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ESTIMATION OF LIME IN THE SHELL AND IN THE INTERIOR OF THE EGG, BEFORE AND AFTER INCUBATION.

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In the egg of the common fowl, the evident purpose of the shell is the protection of the contents, while its porous structure admits of that entrance and exit of air necessary to the development of the chick. Whether it serves also another purpose in supplying calcareous matter for the formation of the skeleton, has, so far as we know, not been made an object of investigation since the days of Prout. In a remarkable memoir[1] published in 1822, that distinguished inquirer says "With respect to the earthy matter found in the skeleton of the chick when it quits the shell, I think I can venture to assert after the most patient and attentive investigation that it does *not pre-exist in the recent egg;* certainly not at least in any known state. The only possible sources, therefore, whence it can be derived, are from the shell, or transmutation from other principles." Prout did not attempt to settle this difficulty because he believed that the differences between the shells of different eggs were too great to allow of the application of averages; and he evidently was inclined to adopt the theory of transmutation, "though I confess myself not bold enough to assert such a theory in the present state of our knowledge."

We venture to think that Prout exaggerated the difficulties of taking a satisfactory average, and that our results shew no necessity to take refuge in the doctrine of transmutation.

Our method was as follows: after destroying organic matter by burning, the lime was dissolved by hydrochloric acid, precipitated as sulphate, in presence of alcohol, dried and weighed.

The chick was secured when fully developed but still within the shell, was assisted to escape, killed without loss of substance and subjected to the same processes as the shell. The membranes were counted a part of the shell and estimated with it. Medium sized eggs

[1] Some Experiments on the changes which take place in the fixed principles of the Egg during incubation. By William Prout, M.D., F.R.S., *Phil. Trans.* 1822, p. 377.

Table of Analyses.

	Amount of $CaSO_4$.		Average.	
	Grammes.	Grammes.	Grammes.	Grammes.
(1) From interior of 6 eggs	·45755		·07525	
From shells of 6 eggs		37·702		6·283
(2) From interior of 6 eggs	·383		·0638	
From shells of 6 eggs		30·521		5·0868
Total amount from interior	·83455			
Average from interior			·0695	
Total amount from shells		68·223		
Average from shells				5·685
(3) From interior of 1 egg	·066		·066	
From shell of 1 egg		5·15775		5·15775
(4) From 2 chickens	·593		·2965	
From shells of 2 chickens		11·822		5·911
(5) From 3 chickens	1·21525		·405	
From shells of 3 chickens		16·17225		5·39075
(6) From 1 chick	·362		·362	
From shell of 1 chick		5·768		5·768
(7) From 1 chick	·3445		·3445	
From shell of 1 chick		5·7195		5·7195
(8) From 5 chickens	2·0765		·4153	
From shells of 5 chickens		24·851		4·9702
Total in chickens (12)	4·59125			
Total in shells		64·33275		
Average in chick			·3826	
Average in shell				5·361
Average loss in shell	·3239			
Average gain in chick	·3131			
Loss not accounted for	·0108			

only were used, those either larger or smaller than the average being rejected.

The results given in the Table of Analyses shew that the average amount of lime in one fully developed chick is five and a half times that found in the interior of one fresh egg. That is, the chick has appropriated the amount of lime contained in ·3131 grammes of $CaSO_4$ more than can be obtained from the interior of one egg. It is probable that in the fourth experiment, where the lime from two chickens was weighed, a portion was lost, so that the figures ·295 grammes as

the weight of one are less than they should be. Had the full weight been preserved, the excess in the chick would be still more evident.

The Table also shews that the loss in the shell is more than sufficient to account for the gain of lime in the chick.

Considering it proven that lime is taken by the chick from the shell, another problem remains to be solved. By what agent is it dissolved and by what course does it traverse the intervening tissues? The membrane immediately surrounding the embryo, the allantois, is delicate and very vascular; but those exterior to this, the lining membranes of the shell, are entirely destitute of blood-vessels, though easily permeated by fluids.

The shell consists chiefly of calcic carbonate, soluble in most acids, neutral salts of the alkalies, etc. Lehmann says, "After fourteen days of incubation, the inner membrane of the shell, the interior parts of the embryo, and, in one case also, the liquor amnii exhibited an acid reaction." To what acid this is due is not stated, but it seems possible that by this means the gradual solution of the lime is effected, and the absorption by osmosis into the vessels of the allantois might take place.

According to Von Baer, ossification takes place chiefly after this time, a few centres appearing on the eighth or ninth, but the majority during the eleventh, twelfth and thirteenth days.

Probably the atmospheric gases which pass freely through the shell and its membranes should be studied in this connection, as calcic carbonate is soluble in some of them under certain conditions.