

PART I
Spontaneous Generation
and Fermentation

Observations . . . concerning little animals
observed in rain-, well-, sea- and
snow-water

1677 • *Antony van Leeuwenhoek*

Observations, communicated to the Publisher by Mr. Antony van Leeuwenhoek, in a Dutch Letter of the 9th of Octob. 1676, here English'd: Concerning little Animals by him observed in Rain- Well- Sea- and Snow-water; as also in water wherein Pepper had lain infused. *Philosophical Transactions of the Royal Society of London*, Vol. 11, 1677, no. 133, pages 821–831.

. . . 3. MAY THE 26TH, I TOOK ABOUT $\frac{1}{2}$ of an ounce of whole pepper and having pounded it small, I put it into a Thea-cup with $2\frac{1}{2}$ ounces of Rain-water upon it, stirring it about, the better to mingle the pepper with it, and then suffering the pepper to fall to the bottom. After it had stood an hour or two, I took some of the water, before spoken of, wherein the whole pepper lay, and wherein were so many several sorts of little animals; and mingled it with this water, wherein the pounded pepper had lain an hour or two, and observed, that, when there

was much of the water of the pounded pepper, with that other, the said animals soon died, but when little they remained alive.

June 2, in the morning, after I had made divers observations since the 26th of May, I could not discover any living thing, but saw some creatures, which tho they had the figures of little animals, yet could I perceive no life in them how attentively I beheld them.

The same day at night, about 11 a clock, I discovered some few living creatures: But the 3d of June I ob-

served many more which were very small, but 2 or 3 times as broad as long. This water rose in bubbles, like fermenting beer.

The 4th of June in the morning I saw great abundance of living creatures; and looking again in the afternoon of the same day, I found great plenty of them in one drop of water,

which were no less than 8 or 10000, and they looked to my eye, through the Microscope, as common sand doth to the naked eye. On the 5th I perceived, besides the many very small creatures, some few (not above 8 or 10 in one drop) of an oval figure, whereof some appear'd to be 7 or 8 times bigger than the rest. . . .

Microscopical observations about animals in the scurf of the teeth

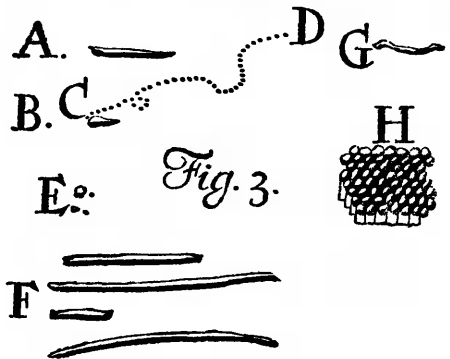
1684 • Antony van Leeuwenhoek

An abstract of a Letter from Mr. Anthony Leeuwenhoek at Delft, dated Sep. 17, 1683. Containing some Microscopical Observations, about Animals in the scurf of the Teeth. . . . *Philosophical Transactions of the Royal Society of London*, Vol. 14, May 20, 1684, no. 159, pages 568-574, 1 pl.

. . . THO MY TEETH ARE KEPT USUALLY very clean, nevertheless when I view them in a Magnifying Glass, I find growing between them a little white matter as thick as wetted flower: in this substance tho I do not perceive any motion, I judged there might probably be living Creatures.

I therefore took some of this flower and mixt it either with pure rain water wherein were no Animals; or else with some of my Spittle (having no Air bubbles to cause a motion in it) and then to my great surprize perceived that the aforesaid matter contained very many small living Animals, which moved themselves very extravagantly. the biggest sort had the shape of A. their motion was strong & nimble, and

they darted themselves thro the water or spittle, as a Jack or Pike does thro the water. These were generally not many in number. The 2d. sort had the shape of B. these spun about like a Top, and took a course sometimes on



one side, as is shown at G. and D. they were more in number than the first. In the 3d. sort I could not well distinguish the Figure, for sometimes it seemed to be an Oval, and other times a Circle. These were so small that they seem'd no bigger than E. and therewithal so swift, that I can compare them to nothing better than a swarm of Flies or Gnats, flying and turning among one another in a small space [Brownian movement?]. Of this sort I believe there might be many thousands in a quantity of water no bigger than a sand, tho the flower were but the 9th part of the water or spittle containing it. Besides these Animals there were a great quantity of streaks or threds of different lengths, but like thickness, lying confusedly together, some bent, and others streight, as at F. These had no motion or life in them, for I well observed them, having formerly seen live Animals in water of the same figure.

I observed the Spittle of two several women of whose Teeth were kept clean, and there were no Animals in the spittle, but the meal between the teeth, being mixt with water (as before) I found the Animals above described, as also the long particles.

The Spittle of a Child of 8 years old had no living Creatures in it, but the meal between the Teeth, had a great many of the Animals above described, together with the streaks.

The Spittle of an old Man that had lived soberly, had no Animals in it; But the substance upon & between his Teeth, had a great many living Crea-

tures, swimming nimbler then I had hitherto seen. . . . The Spittle of another old man and a good fellow was like the former, but the Animals in the scurf of the teeth, were not all killed by the parties continual drinking Brandy, Wine, and Tobacco, for I found a few living Animals of the 3d. sort, and in the scurf between the Teeth I found many more small Animals of the 2 smallest sorts.

I took in my mouth some very strong wine-Vinegar, and closing my Teeth, I gargled and rinsed them very well with the Vinegar, afterwards I washt them very well with fair water, but there were an innumerable quantity of Animals yet remaining in the scurf upon the Teeth, yet most in that between the Teeth, and very few Animals of the first sort A.

I took a very little wine-Vinegar and mixt it with the water in which the scurf was dissolved, whereupon the Animals dyed presently. From hence I conclude, that the Vinegar with which I washt my Teeth, kill'd only those Animals which were on the outside of the scurf, but did not pass thro the whole substance of it. . . .

The number of these Animals in the scurf of a mans Teeth, are so many that I believe they exceed the number of Men in a kingdom. For upon the examination of a small parcel of it, no thicker then a Horse-hair, I found too many living Animals therein, that I guess there might have been 1000 in a quantity of matter no bigger then the 1/100 part of a sand.

Comment

These are only a few of the many microscopical observations which van Leeuwenhoek made and reported by letter to the Royal Society of London. The observations presented here are the ones

which seem most likely to represent descriptions of bacteria.

van Leeuwenhoek was a minor city official who built microscopes as a hobby. He became probably the best microscope

builder in Europe, and people traveled long distances to look through his instruments, although he kept his construction methods secret.

It is amazing that van Leeuwenhoek was able to see bacteria, since he built microscopes with a single lens, rather than the compound type used today. It was only because of his great skill as a microscope builder that he was able to achieve the high resolving power needed to see bacteria. He made a large number of observations, painstakingly recorded. His work became widely known through

its publication in the *Philosophical Transactions* of the Royal Society, and was very influential on later workers. Eighteenth and early nineteenth century investigators cited his work frequently.

van Leeuwenhoek himself did not speculate on the origin of microorganisms or on their relationship to disease, although a number of workers felt that these organisms might be implicated in infectious diseases. But it was not until the late nineteenth century, through the work of Koch, that this idea was finally shown to be correct.

Observations on the generation, composition, and decomposition of animal and vegetable substances

1748 • *Turbevill Needham*

A Summary of some late Observations upon the Generation, Composition, and Decomposition of Animal and Vegetable Substances; Communicated in a Letter to Martin Folkes Esq.; President of the Royal Society, by Mr. Turbevill Needham, Fellow of the same Society. Written in Paris, Nov. 23, 1748, read Dec. 15 and 22. 1748. In *Philosophical Transactions of the Royal Society of London*, Vol. 45, 1748, no. 490, pages 615-666.

. . . FOR MY PURPOSE, THEREFORE, I took a Quantity of Mutton-Gravy hot from the Fire, and shut it up in a phial, clos'd up with a Cork so well masticated, that my Precautions amounted to as much as if I had sealed my Phial hermetically. I thus effectually excluded the exterior Air, that it might not be said my moving Bodies drew their Origin from Insects, or Eggs floating in the Atmosphere. . . . I neglected no Precaution, even as far

as to heat violently in hot Ashes the Body of the Phial, that if any thing existed, even in that little portion of Air which filled up the Neck, it might be destroyed, and lose its productive Faculty. Nothing therefore could answer my Purpose of excluding every Objection, better than hot roast-Meat Gravy secured in this manner, and exposed some Days to the Summer-Heat: and as I determined not to open it, till I might reasonably conclude,