

III. *An Extract of a Letter from Mr. Anthony Van Leeuwenhoek, to the R. S. containing his Observations on the Seeds of Cotton, Palm, or Date-stones, Cloves, Nutmegs, Gooseberries, Currans, Tulips, Cassia, Lime-Tree: On the Skin of the Hand, and Pores, of Sweat, the Crystalline Humour, Optic Nerves, Gall, and Scales of Fish: and the Figures of several salt Particles, &c.*

Since my former Observations on the Seeds of Plants, (Vide *Philosoph. Transact.* N^o 199, p. 700.) I was surprized to find a Variety from what I then wrote concerning the Mealy and Oily Substance, as likewise the *Embryo-plant* itself, to be nourisht by them; in the Seeds of *Cotton*, which lie Eight or Nine in clusters, in the *Cotton-wool* that comes from *India*: For having opened the hard Shell or Rind, with which the Seeds are covered, and from whence the *Cotton* proceeds, and stripping them from that curious, thin, whitish Coat, which wraps up each Seed so as to look like a little round Egg, the Seed itself shew'd, as Figure 1. which I have drawn larger Fig. 2. *ABC*; dissecting and opening this, I found no Mealy Substance at all, but four small Leaves enwrapping one another, and compassing the Root that lay in the midst of them. These Leaves are represented Fig. 3. *DEFGH*, sufficiently large, to shew the Vessels and dark green Globules between them. *ED* is the Root, in which were but few Globules. Some of these Globules being dissected, some Particles of them were of the fairest light Green I ever saw, others were of a very dark Green: *a b c* are Three small Pins I fasten'd the Leaves down
K k k
with

with. These Leaves, as I said, were spotted all over with little Specks ; and enquiring of some that had seen the *Cotton* grow, they told me, the Leaves of the Plant itself were thus spotted. So that we see, that Nature in this Subject, does not only wrap up the future Plant, but such a little Plant whose very Leaves are the same as on the grown Tree, only smaller.

This brought to my Mind that I had observed in the Eggs of some Insects (taken out of their Bodies) none of that Substance designed for the Nutrition of the *Embryo* ; but that in these Eggs were contained perfect and living Animals : so that as these Animals are perfect in the Egg, even whilst it is yet in the *Uterus* of the Parent, so the Cotton-seed contains a perfect Plant, even whilst it yet hangs on the Tree ; and besides, that part whence the Root grows is very large. And as the forementioned Animalcules need no Yolk in the Egg, being already perfect and fitted to search their Food abroad, so the Seeds of this Plant contain such an *Embryo-plant* as is already fit to shift for itself, and as soon as it falls from the Tree, the wet it meets with bursts the Shell, and it strikes Root, and displays its Leaves.

I cut the little Root transverse ; and whereas the innermost part in others is round or oval, in this it was eight-sided, wherefore I have drawn it Fig. 4. *ABCD*. This part was full of Pores, and encompass'd with a smooth white Body, in which I could see no Pores, *EFGH*, and this again was environed with another Body like the innermost, full of Pores, only they were smaller, *IKLM*. Tho' some of the Seeds I examin'd were very old, yet they contained a great deal of Oyl, and in some the Embryo was so fresh, that I thought it might grow, tho' I could never yet meet with a Seed that would.

Before I had made any Observations on Date-stones, I thought no other, but that the hard shell was only the covering to the Seed or Kernel ; but I found it quite other-

otherwise : for that very hard part is furnisht with plenty of Pores, and little *Tubuli*, serving for the Nourishment of the *Embryo-plant* contained in the midst, which is soft and easily cut with a sharp Knife. Altho' I have often observed in that part which is to be the Root and Trunk, very many long slender Fibrous parts, like Vessels lying by one another, and some of them fill'd with a White substance, yet I could never discover that part which gives beginning to the young Leaves. Some of these Date-stones I kept in hot moist Sand, and after some time, that part which is to be the Root and Plant, was shot out half an Inch ; but for all this I could not discover the Rudiments of any Leaves, I only found the part shot out to consist of long slender Particles, something smaller than those that I had observed in the beginning of the stem. I found some larger Vessels also of another form, coming from the beginning of the stem. Fig. 5. shews, The Date-stone with that side upper-most, as it is to be sowed. Fig. 6. shews, That side that is to be placed downwards in the Earth ; *A*, a round crooked part whence the Embryo proceeds. Fig. 7. Shews it when it has lain so long in the Earth, till the stem was grown to the length *BC*. Fig. 8. As it shew'd when the Root and Stem was of the length *DE*. In this Stem I observed nothing remarkable, only some large wide Vessels, whence I judged the Palm-Tree consisted of a very brittle infirm Wood ; and from a cavity in the midst thereof, I judged the Tree to be hollow, as the Bamboo, and some other *Indian* Plants are ; and altho this part being still included in the other hard part, was increased one 36th part bigger than it was before it was put into the hot Sand, I could observe nothing material, I only saw that which makes the Root ; and indeed, the Origine of a Plant is more like to nothing than a little Mushroom, as it grows on the Ground.

I chose some of the largest Cloves I could find, called Mother-Cloves ; for they are usually gathered while unripe : in some very large ones, which I judged perfectly ripe, I examined the inside only, and found it to consist of two parts, lying one upon the other ; which tho' they lie with several Angles, and each in a different manner, yet they are the Kernels, or Medullary part : for between these the *Embryo-plant* is placed, and is joyned to them by Ligaments, by means of which it is nourish'd. The beginning of the *Embryo-plant* is delineated Fig. 9. wherein *EF* shews the complicated Leaves. *BCDE* and *GHIK*, the Broken Ligaments which are joyned to every part of the Kernel or Medulla ; which manner of Union is in many Seeds, but in some Seeds the joyning is only where the Trunk and Root begins. *ABKL* is that part of the young Plant, whence the Stem or Root begins, of which this is but a sixth part : this was of a dark Green, full of several very shining Globules : I wetted that part whence the Stem proceeds, otherwise it was too brittle to cut, and then sticking to the Knife, it presently turned black, by reason of the Salt it contained, tho' before it was very white. Fig. 10. *MNOP* is one of these Pieces so cut off, in which the transparent shining Globules represented in the former Figure between *A* and *L*, are here seen cut through. I could discover but few Pores in the outward Skin, by reason most of them were shrunk and dried up. I endeavoured to make some of the Mother-Cloves to vegetate by sowing them in Sand ; but in vain only, one time I made the little Leaves of the Embryo begin to open themselves, as Fig. *B* — *QRS*, in which Leaves the aforementioned shining Globules were visible, tho' in the other Leaves they were not. The manner of curing Cloves in *India*, is by soaking them in Salt water, and drying them in the Smoak, which makes them look so black, which when I heard of a Gentleman that

that had lived there, it put an end to my farther Tryals.

I examined Nutmegs, as well preserved, as dry ones, and found always under the Mace a thin Skin, before we come to the hard Shell, and in one place a Ligament by which it was united to the Tree, which entered the hard Shell, and was joynd to the Nut at that part whence the Root shoots out: which was all I could find, they being, as I suppose, gathered green, and spoil'd in the curing, so that they will not grow.

I took the largest Gooseberries, and in the Seeds of them, whereof there are sometimes near Sixty in one Berry, each nourisht with a peculiar Ligament; viewing the *Embryo-plant*, I not only found the foremention'd parts, but could discover the ascending Vessels, as Fig. 11. *ABCD*. Examining the proportion the *Embryo-plant* in these Seeds bears to the Seed itself, I found the Seed seven times longer, broader, and thicker than the *Embryo-plant*, that is Three hundred times the Bulk thereof.

Out of one of the largest Black Currans, I took Sixty three Seeds, each furnisht with a particular Ligament, the *Embryo-plant* in these, was such as is represented Fig. 12. *EFH*, is that part whence the Root and Stem proceed. *FGH* are the two Leaves: in this, I reckon, the Seed is above Sixty times bigger than the little Plant. Hence we may conclude, there is no Seed but what has its *Embryo-plant*.

I have been often told, that the Flowers of the Tulip might be seen in the Bulb thereof; which I could never believe, and should rather look for it in the perfect Seed; however, I have cut open many Bulbous-roots, but could never meet with any thing material. Examining Tulip-seeds, I found the Origine of the Plant, oblong, and round at each end, furnished with ascending Vessels.

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Since many have doubted of the Truth of my Discoveries, and because I am a zealous Lover of Truth, for the satisfaction of the Incredulous, I made choice of two Seeds, *viz.* the Seed of *Cassia*, and of the small *Olive* : in the last whereof we may with our naked Eye discern, not only the young Plant in the Kernel, for it is very large, but the Membranes enwrapping it, and the Ligament, and that the better, because the Ligament is of a different colour from the Membrane. And in *Cassia-seed* are observable, the young Plant, and especially the Leaves, which I conceive are so large, for the better nourishing the Root, which is in this Seed very small, and by sowing it in wet Sand, the Root began to shoot down the Leaves, display themselves, and the young Plant appear between them.

The Seed of the Lime-Tree is the most pleasant Spectacle : for in these, the young Leaves neither lie plain, nor are wrapt up, but wrinkled like the first Leaves of Trees in the Spring of a pleasing green Colour, and with a Microscope, the Fibres of the Leaves are very visible, and contrary to most other Seeds, the Root of the Embryo grows next the Tree.

In the great heat of the Summer, I observed several little transparent Pimples on my Hand, containing a clear Liquor, which I supposed were caused by the Skin, not permitting the Sweat to pass through it ; wherefore I cleansed well, part of the Skin of my Hand, and by my Microscope, in a space not bigger than a Sand, I saw the Sweat issuing out at about Fifty places, which as they touched, joyned together into one little Bubble.

After drinking about a Quart of *French-Wine* over Night, I found my self a little out of order the next Morning, at Dinner I drank a Pint and half more, and after about Two Hours, I drank Half a pint of Tea very hot, that I might throw my self into a Sweat : which taking off my Face as clean as I could, I examined

it, and found therein a great number of such Scales as constitute the outward Skin, and very many Globules about $\frac{2}{3}$ of the bigness of a Blood-Globule, and yet a much greater number of much smaller Globules, and amongst these a great number of salt Particles very small, yet of a curious four-sided Figure, which as the moisture exhales, joyned together in mishapen Figures, which with the least moisture of the Air turned to Water again, among these were some few of the shape of Willow-leaves, and like the Figures made by *Sal Armoniac*. I made this Experiment, to see if any of the salt Particles to be found in my Sweat, were like those found in Wine; which tho' I attempted three days successively, yet I could not discover any.

Another day, after Dinner, when I had drank no Wine, I observed my Sweat, and found as before, the Scales, Globules, and salt Particles, which were square, and some pyramidal, others were longish, others branched, which was only by the uniting of several small ones.

A learned Person caused the little Furrows in his Hands to be designed, supposing them to be the Pores whence the Sweat issues forth; which I could never imagine: for I have observed the Sweat to come more from the Ridges than out of the said Furrows: and examining these Furrows, I found more and closer Scales in the Furrows than on the Ridges. Wherefore, I conclude, that these Indentings are the places where the Scarf-skin is most united to the Skin underneath it.

I examined the *Crystalline Humour* of an Horses Eye, and found it little different from an Oxes, Hogs, Sheeps, &c. only it was very large, so that its greater Axis was $\frac{2}{3}$ of an Inch. I formerly observed, that there was no cavity in the *Optic Nerve* of an Oxes Eye, but that its substance was made up of very many Fibres or Threads, which were filled with gently flowing Globules, (and that if one of these Globules in one of these

these Threads) nearest to the Eye, were moved by the Object, by this means not only the next, and so successively all the Globules in that Thread; and lastly, the Brain itself would be moved. I have found the same since in the Optic Nerves of four Horses Eyes, and if it be not allowed that the sight is thus performed, yet it must be granted, that great plenty of new matter continually thus flows from the Brain for the nourishment and generation of the Eyes.

I examined the Gall of a Trout, and found therein a very great quantity of small Globules, lesser than Blood-gobules, and yet a greater number of much smaller ones scarce to be discovered by my best Microscopes, so that I think it impossible the Liquor should be so very fluid, unless these Globules sometimes changed Figure, and that easily as they pass by each other. But what Method soever I made use of, yet I could not discover any salt Particles therein, which was my aim.

I observed the Skin of a very large Eel, and found the Scales on the Back and Belly, in strait Rows one upon another, but those on the sides were some sloping towards the Belly, others towards the Back, but all downwards. Examining the Matter or Slime covering these Scales, which is generally thought to come from without to the Scales, whereas it is a real part of the Body itself, furnished with Capillary Vessels, and Veins admirably interwoven; of which some are so very slender, that if a common Blood-gobule were divided into a Thousand parts, one of these could yet scarce pass them. From which Observations I conclude, this Slime is but as the *Cuticula* that covers the Scales, and if these be rubb'd off by any external Accident, the Eel will not live long. This outward Skin of Eels, as I call it, I found cover'd with very small round Particles, not a fourth part so big as those whereof the Scales seem to be constituted.

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That Slime also wherewith the *Bream* is covered, is nothing else but a kind of *Cuticula*, tho' the Vessels thereof are so very small as to require a very excellent Microscope; and this substance is likewise cover'd with extrem minute Globules, This commonly called Slime, does not only proceed from the innermost Skin of the Fish, but partly out of the Scales: for I discovered clearly that part of the represented Scales. Fig. 13. *BCD*, was united to a very great number of small Vessels, so that the remaining part of the Scale *AB, DE*, had no Vessels or Slime proceeding from it, which last part was covered only by the Vessels that proceeded out of the other Scales. The Vessels producing this Slime, proceeded not only from the outer part of the Scale, but from that side also which is next the Fish; which upper and under Vessels proceeding to the gibbous part of the Scale *BCD*, intermix there. The remainder of the Scale *AB, DE*, is partly covered by Vessels coming out directly from the Skin. Secondly, By Vessels proceeding from within, from *FGH*. Thirdly, By Vessels proceeding from the gibbous parts of the Scales 1, 2, 3. it is necessary, that no Vessels forming this Scarf-skin, should proceed from *AB, DD*, otherwise the Fish could not bend itself, if no part of the Scales were free, but that they were all closely united together; whereas, by this means, they can easily slip over one another. The Vessels that proceed from one Scale in Eels, extend themselves over at least Twenty five Scales, and interweave with others, whence proceeds that extraordinary toughness observed in their Slime.

Next I viewed the Scales of *Perch*, and found them likewise furnish'd with such a sort of Slime or Skin also, the difference being only in that the Vessels making it are much stronger, so that it is not so easily rubb'd off, and is defended by little Pricks that stick out at the ends of the Scales.

Being not fully satisfied with these Observations, I proceeded to search for these Vessels in the Scales themselves, and to represent the Make of the Scales, I have drawn a very small part of one which in the Microscope, shewed like clear Crystal, with several streaks one under another, as Fig. 14, *IKLM*. *IM* is that part that is joyned to the Skin of the Fish, and is about as long as two ordinary Sands. I told five Ridges from *I* to *K*; the *Bream* from whence I took this Scale, I judged about twelve Years old. The Make of these Scales, with the Manner how the Streaks cross one another, is best understood by the Figure *KLN*.

I set some Beer-Vinegar in my Closet, and after eight or ten days, I found therein a great number of salt Particles, sharper than those I had formerly seen in Wine-Vinegar: I have drawn them Fig. 15. *A*. In some I saw a little cavity in the middle; others were, as I thought, not perfectly formed, wanting one Point, as *B*. others were a great many joyned together: I put some Crabs-Eyes into the Vinegar, and then the salt Figures were so small, and all encompassed with little Particles, that I could not discover any perfect salt Particles.

Juice of Lemons and Citrons afforded me no salt Particles, but after freezing, and a little settling at the bottom of the Vial, the clear Juice yielded plenty of them, much like those of Wine and Beer-Vinegar, represented *AB*.

Spirit of *Sal Armoniac*, after a while exposing in my Closet, began to shoot, and examining the Figures, I found a great many small Particles coagulated into one little Mass, each of which were a little longer than broad, with a little cavity, so that it seemed as if they had been plain at first, and that the sides turned up. I viewed a little of this Spirit, 'till it shot into Salts before my Eyes, which it did in an instant, like Lightning; but the Figures by this means made, were like little irregular Pipes, so that I am not certain concerning the Figures in this Spirit.

I mixt some of this Spirit with an equal quantity of Blood, and at first could see no alteration: but in about $\frac{1}{4}$ of an hour several of the Blood-globules were dissolved, and the Spirit mixt with the *Serum* lookt reddish; in another Quarter there were but few Globules undissolved, and the *Serum* lookt redder than before.

I got a little Phial of the famous *Sal volatile Oleosum*, and looking upon it in the open Air, I admired to see so great a quantity of Oyl get together in the little Globules, amongst which some were not bigger than Blood-globules swimming in a thin Water; so that it is this Oyl only which gives it the yellow colour. It is observable, that this Oyl did not separate from the watry part, 'till it had been expos'd to the Air, and some part evaporated. Next I examined the Figures of the Salts, of which some were so small, that I could not see their shape; others were such as is represent'd, Fig. 16. *A*; others like *B*, such as I have seen in Wine, and some of a Cubical Figure like common Salt, as *C*: there were a great number of other Particles, which by reason of their number, and the thick matter in which they were, could not well be discerned, they were of a dark colour, and may be reckon'd Globules. Then I took $\frac{1}{4}$ of this *S.V.O.*, and put to it $\frac{1}{2}$, or more, of strong Wine-Vinegar, and having shook it well together, after an hour's time I view'd it; but the salt Particles were in as great a quantity in the Vinegar, as if no *S.V.O.* had been mixt therewith: the same happened when I put equal parts of both together. I tast'd this last mixture, and found it very sour: I repeated it with other *S.V.O.* bought at another place, with much the same success, only there happened to be a little bit of straw in the Phial, consisting of three little Pipes, Fig. 17. *ADEF*, about which were presently gathered several little Air-bubbles, *BCDG*, which growing bigger and bigger, separated themselves from the bit of straw and burst. I have often observed, that a small Glo-

bule of Air as *B* has been above a larger as *A*, which Globule has not risen upward to *C*, and so to *D*, but been thrust downwards to *A*, whence it was distant about two hair's breadths, and immediately upon touching united therewith. I have likewise observed, that a little Air-bubble as *G*, loosening itself from the straw, when a larger Bubble, as *F*. was underneath it, has there rested immovable in the Liquor, when at the same time other much smaller Bubbles have risen to the top thereof. The reason of the standing still of the Bubble *G*, I suppose was from a double motion it is impelled to, the one upwards from its being specifically higher than the Liquor, the other downwards, by which it was protruded, to joyn with the other larger Bubble *F*. Tho' I have seen several Effects of Sympathy, if we may so call it, yet I never saw any so manifest as this, of the descending of a Bubble contrary to its levity, to unite with another.

IV. *An Instance of the Excellence of the Modern ALGEBRA, in the Resolution of the Problem of finding the Foci of Optick Glasses universally.* By E. Halley, S. R. S.

THE Excellence of the *Modern Geometry* is in nothing more evident, than in those full and adequate Solutions it gives to Problems; representing all the possible Cases at one view, and in one general Theorem many times comprehending whole Sciences; which deduced at length into Propositions, and demonstrated after the manner of the *Ancients*, might well become the Subjects of large Treatises: For whatsoever Theorem solves the most complicated Problem of the kind, does with a due Reduction reach all the subordinate Cases. Of this

