THE EGG OF CUCULUS CANORUS.

AN ATTEMPT TO ASCERTAIN FROM THE DIMENSIONS OF THE
CUCKOO'S EGG IF THE SPECIES IS TENDING TO BREAK UP
INTO SUB-SPECIES, EACH EXHIBITING A PREFERENCE FOR
SOME ONE FOSTER-PARENT.

SECOND MEMOIR.

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(1) *On the Existence of Cuckoo Gentcs.*

In my previous paper (*Biometrika*, Vol. i. No. 2, January 1902, pp. 164—176) I examined this and certain other questions relating to the egg of the Cuckoo. On that occasion I had measurements of only 243 eggs. I have now been able to obtain the dimensions of 1572 specimens (including those dealt with previously) and am therefore in a position to speak with more confidence. Of this number, 717 eggs were measured by myself; and I must here take the opportunity of recording my grateful thanks to Prof. A. Newton of Cambridge, Dr E. Hartert of the Tring Museum, Mr F. Norgate of Bury S. Edmunds, Mr J. H. Gurney of Keswick Hall, Norwich, and many other private collectors for their courtesy in granting me help and access to their collections. I am further indebted to a large number of my pupils at Charterhouse for assistance in tabulating the measurements and in checking the accuracy of the calculations. The remaining 855 specimens were measured by Eugene Rey of Leipzig, and the dimensions published in *Zoologische Vorträge herausgegeben von W. Marshall*, Leipzig, 11th Heft, 1892; *Ornithologische Monatschrift d. Deutschen Vereins z. Schutze der Vogelwelt*, XIX. Jahrgang, 1894, No. 5; and *Journal für Ornithologie*, XLIII. Jan. 1895.

In the present instance I have confined myself to the attempt to ascertain if the eggs of Cuckoos deposited in the nests of any one species stand out as a set apart from Cuckoo's eggs deposited elsewhere. The series includes eggs taken from the nests of no less than eighty-four different species of foster-parents, in addition to a number whose history was not ascertainable. From the nests of sixteen species of foster-parents sufficient Cuckoo's eggs were obtained to make it

worth while to test the point in question in respect of the dimensions of length and breadth. The method employed is fully explained in my previous paper, but it will be convenient to re-state it. The mean (M) length or breadth, as the case may be, of all the Cuckoo's eggs is first computed, thence the standard deviation (σ) is obtained by the formula $\sigma^2 = \frac{\text{sum } (M - x)^2}{n}$, where x = the measurement of any one

egg and n = the number of eggs measured: the coefficient of variation, $\frac{100 \sigma}{M}$, can

then be found. To test whether the deviation occurring in Cuckoo's eggs deposited in the nests of any particular species of foster-parent is significant, M_r is taken as the mean of the whole race of Cuckoos, and M_s as the mean of Cuckoo's eggs found in the nests of the foster-parent species: the standard deviation (σ_s) of such eggs is also ascertained. The value of $M_r - M_s$ is then compared with that of

$0.67449 \sqrt{\frac{\sigma_r^2}{n_1} + \frac{\sigma_s^2}{n_2}}$ (where n_1 = total number of Cuckoo's eggs, and n_2 = the number of Cuckoo's eggs in the nests of the species in question), which is the probable error of $M_r - M_s$ due to random sampling. If the value of $M_r - M_s$ be not at least 2 to 3 times as great as the value of the other expression, then the difference of M_r and M_s is not definitely significant. It will be seen by reference to the tabulated summary below that in the case of four of the sixteen sets examined, viz. Robin-Cuckoos, Wren-Cuckoos, Whitethroat-Cuckoos, and Hedge-Sparrow-Cuckoos, the differences are significant in respect of both length and breadth. Of the remainder, five, viz. Garden-Warbler-Cuckoos, Barred-Warbler-Cuckoos, Marsh-Warbler-Cuckoos, Reed-Warbler-Cuckoos, and Tree-Pipit-Cuckoos, exhibit differences significant in one dimension, but doubtful in the other; two, viz. Sedge-Warbler-Cuckoos and White-Wagtail-Cuckoos, exhibit significant differences in one dimension only; one, viz. Meadow-Pipit-Cuckoos, exhibit doubtfully significant differences in but one dimension; and four, viz. Redstart-Cuckoos, Red-backed-Shrike-Cuckoos, Pied-Wagtail-Cuckoos, and Yellow-Ammer-Cuckoos, do not present differences significant in either dimension. The balance of evidence is thus decidedly in favour of there being distinct sets of Cuckoos. As a result it now seems fairly certain that Prof. A. Newton's suggestion (*Dictionary of Birds*, p. 123) is correct, and that there are certain "gentes" of Cuckoos whose members being closely related lay eggs of somewhat similar dimensions, and in the main confine their attentions, generation after generation, each to its own particular variety of foster-parent. In other words, the evidence here adduced points to the conclusion that the species *Cuculus canorus* is tending to break up into a number of sub-species, each with its own particular habits in respect of selecting a foster-parent. There are recorded numerous instances of individual Cuckoos adhering to one species of foster-parent whenever possible, but it appears that in the event of failure to find a nest of the species preferred the Cuckoo places her egg in any nest that comes handy. This fact probably accounts for the very large number of species in whose nests Cuckoo's eggs have been found, and emphasises the importance of obtaining large numbers of measurements for investigations of this character.

TABLE I.
Summary of Results.

Group	Length in Millimetres				Breadth in Millimetres				Remarks
	Number of Eggs	Mean ($\bar{M}$)	Standard Deviation (σ)	Coefficient of Variation	Significance Test*	Mean ($\bar{M}$)	Standard Deviation (σ)	Coefficient of Variation	Significance Test*
Cuckoo (Raoe) ...	1572	23.3	.9842	4.33	—	16.5	.5852	3.60	—
Robin-Cuckoo ...	78	23.8	1.1638	5.105	5.5	16.8	.7127	4.242	6
Garden-Warbler-Cuckoo ...	91	21.9	.7860	3.587	7.01	16.4	.4900	2.980	2.8
Meadow-Pipit-Cuckoo ...	86	23.3	.8851	3.869	—	16.6	.5238	3.149	2.57
Wren-Cuckoo ...	54	21.4	.9375	4.380	10	16.2	.6578	4.060	5.0
Redstart-Cuckoo ...	64	23.4	.8840	3.857	1.3	16.6	.5225	3.16	—
Sedge-Warbler-Cuckoo ...	48	22.1	.8842	3.91	11.1	16.4	.6121	3.730	1.6
Barred-Warbler-Cuckoo ...	35	21.8	.9617	3.952	5.0	16.3	.6090	3.736	2.85
Whitethroat-Cuckoo ...	37	21.8	.8545	3.919	5.2	16.2	.6071	3.747	4.4
Marsh-Warbler-Cuckoo ...	37	23.1	.8330	3.769	2.1	16.3	.4647	2.850	4.0
Red-backed-Shrike-Cuckoo ...	307	23.3	.7976	3.56	—	16.5	.4909	2.975	—
White-Wagtail-Cuckoo ...	115	22.4	.7606	3.398	1.8	16.7	.6768	4.051	4.8
Pied-Wagtail-Cuckoo ...	86	23.3	.9192	4.122	—	16.5	.5242	3.176	—
Reed-Warbler-Cuckoo ...	68	23.6	1.0219	4.51	3.2	16.6	.5768	3.479	2.04
Tree-Pipit-Cuckoo ...	48	23.6	.9514	4.209	3.0	16.6	.4394	2.647	2.3
Hedge-Sparrow-Cuckoo ...	58	23.6	.8759	3.875	3.75	16.8	.4970	2.958	6.6
Yellow-Ammer-Cuckoo ...	31	23.2	.9846	4.43	0.8	16.5	.4981	3.0	—

4 species differ significantly in both dimensions.

5 " " one and perhaps in both.

2 " " one only.

1 " " perhaps one only.

4 " " neither dimension.

* Ratio of difference of racial and group means to the probable error of this difference.

We note that judged by the coefficient of variation the Cuckoo's egg is more variable than the eggs for the sub-groups for

Length in 12 out of 16 cases,

Breadth in 10 out of 16 cases.

It is less variable in both breadth and length in the cases of Robin-Cuckoo and Wren-Cuckoo, less variable in length only in Yellow-Ammer-Cuckoo and Reed-Warbler-Cuckoo, and less variable in breadth only in Sedge-Warbler-Cuckoo, Barred-Warbler-Cuckoo, Whitethroat-Cuckoo, and White-Wagtail-Cuckoo. We therefore see that as a rule the egg of the *gens* is less variable than that of the race.

(2) *On the Relation of the Gens Egg to the Foster-Mother's Egg.*

Taking these 16 cases and correlating the dimensions of the Cuckoo's egg with those of the foster-mother, we find:

Correlation of length of Cuckoo's and foster-mother's egg* = .10,

Correlation of breadth of Cuckoo's and foster-mother's egg = .24.

These are not very large values, and the number of cases dealt with is only 16, but it does appear that there is some relationship between the size

TABLE II.

Bulk-Modulus of Cuckoo's and Foster-Mother's Eggs.

Species	Size of Foster-Mother's Egg	Size of Frequenting Cuckoo's Egg
Robin	4791	6435
Garden-Warbler ...	5197	5890
Meadow-Pipit ...	4142	6145
Wren	2855	5616
Redstart	3724	6173
Sedge-Warbler ...	3234	5944
Barred-Warbler ...	5478	5792
Whitethroat ...	3831	5721
Marsh-Warbler ...	3724	5872
Red-backed-Shrike	6359	6071
White-Wagtail ...	4877	6247
Pied-Wagtail ...	4690	6071
Reed-Warbler ...	2871	6228
Tree-Pipit	4560	6228
Hedge-Sparrow ...	4322	6379
Yellow-Ammer ...	5504	6044
Mean	4385 mm. ³	6053.5 mm. ³
Standard Deviation	959.13 mm. ³	225.72 mm. ³

* Mean Length of Cuckoo's Egg, 22.225; of Foster-Parent's Egg, 19.806; the mean breadths are respectively 16.500 and 14.768; the corresponding standard deviations are: Length .8544 and 1.6414; Breadth .1837 and 1.0971.

of the foster-parents' eggs and those which the Cuckoo lays in their nest. It is worth while considering this relationship from another standpoint. The bulk of an egg must be approximately proportional to its length $\times$ (breadth)², and we may take this roughly as a bulk-modulus. Using it we obtain the foregoing Table II. for the bulk-moduli in cubic millimetres. This leads to a correlation of .1746, or .17, say, and confirms the previous results. There thus appears to be really a small relation between the bulk of the Cuckoo's egg and that of the foster-parent. The results are based on only 16 classes, which is, of course, small for determining a correlation, but it would seem that we must, since all three measurements give a positive correlation, assume some slight relationship between size of Cuckoo's egg and that of the foster-parent. This relation might be clearer and less irregular, if we had measurements of fairly long series of the eggs of the foster-parents. It is perhaps worth noting that the breadth measurement is the one in which the resemblance is closer. We may therefore ask: Is it possible that the differentiation in size of egg, which we find as we pass from the foster-parent of one to the foster-parent of a second species, is merely due to a slight constriction of the oviduct, instinctive or otherwise, following on the choice of a foster-parent? Were this the case, it would be unnecessary to suppose separate Cuckoo *gentes*. Now the relation between length and breadth of egg has been worked out for Thrush, Blackbird, House-Sparrow and Linnet and the value of the correlation lies between .35 and .40. We should expect therefore that if the differentiation of the Cuckoo's egg were produced solely by such a constriction of the oviduct, that the length of the egg would be increased, or the above correlation between length and breadth be at any rate reduced. We find, however, that if the length and breadth of the 16 Cuckoo groups be correlated, the resulting value is .91. There can hardly be a doubt therefore that the variation in the Cuckoo's egg as we pass from one species of foster-parent to a second is a real variation in bulk, the length and breadth changing in a closely correlated manner. Thus although the egg is only slightly correlated with the size of the foster-parent's egg it varies as a whole in a manner not consonant with a mere constriction of the oviduct, and the fact that the breadths of foster-mother's and Cuckoo's eggs are more closely correlated than their lengths, does not enable us to dispense with a theory of *gentes*.

Table IV. shows the dimensions of the eggs of the foster-parents for comparison with those of the Cuckoo frequenting their nests. The approximate sizes of the birds are also inserted.

(3) *On the Distribution of Frequency in the Cuckoo's Egg.*

A consideration of the first two columns of totals under the heading "Race" in Table III., shows that Rey has measured the great bulk of his eggs to only .5 mm. accuracy; he has probably not used a vernier and the result is that his frequencies are crowded up on the whole and half millimetres; a similar crowding although less conspicuous is obvious in the additional 717 measurements. This unconscious

TABLE III. *Measurements of Cuckoo's Eggs.*
Length of Egg.

Length in mm.	Race			Genus															
	Key	Latter	Total	Robin	Garden-warbler	Meadow-pipit	Wren	Redstart	Sedge-warbler	Barred-warbler	White-throat	Marsh-warbler	Red-backed-shrike	White-wagtail	Pied-wagtail	Reed-warbler	Tree-pipit	Hedge-sparrow	Yellow-ammer
19.1	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
19.6	—	1	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
19.7	1	1	2	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
19.8	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19.9	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20.0	13	3	16	1	2	—	6	—	—	—	—	—	1	—	1	1	—	—	1
20.1	2	4	6	—	—	1	—	—	—	1	—	—	—	—	1	—	—	—	—
20.2	4	4	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20.3	4	1	5	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
20.4	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20.5	15	2	17	—	3	—	1	—	—	4	1	—	4	1	—	—	—	—	—
20.6	6	2	8	1	—	1	1	—	—	—	—	—	2	1	—	—	—	—	—
20.7	8	2	10	—	1	1	3	—	—	—	—	—	3	—	—	—	—	—	—
20.8	7	6	13	—	2	2	3	—	—	1	—	1	1	1	2	1	—	1	—
20.9	4	15	19	1	7	2	3	4	3	3	5	1	13	4	2	3	2	1	1
21.0	56	18	74	5	7	1	7	4	—	—	—	—	—	—	—	—	—	—	—
21.1	6	13	19	2	2	1	—	—	—	—	1	—	1	2	—	—	2	—	3
21.2	14	17	31	—	4	—	1	1	—	—	—	1	4	3	2	3	2	—	1
21.3	12	13	25	1	1	1	4	—	2	—	1	—	4	2	1	1	—	—	1
21.4	9	9	18	—	3	1	—	1	—	—	1	2	1	—	2	1	—	—	—
21.5	46	8	54	1	8	2	3	2	4	2	1	—	9	4	4	4	2	2	1
21.6	11	8	19	—	2	2	1	1	3	2	1	1	—	—	—	2	—	—	—
21.7	20	16	36	1	1	4	—	2	2	—	2	1	10	1	—	2	—	3	—
21.8	17	24	41	1	2	2	—	1	2	—	1	4	10	1	5	1	2	—	—
21.9	17	29	56	—	1	8	—	1	2	2	2	4	9	3	6	1	1	—	2
22.0	131	58	189	5	11	10	6	16	6	7	3	4	48	18	5	5	6	9	2

23.1	18	47	8	3	1	1	1	1	1	10	2	1	2	1	1	1	5	—	1
23.2	30	59	1	—	1	1	1	1	1	13	6	1	3	1	1	1	—	1	1
23.3	34	67	1	1	1	3	2	1	1	18	4	4	2	—	2	2	2	1	1
23.4	16	37	4	2	—	2	—	—	—	8	6	1	1	—	1	—	—	1	1
23.5	63	92	3	3	—	6	—	—	—	18	9	4	4	—	3	7	—	1	2
23.6	19	38	3	2	—	—	—	—	—	7	7	2	—	—	—	1	1	1	2
23.7	35	64	2	—	—	—	—	—	—	10	8	2	1	—	2	3	1	2	—
23.8	26	59	2	2	—	—	—	—	—	12	1	2	3	—	1	4	4	—	1
23.9	14	43	3	4	—	—	—	—	—	6	4	2	1	—	2	—	—	—	2
23.0	74	113	11	3	—	—	—	—	—	31	14	4	4	—	1	6	—	1	2
23.1	14	24	4	1	—	—	—	—	—	6	3	4	3	—	1	2	3	—	—
23.2	10	23	—	2	—	—	—	—	—	6	1	1	1	—	2	1	1	1	2
23.3	10	28	1	—	—	—	—	—	—	7	3	1	1	—	4	1	1	—	—
23.4	1	6	—	—	—	—	—	—	—	1	1	—	1	—	1	—	—	—	—
23.5	23	30	2	—	—	—	—	—	—	7	1	—	1	—	1	—	—	—	1
23.6	4	11	2	—	—	—	—	—	—	3	2	—	2	—	1	—	—	—	—
23.7	10	15	1	—	—	—	—	—	—	6	—	—	1	—	3	—	—	—	—
23.8	1	16	1	—	—	—	—	—	—	1	—	—	1	—	1	2	—	—	—
23.9	3	14	3	—	—	—	—	—	—	1	—	—	1	—	1	1	—	—	—
24.0	27	44	7	—	—	—	—	—	—	6	4	—	3	—	4	2	—	—	—
24.1	1	2	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
24.2	1	6	—	—	—	—	—	—	—	2	—	—	—	—	2	—	—	—	—
24.3	3	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.4	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.5	7	8	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—
24.6	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.7	3	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.8	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.9	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.0	6	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.3	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	855	717	1672	78	91	86	54	64	48	35	37	37	307	115	85	66	48	58	31

TABLE III.—(continued).
Breadth of Egg.

	RACE			GENRES																
Breadth in mm.	Bay	Latier	Total	Robin	Garden-Warbler	Meadow-Pipit	Wren	Redstart	Sedge-Warbler	Barred-Warbler	Whitethroat	Marsh-Warbler	Red-backed-Shrike	White-Wagtail	Pied-Wagtail	Reed-Warbler	Tree-Pipit	Hedge-Sparrow	Yellow-Ammer	
14.0	—	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
14.5	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
14.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
14.7	1	—	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	
14.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
14.9	—	2	2	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	
15.0	9	2	11	—	—	—	2	2	—	2	—	—	2	1	—	—	—	—	—	
15.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
15.2	3	3	6	1	—	1	1	—	—	—	—	—	—	1	—	—	—	—	—	
15.3	5	6	11	—	—	—	2	—	—	—	1	—	1	—	3	—	—	—	—	
15.4	2	7	9	—	1	—	—	—	2	—	—	—	—	1	—	—	1	—	—	
15.5	22	6	28	1	4	—	5	—	1	2	1	1	2	—	1	1	—	—	1	
15.6	6	11	17	1	—	1	—	—	2	1	1	1	—	3	—	—	—	—	—	
15.7	27	10	37	—	3	3	4	2	3	2	2	1	7	1	1	3	1	1	—	
15.8	16	25	41	1	1	2	1	1	2	1	3	3	5	—	2	—	1	1	2	
15.9	11	34	45	2	1	2	3	—	2	2	—	2	6	2	4	1	—	—	3	
16.0	136	68	204	10	24	2	10	10	4	4	8	3	45	13	8	10	5	3	3	
16.1	15	36	51	1	7	4	1	2	3	1	—	2	5	1	3	5	—	2	2	
16.2	38	64	102	3	6	8	4	4	—	2	2	4	19	4	10	3	3	3	2	
16.3	29	33	62	3	—	4	—	1	2	1	2	3	18	2	5	1	4	2	2	
16.4	22	31	53	3	3	6	2	1	2	—	3	1	12	1	2	1	1	2	1	
16.5	124	34	158	7	8	4	3	14	7	6	4	2	44	16	6	7	6	4	2	
16.6	23	22	45	2	4	2	1	1	1	—	2	2	10	3	3	2	2	2	—	
16.7	45	32	77	2	5	3	1	2	1	2	—	3	20	5	5	2	4	8	2	
16.8	54	38	92	3	6	10	3	2	—	1	—	2	35	1	3	—	3	3	1	
16.9	18	51	69	4	—	6	—	1	1	1	3	2	6	4	8	3	1	3	—	
17.0	128	70	198	7	12	13	4	17	7	4	3	2	34	24	11	11	8	7	7	
17.1	17	38	55	4	2	4	2	1	3	1	—	2	11	2	3	3	2	5	—	
17.2	17	25	42	2	1	3	1	1	1	1	—	1	8	1	3	3	—	2	2	
17.3	15	21	36	4	1	4	1	—	1	—	—	—	4	4	1	3	2	2	1	
17.4	6	7	13	3	—	—	1	—	1	—	—	—	1	2	—	—	—	—	—	
17.5	29	9	38	5	2	1	1	1	—	1	1	—	8	6	1	5	1	4	—	
17.6	6	3	9	—	—	1	—	—	—	—	—	—	—	3	1	—	—	1	—	
17.7	12	7	19	2	—	—	1	1	2	—	—	—	1	6	1	1	—	2	—	
17.8	5	7	12	2	—	1	—	—	—	—	—	—	—	2	—	—	1	1	—	
17.9	4	4	8	—	—	—	—	—	—	—	—	—	—	4	—	1	2	—	—	
18.0	9	4	13	3	—	1	—	—	—	—	—	—	2	1	—	—	—	—	—	
18.1	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
18.2	1	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
18.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
18.8	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
19.2	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Totals	855	717	1572	78	91	86	54	64	48	35	37	37	307	115	85	66	48	68	31	

Of the remaining 332 Cuckoo's eggs the measurements of which are given in the totals: 46 were not classed, 11 were in Reed-Bunting's nests, 17 in Wood-Warbler's, 17 in Linnet's, 14 in Chaffinch's, 4 in Bullfinch's, 14 in various Lark's, 14 in Yellow-Wagtail's, 15 in Blueheaded-Yellow-Wagtail's, 10 in Spotted-Flycatcher's, 15 in Willow-Wren's, 5 in Nightingale's, 15 in Greenfinch's, 20 in Blackcap's, 7 in Whinchat's, 14 in Lesser-Whitethroat's, 6 in Wheatear's nests, and the remainder in numbers of 5 and under in the nests of various other species.

TABLE IV.

	Cuckoo's Eggs in mm.		Foster-Parent's Egg in mm.		Approximate Length of Bird in inches
	Length	Breadth	Length	Breadth	
Robin	22.8	16.8	20.2	15.4	5 $\frac{1}{2}$ —6
Garden-Warbler ...	21.9	16.4	*20.3	16.0	5 $\frac{1}{2}$
Meadow-Pipit ...	22.3	16.6	19.7	14.5	5 $\frac{1}{2}$ —6
Wren	21.4	16.2	*17.7	12.7	3 $\frac{1}{2}$
Redstart	22.4	16.6	*19.0	14.0	5 $\frac{1}{2}$
Sedge-Warbler ...	22.1	16.4	*16.5	14.0	4 $\frac{1}{2}$
Barred-Warbler ...	21.8	16.3	*22.8	15.5	6 $\frac{1}{2}$
Whitethroat ...	21.8	16.2	*19.0	14.2	5 $\frac{1}{2}$
Marsh-Warbler ...	22.1	16.3	*19.0	14.0	5 $\frac{1}{2}$
Red-backed-Shrike..	22.3	16.5	*22.8	16.7	7 $\frac{1}{2}$
White-Wagtail ...	22.4	16.7	*20.3	15.5	7 $\frac{1}{2}$
Pied-Wagtail ...	22.3	16.5	*20.3	15.2	7 $\frac{1}{2}$
Reed-Warbler ...	22.6	16.6	*17.8	12.7	5 $\frac{1}{2}$
Tree-Pipit	22.6	16.6	20.0	15.1	6 $\frac{1}{2}$ —6 $\frac{1}{2}$
Hedge-Sparrow ...	22.6	16.8	20.0	14.7	5 $\frac{1}{2}$ —6
Yellow-Ammer ...	22.2	16.5	21.5	16.0	6 $\frac{1}{2}$ —7
Cuckoo	22.3	16.5	—	—	14

TABLE V.

Frequency Distributions of Cuckoo's Eggs.

A. With .5 mm. unit of grouping.

Length	Number		Breadth	Number	
	Rey + O. H. L.	O. H. L. only		Rey + O. H. L.	O. H. L. only
18.75—19.25	1	1	13.75—14.25	1	1
19.25—19.75	3	2	14.25—14.75	2	1
19.75—20.25	33	14	14.75—15.25	19	7
20.25—20.75	39	8	15.25—15.75	102	40
20.75—21.25	156	69	15.75—16.25	443	227
21.25—21.75	152	54	16.25—16.75	395	152
21.75—22.25	392	179	16.75—17.25	456	222
22.25—22.75	288	121	17.25—17.75	115	47
22.75—23.25	286	148	17.75—18.25	37	18
23.25—23.75	100	53	18.25—18.75	0	0
23.75—24.25	86	53	18.75—19.25	2	2
24.25—24.75	21	8			
24.75—25.25	12	5			
25.25—25.75	2	1			
25.75—26.25	0	0			
26.25—26.75	1	1			
Totals	1572	717	Totals	1572	717

* Computed from measurements given in inches by W. J. Gordon in *Our Country's Birds*.

B. With 1 mm. unit of grouping.

Length	Number			Breadth	Number		
	Rey + O. H. L.	Rey only	O. H. L. only		Rey + O. H. L.	Rey only	O. H. L. only
18·75—19·75	4	1	3	13·75—14·75	3	1	2
19·75—20·75	72	50	22	14·75—15·75	121	74	47
20·75—21·75	308	185	123	15·75—16·75	838	459	379
21·75—22·75	680	380	300	16·75—17·75	571	302	269
22·75—23·75	386	185	201	17·75—18·75	37	19	18
23·75—24·75	107	46	61	18·75—19·75	2	0	2
24·75—25·75	14	8	6				
25·75—26·75	1	0	1				
Totals	1572	855	717	Totals	1572	855	717

prejudice in favour of the half and whole millimetres may have tended to obscure some of the points involved and renders it difficult to deal satisfactorily with the distribution of frequency. The multimodal character of the previous distributions (see *Biometrika*, Vol. I. pp. 175 and 176) was chiefly due to the manner in which this emphasis of certain values upset the grouping. Admitting the defect the only legitimate grouping is that which takes an entire millimetre as its unit, but this is very coarse, especially in the case of the breadths, for the purpose of drawing any conclusions. In Table V. B the frequencies are given with 1 mm. unit of grouping and we see that the .5 mm. modes have disappeared, but the grouping is very coarse. Working, however, from these we find:

TABLE VI.

Authority	Mean in mm.		Standard Deviation in mm.	
	Length	Breadth	Length	Breadth
Rey	22·266	16·559	·8450	·5955
O. H. L. ...	22·486	16·613	·9546	·6021
Total ...	22·366	16·583	·9557	·5992

An examination of this table seems to indicate that the English Cuckoo's egg is for both dimensions slightly larger and more variable than the German. The difference, however, is not such that we can lay any stress upon it, and in round numbers we may certainly take:

Length of egg 22·4, Breadth 16·6, standard deviation of Length = ·96 and of Breadth = ·60.

The following results were obtained by calculating the normal curves for four sets of frequencies*:

* The determination of P , the goodness of fit, from χ^2 has been made by aid of Palin Elderton's Tables, *Biometrika*, Vol. I. p. 169.

Length				Breadth			
Rey		Latter		Rey		Latter	
Obs.	Calc.	Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
1	3.32	3	1.49	—	—	—	—
50	43.14	22	23.27	1	1.01	2	0.71
185	203.66	123	133.24	74	73.43	47	53.44
380	344.74	300	278.73	459	460.36	379	369.01
185	210.39	201	213.77	302	300.75	269	272.68
46	46.06	61	59.16	19	19.35	18	21.02
8	3.57	6	7.11	0	.10	2	0.14
0	.10	1	0.23	—	—	—	—
$\chi^2=16.36$ $P<.025$		$\chi^2=8.09$ $P=.325$		$\chi^2=.62$ $P>.99$		$\chi^2=28.59$ $P<.00004$	

The odds are thus more than 40 to 1 against Rey's lengths of eggs fitting a normal distribution. But only once in 100 random samples of 855 eggs should we expect a better result than we have got for the breadths, if the distribution be really normal. Turning to the 717 measurements we find the length distribution reasonable on the basis of a normal curve; once in every three random samples of 717 eggs we should get a worse result, but the breadths are quite impossible. This impossibility arises, however, entirely from the two giant breadths of 18.8 and 19.2. They are undoubtedly abnormalities and if they be excluded, the fit is a good one, i.e. about 55 samples in 100 would give a worse result. With regard to Rey's length distribution the sources of improbability are seen on analysis to be (a) the crowding up of seven eggs on 25.0 mm., (b) of 131 eggs on 22.0, and (c) of 63 on 22.5 mm. These contribute more than half the value of χ^2 ! In other words there is little reason to doubt that the variability in length of Cuckoo's eggs would follow a normal curve, were it not for Rey's tendency to heap up observations on the .5 and .0 millimetre groups*. It does not therefore seem worth while pursuing the distribution of variability further on the present observations. We see that it is quite possible that the normal curve would really suffice to describe the frequency. On the other hand, if the *gentes* theory be considered as established, we should naturally expect the heterogeneity to show itself in some deviations from any smooth curve of frequency.

In conclusion I must gratefully acknowledge the generous assistance of Prof. Karl Pearson in the preparation of this paper and in the statistical examination of the measurements obtained: indeed without his aid I should have been quite unable to perceive their significance, nor would this paper have been written.

* The evil of this heaping up may be easily seen if we take the first group 19.05–20.05 instead of 18.75–19.75 still grouping by mm. The mean will now be found to be 22.10 and the standard deviation 1.0014 instead of 22.27 and .9450 respectively!