Robert Hooke (1635-1703)

http://www-history.mcs.st-andrews.ac.uk/history/PictDisplay/Hooke.html

•Very early in his life he showed great interest in making mechanical toys and in drawing.

•As a chorister at Oxford, he came into contact with many scientists, including Robert Boyle, with whom he perfected an air pump.

•He began working on springs in order to develop a solution to the Longitude problem; his goal was to use springs, instead of gravity, for making a body vibrate. He published the first paper that discussed the elastic properties of solids, "De Potentiâ Restitutiva (Of the Spring)".

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ut tensio sic vis (As the extension, so is the force)

•Became interested in microscopy, and published "Micrographia".

•Was very active in London's reconstruction after the Great Fire of London In 1666; he was made a surveyor by the city magistrates, and designed (as did Christopher Wren) numerous buildings.

- **Had a clear picture of universal gravitation.**

At a meeting of the Royal Society of London in 1666, he explained

"I. That all heavenly bodies have not only a gravitation of their parts to their own proper centre, but that they also mutually attract each other within their spheres of action."

"II. That all bodies having a simple motion, will continue to move in a straight line, unless continually deflected from it by some extraneous force, causing them to describe a circle, an ellipse, or some other curve."

"III. That this attraction is so much the greater as the bodies are nearer. As to the proportion in which those forces diminish by an increase in distance, I own [says he] I have not discovered it although I have made some experiments to this purpose. I leave this to others, who have time and knowledge sufficient for the task."

I

MICROGRAPHIA,

OR SOME

Physiological Descriptions

OF

MINUTE BODIES,

MADE BY

MAGNIFYING GLASSES;

WITH

OBSERVATIONS and INQUIRIES thereupon.

Observ. I. *Of the Point of a sharp small Needle.*

AS in *Geometry*, the most natural way of beginning is from a Mathematical *point*; so is the same method in Observations and *Natural history* the most genuine, simple, and instructive. We must first endevour to make *letters*, and draw *single* strokes true, before we venture to write whole *Sentences*, or to draw large *Pictures*. And in *Physical* Enquiries, we must endevour to follow Nature in the more *plain* and *safe* ways she treads in the most *simple* and *uncompounded bodies*, to trace her steps, and be acquainted with her manner of walking there, before we venture our selves into the multitude of *meanders* she has in *bodies of a more complicated* nature; lest, being unable to distinguish and judge of our way, we quickly lose both *Nature* our Guide, and *our selves* too, and are left to wander in the *labyrinth* of groundless opinions; wanting both *judgment*, that *light*, and *experience*, that *clew*, which should direct our proceedings. *Schem. 2. Fig. 1.*

We will begin these our Inquiries therefore with the Observations of Bodies of the most *simple nature* first, and so gradually proceed to those of a more *compounded* one. In prosecution of which method, we shall begin with a *Physical point*, of which kind the *Point of a Needle* is commonly reckon'd for one; and is indeed, for the most part, made so sharp, that the naked eye cannot distinguish any parts of it: It very easily pierces, and makes its way through all kind of bodies softer then it self: But if view'd with a very good *Microscope*, we may find that the *top* of a Needle (though as to the

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Observ. I. *Of the Point of a sharp small Needle.*

not appear so rounded, and lying above the Paper, as it were, as it ought to do) that is, it was for the most part pretty oval end-ways, somewhat like an Egg, but the other way it was a little flatted on two opposite sides. Divers of these Eggs, as is common to most others, I found to be barren, or addle, for they never afforded any young ones. And those I usually found much whiter then the other that were prolifick. The Eggs of other kinds of Oviparous Insects I have found to be perfectly round every way, like so many Globules, of this sort I have observ'd some sorts of Spiders Eggs; and chancing the last Summer to inclose a very large and curiously painted Butterfly in a Box, intending to examine its gaudery with my *Microscope*, I found within a day or two after I inclos'd her, almost all the inner surface of the Box cover'd over with an infinite of exactly round Eggs, which were stuck very fast to the sides of it, and in so exactly regular and close an order, that made me call to mind my *Hypothesis*, which I had formerly thought on for the making out of all the regular Figures of Salt, which I have elsewhere hinted; for here I found all of them rang'd into a most exact *trigonal* order, much after the manner as the *Hemispheres* are place on the eye of a Fly; all which Eggs I found after a little time to be hatch'd, and out of them to come a multitude of small Worms, very much resembling young Silk-worms, leaving all their thin hollow shells behind them, sticking on the Box in their *trigonal* posture; these I found with the *Microscope* to have much such a substance as the Silk-worms Eggs, but could not perceive them pitted. And indeed, there is as great a variety in the shape of the Eggs of Oviparous Insects as among those of Birds.

Of these Eggs, a large and lusty Fly will at one time lay neer four or five hundred, so that the increase of these kind of Insects must needs be very prodigious, were they not prey'd on by multitudes of Birds, and destroy'd by Frosts and Rains; and hence 'tis those hotter Climates between the *Tropicks* are infested with such multitudes of Locusts, and such other Vermine.

Obſerv. XLII. *Of a blue* Fly.

THis kind of Fly, whereof a *Microscopical* Picture is delineated in the first *Figure* of the 26. *Scheme*, is a very beautifull creature, and has many things about it very notable; divers of which I have already partly describ'd, namely, the feet, wings, eyes, and head, in the preceding Observations.

And though the head before describ'd be that of a grey *Drone-Fly*, yet for the main it is very agreeable to this. The things wherein they differ most, will be easily enough found by the following particulars:

First, the clusters of eyes of this Fly, are very much smaller then those of the *Drone-Fly*, in proportion to the head.

And

Obſerv. XLII. *Of a blue* Fly.

Obſerv. XLIX. *Of an* Ant *or* Piſmire.

THis was a creature, more troubleſom to be drawn, then any of the reſt, for I could not, for a good while, think of a way to make it ſuffer its body to ly quiet in a natural poſture; but whil'ſt it was alive, if its feet were fetter'd in Wax or Glew, it would ſo twiſt and wind its body, that I could not any wayes get a good view of it; and if I killed it, its body was ſo ſmall, that I did often ſpoile the ſhape of it, before I could throughly view it: for this is the nature of theſe minute Bodies, that as ſoon, almoſt, as ever their life is deſtroy'd, their parts immediately ſhrivel, and loſe their beauty; and ſo is it alſo with ſmall Plants, as I inſtanced before, in the deſcription of Moſs. And thence alſo is the reaſon of the variations in the beards of wild Oats, and in thoſe of Muſk-graſs ſeed, that their bodies, being exceeding ſmall, thoſe ſmall variations which are made in the ſurfaces of all bodies, almoſt upon every change of Air, eſpecially if the body be porous, do here become ſenſible, where the whole body is ſo ſmall, that it is almoſt nothing but ſurface; for as in vegetable ſubſtances, I ſee no great reaſon to think, that the moiſture of the Aire (that, ſticking to a wreath'd beard, does make it untwiſt ſhould evaporate, or exhale away, any ſwifter then the moiſture of other bodies, but rather that the avolation from, or acceſs of moiſture to, the ſurfaces of bodies being much the ſame, thoſe bodies become moſt ſenſible of it, which have the leaſt proportion of body to their ſurface. So is it alſo with Animal ſubſtances; the dead body of an Ant, or ſuch little creature, does almoſt inſtantly ſhrive and dry, and your object ſhall be quite another thing, before you can half delineate it, which proceeds not from the extraordinary exhalation, but from the ſmall proportion of body and juices, to the uſual drying of bodies in the Air, eſpecially if warm. For which inconvenience, where I could not otherwiſe remove it, I thought of this expedient.

I took the creature, I had deſign'd to delineate, and put it into a drop of very well rectified ſpirit of Wine, this I found would preſently diſpatch, as it were, the Animal, and being taken out of it, and lay'd on a paper, the ſpirit of Wine would immediately fly away, and leave the Animal dry, in its natural poſture, or at leaſt, in a conſtitution, that it might eaſily with a pin be plac'd, in what poſture you deſired to draw it, and the limbs would ſo remain, without either moving, or ſhriveling. And thus I dealt with this Ant, which I have here delineated, which was one of many, of a very large kind, that inhabited under the Roots of a Tree, from whence they would ſally out in great parties, and make moſt grievous havock of the Flowers and Fruits, in the ambient Garden, and return back again very expertly, by the ſame wayes and paths they went.

It was more then half the bigneſs of an Earwig, of a dark brown, or reddiſh colour, with long legs, on the hinder of which it would ſtand

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Obſerv. XLIX. *Of an* Ant *or* Piſmire.

feminal principle from which this minute Plant on Rose leaves did spring, were, before the corruption caus'd by the Mill-dew, a component part of the leaf on which it grew, and did serve as a *nourrit* in the primitive nutrition and continuation of it, yet might it be so conformate, as to produce a Seed which might have a power of propagating the same Species: the wisdom of the Creator seeming to affect an excellency, that though they are unable to help to the putrifying of the more compounded essences of the greater Plant or Animal, they may have notwithstanding an ability of acting singly upon their own internal principle, so as to produce a Vegetable body, though of a less compounded nature, and so proceed so far in the method of other Vegetables, as to bear flowers and seeds, which may be capable of propagating the like. So that the little cases which appear to grow on the top of the slender stalks, may, for ought I know, though I should suppose them to spring from the perverting of the vital course of the parent Vegetable, contain a seed, which, being scatter'd on other leaves of the same Plant, may produce a Plant of much the same kind.

Nor are Damask-Rose leaves the only leaves that produce these kinds of Vegetable sprouings; for I have observ'd them also in several other kinds of Rose leaves, and on the leaves of several sorts of Briers; and on Scarlet leaves they are sometimes to be found in very great clusters; so that I have found in one cluster, three, four, or five hundred of them, making a very conspicuous black spot or scab on the back side of the leaf.

Obſerv. XX. *Of* blue Mould, *and of the firſt Principles of Vegetation ariſing from* Putrefaction.

The blue and White and several kinds of hairy mouldy spots, which are observable upon divers kinds of *putrify'd* bodies, whether *Animal* substances, or Vegetable, such as the skin, raw or dress'd, flesh, blood, humours, milk, green Cheese, &c. or rotten sappy Wood, or Herbs, Leaves, barks, Roots, &c. of Plants, are all of them nothing else but several kinds of small and variously figur'd Mushrums, which, from convenient materials in those *putrifying* bodies, are, by the concurrent heat of the Air, excited to a certain kind of vegetation, which will not be unworthy our more serious speculation and examination, as I shall by and by shew. But, firſt, I muſt premiſe a ſhort deſcription of this ſpecimen, which I have added of this Tribe, in the firſt Figure of the XI. Scheme, which is nothing elſe but the appearance of a ſmall white ſpot of hairy mould, multitudes of which I found to beſpeck & whiten over the red covers of a ſmall book, which, it ſeems, were of Sheep-ſkin, that being more apt to gather mould, even in a dry and clean room, then other leathers. Theſe ſpots appear'd, though a good Microſcope, to be a very pretty ſtory'd Vegetative body, which, from almoſt the ſame part of the Leather, ſhot out

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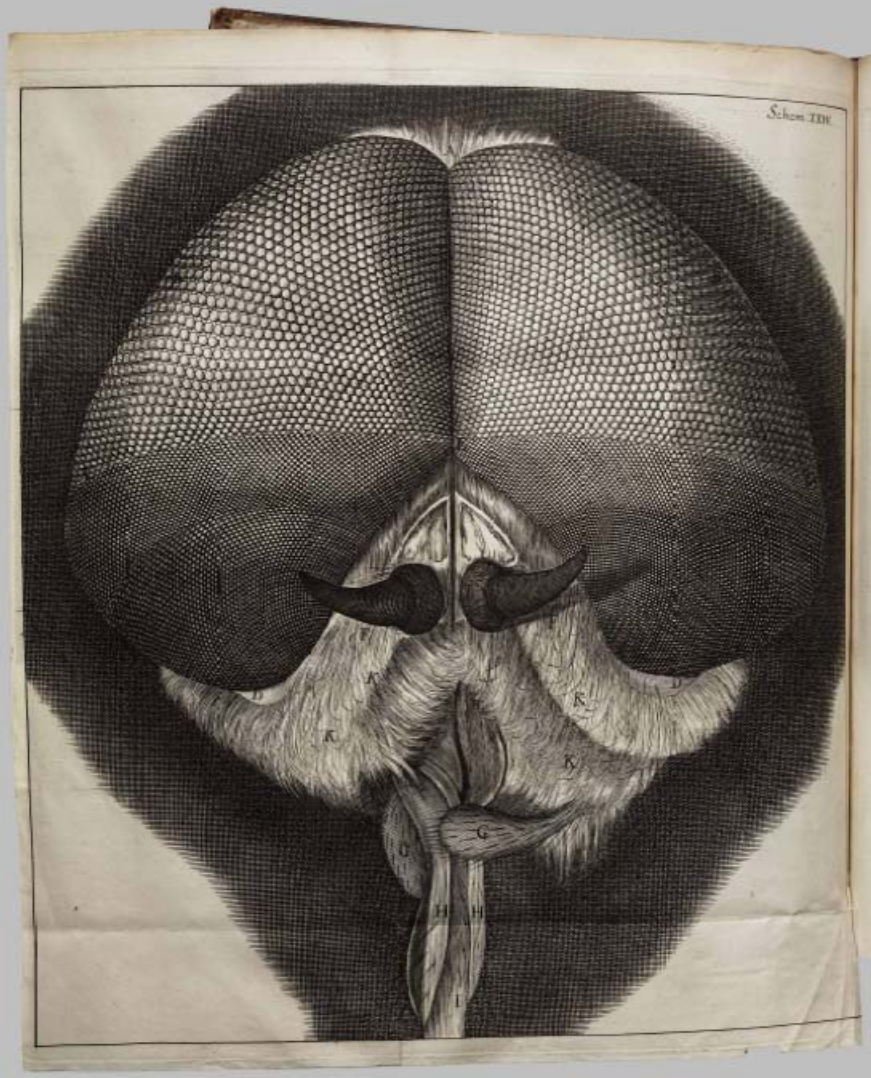
Obſerv. XX. *Of* blue Mould, *and of the firſt Principles of Vegetation ariſing from* Putrefaction.



Obſerv. XXXIX. *Of the Eyes and Head of a* Grey drone-Fly, *and of ſeveral other creatures.*

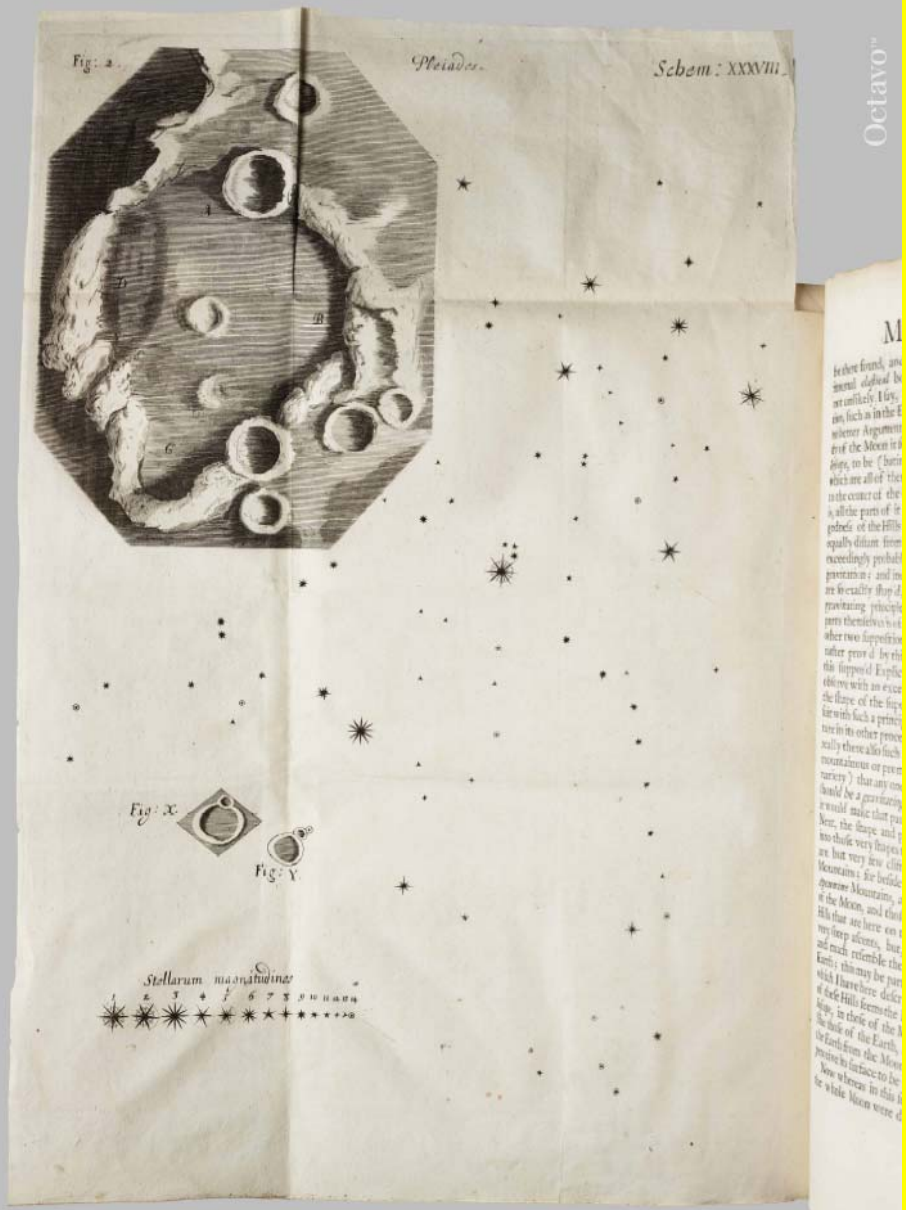
I took a large grey *Drone Fly*, that had a large head, but a ſmall and ſlender body in proportion to it, and cutting off its head, I fix'd it with the forepart or face upwards upon my Object Plate (this I made choice of rather then the head of a great blue Fly, becauſe my enquiry being now about the eyes, I found this Fly to have but the biggeſt cluſters of eyes in proportion to his head, of any ſmall kind of Fly that I have yet ſeen, it being ſomewhat inclining towards the make of the large *Dragon-Flies*. Next, becauſe there is a greater variety in the knobs or balls of each cluſter, then is of any ſmall Fly.) Then examining it according to my uſual manner, by varying the degrees of light, and altering its poſition to each kinde of light, I drew that repreſentation of it which is delineated in the 24. *Scheme*, and found theſe things to be as plain and evident, as notable and pleaſant.

Firſt, that the greateſt part of the face, nay of the head, was nothing elſe but two large and *prominent* bunches, or *protuberant* parts, ABCDEA, the ſurface of each of which was all cover'd over, or ſhap'd into a multitude of ſmall *Hemiſpheres*, plac'd in a *trigonal* order, that being the cloſeſt and moſt compacted, and in that order, rang'd over the whole ſurface of the eye in very lovely rows, between each of which, as is neceſſary, were left long and regular trenches, the bottoms of every of which, were perfectly intire and not at all perforated or drill'd through, which I moſt certainly was aſſured of, by the regularly reflected Image of certain Objects which I mov'd to and fro between the head and the light. And by examining the *Cornea* or outward ſkin, after I had ſtript it off from the ſeveral ſubſtances that lay within it, and by looking both upon the inſide and againſt the light.

Next, that of thoſe multitudes of *Hemiſpheres*, there were obſervable two degrees of bigneſs, the half of them that were lowermoſt, and look'd toward the ground or their own legs, namely, CDE, CDE being a pretty deal ſmaller then the other, namely, ABCE, ABCE, that look'd upward, and ſide-ways or foreright, and backward, which variety I have not found in any other ſmall Fly.

Thirdly, that every one of theſe *Hemiſpheres*, as they ſeem'd to be pretty neer the true ſhape of a *Hemiſphere*, ſo was the ſurface exceeding ſmooth and regular, reflecting as exact, regular, and perfect an Image of any Object from the ſurface of them, as a ſmall Ball of Quick-ſilver of that bigneſs would do, but nothing neer ſo vivid, the reflection from theſe being very languid, much like the reflection from the outſide of Water, Glaſs, Cryſtal, *&c.* In ſo much that in each of theſe *Hemiſpheres*, I have been able to diſcover a Land-ſcape of thoſe things which lay before my window,

Obſerv. XXXIX. *Of the Eyes and Head of a* Grey drone-Fly, *and of ſeveral other creatures.*



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Obſerv. LX. *Of the* Moon.