CIX. GROWTH AND CHEMICAL COMPOSITION OF OVUM OF FUNCTIONING FOWL'S OVARY (*GALLUS DOMESTICUS*).

By ALEXIS LAWRENCE ROMANOFF.

From the Laboratory of Experimental Embryology, Cornell University Agricultural Experiment Station, Ithaca, New York, U.S.A.

(*Received April 24th, 1931.*)

THE rate of growth of the ovum of *Gallus domesticus* was divided by the earliest workers into several more or less distinct periods. His [1868] distinguished by microscopic appearance four periods, while D'Hollander [1904] distinguished, on the basis of nuclear phenomena, three periods. Later Riddle [1916] suggested that there might be only two phases of the growth of the ovum: (1) from primary oöcytes up to 3 mm. in diameter, and (2) from 3 mm. to 6 mm. in diameter. At the end of the second period the rate of growth of the ovum is marked by a rapid deposition of yolk. Within 5 to 8 days the ovum reaches full maturity and is ready for exclusion. The latter period of growth or maturation of the ovum is caused by rapid assimilation of food materials, which constitute the chemical elements of the yolk proper. These chemical elements have probably never been determined quantitatively in successive stages of maturation as well as during the early growth period of the ovum. To throw some light on this problem a series of analyses has been performed.

The ova used were only from White Leghorn hens of known history. The experiments were conducted in the spring months (May and June) when the ovaries of possibly all egg-laying animals are under natural stimulus for egg production [Hoffmann, 1892]. A hen was killed at the time when an egg could be detected in the lower portion (uterus) of the oviduct, to provide uniform conditions in respect to the size of all ova in the examined ovaries. The length of oviducts was found to be on an average 59 cm., which corresponds with the results of Buckner and Martin's [1929] study of laying hens.

The data on the growth of the fowl's ovum are shown in Table I. As already suggested, these indicate growth periods, shown by the weight and shape of the ovum. Riddle [1916] and Stieve [1918] demonstrated that the ovum is almost a spherical body. However, our data on the shape of ova have been obtained by measuring the height (with spherometer) and width (with micrometer) of an ovum laid on a plane surface. The ratio of height to width might therefore be different from that described by the above workers. It is an index of elasticity of the vitelline membrane of the ovum.

Table I. *Growth of fowl's ovum.*

Phases of growth	Series of ova No.	Size of ovum: Average weight g.	Size of ovum: Dry matter content %	Shape of ovum: Height mm.	Shape of ovum: Width mm.	Shape of ovum: Ratio H/W Index
After laying	—	17·650	52·36	14·5	39·0	0·37
Before laying	—	17·076	52·76	16·0	35·5	0·45
Maturation phase	1	15·029	54·54	23·5	32·5	0·72
	2	10·782	53·20	20·5	29·5	0·69
	3	5·572	51·05	17·0	23·5	0·72
	4	2·287	48·15	12·0	17·5	0 69
	5	0·608	39·30	7·5	10·5	0·71
	6	0·250	18·57	6·0	8·5	0·71
	7	0·199	17·60	5·5	7·5	0·73
Second phase of growth	8	0·169	15·18	5·25	7·0	0·75
	9	0·157	14·45	5·0	6·5	0·77
	10	0·144	14·25	4·25	5·5	0·77
	11	0·128	14·12	3·5	4·5	0·78
	12	0·122	13·47	3·25	4·0	0·81
	13	0·115	11·90	3·0	3·75	0·80
	14	0·095	14·43	3·0	3·5	0·86
	15	0·089	13·58	3·0	3·5	0·86
	16	0·083	11·32	3·0	3·5	0·86
	17	0·071	15·31	3·0	3·5	0·86
	18	0·065	13·31	3·0	3·5	0·86
	19	0·063	12·80	3·0	3·5	0·86
	20	0·058	—	3·0	3·5	0·86
	21	0·045	—	3·0	3·5	0·86
	22	0·042	—	2·75	3·25	0·85
First phase of growth	23	0·035	—	2·75	3·0	0·92
	24	0·016	—	2·75	3·0	0·92
	25	0·013	—	2·5	2·75	0·91
	26	0·012	—	2·5	2·75	0·91
	27	0·012	—	2·5	2·75	0·91
	28	0·012	—	2·5	2·75	0·91

This index is noticeably high in small ova, and rapidly declines after ovulation, because the yolk, by absorption of moisture from the surrounding albumin, enlarges in size, becomes watery and thus weakens the elasticity of the vitelline membrane. The percentage of dry matter rapidly increases during maturation, reaching its highest point in a large ovum. Soon after ovulation this value drops to that which is usually found in fresh eggs.

The density of the contents of large ova corresponds with the percentage

Table II. *Chemical composition of fowl's ovum.*

Series of ova	Density $\frac{W_1}{W} D$	Calcium (CaO): Content g.	Calcium (CaO): % of wet weight	Fat (ether extract): Content g.	Fat (ether extract): % of wet weight	Fat (ether extract): Iodine value (Wijs)	Fat (ether extract): Refractive index	p_H
After laying	1·03181	0·412	2·33	5·363	30·38	72·58	1·4685	5·985
Before laying	1·03187	0·410	2·40	5·148	30·15	(71·95)	1·4679	5·968
In ovary:								
1st ovum	1·03448	0·390	2·59	4·294	28·57	73·35	1·4685	5·900
2nd ,,	1·03372	0·208	1·93	3·161	29·32	68·33	1·4675	5·917
3rd ,,	1·03128	0·134	2·40	1·710	30·69	60·95	1·4679	6·027
4th ,,	—	0·091	3·98	0·652	28·51	—	1·4672	6·137
5th ,,	—	0·029	4·77	—	—	—	—	6·289

of dry matter (Table II). The content of calcium, as calcium oxide, gradually increases up to the time of ovulation with a slight change in the percentage composition. Fat (ether extract) content increases but without change in the percentage composition. There is an indication of a slight change in the iodine value, and no change whatsoever in the refractive index. Hydrogen ion concentration shows little if any change.

Conclusions.

The growth phases and particularly the maturation phase of the fowl's ovum are marked by a very rapid increase in the percentage of dry matter, reaching the highest point in a mature ovum.

Calcium and fat contents of the ovum increase proportionately with the advance of maturation.

Density and p_H of ovum, iodine value and refractive index of the extracted fat show only slight changes during the maturation phase.

REFERENCES.

Buckner and Martin (1929). *Amer. J. Physiol.* **89**, 164.
His (1868). Untersuchungen über die erste Anlage des Wirbelthierleibes. Die erste Entwickelung des Hühnchens im Ei (Leipzig).
Hoffmann (1892). *Arch. Neerl. Sci. Nat.* **17**, 168.
D'Hollander (1904). *Arch. Anat. Micr.* **7**, 117.
Riddle (1916). *Amer. J. Physiol.* **41**, 387.
Stieve (1918). *Arch. Entw.-mech. Organ.* **44**, 530.