

An Abstract of a Letter from Mr. Anthony Leeuwenhoeck of Delft about Generation by an Animalcule of the Male seed. Animals in the seed of a Frog. Some other Observables in the parts of a Frog. Digestion, and the motion of the blood in a Feavor.

HAVING been solicitous to examine the generation of *Frogs*, upon the account of their young ones being like a *Worm*, with a round thick body and a short taylor: I was surprized to find that the *Male* was not joyned to the *Female* in Copulation, but that he only sat upon her; and had no *Membrum Masculum*: that at the same time when the *Female* cast her *Eggs* or *Spawn*, the *Male* also dropt his *Seed*; which is to be spread under the *Eggs*: in like manner as the *Seed* of *Fishes* that want the *Membrum Masculum* is cast under the *Eggs* of the *Female*, that the *Animalia in semine* may conveniently impregnate the eggs. For I hold it necessary that some one of the *Animals in semine* should get into a certain * *point* of the yolk of the *egg* (which *point* is only fit to receive it, and give it the first Nourishment, till such time as the *Egg* comes to be fat on) But if no one *Animal* should find this *point*, then the *Egg* is unfruitful: and this may be a reason why there are so many thousand more *Animals in semine Masculo*, than *Eggs* in the *female*.

In several of my Observations I had not found the *Animals* taken out of the *Testicles* and *Vasa Deferentia* of *Frogs* to be alive. But on the first of *April* when *Frogs* were ready to spawn, I took some of the *Males* sitting upon the *Females*, and squeezed their hinder parts that I might get the seed out of the *Vasa deferentia* but the *Ani-*

* By this point or speck he means the Cicatricula.

malcules

malcules I then found, moved but little, because the matter they were in was full of salt particles, which made me judge it to be *Urine*.

I then cut open the *Testicles* and there I found an innumerable company of *Animalcules* swimming among a sort of ill shapen particles, these continued alive till the next day, tho there were but a small quantity of liquor to contain them.

I judge the Bodies of the *Animalcules* to have been of the thickness of $\frac{1}{1000}$ part of a hair of my head: If the matter they moved in had not been so thick I should have seen them much plainer, nevertheless they are represented to the best of my skill in *Fig. first* where ABC is an *Animalcule* as it lay in the Watry matter, and moved it self therein, sometimes the head appeared to be thicker then other times, and often I could see the Body but from A to B by reason of the thinness of the Tail BC. when the Animal moved it self strongly, tho the progress were but little, the motion towards the head was like that of a Snake, and the taylor was cast into 3 or 4 Bows. *Fig. D* is an *Animalcule* lying dead, and stretcht out at length, but in this posture I saw but few, for many that were dead lay with the fore part of their body bent in, as in *Fig. E* others made as, it were a half circle others had the forepart of their Body bent and moved their hinder parts: these last I took to be ready to dye.

The number of *Animalcules* in all the seed was so great that I judge there might be 10000 of them to one of the *Females* Eggs, the same computation I formerly made of the *Milt* of a *Codfish*, but it must not be thought that all the *Animals* in the *Milt* of the *Codfish* live together, but only such of them as are nearest the passage they are to be cast out of, and who have more moysture about them; the rest of them being more remote in the body, and being incompass'd with a thicker matter, are not alive; for tho some *fishes*, as the *Bream*, and *Trout*, cast their *Milt* and *Spawn* in two days time, yet *Codfishes* are about a *Moneth*
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in doing it ; in all which time the seed is successively ripened and perfected. So also are *Frogs* by what I have experienced, for the first *Animals* I sought were dead, and though I afterwards found live ones, yet those were dead that lay deepest in the *Testicle*.

Tis well known that when a *Cock* hath trod a *Hen* but once, many *Eggs* are made fruitful, the reason that I give for it is, that many of the *Eggs* in the *Ovary*, have each of them received an *Animalcule* out of the *Male seed*. This *Animalcule* while the *Egg* is late upon does not presently take the figure of a *Chick*, but grows into a disorderly Bulk, wherein the heart is first plainly to be discerned. Other *Fetus's* have a different way of growth, the *Louse* has all its parts, and is a *Breeder* while it is yet in the *Egg*; the *Flea* shows like globules swimming in a watry substance, it afterwards becomes a *Worm*, then a *Nympha*. The *Frog* is a thick *Worm* till it be of a considerable bigness. The *Humane Fœtus* tho no bigger then a *Green Pea*, yet is furnished with all its parts. I have often endeavoured to discover the *Animal* coming out of the *Male seed*, in the egg of the *Hen*; but have been unsuccessful tho some of the *Globules* of the *Egg* were magnified to the bigness of common Apples. This disappointment has put me upon the *Eggs* of *Insects* as the *Flea*, and *Louse*, which being very small, may be so much the fitter for this discovery.

A certain *Physician* writing of Generation sets down these words, in the Margent *from the female seed the fruit must grow however the thing came to pass*. This he enlarges upon in the *Text*, but I think under correction that by one instance I shall bring a sufficient proof of the fruits coming from the *Male seed*, and the *females* only contributing to the nourishment and growth of it. Many of our *Neighbours* either for their pleasure or profit, keep tame *Rabbits*, which are large long eard, ordinarily of a white colour, but sometimes of a Blew, Black, and Pyed; those that would make a proffit of these *Rabbits* by causing them to bring gray young ones, which in the fore part of
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the year may be sold for a wild kind; get a *grey Male*, such as are ordinarily found on our *sand hills*, to put to their female: The *Breed* that comes from hence always takes the gray colour of the *Male*, and it has never been seen that any of the young has had any *white*, or other coloured hair then *gray*, there withal they are never so bigg us the *Dam*, nor have so great ears, nor are so tame, but of a wilder kind.

The first *Frog* which I anatomized lay on the ground in my way, and seemed so weak through cold that tho I kicked it with my foot, it would not leap away, this proved a *Female*, in the gutts of it I found *worms* like those in *Children* of about the thickness of a hair of my head. The blood consisted of flat oval particles, swimming in a clear liquor: these had no colour as they lay singly, but when 2 of them lay upon one another, as here *Fig. 2d.* their colour was stronger. A is an *Ovale* of blood partly covered with B a *2d. Ovale* of blood, C is a *3d. Ovale* of blood covering a part of ACB as at D. and casting a deeper colour, by reason that 3 *Plates* lye upon one another: But there was another small *Oval* hard by represented by E which showed of a higher red then the three *Plates* together. Many of these *Ovale* particles were very pleasant to look upon, especially when the moisture wherein they swam (having also *Globules* on the surface as big as $\frac{1}{8}$ of a *blood Globule*) was evaporated; for some had in the middle a faint *Ovale* shade, others appeared as if they were made of several *Ovales* of unequal bigness, others seemed to be set round with small *globules*, others had no *globules* in the Circumference, but several in the middle: these *Globules* I believe were at first swimming in the Watry liquor under the *Ovales*, tho now they cleave to them by Accident.

Upon the Plate whereon I layd the Frog that I anatomized I found several *Animals* moving in a watry blood, they were about half as long and half as broad as the *Oval Particles*, and about 50 of them might lye in the space
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of a sand, these I had never seen in the pure blood, nor could I perceive them in the water that came out upon ripping the skin from the flesh, or upon opening the belly, or squeezing the head of the *Frog* to make it lye quiet upon the *Plate*. At length in the moneth of *June* I met with some *frogs* whose excrement was full of an innumerable company of living Creatures, of different sorts and sizes, the greatest sort were shaped like *Fig. F* and of these I judged that 40. might be in the space of a sand. The 2d. sort had the shape of *Fig. G.* these were but few in number. The 3d. sort was like our River Eeles as *Fig. H.* and these were more in number then the first; But the whole excrement besides was so full of living things, that it seemed all to move, & I gueest there was not less then 1000 of the third sort in the space of a sand. From hence I concluded that the *Animals* found among the blood might come from my cutting a Gut.

By the way I observed something of the dammage that *frogs* may do to *fish-ponds*, for I took out of some of their *Stomacks* 8. 10. or more young *fishes*.

I took notice of a small vein, of about the thicknes of a hair of my head, that when the blood was out of it, the Coat was like a *frogs* outward skin.

The same Coat of the vein was made of threds or *filaments* runing by the side of one another, just as if they had been wound close about a small round stich, so as to cover it all over. Now if there be *Capillarys* in the body a 1000 times less then this which I examined, how thin must the threds necessarily be of which the Coat is made? and how easily must these threds be separated and divided from one another, so as to let the blood when it is very forcibly moved in the *Artery*s, start out between them; and I was the more confirmed in this Opinion, upon spreading hard the Coat of the vein, for I then saw through it as through a hair five, hence may a probable account be given of *St. Anthony's fire*, red *swellings*, or

the *Small pocks*, and perhaps the blood may be more gently strained through these passages for the nourishing of some parts of the body.

I examined one of the *Muscles* of the hinder leg of a *frog*, which consisted of *filaments*, and those again of a great number of lesser *filaments*, but because they had more rings in them than I had formerly seen in the muscular threads of an *Oxe*, *Fly*, *Gnat*, *Flea* or *Louse*, I have here represented part of one in *Fig. I.* such numerous rings I have since met with in the *filaments* of the *Muscle* of a *Lamb*, taken from the rim of the Belly, near the hinder leg. From the indentings of these *filaments* I cannot only satisfy my self how the *limbs* come to stand bent, when the *muscles* are at rest, but also why we can walk a longer time than stand still; and why our *Arms* when we walk do not hang down at their full length, stretcht out by our sides; but more backwards and forwards; for if the *Arms* should still hang straight down, then would one *Muscle* be stretcht too much, and another bent or drawn up too close; both these things disagreeing with the Natural constitution of the *Muscle*, and for this reason it is, that when we stand a long time, we do not rest equally upon both legs, but first raise up one foot, then the other, touching the ground only with the fore part of the foot, while the *Muscles* of that leg rest themselves.

I have been puzzled why some of the wrinkles in the *filaments* of *Flesh* and *Fish muscles*, were *serpentine*, as I represented in my letter of the 3d. of *March* (*Fig. 1st. E E G H* and *I K L M.*) but I consider that the *filaments* lose their roundness by being prest hard upon one another. It is also probable that they may be bent after that manner by the evaporating of their moisture, which makes up $\frac{2}{3}$ parts of their bulk: as *Fig. K. α β γ δ.* is a *Filament* which had been round, but is now altered by the evaporating of its moisture, and bended in as at *α*, where-
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by the rings that were formerly streight, appear serpentine, as between β and γ .

In a letter of mine to Mr. *Oldenburg* (which was not published) I affirmed, that *Concoction* was not performed by an *Acidliquor* dissolving our meat, but by the *motion* of the *Stomach*, and *guts*, which bruises, and breaks the meat to pieces. This motion is caused by the *Diaphragme* pressing upon the parts of the lower belly, as often as we take *breath*; in the same manner as a bladder almost full of water, is molded and rolled between the hands. There is also a natural *warmth* to be considered in the *stomach*, and a natural *folding* or closing it self, about the *Vituals* which it holds, be it never so little; but especially there is a kneeding or contracting of themselves, remarkable in the Bowels of beasts, even after they are taken out of the body. I am lately more confirmed in this *opinion*, by my *observations* on the *Excrements* of a *Codfish*. which I find to be made up of very short pieces of the *Filaments* of *Fish*, appearing by the *Microscope* like the shavings of ones Beard, for as in some Creatures the taking of *breath*, so in fishes the moving of the *Gills*, causes a compression and dilatation in the *stomach*, whereby the *Aliment* is catcht in its folds, nipt a sunder, and divided into such small particles as are fit for the nourishment of their bodies. Now if the *Contraction* of the *stomach* be supposed to happen no oftner then a man *breaths* in an hour, there will be about 3000 times: which will be quickly enough to wast, and tear in pieces a little fish swallowed down by a great one, although the teeth of the *Devourer*, and the *Acidjuice* should contribute nothing to *digestion*.

Sometimes these threds are not to be found in the *excrements*, as perhaps when the *Codfish* has been long catcht; and without food, for then the threds are broken so short; that they are no bigger when they are voyded, then small *Globules*, which I judged to be $\frac{1}{2}$ of a *blood Globule*. When the *Codfish* has abundance of food, then the pieces of

threads are droven the faster out of the *stomach*, and through the *Bowels*, and therefore are the less broken and shortned.

Such like *Filaments* or pieces of flesh I have observed in my one *Excrements*, which I conceive were made by the nipping of the *folds* of the *stomack*: for these *Filaments* are not strong, when there lye yut few of them together; or when we make a *Cord* or *Rope* of them, which upon stretching bears unequally; though in another case a *muscle* made up of several of these *filaments*, and bearing equally in every part, may be very strong.

I have often maintaind among our *Pyhsicians*, that tho the heart and Pulse beat quicker then ordinary, yet the *Circulation* of the *blood* is not performed in lesser time; and the reasons which I gave were these. The blood in many *Feavorish persons* is very thick, and therefore passeth slowly, and with difficulty, thro the smaller *Arterys*, and requires a very strong beating in the heart to force its way. When the blood is thick and makes this resistance, the heart upon contracting it self, cannot force it all out, but a great part remains behind in the *Ventricles*. This remaining blood being over heated by the heart, makes that little blood which comes fresh out of the *Veins*, too hot likewise; and in the mean time the heart not being able to free it self of all the blood contained in its *Cavities*, casts out only the thinner part, which is quickly spent in the nourishment of the body, whereby the blood still becomes thicker, and *circulates* less fast. I can not admit that the time of the *circuite* of the blood, should be estimated by the number of *Pulses* in an hour, and the capacity of the *Cavitys* of the heart; for as the *Lungs* upon expiration are never totally without air, so the heart in a well constituted body, is never upon the *Sistole* absolutely without blood: I imagine also that when the *heart* is too full of *blood* (as I have before urged) its muscles may be so far strained, and kept beyond their usual bent, that they

they would not be relaxed, tho' the blood were very thin, and fit for motion; just as we see the *bladder* by being kept long too full of *water*, has the *Muscles* so reacht, that they can not be contracted. So also the *Easterne People* who would acquire to themselves the reputation of *Saints*, remain with their *Limbs* so long stretcht out in one posture, that they can not draw them back again.

Philosoph. Transact. Number, 152.

