The anomalous position of Clutch U is clear from the table. The egg that was presumed terminal does not appear to be so. Judging by the pigmentation the egg is *not* spurious (parasitic), and the most

likely interpretation is that this bird was prepared to lay a fourth egg, which would have been the genuine terminal egg and would have had the properties of a terminal egg.

In the case of Clutch D, there seems a likelihood that the egg marked D_3 may not have been laid by the same bird which laid D_1 and D_2. Eggs D_1 and D_2 agree closely in background color and in pigmentation generally. Egg D_3, on the other hand, has a darker background

TABLE 4

COMPARISON OF VARIOUS METHODS OF DETERMINING TERMINAL EGG OF A CLUTCH

Clutch	Maximum length	Minimum breadth	Least value of R_B	Visual estimates F. W. P.	J. E. P.
A	x	x	x	x	x
B	x	x	x	x	x
C	x			x	x
D	x	x			
E	x	x	x	x	x
F			x	x	x
G	x	x		x	x
H	x		x	x	x
I	x	x	x	x	x
J	x	x	x	x	x
K		x	x	x	½
L	x	x	x	x	x
M	x		x	x	x
N	x	x	x	x	x
P	x	x	x	x	x
Q		x	x	x	x
R		x	x	½	x
S	x			x	x
T		x	x	x	
U		x			
V		x	x	x	x
W	x		x	x	x

altogether, and its spotting is also different. The shape of the egg is very definitely not what we expect in a terminal egg, and the fact that two of the measurements endorse it as terminal is perhaps merely coincidental.

If we assume that Clutch U is incomplete and that Clutch D contains a spurious terminal member, we reach very nearly 100 per cent success in identifying terminal eggs by inspection, and about 90 per cent by any one of several criteria.

Comparison of British and American Common Tern Eggs.—Witherby *et al.* (1944: 32) give the average dimensions of one hundred British Common Tern eggs as 40.99 mm. × 30.31 mm. These figures are substantially below the average of the present collection of sixty-six American Common Tern eggs. Table 5 records the comparison.

It is not certain that any of these collections is typical of Britain as a whole or of North America or even New Jersey as a whole. It does appear, however, that there is a possibility that the New World birds are slightly larger and more robust than the Old World birds. Both groups are assigned to the same subspecies (*Sterna hirundo hirundo*). The New Jersey birds are breeding in a distinctly more

TABLE 5

COMPARISON OF AMERICAN AND BRITISH EGGS OF THE COMMON TERN

Source	Place in clutch	Number	Average length	Average maximum diameter	Reference
American (New Jersey)	First egg	22	1.6546″ =42.0 mm.	1.210″ =30.8 mm.	This report
	Second egg	22	1.6420″ =41.7 mm.	1.212″ =30.8 mm.	
	Third egg	22	1.6688″ =42.3 mm.	1.192″ =30.3 mm.	
	Overall average	66	42.0 mm.	30.63 mm.	
American	—	82	41.5 mm. (rounded off to nearest ½ mm.)	30.0 mm.	Bent (1921:241)
British	—	100	40.99 mm.	30.31 mm.	Witherby *et al.* (1944:32)

Since the average size of the British eggs reported on by Witherby *et al.* is so much less than that of our New Jersey specimens, it seemed imperative to make at least an attempt to see if the difference is significant. In the case of the American eggs, we have not only the average length and average width, but also the standard deviations. In the case of the British ones, we have only the averages. In order to make a test of significance, we made the assumption that the standard deviation of the British eggs might very well be close to that found in the American ones. This may not be a very safe assumption, but it seems the only thing to do in the circumstances. Making this assumption, we find that there is a significant difference between the New Jersey eggs and the British ones: the difference is significant, by "Student's" t-test, at the 95 per cent level for width and at the 99 per cent level for length.

The explanation of this difference is not clear. It may be that our own specimens were taken from the birds that bred early and thus were the older birds or the more vigorous ones; and if we had sampled the colony at intervals throughout the breeding season, we might have found a change in average size. The British eggs may quite likely not all have been the earliest of the season. Since Bent's values, though "rounded-off," are slightly smaller than ours, though larger than those of Witherby *et al.*, this explanation may be the correct one. On the other hand, since his averages are definitely larger than the British ones, it may indicate that there is some real difference in size or vigor between the American and the British terns.

southern latitude than the British ones and therefore might be expected to be slightly smaller.

The point may be worth making that in all probability eggs can be measured with far greater precision than most parts of a bird's anatomy, and that subspecies might be detected earlier in the eggs than in the birds.

This paper is restricted to questions of shape. It was noted in the work on the Laughing Gull, and confirmed for the present species, that the terminal egg commonly has a different and characteristic arrangement of the pigmentation. On this we may report later.

While the Common Tern eggs were being marked and collected, nests

of the Least Tern also were encountered, marked, and in some cases collected. This species seems to lay two eggs as often as three, and an effort was being made to collect only three-egg clutches. Partly on account of this restriction, but more on account of the nightly thunderstorms that flooded the flats and destroyed the nests, an insufficient number of clutches was obtained for quantitative work; but on a qualitative basis it seems very likely indeed that what has been found true for the Laughing Gull and the Common Tern applies also to the Least Tern.

Other Differences between Terminal and Earlier Eggs.—We have now established that, in the Laughing Gull and the Common Tern at least, the last egg of a clutch differs from the other eggs in two particulars, size and shape (B and R_B). It is, therefore, likely that it differs in other particulars of a less obvious nature. We know that it differs in character of pigmentation (vermiform spots, and concentration of spots in a ring). We know also that it is frequently different in background color, which may be either lighter or darker; but sometimes the *first* egg is the odd one in this respect. There may be more subtle distinctions, such as texture of the shell, its porosity, and its surface gloss.

It appears to us that, judging from the ease of removing pencil marks from the shell, the big end is more porous or less glossy than the small end of an egg, and the last egg of a clutch is often less glazed than the others. This would agree with what we suspect about the Brazilian Seriema (*Cariama cristata*), a distant relative of the cranes that lays two eggs (like the cranes), but one egg is very glossy and the other very mat.

Conclusion.—There is a significant difference between the shape of the third (last) egg of the clutch of the Common Tern and the shape of the first two eggs. These differences are similar to those previously found in the eggs of the Laughing Gull.

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Preston Laboratories, Box 149, Butler, Pennsylvania, November 25, 1953.

Erratum. In the previous paper (Preston, 1953: 179), the length of the Lapwing's egg was given as 40.7 mm. This should read 49.7 mm. This slip does not affect any calculation or any other statement in that paper.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Notice is hereby given that the possible use by the International Commission on Zoological Nomenclature of its Plenary Powers is involved in applications relating to the under-mentioned names included in part 3 of Volume 11 of the *Bulletin of Zoological Nomenclature*, published on 28 February 1955:

>*obscura* Berezowsky and Bianchi, 1891, as published in the combination *Larvivora obscura*, validation of (pp. 93–94). Z.N. (S.) 876.

>*bei* Ridgway, 1874, as published in the combination *Eremophila alpestris* var. *bei*, supression of (pp. 103–104). Z.N. (S.) 817.

Any specialist who desires to comment on either of the foregoing applications is invited to do so in writing to the Secretary to the International Commission (Address: 28 Park Village East, Regent's Park, London, N.W. 1, England). Comments should be marked with the Commission's File Number as given in the present notice and should reach the Secretariat by 28 August 1955.

Francis Hemming
Secretary