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Heape, Walter, 1855-1929.
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Publication/Creation

[Cambridge] : [Cambridge University Press], [1908]

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Note on Russo's attempt to show differentiation of sex in the ovarian ova of the Rabbit. By WALTER HEAPE, M.A., F.R.S.,
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[Read 26 October 1908.]

The question as to whether or not the conditions of environment exert influence on the proportion of the sexes produced by an animal is a matter of great interest. I am myself strongly of opinion such is the case and that physical conditions and food especially, that is to say the quality or quantity of food supplied to the mother and her individual capacity for assimilating food and transmitting nutriment to the ovary under varying conditions of metabolism, are factors of importance in determining the proportion of the sexes ultimately produced by all animals in which only a limited number of their ovarian ova come to maturity.

I have dealt with this matter somewhat fully in a forthcoming paper on "the proportion of the sexes amongst whites and coloured people in Cuba"; I would only here add that histological examination supports this view and that it would appear to have a very important bearing, not only on sex ratio but on many other problems concerned with the proportionate production of individuals carrying a variety of other characters.

On the assumption that the female germ cell is possessed of dominant sexuality, it would be of extreme value to discover means by which ovarian ova can be histologically recognised as M. or F. ova.

For this reason the publication of elaborate investigations on the subject by Russo¹ is calculated to excite considerable interest, for he thereby seeks to show: (1) that by means of the introduction of lecithin into the doe rabbit he can profoundly modify the proportion of the sexes produced by her; (2) that he can thereby also demonstrate histologically two kinds of ovarian ova, the one of which he declares to be M. the other F. ova.

So far as the former is concerned, an examination of the tables published by Russo has led my friend Professor Bateson to conclude they are not of statistical value, inasmuch as it would appear the cases recorded are selected cases and do not include all births².

¹ Russo, "Modificazioni sperimentali dell' elemento epitheliale dell' ovaia dei mammiferi," *Atti R. accad. Lincei, Roma*, vol. xvi. 1907; "Metodi adoperati per aumentare artificialmente la produzione del sesso femminile nei conigli," etc. *Rend. d. R. accad. Lincei, Roma*, vol. xvi. 1907; "Sulla origine e sulla funzione dell' apparato mitocondriale nelle cellule sessuali dei mammiferi," *Proc. acad. Gioenia, Sci. Nat. Catania*, 1908.

² Bateson, "Heredity of sex," *Science*, No. 698, vol. xxvii. 1908.

At Prof. Bateson's suggestion I have examined Russo's histological evidence and compared his figures with my own preparations of rabbits' ovaries, with the following result:

Russo's histological methods are, so far as I understand them, specially adopted to enable him to demonstrate the existence of fatty matter in the ovum and surrounding tissue. He describes and figures two kinds of ova; the one in which fat is more or less abundantly evidenced both in the ovum, in the zona radiata and, in some cases, in the surrounding follicular tissue; the other in which no such deposit of fat is seen; and he maintains, as I understand him, that while the former are F. ova, those in which no fatty matter is present are M. ova.

In view of the belief which is very generally held and which I admit I am myself strongly disposed to credit, that females require more nutriment than males for their successful development, this demonstration by Russo deserves special attention.

He figures many ova of different ages, from very young to fully mature ova, in which fatty material is present in varying degree, and it may be that the lecithin he supplied is responsible for some of that fat. But it is I believe known that lecithin is normally present in the yolk of eggs, and we are at once arrested by the query why, if that be so, do certain ova figured by him show no sign of its presence.

He figures two such ova and especially refers to them as M. ova.

The first of these is an ovum lying in the centre of a large follicle surrounded by its discus proligerus. It is drawn on too small a scale to admit of detailed criticism, but there are indications that foreign elements are present among the cells of the discus. I find examples among my own preparations of a similar appearance, and when examined under a higher power it is seen to be due to the presence of leucocytes. I have no doubt whatever that the presence of leucocytes in a follicle is a sure sign of degenerative change, and though I cannot assert Russo's figure is that of a degenerating follicle, it is not free from the suspicion that such is the case, and it is to be regretted he did not give a more detailed drawing of it.

Of the second "male" ovum figured by Russo there can be no such doubt. He calls it a ripe ovum ready to be discharged from the ovary, and it is represented possessed of a nuclear spindle, lying free in a sharply-bounded cavity the cells surrounding which are more or less cubical or flattened. The cavity is either a hole in the discus or the follicular cavity itself, probably the former. The specimen is highly magnified and only a few of these surrounding discus (follicular?) cells are included in the drawing.

Now no such condition is ever seen in the healthy, ripe follicle

of a rabbit's ovary. The discus proligerus cells are always attached to the zona during the growth of the ovum, it is in fact through them that nutriment is conveyed to the ovum. They are at first columnar, becoming more fusiform with the growth of the ovum; as the latter attains maturity they are still further withdrawn until eventually, when maturation takes place, they are exceedingly attenuated, remaining attached to the zona only by fine processes which readily break away when the follicle ruptures, thus permitting the ovum to escape free from them. But in the healthy follicle these cells are always present either as columnar or fusiform cells, never as flattened cells.

The so-called ripe "male" ovum figured by Russo has nothing in common with this condition; it is, in fact, not a ripe ovum, it is an immature ovum lying in a cavity (in the discus) in a degenerate follicle, and I can only suppose he has jumped to the conclusion it is ripe because it possesses a nuclear spindle. But here again he is wholly mistaken; a nuclear spindle, and polar bodies also, are commonly to be found in ovarian ova which, in consequence of degenerative changes, have lost connection with their discus cells; such ova may even exhibit partial segmentation. Unless I am entirely mistaken such premature maturation phenomenon is associated with cessation in the supply of nutriment to the ovum, precisely as in the case of the healthy matured ovum, with its polar bodies, where discus cells have been withdrawn by normal causes and the supply of nutriment thus curtailed or stopped entirely.

It is astonishing that recognition of these facts should have escaped Russo, but it does not seem that he is familiar with various forms and degrees of degeneration commonly met with in the rabbit's ovary. Certain of his figures of female ova are not free from suspicion of degenerate change though it is much less marked in them and is chiefly suggested by the condition of the zona.

I find in my preparations that not infrequently the zona is absorbed, and when that is so the ovum loses connection with the discus cells and degenerates. In some of Russo's figures I judge there is indication of the absorption of the zona, but it is important to note that unless the draughtsman was on the look out for this he might give the impression of degeneracy when perhaps it was not there; the fact that these ova are still amply supplied with fat is evidence that degeneration, if it is in progress, has not gone far.

It is impossible to avoid remarking that of all the ova which must have passed under his observation Russo figures only two which, so far as I can find, he directly refers to as "male" ova; and it is significant that of these two, one is undoubtedly de-

generate and the other suspiciously similar to examples in my possession of an early stage of that condition.

Thus it is with great regret I am obliged to conclude he has not proved what, at first sight, seemed to be such a clear exposition of the correctness of my own belief.

At the same time it is to be noted that the ova he figures which have absorbed lecithin, are represented as having done so in very various degrees. If this be so it is of interest inasmuch as it bears upon the constitutional variability of ova and of the power to affect them, to stimulate or to retard the growth and maturation of certain of them, by means of different foods supplied to the mother. I have elsewhere shown there is an overwhelming mass of evidence in favour of the view that *F.* larvae require more nourishment than do *M.* larvae for their successful development, and that the same relative requirements are probably evinced by ovarian ova of different sexes; it is not impossible then that the variable amount of lecithin in different healthy ova, shown by Russo, may have important bearing on this point.