

Further note on the transplantation and growth of mammalian ova within a uterine foster-mother / by Walter Heape ; communicated by W.H. Gaskell.

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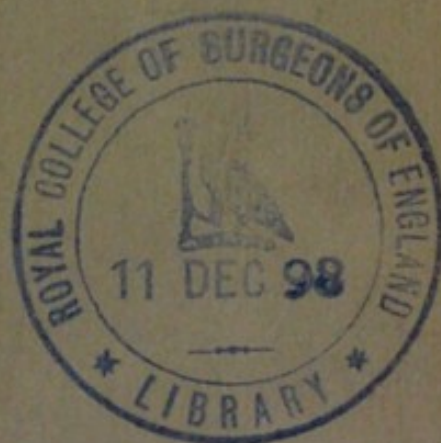
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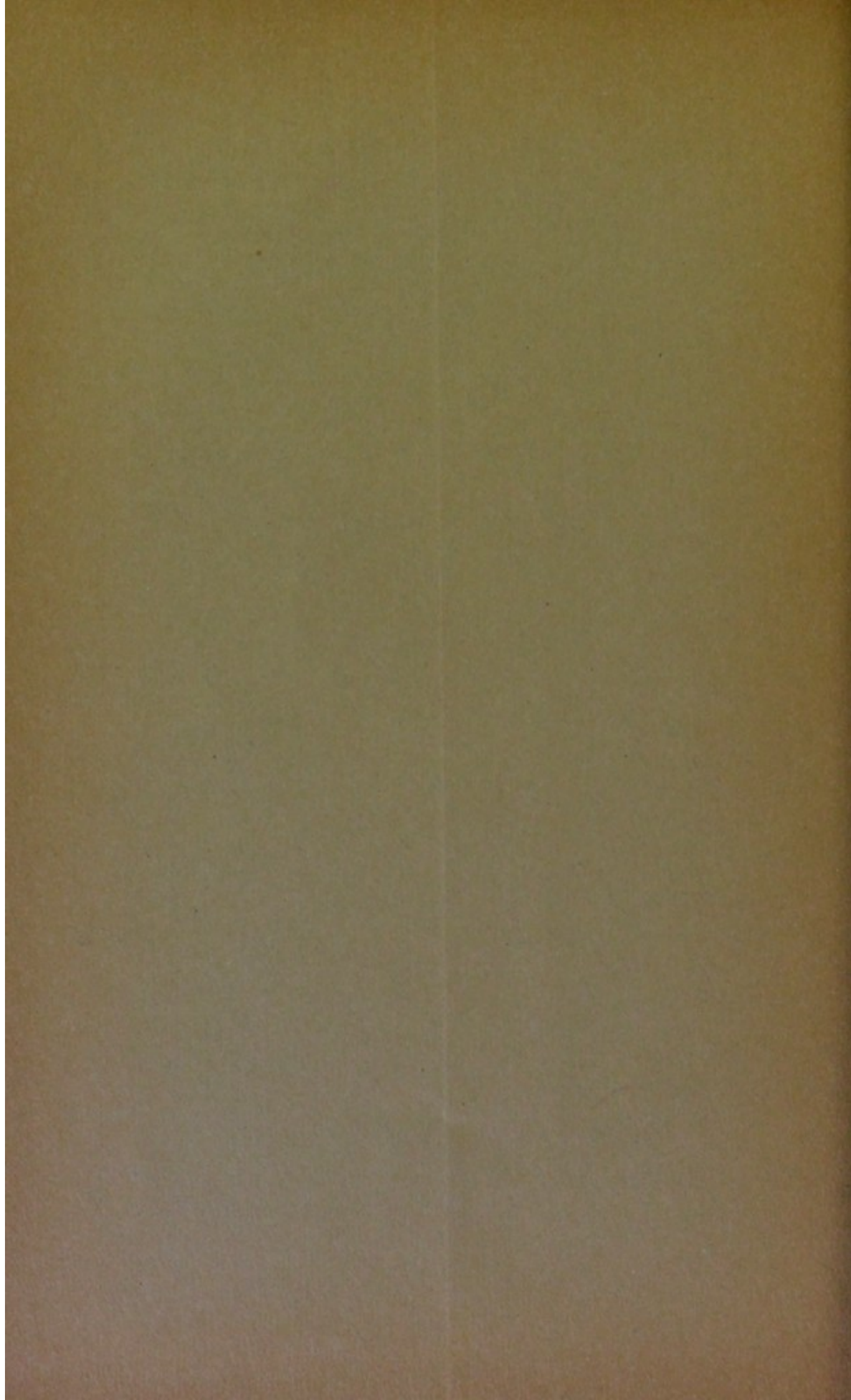
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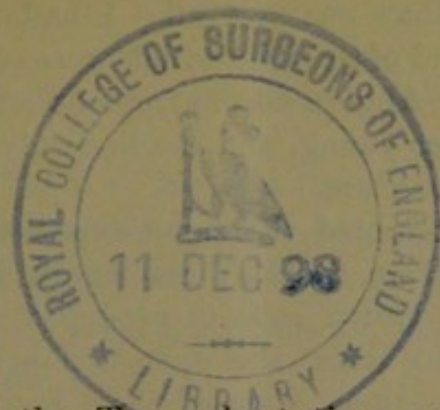
FURTHER NOTE ON THE TRANSPLANTATION AND
GROWTH OF MAMMALIAN OVA WITHIN A
UTERINE FOSTER-MOTHER.



BY

WALTER HEAPE, M.A.





"Further Note on the Transplantation and Growth of Mammalian Ova within a Uterine Foster-mother." By WALTER HEAPE, M.A., Trinity College, Cambridge. Communicated by Dr. W. H. GASKELL, F.R.S. Received November 2,—Read November 25, 1897.

In 1890 I recorded* an experiment designed to show that it is possible to make use of the uterus of one variety of rabbit as a medium for the growth and complete foetal development of fertilised ova of another variety of rabbit.

The experiment was further undertaken in order to determine what effect, if any, a uterine foster-mother would have upon her foster-children, and whether or not the presence, during development, of foreign ova in the uterus of a mother would affect offspring of that mother present in the uterus at the same time. In the experiment above referred to, two fertilised ova were obtained from an Angora doe rabbit which had been inseminated thirty-two hours previously by an Angora buck, and they were inserted into the fallopian tube of a Belgian Hare doe, which had been inseminated three hours before by a buck of the same breed as herself.

In due course the Belgian Hare doe littered six young, four of which were Belgian Hares, while the other two were Angoras. There was no trace of any cross in any of these young, the four Belgian Hares and the two Angoras were true bred.

The experiment seemed to me to show, so far as a single experiment could show, that a uterine foster-mother has no power of modifying the breed of her foster-children, and that her uterus during gestation and the nourishment she supplies to the embryo is analogous to a bed of soil with its various nutrient constituents.

I had hoped to follow this experiment with others on a larger scale the following year, but was unable to make the attempt until 1893. That year I had extraordinary bad luck with my rabbits. I used Angoras and Belgian Hares as before, and out of ten Angora does used, four had no ova in their fallopian tubes after being satisfactorily covered, two had dead ova, and only four produced seg-

* 'Roy. Soc. Proc.,' vol. 48.

menting ova. But that was not all: I had a stock of fourteen Belgian Hare does, and of the four which were operated on to receive the ova from the four Angora does, three of them died under chloroform and only one bore young, and she had only one young one, and that one was a Belgian Hare.

In 1896 I again attempted the same experiment, using this time Dutch and Belgian Hare rabbits; and again I failed, but from a different cause. The Dutch rabbits produced segmenting ova, and the Belgian Hare does stood the operation perfectly satisfactorily, but they were bad breeders. Two of them had only one young one each, one had two, and one six young ones; they were all undoubtedly Belgian Hares.

These Belgian Hare does I had kept for one, some of them for two years, without allowing them to breed, and I am inclined to think that was the reason why they were not so prolific as usual. I considered also that their disinclination to breed might operate adversely on the foreign ova which were introduced, and so check their development.

This year I made five experiments, using again Dutch and Belgian Hare rabbits. The method adopted was the same as that already described. A Dutch doe was covered by a Dutch buck, twenty-four or thirty hours later a Belgian Hare doe was covered by a Belgian Hare buck; the Dutch doe was then killed, and segmenting ova, by this time divided into two or four segments, were taken from her fallopian tube and placed into the open anterior end of the fallopian tube of the Belgian Hare doe.

The operation is a very simple one. The Belgian Hare doe is put under anæsthetics and stretched out on her stomach. A longitudinal incision, 2 in. long, is then made through the skin at a place $1\frac{1}{2}$ to $3\frac{1}{2}$ in. from the anterior edge of the pelvis, and on a level with the ventral border of the lumbar muscles. A smaller incision is then made through the body-wall just ventral to the lumbar muscles, and the anterior end of the fallopian tube is readily found and pulled out through the opening with the help of a pair of forceps. The foreign ova are then taken out of their maternal fallopian tube on the point of a spear-headed needle, the foster-mother's infundibulum is held open with a pair of forceps and the ova placed well within the anterior end of her fallopian tube; after pushing the latter gently back again and washing with some antiseptic solution, the wound is sewn up and dressed with collodion and cotton-wool.

In one case the rabbit died under anæsthetics before the operation began, from heart failure (degeneration), but in the other four cases the recovery was rapid and no discomfort even shown, after the effects of the anæsthetic had worn off.

Of these four experiments, in one case the Belgian Hare doe proved barren; in another she gave birth to eight Belgian Hare

young; in a third she gave birth to eleven Belgian Hare young; while in the fourth case the Belgian Hare doe gave birth to seven young, of which five were Belgian Hares and two were apparently Dutch.

When the young began to run about, I observed that both these Dutch young were irregularly marked, and at first I was inclined to think it was possible, after all, either—

- (1) That the Belgian Hare foster-mother had influenced the Dutch fertilised ova; or
- (2) That these two young were really a cross between Dutch and Belgian Hare.

In order to test the first of these possibilities, I made the following experiment. I put the same Dutch buck which had been used in the foregoing experiment, to a thorough-bred Dutch doe, and she produced a litter every one of which was badly marked, most if not all of them, were as badly marked as the Dutch foster-children, while certain of them were even worse marked.

This Dutch doe I bred myself; she was one of an exceptionally good litter, and I obtained out of her by another buck, the previous year, a very good litter. I have no doubt the bad marking of the young in this last litter is the fault of the buck now being used; he is not well bred. Dutch rabbits frequently have some badly marked young in their litters, even when they are themselves excellently well-bred animals, but the litter described above consists altogether of outrageously badly marked young; in fact most of them could not be recognised as Dutch at all, as far as their marking is concerned.

This experiment therefore shows that the bad marking of the foster-children can be fully accounted for by the fact that their father is badly bred, and it is not necessary therefore to suppose that the foster-mother is the cause of the irregularity.

The second possibility is, however, far more difficult to test, and I do not hold that, under the circumstances attending my experiment, it is possible to determine it quite satisfactorily; at the same time I think a strong case of probability can be made out.

With regard to the possibility of getting a cross between the Dutch buck and the Belgian Hare foster-mother, in consequence of my experiment, it is by no means impossible this should have been done; for it must be remembered that when the foreign Dutch segmenting ova were introduced into the fallopian tube of the Belgian Hare foster-mother, they were still surrounded by spermatozoa from the Dutch buck, spermatozoa that were still alive though perhaps failing in vigour; and numbers of these Dutch spermatozoa, there can be little doubt, were introduced into the foster-mother's fallopian tube along with the Dutch fertilised ova.

Then again the Belgian Hare foster-mother had not ovulated when the operation was performed; ovulation in the rabbit does not take place until about ten hours have elapsed after the act of coition, and the operation was performed one hour or less after coition.

It was quite possible then, that when ovulation did take place, some nine hours later, some Dutch spermatozoa might still be alive and in a condition to fertilise the Belgian Hare ova when they were produced.

But the Belgian Hare doe had been inseminated by a Belgian Hare buck just before the operation; and the spermatozoa from this buck would arrive at the end of the fallopian tube before ovulation took place; this spermatozoa would be at least twenty-four hours younger than the foreign Dutch spermatozoa, and both more vigorous and in far greater numbers than the foreign spermatozoa.

It seems to me that the possibilities are distinctly in favour of the host of younger and more vigorous Belgian Hare spermatozoa beating the comparatively small body of older and less vigorous foreign Dutch spermatozoa, in the struggle for the Belgian Hare ova, but at the same time it is possible the latter won, and that, in the case now under consideration, these two badly marked young are the result of a cross between Dutch spermatozoa and Belgian Hare ova.

The only way to test this at all seemed to be by crossing the same Dutch buck with Belgian Hare does, and comparing the offspring of such crosses with the young foster-children. But even this could not be conclusive proof no matter what result was obtained, for, as is well known to rabbit breeders, although probably the majority of offspring got by crossing two distinct breeds will be of a nondescript character, yet cases continually occur where apparently thorough-bred young, of one breed or the other or perhaps of both breeds, are produced in the same litter together with obvious cross-breeds.

However, I crossed this Dutch buck with two Belgian Hare does and in the first case there were five young, one of which was Belgian Hare purely in colour, two were coloured like a Belgian Hare with white spots or patches here and there, one was black with a couple of white spots, and one was white speckled with the characteristic Belgian Hare brown colour.

In the litter out of the second Belgian Hare doe by this same Dutch buck there were also five young, two of which were of pure Belgian Hare colour, one was a light fawn colour mixed with a bluish dun and with one white shoulder and fore leg, a fourth was a slightly darker shade of the same colour with white fore feet, and the fifth a very light fawn underneath, while somewhat darker on the back and with white fore feet and white dash on the tail.

None of the ten young produced in these two cross-bred litters at

all closely resembled their Dutch father, but three of them were apparently thorough-bred Belgian Hares; it certainly seems that in the case of these animals the Belgian Hare strain is much the stronger of the two; at the same time the father's influence is seen in the very general introduction of white and in the fawn and dun colours of certain of the young.

With regard to the foster-children, one of them unfortunately died at an early age, but the second one lived and is now more typically Dutch than it was when very young. It is coloured like its mother, fawn and white, and has no trace of the bluish dun shade noticeable here and there in its father's coat. Its head, feet, and legs, are remarkably like its mother's, the saddle on the back is fairly well defined, especially on one side, and the main faults are white tips to the ears and patches of white across the fawn colour of the back and sides.

In reviewing the whole question one may claim :—

- (1) That in two litters got by the Dutch buck out of Belgian Hare does, there were ten young ones, not one of which so nearly approaches the Dutch type as does the single Dutch young one borne by the Belgian Hare foster-mother.
- (2) That the bad marking of the young got by the Dutch buck out of a pure-bred Dutch doe is shown to be the fault of the father, and that, consequently, it is not surprising his other offspring, the foster-child, should also be badly marked.
- (3) That the probability of the Dutch buck begetting characteristic Dutch young when crossed with a doe of another species, is reduced to a minimum; while, on the other hand, the probability is increased that a young one, with such strongly marked Dutch characteristics as the foster-child is possessed of, is derived from the ovum of a Dutch mother.
- (4) That the chance of producing a cross-bred young one out of the Belgian Hare foster-mother by the help of Dutch spermatozoa, which was twenty-four or more hours old when introduced into her fallopian tube, is remote; and is rendered still more improbable when it is remembered that fresh Belgian Hare spermatozoa in ample quantity would also be present.
- (5) That the similarity of the result now obtained with that obtained in 1890, is striking evidence in favour of my contention that these experiments present strong evidence towards the proof, (1) that it is possible to make use of the uterine of one variety of rabbit as a medium for the growth and complete foetal development of fertilised ova of another variety of rabbit; and (2) that the uterine foster-mother

exerts no modifying influence upon her foster-children in so far as can be tested by the examination of a single generation.

- (6) It follows, if the above is true, that in case telegony be actually demonstrated, the characteristics of a primary husband which are transmitted to the offspring got by a secondary husband, can only be so transmitted through the ovarian ova of the mother.

Romanes, in his work on 'Darwin and after Darwin,' vol. 2, pp. 146—148, refers to my earliest experiment; he thereon remarks that rabbits when crossed in the ordinary way never throw intermediate characters, and that the experiment is clearly without significance as far as it bears upon the inheritance of acquired characters.

Mr. Romanes does not give his authority for the statement that rabbits when crossed never throw intermediate characters, and I venture to think he was mistaken in his view; that they do produce young which are apparently pure bred of the one type or the other, and possibly both, in the same litter is no doubt true, but it is also true that some at any rate of the young got by crossing are of an intermediate character. An examination of the litters I got by crossing a Dutch buck with Belgian Hare does confirm this view.