Artificial Fertilisation of Rabbits

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(Please return this to F. Galton 42 Rutland Gate SW)

Private for the present June 28/94

F.1 (1)

A plea for experiments on the artificial fertilisation of mammalia — by F.G.

It seems reasonable, on the following grounds, that experiments should be made on the possibility of artificially fertilising mammalia, beginning with such inexpensive animals as mice and guinea-pigs.

The two facts, that a single spermatozoon suffices to fertilise an ovum when brought to the proper place at the proper season, while the number of them secreted by the male is enormous, show that a vast quantity of material is wasted. A breeder is unable at present to widely introduce in a single generation any fresh strain of exceptional value, that may chance to make a sudden appearance as a sport, and is therefore hereditarily transmissible. Therefore if artificial fertilisation prove to be possible, by using only a minute portion of the available material, a new and valuable power would be placed under the control of breeders.

There are two main heads for experimentation —

(1) On methods of preserving spermatozoa in (life and vigour and in fertilising) during many days.

(2) On the possibility of fertilising, with fair average success, by mechanically conveying to the mouths of the Fallopian tubes, a minute fraction of the available material.

As regards (1) it is conceivable that some culture fluid should be found, more conducive to the vitality of the microbes than that in which they naturally live. They are said to live in milk; therefore other appropriate fluids may exist, possibly the more suitable if oxygenated, that would admit of their being kept in vigour for some days, and of being easily transported.

As regards (2), the artificial fertilisation of women, where husbands have hypospadia, has been tried with success on a considerable scale. Hunter was the first to attempt it, it then became forgotten, but has been reintroduced both in France and in America during recent years, by making one injection monthly, soon after the cessation of the menses. Particulars may be found in Tarnier, "Art des Accouchements" Paris 1882, p 176 (see also p 166 on the artificial Spermatogony)

The apparatus there described might doubtless be further simplified and reduced in size, considering how minute an application is necessary if directed to the right place. The immense waste of material under the ordinary conditions is due to the non-fulfilment by nature of this requirement, as may be inferred from the fact that the amount of the material discharged by different animals varies roughly with their size although that of the individual spermatozoon is about the same in all, as in the rat, the dog, the man, the horse and the bull. In other words, the number of the microbes that are discharged, is proportionate to the area of the walls of the canal about which they have to be wastefully dispersed, on the chance of some one of them reaching the required spot.

It is scarcely possible to think of the practicability of artificially fertilising domestic animals, without extending in imagination its application to humanity under some ~~other~~ different form of civilisation to ~~to~~ our own. ~~Perhaps that~~ It is a process which might be effected by female surgeons, in a purely female establishment, even under anaesthetics if thought desirable, and without wholly destroying the Levitical ~~signs~~ proofs of virginity. In short, that a maid might bear her first-born to the State, wholly unsullied by sexual passion.

F.G. June 28/94

Artificial Inbreeding
of Mammalia
FG
1894

Heape

St Mary's,
Trumpington,
Cambridge.

1. July. 94.

Dear Sir,

In reply to your note of the 29th I beg to assure you it gives me very great pleasure to have the opportunity of placing at your disposal not only advice, but any help I can possibly give you, with regard to the experiments you are desirous of making.

I hope you will, as you
suggest, send me a short
account of what you propose
to do, together with any queries
which may occur to you.

Yours faithfully
Walter Heape.

Francis Galton Esq. F.R.S.

Walter Heape

f. 3

ST MARY'S.
TRUMPINGTON,
CAMBRIDGE.

3. July. 94.

Dear Sir,

I have much to say on the matter of the experiment you suggest: your note of which I have duly received this morning and read with very great interest.

I shall be in London tomorrow, and would call upon you at 4. P.M. for an hour, if it will be convenient for you to receive me then. May I ask you to send me a telegram on the receipt of this letter, as I leave here

Early tomorrow morning.
If tomorrow Wednesday at 4 is not convenient I could come on Thursday morning about 9·30 or 10, and if neither day suits you I will write on my return home.

I should like to tell you of some experiments I have been engaged in for some months past, upon the mechanism of ovulation; they bear somewhat closely upon considerations which ~~that~~ your proposed experiments will necessitate — & they will I think interest you.

I will of course regard your communication as strictly private.

Very faithfully yours
Walter Heape

Francis Galton Esq

Hewlett

f. 5

St Mary's,
Trumpington
Cambridge.

9. July. 94.

My dear Sir,

I send you a line to say I have consulted Pathologists here and am advised to try sterilized hydrocele fluid as a medium for spermatozoa. It may be some time before I can get this properly prepared, but as soon as I can get it I will begin experiments, and will keep different percentages of spermatic fluid at various temperatures.

I merely send you this hurried
line to let you know what I am
doing in the matter, pray
don't trouble to answer the letter
unless indeed you have suggestions
to make.

Yours very faithfully
Walter Heape.

Francis Galton Esq

F. 7r

St Marys,
Trumpington,
Cambridge.

31. July. 94.

Dear Mr Galton,

I hasten to send you a line today & will, until I hear from you, write only in such manner as may allow of your sister reading -

I put some spermatic fluid into sterilised hydrocele fluid on Saturday ~~kept~~ left it until Monday in an incubator - the tubes were unfortunately, by error,

but see no reason why half a
dozen experiments should not be
performed in that time –

Very faithfully Yours
Walter Heape.

removed two or three hours before
I was able to examine them —
I found spermatozoa therein, but they
were motionless, & actively &
plentiful crop of bacteria was also
present — The latter were doubtless
introduced with the spermatic fluid
& a plan must now be devised to
obtain the spermatozoa free from
such contamination —

A great proportion of the spermatozoa
in the hydrocele fluid had no marked
appearances of degeneration, & there seems,
so far, no reason why they should not
live if proper precautions are taken —

I think it will be advisable to gain the assistance of one of the trained bacteriologists in the pathological laboratory here - the experiments will be more reliable and more valuable to you if they are performed by one who is fully conversant with all the methods of that science -
If therefore, you are agreeable I will find some one who will undertake this part of the work and he will together report to you -
Please let me have a line before you leave tomorrow - I shall, myself, be much away for the next two months

W. Heape

f. 9r

ST MARY'S.
TRUMPINGTON.
CAMBRIDGE.

14. Oct. 94.

Dear Mr Galton,

I have delayed answering your letter in the hopes that I might be able to tell you the experiments are progressing, but unfortunately I cannot say so. My stock of rabbits altho' large do not include either bucks or does in a breeding condition. They are all either casting their coats or

manipulation, and he does not doubt they were present in the spermatic fluid which was taken from the vagina before it was extracted therefrom. This appears to me exceedingly likely and I do not think any satisfactory experiment in the direction of preserving the spermatic fluid can be performed until it can be obtained by artificial means, viz by the ejection of it without ~~coo~~ copulation, into a properly sterilised vessel.

Hitherto I have been unable to effect by artificial means, the ejection of spermatozoa

otherwise so affected that they
are not in breeding trim; -
I have several times found that at
this time of the year a similar
condition prevails & I fear it may
be some weeks before they can be
induced to do their duty in this
respect —
The last experiment D. Barlow & I
performed was to extract spermatic
fluid from the vagina of a doe (killed
for the purpose) a few minutes after
copulation & to place the same in

(and keep it at 37°- temperature)

hydrocele fluid. The greatest care was taken & every precaution adopted to obtain the spermatic fluid ~~in~~ ~~xxx~~ per from septic organisms and the hydrocele fluid was sterilised, but nevertheless about 4 hours afterwards the movement of the Spermatozoa had diminished in rapidity at three hours later they were motionless & apparently dead. at the same time there was a considerable growth of bacteria in the hydrocoele fluid.

Dr Barlow is quite certain the presence of the bacteria was not due to faulty

St Marys,
Trumpington,
Cambridge.

from a Rabbit - I fancy it might be managed by introducing a sterilised rabbit into the cage of a buck which has been sufficiently excited by a doe in heat, and by fixing a sterilised tube in the place of the vagina, it might be necessary to blind-fold the buck, but I think it might be done and I propose to try it as soon as my bucks are in breeding trim.

Dr Barlow thinks it is very doubtful that a highly specialised cell such as a spermatozoan ~~can~~ will live long in

any unnatural medium; but when it is remembered that they live in the male organs for some time after being discharged from the testis & that they live for ~~two~~ 2 or 3 days at least in the female organs after copulation, it seems to me that they may be said to exhibit very considerable hardihood and that it is by no means unlikely they may live in a satisfactory medium for a similar length of time.

I have tried putting a tube into the vagina of a living doe but have hitherto not succeeded in collecting spermatozoa in it.

The experiments connected with artificial
fertilisation with diluted spermatozoa
I will also try as soon as my stock
are in a satisfactory condition –

I am sorry the world has not already
reached a more advanced stage, –
I was fairly tired out by the middle of
August, and went away to Scotland
for the Shooting – returning only 10 days ago.
I hope you have had a pleasant
holiday.

Yours faithfully
Walter Heape.

ST MARY'S,
TRUMPINGTON,
CAMBRIDGE.

21. Nov. 94.

Dear Mr Galton,

You will surely wonder what I have been doing and I am sorry to be obliged to say "nothing" - I cannot prevail upon my stock of rabbits to breed, I hope before long to be more successful with a new lot and will let you know as soon as I have any news for you.

I hope you will not feel I am
neglecting your experiments. the fact
is, the more I investigate the subject
the less I find is definitely known
about it and I am driven back
further & further to experiment
upon points it is requisite to know
before attempting to tackle the problem
you have suggested.
Any work connected with heating is
necessarily slow as I know to my
cost, and this time of year is

Can you refer me to any other account of successful artificial fertilisation - you may remember You gave me Tarnier as a reference and I know of no other -

Tarnier gives only two experiments on the lower mammalia only Spallanzani & one by Pierre Rossi about 1780 - Obviously the experiments on women which he records are not entirely trustworthy for one cannot be assured that the artificial injection was not

subsequently supplemented by copulation.

I am thinking of making a few preliminary experiments upon artificial fertilisation to see if the presence of the male fluid in the uterus is alone sufficient to produce ovulation – It seems to me to be as yet uncertain, and I shall be very much obliged if you can tell me of any published account having reference to this point.

especially unsatisfactory.
I hope I may be able to send you
a more satisfactory account
before very long.

Very faithfully Yours
Walter Heape.

ST MARY'S,
TRUMPINGTON,
CAMBRIDGE.

5. May. 95.

Dear Mr. Galton,

I am but little to tell you I am sorry to say - we have failed entirely in our efforts to procure effective spermatozoa for more than a few hours. The spermatozoa has been obtained from the vagina of female rabbits a few minutes after copulation, and placed in sterilised hydrocele fluid. But

the difficulty is that the injection of spermatozoa alone does not appear to be sufficient to produce ovulation in Rabbits. I have now ~~killed~~ killed a very considerable number of doe rabbits, and have never found one in which ovulation has taken place without copulation. Electric stimulus of the vulva & vagina, which a doe at heat readily submits to, does not

in a very short time bacilli make their appearance and rapidly fill the fluid. the sperm die.

I see no hope of success in this direction. The spermatozoa must be obtained direct from the male in a sterilised condition in order to give it a chance of living.

Rabbits are not convenient animals to work with for this purpose, it does not seem to be an easy matter to induce artificially the ~~ejaculation~~ ejection of sperm. from a rabbit.

In dogs this is readily done — and I would suggest that some experiments should be made with dogs as soon as artificial fertilisation can be performed with some certainty.

At present I have not succeeded in fertilising artificially, rabbits — I have injected sperm: into the vagina and the sperm: has found its way into the uterus, that is not the difficulty we have to contend with,

ST MARY'S,
TRUMPINGTON,
CAMBRIDGE.

induce ovulation apparently -
I am not quite satisfied about
this point, and propose to repeat
the experiment shortly - upon a
doe in which spermatozoa has
been injected artificially - but I do
not expect the experiment to be
attended with any success.
—
I know Everett Millais very well,
and know of his artificial
fertilisation of dogs, at least I am

whatever obstacles I have placed
in their way - The act of copulation
is a very violent act with rabbits
and the vagina exceedingly flexible.
Again I have some reason to think
that the act of copulation itself is not
sufficient to induce ovulation, I am
inclined to think the presence of sperm:
in the uterus is also a necessary factor.
In one case of a doe rabbit in heat
which copulated freely, the uterus
was blocked up and the spermatozoa
did not penetrate beyond the vagina

under the impression that I knew
of all his experiments – he may
have done some which I do not
know about, and will write and
ask him – Those I do know of
are not purely artificial fertilisation
He injects the sperm: say of a
St. Bernard dog into a Basset horned
bitch and then has that bitch
covered by a dog of her own breed
the result being that she breeds
some ~~puppies~~ pups pure basset horned
& some ½ basset & ½ St. Bernard.

by this means he get a cross between
two varieties which need not need
together an account of their different
size &c: but you will observe that
copulation is not omitted from this
experiment. and I cannot help
thinking that copulation is essential,
to the success of his experiments.
I have attempted to allow copulation
and at the same time to prevent the
entrance of Sperm: into the uterus,
but in all cases have failed to keep
them out. they have circumvented

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Trumpington,
Cambridge.

and in this case ovulation did not take place.

It is a very interesting problem & surely the solution is likely to establish several important points connected with breeding, but I confess the solution appears to be a long way off yet.

Of course very many experiments are needed to prove a negative proposition, and I do not for a moment delude myself with the belief that my

experiments prove anything at all,
but they certainly seem to indicate,
that the act of copulation and
the presence of spermatozoa in the
uterus, are both necessary in order
that ovulation should take place
in the Rabbit.

—

I have been far from well for the
last 6 weeks or more and have done
but little work: I hope soon to be
busy again however and will let
you know the results of my
experiments.

I have judged that experiments
upon the preservation of sperm also
may with advantage be left until
artificial fertilization is demonstrated.
Believe me
Yours very faithfully
Walter Heape.

St Mary's.
Trumpington.
Cambridge.

11. May. 95.

Dear M! Galton,

I have heard from Millais and he tells me he has repeatedly fertilised 4 bitches by injecting sperm also into the vagina & without any copulation — He also tells me he has put three bitches in pup from "the single emission of the dog" —

I expect to be in London before long and would call upon you if convenient to you.

Yours faithfully yours
Walter Heape.

This seems to be what you want.
It is very curious that artificial
fertilisation should be possible for
the dog & ~~rabbit~~ apparently
impossible for the Rabbit. —
I expect the difference will be found
to be due to differences in the
maturation of the ovum.
In some mammals Minot says it
said that maturation takes place
after the ovum is shed from the
ovary, while in the case of the

Rabbit I find the ovum matures
while in the ovary and does not
mature until about 9-11 hours
after copulation.
I don't know where maturation
of the ovum takes place in the dog.
Possibly the extent of the phenomenon
of "heat" affects maturation -
bitches are of course greatly affected
by "heat" - I should much
like to see you about this point
some time.

W. Heape June 25

F. 24.

25. Jan. 95.

St Marys.
Trumpington,
Cambridge.

Dear Mr Galton,

I have no news for you

I am sorry to say, a variety of

private matters having combined

to stop my work for the last 6 weeks.

I hear ~~that~~ that artificial fertilisation

is being used in America for horse

breeding, but have not yet discovered

the source of the information.

I will not communicate further
to you on this subject until I hear
of your return from the Continent,
where I trust you may spend a very
pleasant time.

Yours very faithfully
Walter Heape.

St Mary's,
Trumpington,
Cambridge.

11. Oct. 95.

Dear Mr Galton,

I am sorry to say I have really nothing of importance to tell you — I have completely failed to fertilise artificially a doe rabbit — Spermatozoa injected into the vagina may find its way into the uterus & this has occurred in some of my experiments, but in

There is one point which seems
to me of very considerable interest
and which may be found to be
of importance. I mean the time &
place of maturation of the ovum,
In the Rabbit I find from a long
series of experiments that maturation
takes place a definite time after
copulation, & only after copulation,
and yet, before the ovum is discharged
from the ovary — It seems from
Sobotta's researches that in some

no case has ovulation taken place.
Copulation appears to be necessary
in order that ovulation should occur
in the Rabbit. I am quite
prepared to believe this may not be
a necessary adjunct to ovulation
in other animals but I am
strongly of opinion it will be found
to be necessary for Rabbits.
I have tried stimulation of the
vagina & of nerves supplying the
vagina uterus & ovaries, I get a
reaction in the muscular apparatus

which it is highly probable are very similar to the movements which take place in connection with copulation, but as far as I can see the ovary is not affected. I have found no stimulation which affects the vascular supply to the ovary. & it is this I want to find — I have not done much so far and breeding is now a very uncertain matter, however early next year I shall begin again.

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Trumpington,
Cambridge.

Rodents maturation of the ovum
take place after its discharge from
the ovary - The influence which
brings about maturation changes
in the Rabbit would seem then to be,
possibly, more complicated than in those
other Rodents.

Another point of interest is the
uniform appearance of a discharged
follicle: it seems to be punched

Ripe follicle (A)

discharged follicle (B)

If you can make any suggestions
pray let me have the benefit
of them -

together with cover and -
when an ovary containing ripe
~~to~~ vesicles is put into strong nitric
or acetic acid, the ripe follicles
rupture and the walls of these
follicles take the same shape as do
those ruptured naturally (B)

I am in communication with a
gentleman who promises me interesting
details of methods adopted for artificially
fertilising mares, & when I know
particulars will send you word.

I am sorry I have so little to
tell you, but I find this line
of research full of interesting
difficulties and as there seem to be
no authentic experiments to help one
breeding is a "tickle business" at all
times one must expect but slow
progress.

I hope you have had a good holiday
and that you have benefited by it.

Believe me
Faithfully Yours
Walter Heape.

W Heape

f. 30r

St Mary's,
Trumpington,
Cambridge.

25 Oct. 95.

Dear Mr Galton,

I think the enclosed will interest you. Please let me have them back when you have read them.

I expect shortly further information on this matter & will keep you informed of anything that I think will interest you.

Here seems clear evidence that

f. 30 v

"The Horseman" to be obtained at
American newspaper agency .. King William & Strand

a writer? "on Breeding Mares". "The Horseman"
Chicago Horseman Newspaper Co
Chicago Ill.
March 8. 1894 p. 279

Again a writer? "artificial Impregnation" — May 30/1895 p. 677

Also a letter from
Samuel Cook — Harrison — Ill. — Aug 27/94.
full details

a mare can be artificially
~~it~~ fertilised with independently
of copulation — and that the
spermatozoa collected from a single
service is amply sufficient to
fertilise two or three mares.
The case with which these large
animals can be worked makes
them excellent objects for experiment
but I am afraid they are too
expensive for my purse.
It would be worth while ~~if~~ I think

to communicate with breeders who have difficulty with their mares, may I ask you to let me know in case you hear of such.

I must set to work again upon the preservation of spermatozoa - I wish I could get it in larger quantities, than is available from rabbits.

Yours very truly

Walter Heape.

St Mary's,
Trumpington,
Cambridge.

31. Oct. 95.

Dear Mr. Galton,

Pray pardon me for delay, it was unavoidable.
By all means write to D. Billings on the subject. I do not want to keep the matter in my own hands at all.
I shall hope to identify myself with the work when done on the subject I shall do all in my power myself but I am not so selfish as to retard

instruments in warm water until
they are wanted.

I shall set to work again at the preservation
of specimens as soon as possible.
At present I am just on the point of
moving into a newly built house & have
my hands full; after Xmas I shall be free
again, but until the new year I fear
I shall not be able to give undivided
attention to work.

The possibility of crossing varieties
by means of artificial impregnation
in cases where they will not breed

the investigation by keeping it so
secretly.

I know of no one who would be
better to apply to for information
than Dr. Billings, & look forward
eagerly to his reply to your
communication.

About the capsules, I have asked
for samples and will let you know
when I hear further.

Mr. Cook in his letter to the
"Horseman" does not quote any

Jack for his opinion that light
has a more destructive power than
cold on sperm:
He makes his statement in reference
to his method of collecting sperm: from
a mare who cannot retain it in her
vagina. The sperm: runs out again
as the horse comes down from the mare;
he catches the sperm: in a clean pot
& covers it immediately because, as he
says, light has a very destructive power.
when he uses a syringe he keeps his

naturally, will have to be tried if the American story is established: and that opens up a large field. The subject bears closely on my own work and is of very great interest some ~~in~~ from all points of view, both artificial fertilisation, the preservation of sperm; and crossing varieties which are not naturally fertile —

Do you know, by the bye, whether any investigation has been made of the ovary & ~~but~~ testis of the mule, I mean histological investigation —?

I have an impression they are
stated to be normal but I cannot
find any reference.
May I ask you to let me know if
you can refer me to any published
account?

Believe me
Very faithfully yours
Walter Heape.

ST MARY'S,
TRUMPINGTON,
CAMBRIDGE.

1. Dec. 95.

Dear Mr Galton,

Many thanks for you for both the two successes which I now return — Pearson's letter is certainly very important — He has himself "practised the system with success"! It appears to me that one now requires proof that offspring so produced are not abnormal in any way, that they possess average strength, health and reproductive powers.

If this can be shown results will surely

interest and importance, and would it appear to me have more influence upon breeders than any experiment which I can think of.

Will you let me hear what you think of this and whether you are acquainted with a the owner of a ~~mate~~ stud in which a mare might be found best as a test case.?

I do not myself personally know any owner of a large stud of first class horses.

Of course a mare may fail to breed one season and may accompany bear a foal the next year, so that the hope of "better luck next time" may make owners

gladly practice the method: but
without that assurance I imagine
breeders of prize stock will not adopt
a practice which might so easily set
them a bad name.

I was last week at Bedford and
went to see Mr Peck's famous horse
breeding establishment at Howbury Hall.
I found that it is considered satisfactory
if 2/3rds of the mares covered ~~are got~~
~~with foal~~ bear foals. but that the
proportion varies much in different years.
This last breeding season has proved a
bad one, an abnormal number of mares

being barren.— The high prices paid
for covering mares with first class horses
~~mostly trotters~~ (any price being charged
from £50 to £400 per mare) would
surely make owners of mares anxious to
adopt the artificial method if it could
be done certainly, provided the offspring
produced are satisfactory.
The best way I can suggest for proving this
is to induce the owner of a ~~one~~ celebrated
mare, which has failed to conceive in the
ordinary way, to have her artificially
impregnated this next season.
The racing career and the career at Stud
of a foal so got would be of the greatest

difficult to persuade unless they have a mare which has proved herself barren for several reasons.

I am still unsettled with regard to household affairs, the process of removal takes place a fortnight hence, so I hope early next year I shall once more be settled down to hard work.

Very faithfully yours
Walter Heape.

I should much like to see you on the subject of certain breeding experiments I have in mind. I hope next year you will allow me to call upon you & tell you about them.

HEYROUN,
CHAUCER ROAD,
CAMBRIDGE.

18 Jany. 97.

Dear Mr Galton,

Regarding the word "Impregnation" - it seems to me that the same objections apply to its use that apply to the use of the word "fertilisation". I am open to correction of course, but I do not think it is correct to describe the dissemination of an animal as impregnation.

As I understand it, to impregnate means to make pregnant, to cause to

I am very much obliged to you for raising this point, I had included the word in my first rough draft of the paper, but cut it out subsequently thinking that Justification was sufficient for the purpose.

Conception - and the principle of
infusion seems to be included in
the word - to communicate the virtues
of a substance by mixture, digestion
& the like -
Spermatozoa is not incorporated with
the female by infusion as far as is
known, it only mixes with the ovum,
and it seems to me that it is only
the ovum that is impregnated or
fertilised, not the mother.
If it ~~was~~ is correct to use impregnation
in place of insemination, it would
be equally correct to say that ~~we~~

an animal was impregnated which had not conceived, and this seems like a contradiction. At the same time no doubt you are right in arging the admissibility of impregnation appearing as a catalogue word, and I have written tonight to amend the title and add a few words in the text to make that possible. I hope they will accept the alterations.

Yours faithfully
Walter Heape.