

III. *A Letter from Mr Antony Van Leuwenhoek, F. R. S. Concerning some Fossils of Swisserland, &c.*

Delft, the 13th Decemb. 1704.

I *At February* I imparted my Thoughts and Obsevationes to the Learned and Famous Monsieur *Peter Valkenier*, Envoy from the *States General* to the *Swiss Cantons*, about *Mountain-Cristal*, and particularly that it was not produced from Ice, nor grew in the Mountains, where it has its Increase, as many are of opinion; but that it is coagulated of the Air, there where it is fixt in the Mountain, that Air and a little Moisture is shut up in Crystals; the Parts of which being separated, are again resolved into Long Particles, of which a great many are Hexangular.

When the said Gentleman return'd from *Swisserland*, I observed in his House divers Shells of Fishes, and Snails, and other Rarities, which were Petrify'd, and a great many turn'd into Metal, with which he had fill'd a Cabinet; having made the Collection among the Mountains and Rocks of *Swisserland*. A few weeks ago Mr *Valkenier* did me the honour of a Visit, and among other things, gave me four of the little Snail-shells that he had gather'd in the said Mountains, where thro length of time they were chang'd into Metal, for they were extraordinary Heavy.

For my farther satisfaction, I took one of the Snail-shells, that I judg'd to be Metal, and beat it to pieces with a little Hammer; but finding that it broke very easily, I separated the parts with the less trouble, and
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broke the fore-part of it with my Fingers, a small part of which, represented by Fig. ABCDE, I placed before a Microscope, of which BCD was what was joyn'd to the fore part of the Snail-shell, and wherein I observed six prominent Particles, and five others at AE; the which five were fitted or insinuated into the six Particles; and how often soever I broke the said Shell in pieces, I still observed in the fore-part six, and in the hind-part five Particles, in the same order and disposition; so that I fancy it must have been a Limb or Part of the inclosed Snail, and consequently that it had been once a living Creature.

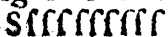
Having placed one of these little pieces of Snail-shell with the Break of the same before a Microscope, I observed that the Matter within was composed of very small shining Particles, which one would take to be broken pieces of Metal.

Forasmuch as I have seen such like seeming Particles of Metal, which was really nothing but Brimstone, I took some of the little pieces of the Shell, and put 'em into a Glass, and then upon the Fire, and observ'd, that in proportion to the smalness of the Parts, a great deal of Water and Sulphur was drawn off of 'em, without discovering the least sign of Metal in the remaining Black Matter.

Moreover, I examin'd that little piece of Matter, which, as I said before, I judg'd to have been the living Creature within the Shell; by its uncommon Weight it seem'd to be also turn'd into Metal, and the more when I had broken it to pieces, for then the manifold exceeding small shining Particles appear'd to be wholly Metallin.

The abovesaid Matter was extraordinary hard, insomuch that when I struck it against a Steel, as they do with a Flint stone, it yielded Sparks of Fire; I beat off a piece of it, and placed the remainder before a Microscope, which show'd itself as Fig. 2. F G H I, the Break of which

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is represented by GH. On which side, the more one view'd it, the more should one be perswaded that the many small shining Particles were certainly Metallin; but when I brought it to the Fire, and endeavour'd as much as I was able to keep the Smoak together, it appear'd plainly to me to be nothing but Sulphur, which was not only manifest by the smell of it, but that which was drawn off was of a yellow Colour, just as Sulphur appears to our naked Eye.

Now that Fig. 1. A B C D E is a part of a real Snail is clear to me, but how, and after what manner the Sulphur gets into the Horn, we can only guess. My opinion of the matter is this: The Snails and other things that are found upon the Mountains of *Switzerland*, and which are supposed to be changed into Metals, have lain, and do still lye where a great quantity of Sulphur is shut up in the Bowels of the Earth; and that Sulphur, by a Subterraneous Heat or Warmth being render'd Fluid, mounts upwards in exceeding fine Particles like Fire, and so insinuates itself not only into the inmost parts of the Snail-shell, where, according to all appearance, the Snail itself is almost consumed, but also into the Pores of the Horn or Shell, and is there fixt and coagulated, so that the whole Snail is converted into a Sulphureous Substance.

This may seem strange to some people, but those that have dealt in Sulphur, and know into what an unpeakable great number of small parts it can be divided by Fire, they can easily conceive into what a number of Bodies, Sulphur, being put into a Fluid Motion, can insinuate itself in some Ages; for, according to the opinion of the Learned Mr, as I have been inform'd, these Snails, and other Testaceous Animals, which are found in the High Mountains of *Switzerland*, have lain there ever since the Deluge; and so many of them by length of time are turned into Metal; or rather, according to my Hypothesis, are mostly Sulphur.

Now,

Now, in order to set before my own Eyes anew the exceeding small Particles into which Sulphur is divided by Fire, I prepar'd a little Glafs Globe represented by Fig. 3. A B C D, and placed in it at B, a small particle of Sulphur about the bigness of a single Corn of Sand ; and when the Glafs and the Air within it was so Temperate as to agree with the Air we commonly breathe in, I seal'd that part of the Glafs which was open at E Hermetically, and then blow'd the Flame of a Candle upon the other part of the Glafs where the Sulphur lay, till it evaporated into Smoak, which Smoak for a small space of time was carried about the Glafs in a Circular Motion ; and after that the Sulphureous Smoak subsided, and settled it self on the Glafs, I examin'd it with a Microscope, and observed so many exceeding fine Particles on the sides of the Glafs, that no man scarce could believe that such a small grain of Sulphur could possibly be divided into so many parts ; insomuch that the smallest Globules of this divided Sulphur could hardly be seen with one of my best Glassies, and the largest Globules lay round about the Sulphureous Matter that was not quite dissolved.

I let the Glafs Sphere lye still about half an hour, and then view'd it anew, and observed with wonder that some of the small Globules of Sulphur, that lay a little remote from the rest, form'd themselves into a right line, and that 4 or 5 were placed lengthwise, and some Globules were so extended in length, that they toucht one another ; but some hours after they were all united, and so composd one little body just like Salt-petre, when being joyn'd to Water, it begins to coagulate.

This Inclination or Coagulation was wonderful to me ; and the more, because some of these Coagulations were twice, others three times as long as some others that lay thereabout ; and just by these coagulated long Particles lay other Sulphurous Particles, but none very small.

'Tis true, we see daily in Fluid Substances, thro' a Secret Inclination, that Homogeneous Particles coagulate together, but how the Particles of Sulphur, that are as it were glew'd down to the Glas, should assemble and unite in one body, is very wonderful to behold.

I had one Snail-shell, represented here by Fig. 4. K L M N O, which was extraordinary heavy in proportion to its bigness, and which seem'd to me not to be quite whole, but that some part of it was broken off, as at L M.

I endeavour'd to break this Shell to pieces with my Fingers, but was not able, wherefore I laid it upon some Lead, and so broke it to pieces.

I wanted no Microscope to view these broken pieces, which seem'd to be full, excepting the slenderest part of the Tail, with a pale yellowish substance, that was visible enough to the naked Eye.

To satisfy my self about the said appearing Metallin Particles, I put about a fourth part of the last mention'd Snail-shell into a Glas, and brought it to such a strong Fire, that the Glas was upon the melting; in doing which, I separated a great deal of Sulphur (in proportion) from it, and when I took the remaining Matter out of the Glas, I saw that all the Sulphur was not extracted from it, for I discovered several Sulphureous Particles lying in the remaining Matter, which one would take for a black burnt Earth; and they were divided from each other in longish Particles, each of 'em having distinct Figures, agreeable to the places which they were to fill.

I seal'd up hermetically the Glas wherein the extracted Sulphur was coagulated, to the end that no Moistness or Vapours should get into it, nor none come out, and then I view'd those Sulphureous Particles that had lain farthest from the Fire, and saw that the Glas (tho' nothing thereof was perceptible to the naked Eye) was cover'd

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cover'd with Globules, just as if one had spread a Table all over with Sand ; and when I view'd the same a little while after, I saw the small Particles were coagulated together in irregular Figures ; and as I did imagine before, that the small Sulphureous Particles were fastned to the Glas, now I saw an Oleagenous and Watry Substance, which one might call the Spirit of Sulphur, drawn off together with the Sulphur, and that several places in the Glas were without the Globules, and nothing but some of this Oleagenous Matter to be seen.

I had also a third Snail-shell, whose outmost part, or Shell, was as smooth as if it had been Polisht ; and when I lookt upon it thro a Microscope, I observed that the Horn or Shell had been adorn'd with wonderful Figures ; from which sight I concluded that the Glasse, or smoothness of the Shell was occasion'd by the long and frequent Attrition of the same against other hard Bodies, before it could get any Rest in the High Mountains ; as we see in hard Stones that are found on the Sea shore, which by the frequent Motion of the Waves or Sand about 'em, become very smooth and polisht ; and 'twas by such Motion that the fine Figures in the Shells are quite worn out.

This Shell described by Fig. 5. PQR I could break very easily with my Fingers, and with my naked Eye discover that it was for the most part composed of the abovemention'd shining Matter, as it was also for the most part full of Sulphur.

I had another Snail-shell, represented by Fig. 6. TVW, which was also very smooth, and when I broke that Shell in pieces, that which seem'd to be so smooth to the naked Eye, appear'd now with as many scratches as if it had been rubb'd with sharp Sand ; and this was adorn'd with Figures too that were not discernable with the naked Eye ; a small part of which is here described by Fig. 7.

AB.

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A B C D E F G H, which was raised a little above the other part of the Shell, and some part lower, as B C D.

The abovemention'd Montieur *Valkenier* put into my hands a little Body, whose form or shape is represented in Fig. 8. X Y Z, which is also found on the high Mountains of *Switzerland*, which seeming to the Eye to consist of three Joynts, I endeavour'd to separate 'em from one another, in order to discover, if possible, the internal figure of it; and tho I attempted to cleave it thro in the joynted parts with a sharp Steel, I could not compass it, but broke it into irregular pieces, all which were so smooth and shining within, that the like never occur'd in any common Stone; and it was moreover more than ordinary hard; the best judgment I could make of it was, that it was compos'd of flat parts.

I laid the biggest piece of it upon Wood coal, and brought it leisurely into a strong glowing heat; in doing which, at first some Splinters of it burst away, and I could not perceive that there was any Sulphur in it; whereupon I dropt it into a small Copper Vessel in which there was not above a Thimbleful of Water, to see whether that would separate the Parts, in order to discover the Homogeneous Parts the better; but instead of doing so, it divided into a vast number of unspeakably small white Particles, to which one may give the name of a Chalky substance.

As soon as this Chalky Matter was separated, I observed a Film or Scum upon the Water, which I took to be the Coagulated Salts thereof.

I took a little of the said Water from under the Scum, and poured it upon a clean Glass, and viewing it presently after, I discover'd, to my great Amazement, so many Clear and Transparent Salt-particles (many of which were so fine and slender, that they seem'd to have but one Circle or Circumference) and of so various and different figures, that I believe no Painter, tho' his fancy were

were never so fruitful, could invent such a number of Figures, or trace them upon Paper, as I there saw; and they were so very small, that several Thousands of 'em together could not equal the magnitude of a single grain of Sand; and forasmuch as a very great many of 'em were long, I fancy'd to my self that that Figure might be peculiar to them, and that all the rest had only assumed a borrowed form, which might be determined by the different manner of their uniting or coagulating in several places.

I let the Water stand upon the so called Chalky Substance a few days till it was all evaporated, and then I discovered a great number of very small shining Particles lying at the bottom of the Copper-Vessel, into which I had put the said matter; all which I took out as clear as I could, and placed them on three several clean Glasses, and then viewing 'em with a Microscope, my wonder was much greater, for I did not only observe so very different Figures, that no two of 'em were like each other, but they were all of them as clear and bright as Crystal, yea, some of them had as fine and regular points as a wrought Diamond, tho' above a thousand times smaller than a course Sand.

Among others, there appeared to me such a Triple-jointed Body as is described by Fig. 8. X Y Z, which also endeavoured to separate by its Joynts, but I could not succeed in this neither.

I laid this too upon a Wood Coal to make it glowing hot, as I had done the other, but a good part of it burst away when it was but just warm, and as it began to be hotter, it made such a bustle, that if I had proceeded farther, I should have kept none of it; whereupon I took a Glass Tube above a hands breadth long, and hermetically sealed at one end, into which I put what remained of the above-mentioned Figure, and then heating that end of the Tube, the said Matter burst with great violence into such small Particles, that many of them seemed

as fine as Meal or Flower, and if I had not stopt the open end of the Tube with my finger, most of this dissolved Matter would have forced its way out from thence.

Afterwards I put the said Tube into a glowing Heat, and then observed that a great deal of thin Watry Vapours were extracted from the rest of the aforementioned substance.

I viewed the small Particles that were in the inside of the Glass, and I saw a great many very thin Scales, some of 'em having right Angles, and all of 'em seem'd to be compos'd of such small Particles, as fine Sand seems to be, to the naked Eye.

I took the aforementioned Matter out of the Glass Tube, and placed it upon a Wood-Coal, in order to put it into a greater Heat, but as soon as I had put it on the Fire, the small Particles flew away so fast, that I was forced to put it into the Tube again; and after having made it red hot, I poured it out of the Tube into the Water, but the Heat was not so great as to make it turn into a Chalky Substance, excepting a little piece no bigger than a Pins head, which I heated again without bursting or breaking, and dropping it into the Water it dissolved into a Chalky Substance.

I had several such like Particles but much smaller, and consisting of five Joynts or Ribs, which were also found upon the Mountains of *Switzerland*. This Particle, which is described by Fig. 9. I K, I slit thro the Joynts, but I could not do it so nicely, but that a small piece of another Joynt stuck to the biggest; so that I could not so perfectly discover the Rose-like figure, as it is represented by I.

I laid these slit Particles also upon Wood-Coal, intending to heat them leisurely, but they made such a bustle upon the Fire, that in case I had proceeded, there had been none left upon the Coals; wherefore I put them likewise into a Glass Tube, as I had done before, but without any other

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other success, tho' I held the Tube and the abovemention'd Matter in it, first in the flame of a Candle, that it might be leisurely heated, and by this means it was so dissolv'd, that it seem'd nothing but a Powder, and in this Operation there was also some moisture exhald.

From this wonderful Bursting, and that in such small pieces, I could conclude nothing else, but that a great many Watery Particles were shut up in this same Matter, and that these Particles were so strongly united, and were moreover of so tenacious a substance, that it did not admit of the least Evaporation of Moisture; and these Watery Particles being rarify'd by Heat, demand'd more space, and so occasion'd the Bursting of the abovesaid Matter.

I set the said Tube with the Powder in it over so violent a Heat that it was ready to melt, and immediately thereupon pour'd the Powder into Water, but it did not turn to a Chalky substance; and afterwards decanting the Water into a Clean Glass-Tube, I observ'd it to be impregnated with Salt particles,

In doing this I saw a great number of exceeding thin Particles like Fig. 9. I K, upon the sides of the Glass, and those that were the thinnest appear'd now just as the small Holes on the outside of a Thimble do to the naked Eye.

I placed several of the small Splinters that burst in the Fire before a Microscope, and order'd my Painter to draw that of which he had the clearest view, as you may see by Fig. 10. NO.

This Splinter was so narrow, that it had but three Rows of little Holes, which were all three no broader than the Hair of one's Head; and in some other Splinters the Holes were yet smaller.

From these Discoveries, I consider'd with my self, whether there had not been some Matter shut up in each of these Holes, which being rarify'd by the Heat, demand'd

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a greater space to contain them ; but being all fast shut up, and having no passage through the Pores, was the cause of those Bodies describ'd by Fig. 9. IK, to burst into so many thousand pieces.

Now if we reflect on the wonderful Composition of the last nam'd Figure, and the infinite number of Salt Particles shut up within it, and the various figures of the Salts that were extracted from Fig. 8. we must lay our Fingers on our Mouths and cry out, O the Depth of these Secrets.

The abovemention'd Gentleman gave me, amongst other things, two little Dice, of the bigness that is describ'd by Fig. 11, LM, adding, that some people said they were Stone, others Bone ; and that these Dice were found in *Switzerland* deep under Ground, and in great numbers in a place, where formerly there had been a *Roman Camp* ; and that the opinion of the *Swissers* was, that the *Roman* Souldiers had made use of 'em in play, whilst they were encamp't there.

I view'd a part of one of these Dice, and struck several blows with a Hammer upon it, which indeed made Holes in it, but without breaking it ; whereas if it had been Stone, it could not have withstood so many blows ; at last, having cut off some small bits, and made 'em glowing hot in the Fire, I observ'd that it was black as Bone is, when it has not lain long in the Fire, and white when it lay longer. In my last viewing of it, I was still the more confirm'd that it was Bone, for I could then discover the Pores of a Bone in it ; yet, in my opinion, it could not be made of the Bone of an Ox, because the Parts were smaller.

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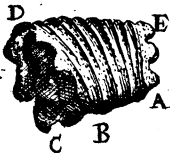


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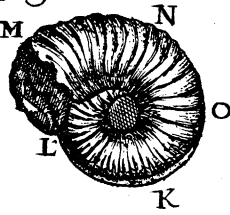


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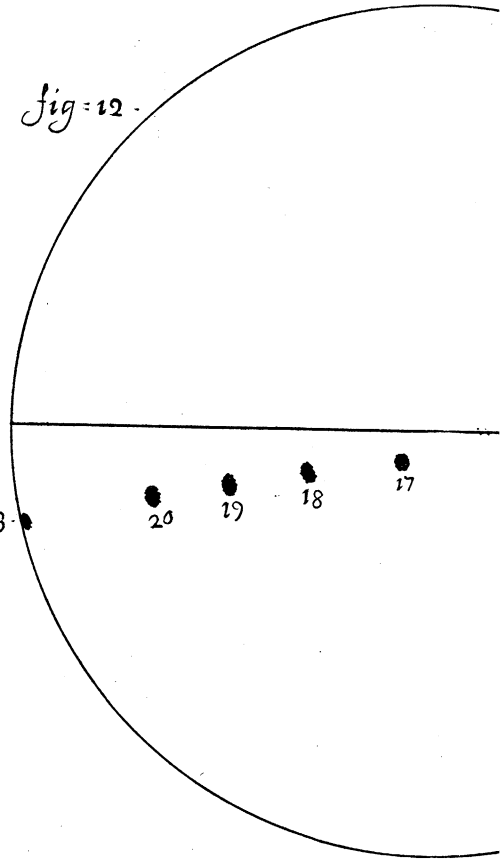


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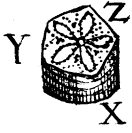
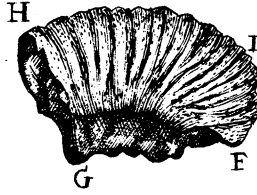


fig = 2 -



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fig = 6 -



fig = 5 -



fig = 7 -

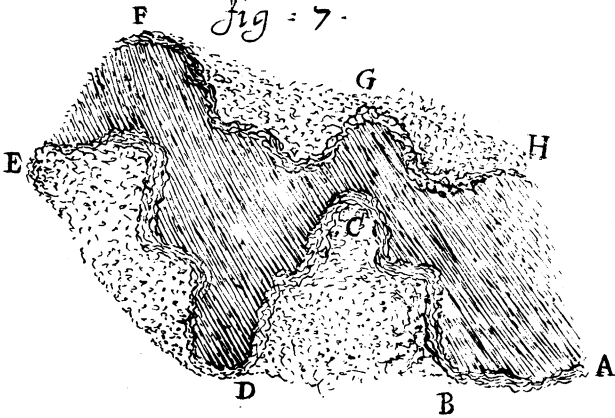


fig = 15 -



fig = 19 -

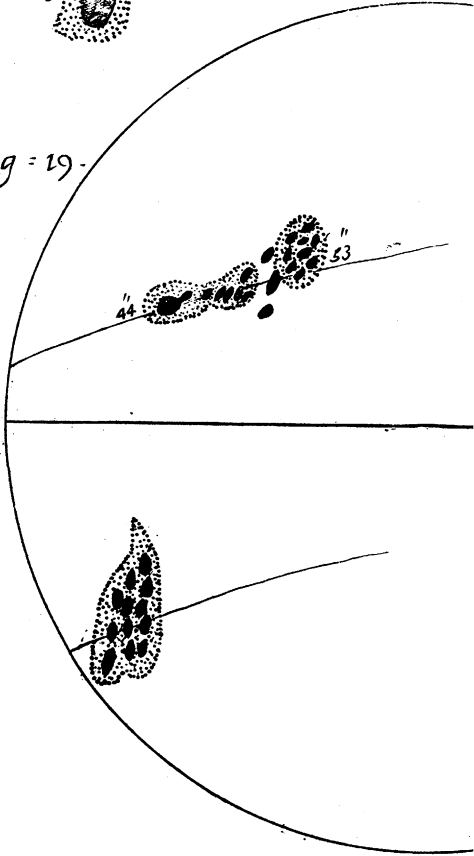


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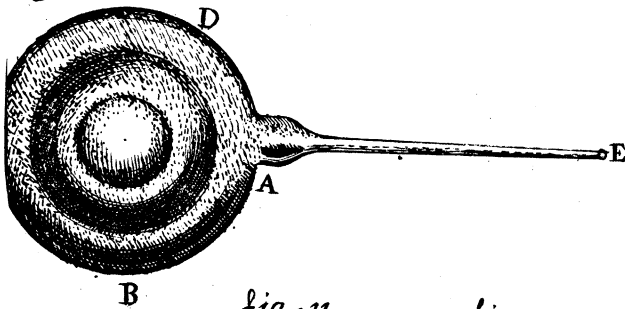


fig = 11 -



fig = 10 -



fig = 9 -



Fig: 18.

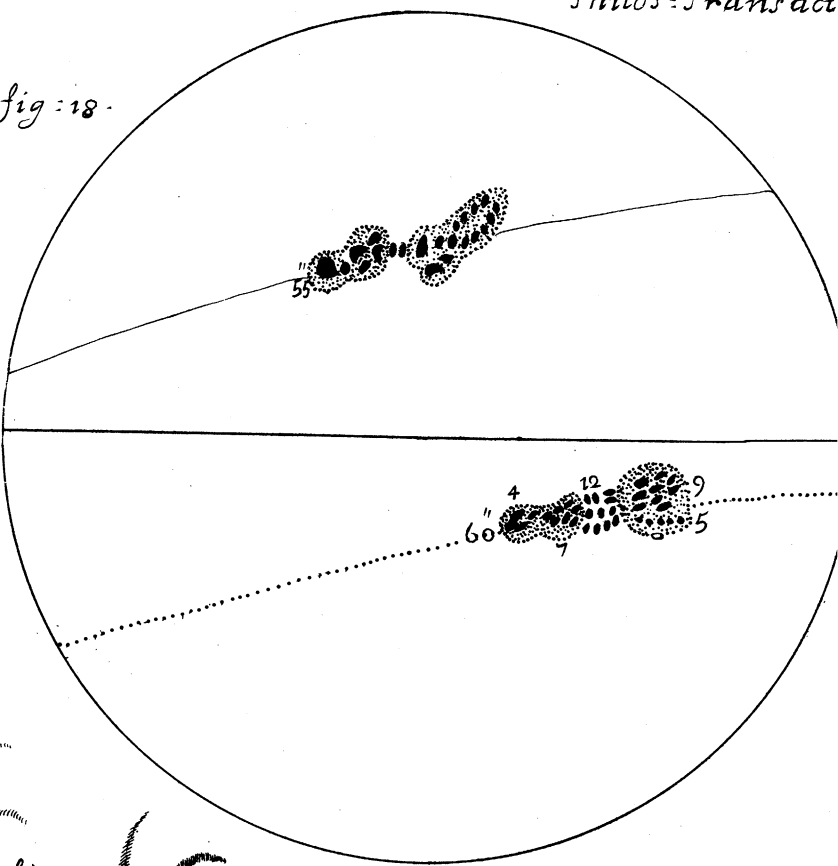


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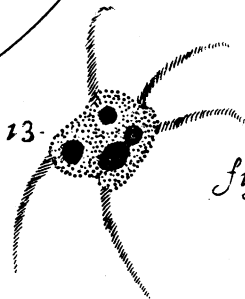


Fig: 14.



Fig: 17.

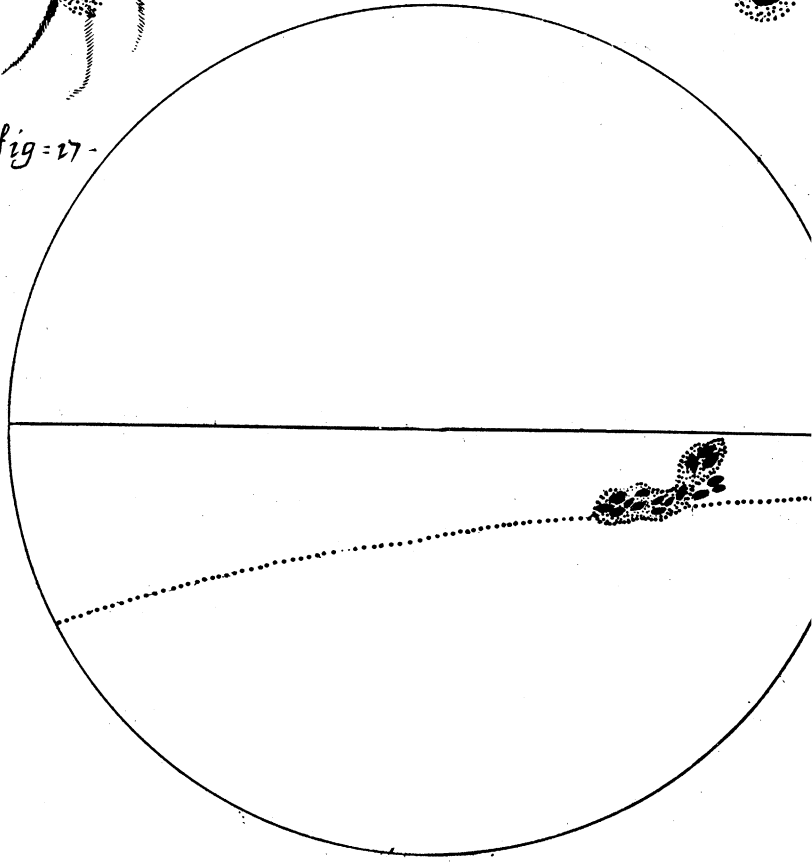


Fig: 16.



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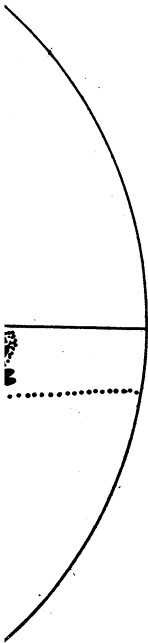
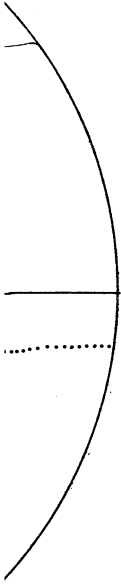


Fig: 1.

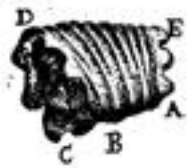


Fig: 4.

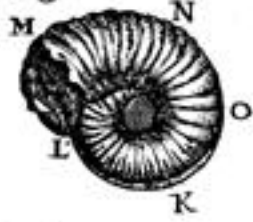


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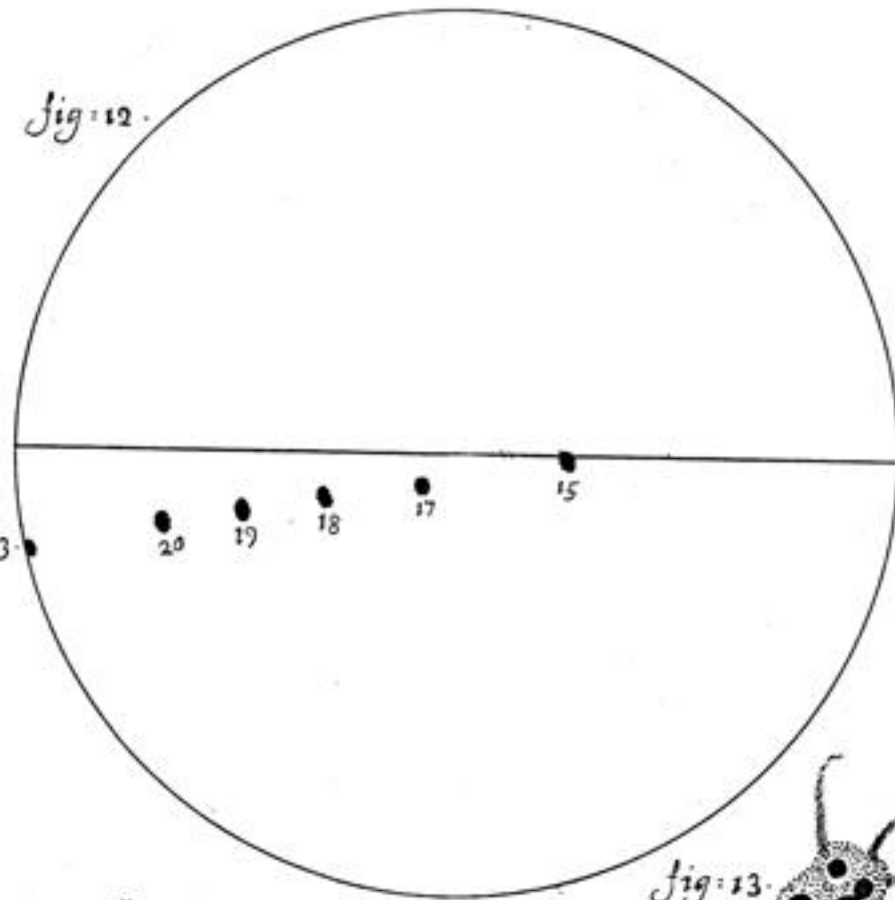


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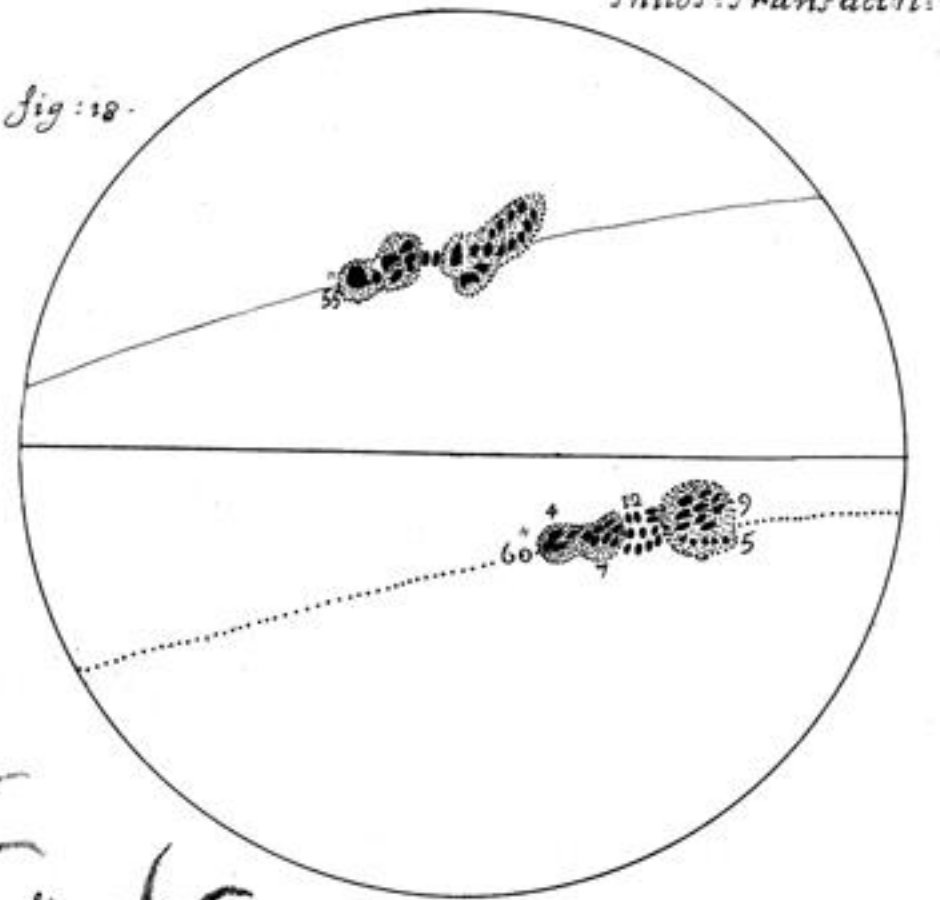


Fig: 8.



Fig: 2.



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Fig: 6.



Fig: 5.



Fig: 7.

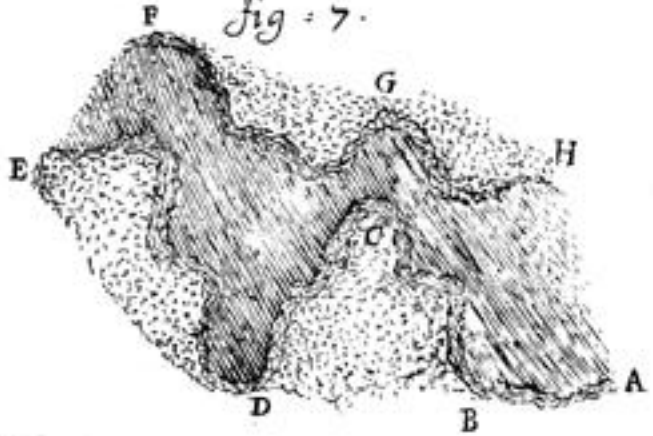


Fig: 13.

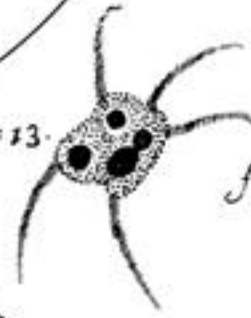


Fig: 14.



Fig: 16.



Fig: 15.



Fig: 17.

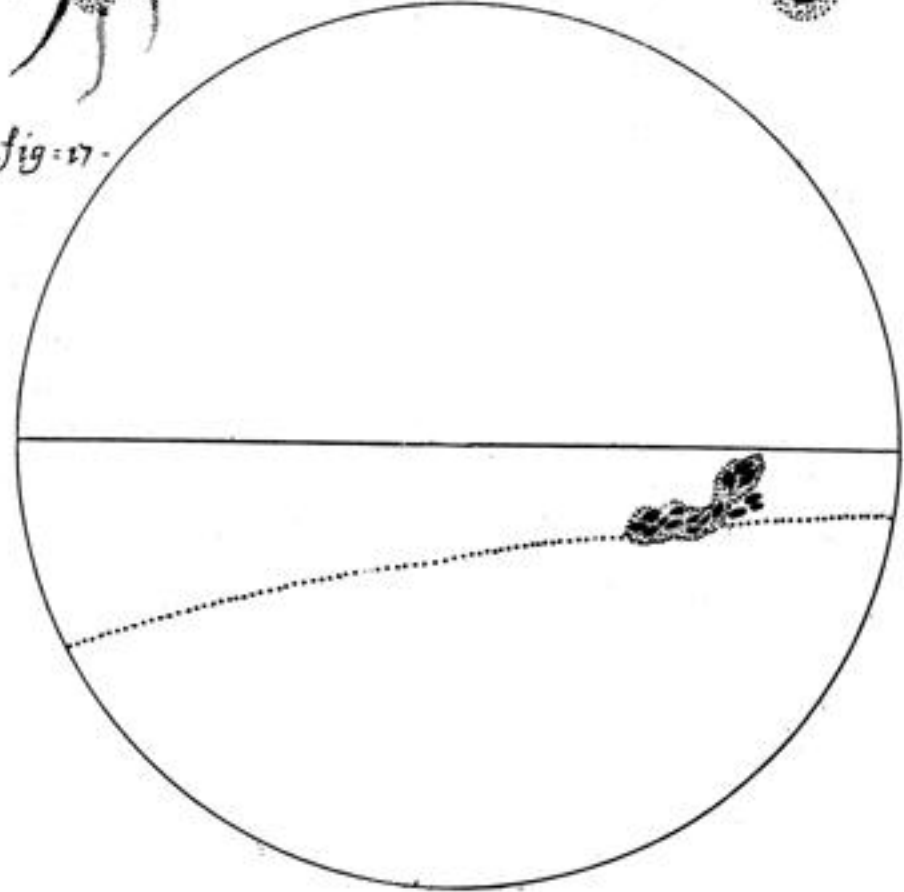


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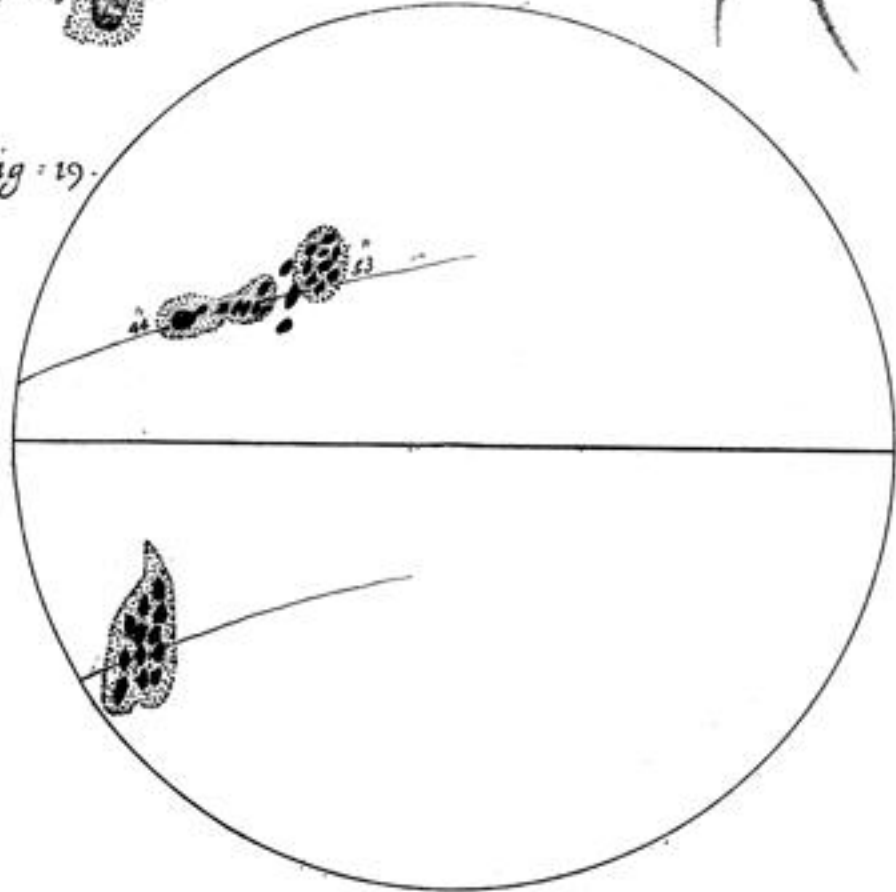


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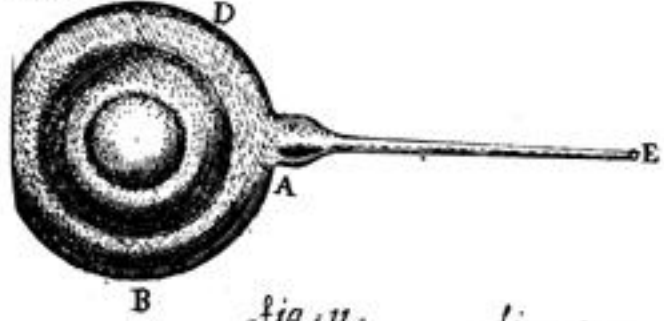


Fig: 11.



Fig: 10.



Fig: 9.

