THE EGG OF CUCULUS CANORUS.

AN ENQUIRY INTO THE DIMENSIONS OF THE CUCKOO'S EGG AND THE RELATION OF THE VARIATIONS TO THE SIZE OF THE EGGS OF THE FOSTER-PARENT, WITH NOTES ON COLORATION, &c.

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Introductory.

THE present paper is the outcome of an examination of 44 Cuckoo's eggs in the collections at the Charterhouse Museum. The results of this preliminary investigation were communicated to the Congress of South Eastern Natural History Associations, held in the summer of 1901 at Haslemere, under the auspices of the Haslemere Microscope and Natural History Society, of which I have the honour to be a member. Finding that 44 was far too small a number of eggs for my purpose I extended the series of measurements by including a large number obtained at the British Museum of Natural History, S. Kensington, and I may here take the opportunity of expressing my thanks to the Director, Prof. Ray Lankester, and Mr Ogilvie Grant for granting me permission to examine the fine series under their care, and also to Mr Baldwin Young of Sheffield, who kindly supplied measurements of six Cuckoo's eggs in his possession. The total number of Cuckoo's eggs measured and included in this enquiry is 243, of which 223 were known to have been deposited in the nests of 42 different species of birds, while the foster-parents of the remaining 20 were not ascertainable; these 20 have not been excluded from the calculations, for their effect upon the value of mean length and breadth is practically negligible. In dealing with coloration, a further 45 which were not accessible for purposes of measurement have been included, bringing the total to 288. All measurements were taken with sliding

callipers reading to millimetres, the decimal parts of a millimetre being estimated by eye aided with a strong lens. The dimensions measured are greatest length and greatest breadth.

It has been established by many observers that the female Cuckoo lays her egg upon the ground and then taking it in her beak puts it into the nest of the foster-parents of her offspring. An explanation is needed of the success which attends this imposition. Are the foster-parents deceived either by similarity of colouring or of size into fancying the Cuckoo's egg to be one of their own? or are they indifferent to these qualities? or are some small birds more expert than others in detecting fraud?

The theory which finds more favour than others is that put forward by Prof. A. Newton (*Dictionary of Birds*, p. 123); who, after mentioning the history of speculation on the matter, writes as follows:—"Everyone who has sufficiently studied the habits of animals will admit the tendency of some of these habits to become hereditary. That there is a reasonable probability of each Cuckow most commonly putting her eggs in the nest of the same species of bird, and of this habit being transmitted to her posterity, does not seem to be a very violent supposition. Without attributing any wonderful sagacity to her, it does not seem unlikely that the Cuckow which had once successfully foisted her egg on a Reed-wren or a Titlark should again seek for another Reed-wren's or another Titlark's nest (as the case may be).....and that she should continue her practice from one season to another..... Such a habit could hardly fail to become hereditary, so that the daughter of a Cuckow which always put her egg into a Reed-wren's, Titlark's, or Wagtail's nest, would do as did her mother..... and it can hardly be questioned that the eggs of the daughter would more or less resemble those of her mother. Hence the supposition may be fairly regarded that the habit of laying a particular style of egg is also likely to become hereditary..... The particular '*gens*' of Cuckow which inherited and transmitted the habit of depositing in the nest of any particular species of bird eggs having more or less resemblance to the eggs of that species would prosper most in those members of the '*gens*' where the likeness was strongest, and the other members would (*caeteris paribus*) in time be eliminated..... The operation of this kind of natural selection would be most needed in those cases where the species are not easily duped—that is in those cases which occur the least frequently. Here it is we find it, for observation shows that eggs of the Cuckow deposited in the nests of the Red-backed Shrike, of the Bunting, of the Red Start and of the Icterine Warbler approximate in their colouring to eggs of these species—species in whose nests the Cuckow rarely (in comparison with others) deposits eggs."

I must confess that I approached this investigation with decided scepticism as to the validity of Prof. Newton's theory. It is very doubtful whether the Cuckoo is aware that she has "successfully foisted her egg on a Reed-wren" or on any other bird: so far as is known she takes no further interest in the egg—it may

escape detection, it may be ejected. Moreover, the theory seems to demand that male Cuckoos should mate with female Cuckoos reared by foster-parents of the same species, or else that the inherited habits and characters of every female Cuckoo should follow only the female line of descent. For suppose a Reed-wren-reared female Cuckoo to mate with a Robin-reared male Cuckoo, then their offspring might be reasonably expected to inherit some characters from each parent and to possess mixed tendencies, some urging them to lay in Robins' nests and others in those of Reed-wrens, and, unless inheritance run only in the female line (or mating taking place only between individuals of like foster-parentage), the tendencies would get further mingled in each succeeding generation. This criticism appears to me to apply with equal force to Reh's theory of the intuitive selection of the nests of the species by which the Cuckoos themselves were reared. Further, there is very little, if any, evidence in support of the operation of natural selection in eliminating eggs that do not match those of the clutch into which they have been introduced. I have not come across any record of such badly-matched Cuckoo's eggs having been found ejected from the nest. Lastly, it is very difficult to conceive how perfection of colour-matching can have arisen by natural selection with relatively few opportunities for the working of this force; and, if the case be as Prof. Newton states, I certainly should have expected to find a large number of Cuckoo's eggs in the nests of those birds whose eggs had at length been so admirably copied.

Size-Matching.

In spite of these criticisms I am compelled by the results of my investigations to admit that I now believe Professor Newton's theory to be in the main correct: I will return to this point later. It will be seen by the appended summary of results and tables of measurements that the mean length (22·40 mm.) and mean breadth (16·54 mm.) of 243 Cuckoo's eggs are respectively greater than the mean lengths and breadths of the eggs of any of the four species [viz. *Anthus pratensis*, the Meadow Pipit; *Anthus trivialis*, the Tree Pipit; *Accentor modularis*, the Hedge Sparrow, and *Erithacus rubecula*, the Robin], of whose eggs I was able to measure a reasonable number. The range of length extends from 19·1 mm. to 25·0 mm.; that of breadth from 14·0 mm. to 18·8 mm.: the standard deviation (σ) of length being 1·058, and the coefficient of variation (C. of V.) of length 4·72, those of breadth being respectively 0·6496 and 3·93. Of the four species which serve as foster-parents and are here dealt with, the Meadow Pipit alone exceeds the Cuckoo in degree of variation, but it must be remembered that the number of measured eggs of Robins and other species is very much less than in the case of the Cuckoo, so that it is quite possible that the Cuckoo does not differ greatly from other birds in this respect*. It is however interesting to note that in

* Further, the Cuckoo's eggs were probably laid by about 200 separate hens, while the 74 Meadow Pipit's eggs, for example, are formed by 20 clutches or due to 20 hens only.

each of the five species length of egg is a far more variable dimension than breadth: this is probably due to uniformity of diameter of the oviduct, and it may also be of importance to the comfort of the female bird during the period of incubation, for an egg projecting far above its fellows in consequence of greater breadth would probably inconvenience the sitter.

My enquiry has thus resolved itself chiefly into an attempt to ascertain (1) 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; (2) if the same eggs depart from the rest in such a direction as to approximate in size to the eggs of that particular species of foster-parent. The method employed is to find the mean (M) length or breadth, as the case may be, thence to compute the standard deviation (σ) 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: and then to find $\frac{100\,\sigma}{M}$, the coefficient of variation. To test whether any deviation is significant, M_r is taken as the mean of the whole race of Cuckoos and M_s the mean of Cuckoo's eggs found in the nest of any one species of foster-parent: the standard deviation (σ_s) of such eggs is also ascertained. The value of $M_r - M_s$ is then compared with that of $0{\cdot}67449\sqrt{\frac{\sigma_r^2}{n_1} + \frac{\sigma_s^2}{n_2}}$, 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 1·5 to 3 times as great as the value of the other expression the difference of M_r and M_s is not definitely significant. Referring now to the tabulated summary below, it will be seen that in the matter of length, the eggs of Meadow-Pipit-Cuckoos (to coin a convenient phrase), of Wagtail-Cuckoos (this includes all species of Wagtails, for their eggs are very similar), and of Robin-Cuckoos, do not differ significantly from those of the whole race of Cuckoos, but those of Hedge-Sparrow-Cuckoos, Tree-Pipit-Cuckoos and of Wren-Cuckoos certainly do present differences marking them out as distinct sets. On the other hand in the matter of breadth the differences are significant in the cases of Meadow-Pipit-Cuckoos, Hedge-Sparrow-Cuckoos and Wren-Cuckoos. It therefore seems highly probable 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 each to its own particular variety of foster-parent. Breadth, as I have already pointed out, seems more likely than length to be a disturbing factor in the nest of the foster-parent if it in any marked way depart from the normal, and it is very remarkable to note how very low are four of the values of σ_s in the breadth tables, viz. 2·28 (Meadow-Pipit-Cuckoo), 2·58 (Wagtail-Cuckoo), 2·65 (Tree-Pipit-Cuckoo), 1·92 (Wren-Cuckoo).

Next, as to whether these sets differ from the main body in the sense of the particular species of foster-parent. In the Wren-Cuckoos this is so beyond

Summary.

Species	Number of Eggs	Mean (M)	Standard Deviation (σ)	Coefficient of Variation	Significance Test (Ratio of difference to its probable error)
Length in millimetres					
Cuculus canorus	243	22·4	1·0585	4·72	
C. canorus-Anthus pratensis (Meadow-Pipit-Cuckoo) ...	45	22·3	0·8933	4·00	difference not significant (1·1)
Anthus pratensis	74	19·7	1·2504	6·37	
C. canorus-Accentor modularis (Hedge-Sparrow-Cuckoo) ...	14	23·1	1·0116	4·37	difference *significant* (3·71)
Accentor modularis	26	20·0	0·8096	4·02	
C. canorus-Erithacus rubecula (Robin-Cuckoo)	16	22·5	0·6628	2·50	difference not significant (1·25)
Erithacus rubecula	57	20·2	0·8565	4·24	
C. canorus-Motacilla, sp. 4 (Wagtail-Cuckoos) ...	26	22·6	0·8783	3·88	difference not significant (1·25)
Wagtails estimated	—	19·9			
C. canorus-Anthus trivialis (Tree-Pipit-Cuckoo) ...	15	23·1	0·8504	3·68	difference *significant* (4·5)
Anthus trivialis	27	20·0	0·6978	3·489	
C. canorus-Troglodytes parvulus	15	21·1	0·7558	3·58	difference *significant* (9·3)
Troglodytes parvulus ...	Estimated from W. J. Gordon	17·7			
Breadth in millimetres					
Cuculus canorus	243	16·5	0·6496	3·93	
C. canorus-Anthus pratensis (Meadow-Pipit-Cuckoo) ...	45	16·7	0·3815	2·28	difference *significant* (3·4)
Anthus pratensis	74	14·6	0·5611	3·84	
C. canorus-Accentor modularis (Hedge-Sparrow-Cuckoo) ...	14	16·8	0·5161	3·07	difference *significant* (2·4)
Accentor modularis	26	14·7	0·4146	2·81	
C. canorus-Erithacus rubecula (Robin-Cuckoo)	16	16·4	0·5326	3·24	difference not significant (·96)
Erithacus rubecula	57	15·4	0·4771	3·09	
C. canorus-Motacilla, sp. 4 (Wagtail-Cuckoos) ...	26	16·6	0·4389	2·58	difference not significant (·93)
Wagtails estimated	—	14·9			
C. canorus-Anthus trivialis (Tree-Pipit-Cuckoo) ...	15	16·6	0·4397	2·65	difference not significant (·75)
Anthus trivialis	27	15·1	0·4488	2·97	
C. canorus-Troglodytes parvulus	15	15·8	0·3042	1·92	difference *significant* (12·3)
Troglodytes parvulus ...	Estimated from W. J. Gordon's "Our Country's Birds"	12·7			

doubt. Unfortunately I had not material sufficient to determine trustworthy means of length and breadth of Wren's eggs, but I have estimated them from measurements given *in inches* by W. J. Gordon in *Our Country's Birds*, and feel confident that no error of any importance exists in his figures, for the measurements given by him of other species' eggs approximate very closely with the means obtained by myself in each case. It will be seen that the egg of the Wren is far smaller than that of any other species with which we are dealing, and that the lengths and breadths of Wren-Cuckoos' eggs are very much less than those of other Cuckoos. For the other species where the differences are significant this sense of the variation is not clear so far as it concerns breadth, though it appears to be so in the matter of length: the two subjoined tables give the comparison.

Mean Length			
Hedge-Sparrow-Cuckoo	23·1	Hedge-Sparrow ...	20·1
Tree-Pipit-Cuckoo ...	23·1	Tree-Pipit	20·0
Meadow-Pipit-Cuckoo	22·3	Meadow-Pipit... ...	19·7
Wren-Cuckoo	21·1	Wren	17·7

Mean Breadth			
Hedge-Sparrow-Cuckoo	16·8	Tree-Pipit	15·1
Meadow-Pipit-Cuckoo	16·7	Hedge-Sparrow ...	14·7
Tree-Pipit-Cuckoo ...	16·6	Meadow-Pipit... ...	14·6
Wren-Cuckoo	15·8	Wren	12·7

Colour-matching.

As already stated, 288 Cuckoo's eggs were examined in this connection and compared with the eggs among which they had been deposited. In 39 cases the matching was extremely close, and in a further 109 there was a fair approximation, rendering the Cuckoo's egg more or less similar in appearance to those of the foster-parent, the two categories giving a total of 148 eggs more or less closely matched to their several clutches, or at any rate within the limits of colour-variations exhibited by the species in question. Reh has observed this last same phenomenon in nests of the Red-backed Shrike (*Lanius collaris*), and eggs of this description possess an especial interest, for they seem to afford very strong support to Prof. Newton's theory. It is a fairly frequent occurrence to find in the nests of birds whose eggs exhibit considerable variation of colour, e.g. Meadow-Pipit, Tree-Pipit and Reed-Warbler, a Cuckoo's egg, not resembling the particular clutch in which it occurs but which would match eggs of another clutch of the same species. On the other hand, I found but three instances of Cuckoo's eggs with a close resemblance to eggs of any one species being deposited elsewhere than in the nests of that species, viz. egg No. 152 found in nest of Lesser Whitethroat is a good match to a Meadow-Pipit's eggs; No. 173 in nest

of Chaffinch matches Wagtail's eggs; No. 187 in Nightingale's nest matches House-Sparrow's (very variable) eggs.

Colour-matching.

Good		Not matched nor within limits of colour-variation of egg	
11	Meadow-Pipit	17	Wren
7	Wagtails	19	Hedge-Sparrow
6	Orphean-Warbler	11	Robin
4	Garden-Warbler	12	Yellow-Ammer
3	Red-Start	13	Reed-Warbler
1	Robin	4	Garden-Warbler
1	Sedge-Warbler	6	Meadow-Pipit
1	Barred-Warbler	4	Tree-Pipit
1	Aquatic-Warbler	5	Willow-Warbler
1	Whitethroat	5	Greenfinch
1	Wheatear {sp. Saxicola melanoleuca	4	Chaffinch
1	Pied-Flycatcher	4	Linnet
1	Hedge-Sparrow	3	Pied-Wagtail
		2	Blackcap
Total 39		2	Red-Start
		2	Lesser-Whitethroat
		2	Nightingale
		2	Wood-Warbler
		2	Spotted-Flycatcher
		2	Sedge-Warbler
Fair, or within limits of colour-variation of egg of species		2	Red-backed-Shrike
		1	Woodchat-Shrike
45	Meadow-Pipit	1	Rock-Pipit
19	Wagtails	1	Sky-Lark
11	Tree-Pipit	1	Crested-Lark
7	Reed-Warbler	1	Goldfinch
6	Robin	1	House-Sparrow
5	Blackcap	1	Common-Bunting
4	Whitethroat	1	Cirl-Bunting
2	Marsh-Warbler	1	Great-Reed-Warbler
2	Sedge-Warbler	1	Marsh-Warbler
2	Red-backed-Shrike	1	Grasshopper-Warbler
1	Lesser-Grey-Shrike	1	Dartford-Warbler
1	Lesser-Whitethroat	1	Barred-Warbler
1	Tree-Sparrow	1	Wheatear
1	Common-Bunting	1	Orphean-Warbler
1	Sky-Lark	1	Chiffchaff
1	Crested-Lark	1	Fire-Crested-Wren
Total 109		Total 140	

The appended table of colour-matching gives in a concise form the more important numerical facts. The total number of successes, complete or partial, in colour-matching is so great, nearly 51·4% of the whole series examined, that mere chance is impossible as an explanation. Moreover, the accuracy with which highly remarkable Cuckoo's eggs are deposited in appropriate clutches is so

striking as to tempt one to dally with conscious selection and deliberate choice on the part of the female Cuckoo: for instance, six blue Cuckoo's eggs occur in the series, of these three were in Red Starts' nests (Nos. 155, 158, and one not accessible for measurement), one (No. 159) in nest of *Saxicola melanoleuca*, and two others (not accessible) in nests of Hedge-Sparrow and Pied-Flycatcher. All these birds lay blue eggs, and so far as my observations go, blue Cuckoo's eggs are not deposited elsewhere, though Howard Saunders's statement (*Manual of British Birds*, p. 288) that "these, (sc. blue eggs), have not been invariably located in nests of the Hedge-Sparrow and the Red Start" leads me to suppose that they may have been found in the nests of birds whose eggs are not blue. Again, the egg of the Orphean Warbler is of a very distinct type, and yet in six cases out of seven the Cuckoo's egg deposited in the nest of this species resembles this type to a nicety, nor is this particular variety of Cuckoo's egg to be found in any other nest.

	Matched more or less	Not matched	Total	Percentage matched
Meadow-Pipit ...	56	6	62	90·3%
Wagtails... ...	26	3	29	89·6%
Hedge-Sparrow....	1	19	20	5·0%
Robin	7	11	18	38·8%
Reed-Warbler ...	7	13	20	35·5%
Tree-Pipit ...	11	4	15	73·3%
Wren	0	17	17	0·0%
Yellow-Ammer ...	0	12	12	0·0%
Garden-Warbler	4	4	8	50·0%
Orphean-Warbler	6	1	7	85·7%

Perhaps the most striking point in connection with colour-matching is its entire absence from the eggs of Wren-Cuckoos, which, though closely resembling one another, in no case match those of the Wren itself. The Wren is the only bird of those dealt with in this paper that constructs a nest of such a character as to render a view of the eggs impossible alike to the Wren and the Cuckoo; hence failure in colour-matching cannot possibly reveal the intruder to the lawful owner and discrepancy in size becomes of more importance. It is very remarkable that, in both length and breadth, as already pointed out, the eggs of Wren-Cuckoos show a far wider variation from the average Cuckoo and in the direction of the Wren's egg than is the case with any other species. It is too a well known fact that the Wren is peculiarly intolerant of interference with her nest—at any rate at the hands of human beings.

To sum up, we note that there are three cases of practically no colour-matching, the Hedge-Sparrow-Cuckoo, the Wren-Cuckoo and the Yellow-Ammer-Cuckoo; in the first two of these cases there is an attempt both as to length and breadth at size-matching. In the third case no significant size-difference is to be found from our data, but these are too scant to be really conclusive.

In spite then of the criticisms expressed above and of the absence of actual

evidence of the ejection of Cuckoo's eggs by small birds, I feel compelled to admit that there is a selective process at work, tending, in many cases, to bring the Cuckoo's eggs into agreement with those of the host both in size and colour, and am inclined to suggest that perhaps there may be *local* "gentes" of Cuckoos which as a rule, but by no means exclusively, patronise the nests of particular species. It seems well established (1) that a Cuckoo returns every year to the same locality, and (2) according to Reh, lays its eggs only in the nests of that particular species which it, or its ancestors, happen to have adopted for that purpose, while the coloration of the egg of every female Cuckoo is peculiar to itself. The evidence that my material furnishes on these points is as follows:—the Cuckoo's eggs in the South Kensington Collection from any one locality frequently exhibit strong resemblances *inter se*, e.g. (*a*) Nos. 107, 108, 109 (Robin-Cuckoo), 180 (Greenfinch-Cuckoo), 189 (Spotted-Flycatcher-Cuckoo), and 61 (Meadow-Pipit-Cuckoo), all taken at Churt in the year 1860, are all so closely similar that they may well be from one and the same bird; (*b*) Nos. 25 and 26 (Meadow-Pipit-Cuckoo) from Lochend, but not dated; (*c*) Nos. 34 and 35 (both in same nest of Meadow-Pipit) from S.W. Lancashire, dated June 29, 1866, and 33 (Meadow-Pipit-Cuckoo) from N.W. Cheshire, dated 25 May, 1866, and all three collected by H. E. Smith; (*d*) No. 193 (Red-backed-Shrike-Cuckoo, June, 1863), 110 (Robin-Cuckoo, June, 1863), 195 (Skylark-Cuckoo, May, 1862), 181 (Greenfinch-Cuckoo, 1864), 243 (Linnet-Cuckoo, June, 1864), and 168 (Yellow-Ammer-Cuckoo, June, 1864), all coming from Churt, and (*e*) Nos. 225—236 (Wren-Cuckoo), Pomerania, 1879, 1880 and 1881, exhibit the same phenomenon in their several sets. But it is to be observed that eggs of the same coloration are not confined to the nests of any one species of foster-parent, except in (*c*) and (*e*). Again, eleven nests contained two Cuckoo's eggs apiece, viz. Nos. 28 and 29, 34 and 35, 36 and 37, 38 and 39, and two others not accessible for measurement, all in Meadow Pipits' nests, 139 and 140 in Orphean Warblers', 210 and 211 in Pied Wagtails', 214 and 215, 217 and 218 in Pied Wagtails', and 145 and 146, 147 and 148 in Reed Warblers', and in each case the two eggs are obviously laid by the same parent. Reh mentions the fact that in 1893 within two kilometres from Leipzig no less than 70 nests were found containing Cuckoo's eggs, and of these, 58 (83 %), were in nests of Red-backed Shrike. It seems possible then that in any given locality a majority of the Cuckoos may favour some one particular species of foster-parent, and if this be so the chances of male and female Cuckoos of like rearing mating together are very largely increased, and the difficulty raised in a preceding passage is to some extent removed. It is however evident that the isolation of "gens" from "gens" is not perfect, and this may perhaps be accounted for by occasional matings between birds of unlike foster-parentage and the offspring inheriting mixed tendencies.

In conclusion I must acknowledge my great indebtedness to Professor Karl Pearson for the interest he has taken in this investigation and for much kind advice and assistance in the statistical portions.

APPENDIX I. *Cuckoo* (*C. canorus*). *Length of Egg in millimetres.*

(The names of species refer to the nest in which the eggs were found.)

Clutch Unknown

1. 22·5
2. 20·1
3. 23·3
4. 22·9
5. 23·1
6. 22·0
7. 22·3
8. 23·6
9. 24·7
10. 23·7
11. 24·0
12. 20·4
13. 21·3
14. 22·0
15. 24·2
16. 21·7
17. 21·0
18. 20·1
19. 21·9
20. 21·9

Meadow-Pipit

21. 21·7
22. 22·6
23. 20·9
24. 21·6
25. 22·2
26. 22·5
27. 22·2
28. 24·3
29. 22·3
30. 22·6
31. 20·1
32. 22·0
33. 22·8
34. 22·0
35. 22·4
36. 22·3
37. 20·6
38. 22·1
39. 21·9
40. 23·0
41. 22·0
42. 22·0
43. 22·1
44. 22·0
45. 19·6
46. 22·8
47. 22·0
48. 23·4
49. 23·8
50. 23·3
51. 22·5
52. 22·3
53. 21·9
54. 22·0
55. 21·7
56. 23·3
57. 22·2
58. 22·3
59. 22·8
60. 22·9
61. 23·7
62. 22·0
63. 21·9
64. 22·2
65. 24·4

Tree-Pipit

66. 22·7
67. 23·3
68. 24·0
69. 23·6
70. 22·1
71. 21·8
72. 21·1
73. 23·4
74. 23·8
75. 23·3
76. 24·0
77. 23·5
78. 23·2
79. 24·0
80. 22·4

Rock-Pipit

81. 23·9

Hedge-Sparrow

82. 22·0
83. 23·9
84. 20·9
85. 23·8
86. 25·0
87. 24·0
88. 21·7
89. 23·8
90. 22·8
91. 23·1
92. 23·1
93. 23·5
94. 23·0
95. 23·0

Robin

96. 21·8
97. 23·0
98. 23·3
99. 22·4
100. 22·4
101. 23·0
102. 23·0
103. 23·0
104. 23·9
105. 22·3
106. 22·0
107. 22·6
108. 22·0
109. 22·1
110. 21·1
111. 23·0

Blackcap

112. 21·3
113. 19·9
114. 22·9
115. 23·3
116. 22·1
117. 20·9

Whitethroat

118. 21·9
119. 22·9
120. 22·4
121. 19·1

Chiffchaff

122. 20·9

Sedge-Warbler

123. 23·0
124. 21·0
125. 22·0
126. 21·3

Wood-Warbler

127. 22·0
128. 22·0

Willow-Warbler

129. 21·3
130. 21·1
131. 23·1
132. 21·0

Garden-Warbler

133. 23·0
134. 23·1
135. 22·9
136. 23·2

Orphean-Warbler

137. 24·4
138. 21·5
139. 23·3
140. 22·3

Reed-Warbler

141. 23·2
142. 22·0
143. 22·2
144. 21·2
145. 21·6
146. 21·6
147. 21·9
148. 22·0
149. 22·9
150. 22·8

Marsh-Warbler

151. 22·7

Lesser-Whitethroat

152. 21·0
153. 22·5

Barred-Warbler

154. 21·9

Red-Start

155. 24·0
156. 23·2
157. 22·3
158. 23·0

Saxicola-Melanoleuca

159. 23·1

Reed-Bunting

160. 23·2
161. 20·9

Yellow-Ammer

162. 22·5
163. 21·9
164. 22·5
165. 23·3
166. 23·2
167. 23·0
168. 21·1
169. 22·9
170. 23·3

Corn-Bunting

171. 20·1
172. 22·9

Chaffinch

173. 23·3
174. 22·3
175. 22·9
176. 21·2

Goldfinch

177. 20·9

Greenfinch

178. 22·7
179. 22·8
180. 22·1
181. 23·4
182. 21·2
183. 22·5

House-Sparrow

184. 23·9

Tree-Sparrow

185. 24·0

Nightingale

186. 22·8
187. 23·2

Spotted-Flycatcher

188. 22·1
189. 22·4

Lesser-Grey-Shrike

190. 23·0

Woodchat-Shrike

191. 22·0

Red-backed-Shrike

192. 22·1
193. 20·8

Sky-Lark

194. 22·2
195. 21·2

Crested-Lark

196. 22·5
197. 21·1

Pied-Wagtail

198. 23·0
199. 23·4
200. 24·0
201. 23·3
202. 23·1
203. 22·4
204. 21·8
205. 21·8
206. 24·9
207. 24·0
208. 22·1
209. 21·0
210. 22·6
211. 21·9
212. 24·0

White-Wagtail

213. 22·3
214. 22·6
215. 22·0
216. 22·7
217. 22·3
218. 22·5

Blueheaded-Yellow-Wagtail

219. 21·2
220. 22·4

Yellow-Wagtail

221. 22·2
222. 22·2
223. 23·0

Wren

224. 19·8
225. 22·1
226. 21·5
227. 20·9
228. 22·0
229. 21·0
230. 22·3
231. 21·0
232. 20·3
233. 20·9
234. 22·0
235. 20·0
236. 20·8
237. 21·2
238. 21·0

Fire-Crested-Wren

239. 24·2

Wheatear

240. 22·8

Linnet

241. 24·7
242. 24·0
243. 22·9

APPENDIX II. *Cuckoo* (*C. canorus*). *Breadth of Egg in millimetres.*

Clutch Unknown

1. 17·0
2. 14·9
3. 16·0
4. 17·4
5. 17·4
6. 16·5
7. 17·2
8. 17·2
9. 18·0
10. 17·8
11. 18·0
12. 15·0
13. 16·0
14. 16·5
15. 17·3
16. 16·9
17. 16·1
18. 15·8
19. 15·9
20. 16·2

Meadow-Pipit

21. 16·1
22. 17·0
23. 16·2
24. 16·2
25. 16·9
26. 16·9
27. 17·3
28. 16·8
29. 16·8
30. 17·0
31. 16·5
32. 16·9
33. 16·5
34. 17·0
35. 17·0
36. 16·3
37. 16·2
38. 16·8
39. 17·0
40. 16·9
41. 17·0
42. 17·0
43. 17·3
44. 16·8
45. 15·8
46. 17·1
47. 16·9
48. 16·4
49. 16·4
50. 16·8
51. 17·1
52. 17·0
53. 17·1
54. 17·2
55. 16·2
56. 16·7
57. 16·8
58. 16·2
59. 16·4
60. 17·2
61. 17·0
62. 17·2
63. 17·0
64. 16·2
65. 16·2

Tree-Pipit

66. 16·3
67. 16·6
68. 17·0
69. 16·9
70. 16·3
71. 16·7
72. 16·5
73. 16·2
74. 16·3
75. 16·7
76. 17·5
77. 17·3
78. 16·4
79. 17·3
80. 16·0

Rock-Pipit

81. 16·4

Hedge-Sparrow

82. 17·0
83. 16·9
84. 15·8
85. 17·3
86. 17·5
87. 17·5
88. 16·2
89. 16·5
90. 16·2
91. 17·1
92. 16·1
93. 16·9
94. 16·7
95. 17·0

Robin

96. 16·0
97. 15·9
98. 17·1
99. 16·6
100. 16·9
101. 16·1
102. 17·2
103. 16·2
104. 16·9
105. 15·2
106. 16·3
107. 17·0
108. 16·0
109. 16·4
110. 16·4
111. 17·0

Blackcap

112. 16·1
113. 16·0
114. 16·0
115. 16·1
116. 17·8
117. 15·3

Whitethroat

118. 17·0
119. 16·4
120. 16·6
121. 14·0

Chiffchaff

122. 15·3

Sedge-Warbler

123. 16·0
124. 16·1
125. 16·3
126. 16·5

Wood-Warbler

127. 16·2
128. 15·2

Willow-Warbler

129. 15·8
130. 15·8
131. 16·6
132. 16·0

Garden-Warbler

133. 16·2
134. 16·8
135. 16·0
136. 17·0

Orphean-Warbler

137. 17·9
138. 16·0
139. 16·4
140. 16·3

Reed-Warbler

141. 16·9
142. 17·1
143. 17·0
144. 16·1
145. 16·5
146. 16·5
147. 16·1
148. 16·5
149. 17·9
150. 16·5

Marsh-Warbler

151. 16·7

Lesser-Whitethroat

152. 16·0
153. 16·2

Barred-Warbler

154. 16·8

Red-Start

155. 17·7
156. 16·2
157. 16·7
158. 17·0

Saxicola-Melanoleuca

159. 17·1

Reed-Bunting

160. 16·9
161. 15·9

Yellow-Ammer

162. 16·0
163. 16·0
164. 16·1
165. 17·2
166. 16·5
167. 17·0
168. 17·0
169. 17·0
170. 16·8

Corn-Bunting

171. 15·8
172. 17·0

Chaffinch

173. 16·1
174. 16·2
175. 17·3
176. 15·7

Goldfinch

177. 16·0

Greenfinch

178. 14·5
179. 16·7
180. 16·9
181. 17·0
182. 16·2
183. 17·0

House-Sparrow

184. 17·7

Tree-Sparrow

185. 16·0

Nightingale

186. 17·2
187. 16·0

Spotted-Flycatcher

188. 15·8
189. 16·5

Lesser-Grey-Shrike

190. 16·8

Woodchat-Shrike

191. 17·0

Red-backed-Shrike

192. 17·1
193. 15·7

Sky-Lark

194. 18·1
195. 15·6

Crested-Lark

196. 16·4
197. 15·9

Pied-Wagtail

198. 16·3
199. 16·7
200. 17·0
201. 16·3
202. 16·7
203. 16·5
204. 16·0
205. 16·0
206. 16·8
207. 15·8
208. 16·2
209. 17·1
210. 16·0
211. 16·9
212. 17·2

White-Wagtail

213. 16·8
214. 17·0
215. 17·0
216. 16·9
217. 17·3
218. 16·9

Blueheaded-Yellow-Wagtail

219. 15·9
220. 17·2

Yellow-Wagtail

221. 16·7
222. 16·4
223. 16·3

Wren

224. 15·0
225. 16·0
226. 16·2
227. 15·7
228. 16·2
229. 15·5
230. 16·0
231. 15·9
232. 15·5
233. 15·9
234. 16·0
235. 15·7
236. 15·9
237. 16·0
238. 16·0

Fire-Crested-Wren

239. 16·9

Wheatear

240. 16·6

Linnet

241. 16·3
242. 18·8
243. 17·1

APPENDIX III.

Frequency Distribution of Cuckoo's Eggs.

Length	Number	Breadth	Number
18·75—19·25	1	13·75—14·25	1
19·25—19·75	1	14·25—14·75	1
19·75—20·25	7	14·75—15·25	5
20·25—20·75	3	15·25—15·75	9
20·75—21·25	29	15·75—16·25	73
21·25—21·75	13	16·25—16·75	51
21·75—22·25	54	16·75—17·25	80
22·25—22·75	38	17·25—17·75	15
22·75—23·25	47	17·75—18·25	7
23·25—23·75	22	18·25—18·75	0
23·75—24·25	21	18·75—19·25	1
24·25—24·75	5		
24·75—25·25	2		
	243		243

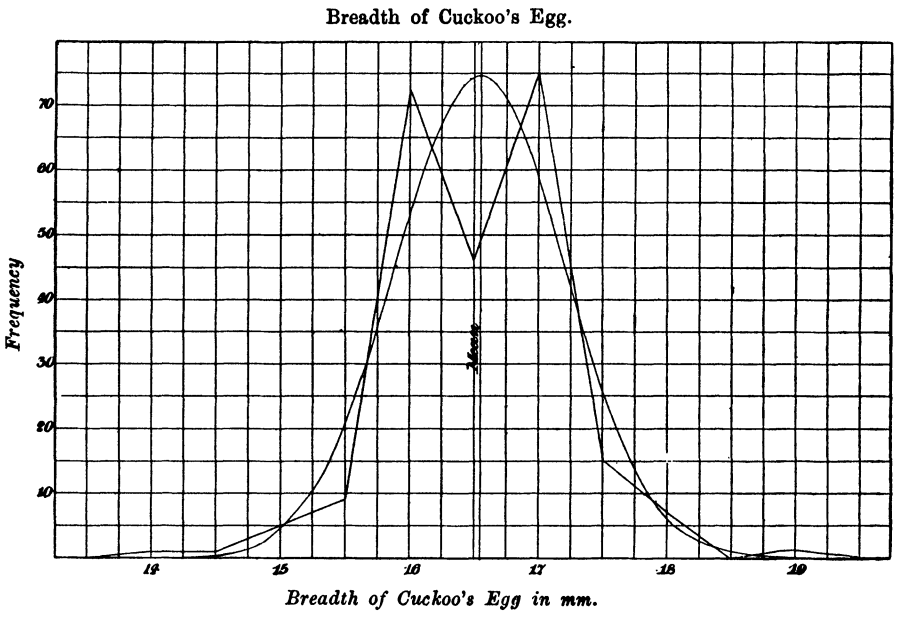
These distributions are fitted with normal curves in the accompanying diagrams.

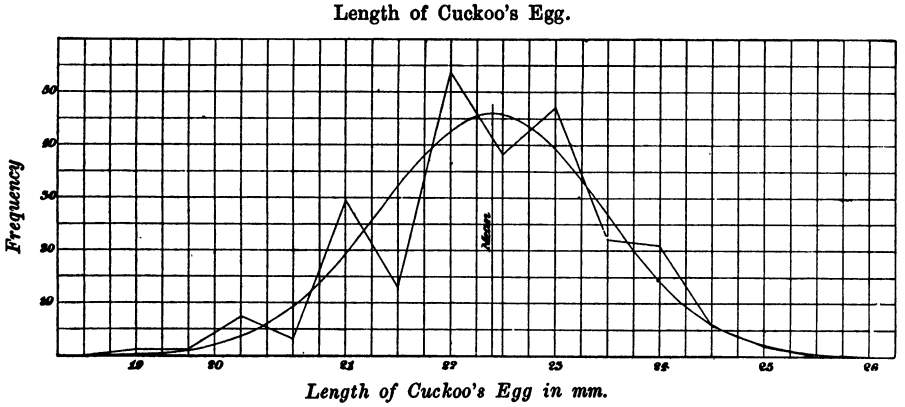
Length $y = 45{\cdot}793\, e^{-\frac{1}{2}x^2/(2{\cdot}117)^2}$.

Origin at 22·40.

Breadth $y = 74{\cdot}618\, e^{-\frac{1}{2}x^2/(1{\cdot}2992)^2}$.

Origin at 16·54.





The curves give fairly reasonable graduated values, considering: (i) the paucity of data, and (ii) the possibility of class differences within the race indicated in this memoir.

APPENDIX IV.

Table of Egg Measurements.

The following is a summary of my measurements on the Cuckoo's and other birds' eggs. I have added the results of recent measurements on the eggs of House-Sparrow, Blackbird, Song-Thrush, Starling and Linnet made by Professor Pearson and some of his co-workers. The whole serves to illustrate the relative smallness of the Cuckoo's egg.

Bird	Approximate length in inches	No. of Cases	Length of Egg			Breadth of Egg		
			Mean	S. D.	C. of V.	Mean	S. D.	C. of V.
Cuckoo ...	14	243	22·40	1·0585	4·72	16·54	·6496	3·93
Blackbird ...	10	114	29·44	1·3568	4·61	21·73	·7874	3·62
Song-Thrush ...	9	151	27·44	·9988	3·64	20·69	·5162	2·50
Starling ...	8—8·5	27	29·78	1·0973	3·68	21·76	·4233	1·94
Wagtail* ...	7—8	16	20·75	1·4448	6·96	14·67	·3703	2·52
Yellow-Ammer	7	32	21·55	·6821	3·17	16·04	·4045	2·53
Tree-Pipit ...	6·5	27	20·01	·6978	3·49	15·09	·4488	2·97
Meadow-Pipit	6	74	19·72	1·2504	6·37	14·56	·5611	3·84
House-Sparrow	6	687	21·82	1·1946	5·47	15·51	·5245	3·38
Hedge-Sparrow	6	26	20·12	·8096	4·02	14·73	·4146	2·81
Robin	6	57	20·22	·8565	4·24	15·43	·4771	3·09
Linnet... ...	5·5—6	65	17·14	·5984	3·49	13·33	·3581	2·69

* This was a mixed series made up of 6 eggs of White-Wagtail, 7 of Pied-Wagtail and 3 of Blue-headed-Yellow-Wagtail. This accounts for the great variability in length. We see that the Cuckoo's egg is the most variable of the whole series in breadth and with the exception of the Meadow-Pipit's and House-Sparrow's the most variable also in length. The biggest of all the birds here dealt with, the Cuckoo has an egg hardly longer than the House-Sparrow's or broader than the Yellow-Ammer's.