

VIII. *A Letter from Mr. Anth. Van Leeuwenhoek, F. R. S. Containing some Microscopical Observations on the Particles of Crystalliz'd Sugar, &c. and his manner of Observing the Circulation of the Blood in an Eel.*

I Send you herewith my last Remarks, concerning the Coagulation of Sugar, which I had traced upon Paper near Three Years ago, and caused them to be Engrav'd upon a Copper-Plate, after that my Painter had Drawn them; and for as much as some of these following Observations do contradict my former Writings, I make no scruple to reject the past, and to take up these which I judge to be better.

I have said that the Particles of Sugar, which we call Sugar-Candy, consist of two broad and two narrow sides; and that the other, *i. e.* the top and bottom run into a sharp point, like the Figure of a Wedge or Chiffel.

Since there is not one Man in a Thousand that knows any thing of the Figures which Sugar-Candy assumes in it's Coagulation, altho' they've often tasted of the same, I have thought it not amiss to represent it to the Eye. Fig. 1. A, B, C, D, E, F, G, H, I, K. represents a small bit of Sugar-Candy, of which one shall seldom see so perfect a Figure; because they are almost always fasten'd to some other Particles of Sugar, whereby we can only discover the Superficies of one side thereof, as here in this Figure. H. I. E. F. G. but when it is taken out of the Syrup

rup or Liquor, without being united to any other Particles, the other side represented by A. B. C. D. K. will also appear after the same manner.

We also observe that all the Particles of the Sugar Candy which we buy, even that which comes out of the *East-Indies*, if it be not too irregularly Coagulated, and fasten'd to the sides of other Particles, has generally one side blunt, and different from the other three, which have sharp Angles, just like a square piece of Wood, one of the Corners of which is partly cut away, as you may see in the said Figure 1. at I. K.

Fig. 2. L. M. N. O. P. Q. does also represent a little Particle of Sugar Candy, which had been joined to others at the side L. M. N. and at O. there appears a very small Particle of the Candy that seems to have been Coagulated with the said *Fig. 2.* when it was much smaller; and that Particle appear'd like Mountain-Chrystal, and under that there was another composed of about ten small Chrystals.

For my farther Satisfaction concerning Sugar Candy and the Coagulation thereof in the Syrup, I took some Powder'd Sugar, and dissolved it in Water, and then boyled it so long, 'till I supposed all the Water to be evaporated; after which I placed it upon several Glasses, to the end that I might observe the Coagulation of the small Particles thereof.

After some days were past (this was in the Month of *March*) I observed a great many compleat Figures, which lay Coagulated into several Shapes, but all of 'em as clear and transparent as Chrystal, infomuch that it was a great Pleasure to view them; but I did expect to have found them all of one and the same shape, and that they would have appeared like *Figure 1.* but when I view'd them with a Microscope, some of them appeared like *Fig. 3.*
R. S. T. V.

This appear'd to me at first something strange; but when I considered that the Particles of Sugar (of which some of them are a great many Thousand times smaller, yea so small, that they escape the sight thro' a Microscope) do not appear to the Eye in the same position, nor that the Wedges thereof are represented as in *Fig. 1.* by B. C. or G. F. but that on the contrary, the side which is described in the said Figure, by C. D. E. F. I. K. lies sometime upper, or undermost; then it is no wonder if the same Particle of Sugar Candy shall appear to the Eye as in *Fig. 4.* A. B. C. D. E. F.

In that Particle of Sugar beforemention'd, I observed several Streaks or Fibres that were internal, and which by reason of the Transparency of the Sugar appear'd plainly to the Eye, as you may see in the said *Fig. 4.* between D and C. and D. and E. and so also from the Center of the Sugar where those Streaks extended on each side to B and F.

From this Observation I concluded, that the Sugar increased from time to time, in proportion to the spaces between each Streak or Fibre.

I likewise saw a few coagulated Sugar Particles, that appear'd in as compleat quadrilateral Figures as I ever beheld with my Eyes, one of which you have describ'd by *Fig. 5.* G. H. I. K. and withal as clear and transparent as any Diamond; you must also observe that these *Figures 3, 4, 5.* were none of 'em bigger than a small Grain of Sand. The reason why there were so many Particles of Sugar, that had but one part of *Fig. 3.* was, as I suppose, that they were Coagulated with others that lay near them of the like figure, insomuch that they hinder'd one another in their Coagulation; but when they lye so far from one another, that there is no actual Contact of the Parts, and yet are Coagulated, we can attribute that effect to nothing else but a secret *Inclination* which the invisible Parts of the Sugar bear to each other.

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In the middle of the *Fig. 3* and *5*. we observed a very clear Particle, which was of the same Figure with the whole Body; from whence we conclude, that the said whole Body was much smaller at its Coagulation, but increas'd continually by new Accessions of Matter round about it; and that in proportion to the number of Circles or Circumferences, the Body increas'd from time to time in bigness: And who knows but that every Circle was made upon a particular Day, and in dry Weather, and that at Night it remained in the same State.

These little Figures preserved their compleat Forms and chrySTALLINE Appearances as long as it was dry Weather; but when it happen'd to be Moist or Rainy, we observed Moisture about the Particles of the Sugar, which in dry Weather evaporated again; and then there Coagulated an infinite number of small Sugar Particles upon the greater, and those were so exceeding small, that a thousand of 'em together were not so big as one of those Particles before described by *Fig. 3*. which, as I said above, was not so large as a single Grain of Sand, and thereby all the Beautiffulness of them disappear'd: And to the end that those little Figures might keep their form 'till they were drawn, I was forced to carry both them and the Microscope, before which they stood, in my Pocket.

Now since we see that from one and the same Matter two different Figures are Coagulated, it is easie to conceive that several other Figures might be produc'd in the first Coagulation, especially when any of the Parts of those little Bodies lye upon one another; and therefore also we shou'd not wonder, to see in the Coagulation of Salts several Figures produced out of one Particle of Salt.

I can't omit acquainting you upon this occasion, that some body sent me last Summer a Piece of Mineral, which was said to be very rich with Gold, and was brought from *Hungary*; and I was desired to enquire into the substance of the said Mineral; which when I had done, I found

found that the fine Gold Colour was nothing else but Sulphur: There was also another Piece, which they said was Copper. One of these Minerals was mix'd with a little stony Matter, just like Particles of Sand, which seem'd by some heterogeneous Matter, to be united to the other Parts of the Mineral.

I separated some of the Stony Matter from the rest, and placed it before the Microscope; and found that some of the Particles, of which it is composed, had as smooth and exact Sides and Angles as any polish'd Diamond can have, that is to say, when they were not united, or lay under others; but where there was a union of the Parts, there appear'd several such Circles or Circumferences as were in *Figure 3* and *5*. some of 'em having particular sides, one of which was twice as broad as another.

These particular Rings or Circles I judg'd also were occasion'd by the Increase or Coagulation of new Matter: I took a great deal of Pleasure in viewing them, for they appear'd as clear as Chrystal. Both the Gold and the Copper, that seem'd to be in these Minerals, were nothing else but Sulphur.

My Intention was to have left off here, but upon second Thoughts I shall trouble you with what follows. I formerly shew'd the Circulation of the Blood in an Eel, and my Custom was to put the Eel into a long Glass Tube with the Tail uppermost: But I have left off that way for some Years, and now I prepare Copper Plates of about a Foot long and seven Inches broad; one end of which of the extent of an Inch I bend, and at the other end I make a square Hole of five Inches long and two broad, in which I put little Glass Plates as clear and as thin as I can possibly procure them: Upon such a Glass Plate I lay one of the smallest Eels I can get, which are sometimes as big as ones Finger; then I bind the Head and the best part of the Body of the Eel about with a Linnen Cloth, to the
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end that it may not see, and then 'twill lye the stiffer upon the Copper-Plate ; and the Tail is laid upon the Glass ; and that part of the Body of the Eel, that is wound about with the Cloth, is also fasten'd to the Plate with a Wire, that the Eel may not riggle it self off.

The Eel being thus placed upon one side of the Glass in the Copper Plate, The Microscope, through which you are to view the Circulation, is fasten'd by Wires and Screws on the other side, in such manner as it may be moved upwards and downwards, and every way. And this I take to be a better Method concerning the Circulation of the Blood than my former ; which if People wou'd therefore use, I doubt not but they might observe the same Things in an Eel as I have done : And then if you wou'd view the Arm, and with great Care consider the Pulse in the Veins, you wou'd certainly discover that the Blood, which makes the Pulse, proceeds from the Hand. I conclude, and am,

Yours, &c.

Antony van Leeuwenhoek.

Fig: 1.

