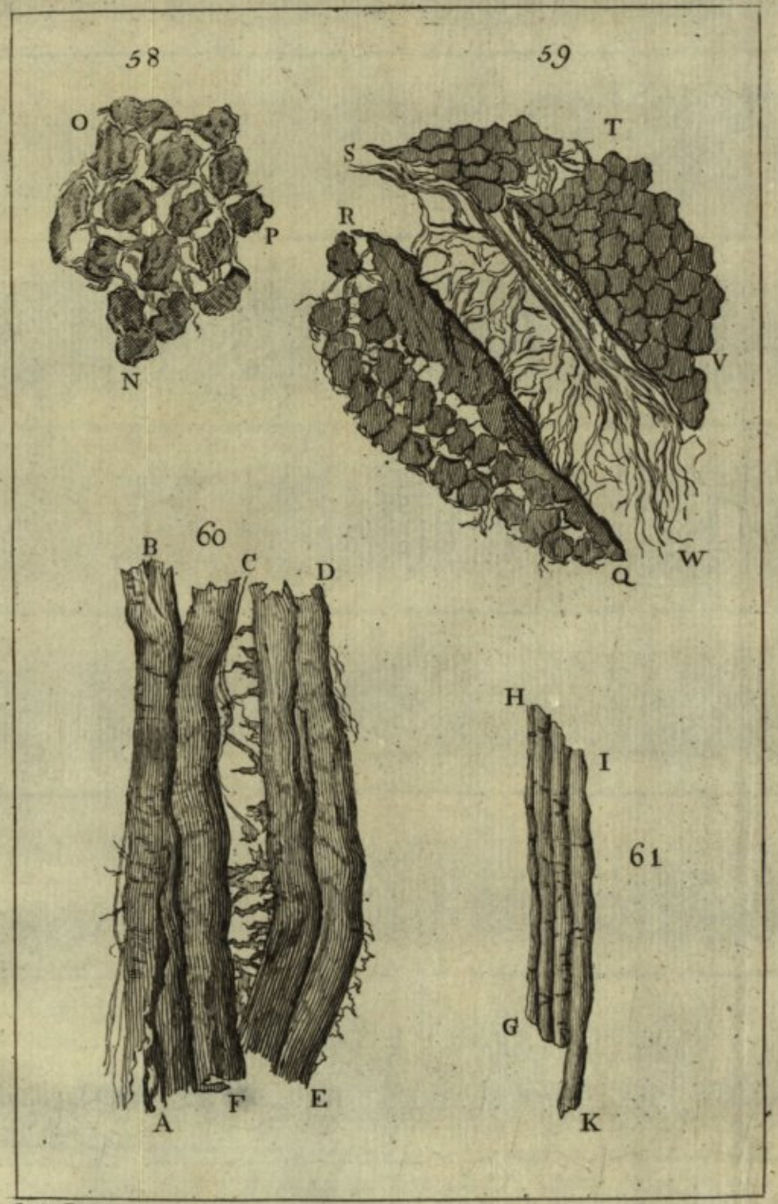


J. Wigley. Sc.

ternal Skin of a Fiſh, * and are placed as in Fiſhes three deep, *i. e.* each Scale is ſo far cover'd by two others, that only a third Part thereof appears, as at M, Fig. 70. their lying over one another, may be the Cauſe why the Skin of the Body appears white; for about the Mouth and Lips, where they only juſt meet together, and do not fold over, the Blood-Veſſels are ſeen thro', and the Parts look red.

The perſpirable Matter is ſuppoſed to iſſue between thoſe *Scales*, (which lie over the Pores or excretory Veſſels, through which the watery and oily Humours perſpire) and may find Vent in an hundred Places round the Edges of the Skin.

A Piece of *Skin* taken from between the *Fingers*, *Neck*, *Arms*, *Forehead*, or any other Part of the Body which is not hairy, ſerves beſt to ſhew the *Scales:* Or if they be ſcraped off with a Penknife, and put into a Drop of Water, and ſo applied to the Microſcope, they will be ſeen to good Advantage, as at L, Fig. 70. and generally conſiſt of five Sides.

Mr. *Leeuwenhoek* tells us 200 of them may be covered with a Grain of Sand †, ſo that if a Grain of Sand can cover 200 of thoſe Scales, it will alſo cover ‖ 20,000 Places through which Perſpiration may iſſue.

To view the Pores of the Skin.

Cut a Slice of the upper Skin with a ſharp Razor, as thin as poſſible; and then immediately cut a ſecond Slice from the ſame Place, which apply to the Microſcope, in a Piece about the Bigneſs of a Grain of Sand, innumerable Pores will be perceived. If a Piece of the Skin between the Fingers, or in the Palm of the Hands, be thus prepared, and then examined, the Light may very pleaſantly be ſeen thro' the Pores.

The Pores thro' which we perſpire, are moſt remarkable in the Hands and Feet §; for if the Hand be well waſhed with Soap, and examined but with an indifferent Glaſs, in the Palm, or upon the Ends and firſt Joints of the Thumb and Fingers, innumerable little Ridges parallel to each other, of equal Diſtance and Bigneſs, will appear; upon which the Pores may be perceived by a very good Eye, but when view'd thro' a very good Glaſs, every Pore ſeems like a little Fountain, with Sweat ſtanding therein, as clear as Rock Water, and if wiped away, it will be found immediately to ſpring up again.

* *Philoſ. Tranſ.* No. 159. † *Arc. Nat. Tom.* I. *Par.* II. *p.* 208. ‖ *Arc. Nat. Tom.* IV. *p.* 48. § *Philoſ. Tranſ.* No. 159.

CHAP.

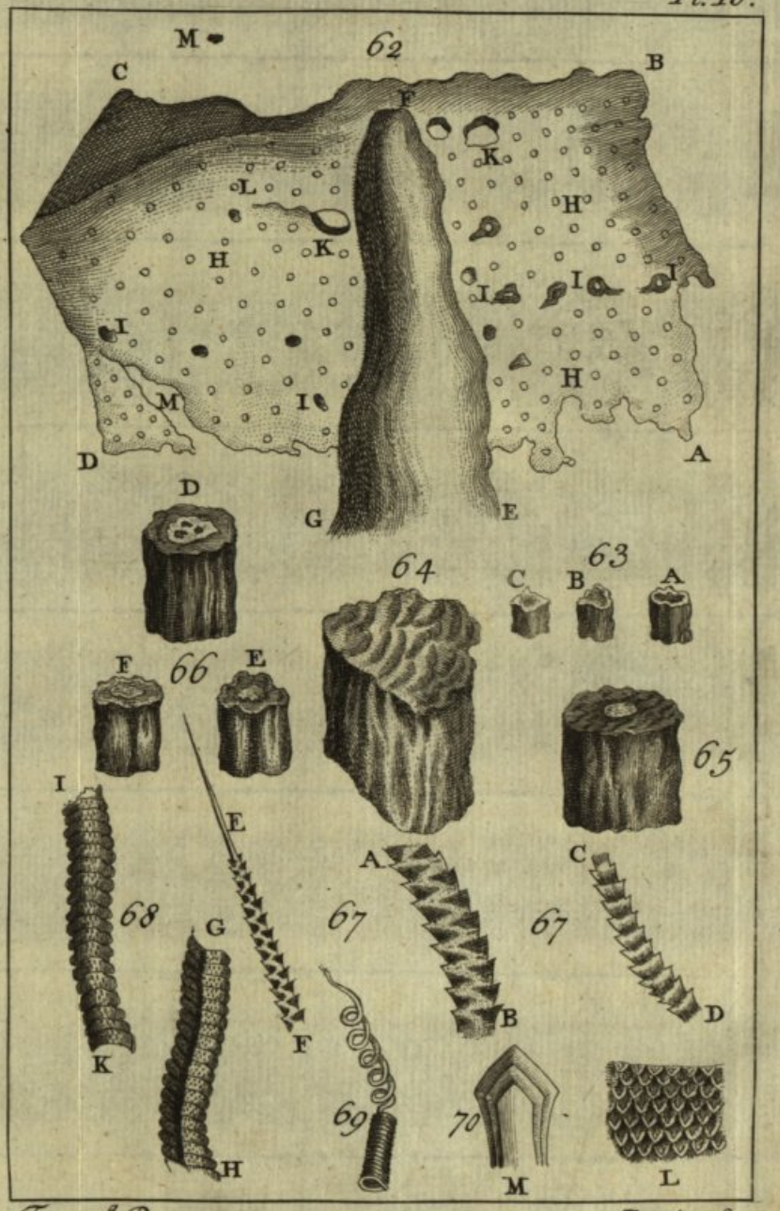
CHAP. XVI.

Of Feathers.

THE *Feathers* of moſt Sorts of Birds afford a beautiful Variety, obſervable in that incomparable Curioſity with which every *Feather* is made; the Vanes thereof are curiouſly gaged, broad on one Side, and narrow on the other; both which adminiſter to the progreſſive Motion of the Bird, as well as to the Union and Cloſeneſs of the Wing; and no leſs exquiſite is the textrine Art of the Plumage alſo, which is ſo curiouſly wrought, and ſo artificially interwoven, that it cannot be viewed without Admiration, eſpecially if the Eye be armed with a Microſcope.

Mr. *Hook* obſerves, that the Make and Texture of their downy Parts are moſt admirable; for, ſays he, there is ſcarce a large *Feather*, but contains near a Million of diſtinct Parts, and every one of them regularly ſhaped; with his naked Eye he counted 300 of the long downy Branches on one Side, and an equal Number on the other Side of more ſtiff and ſhorter Branches, in a middle ſized Gooſe Quill, and examining many of thoſe long downy Branches with his Microſcope, found ſeveral of them to contain near 1200 ſmall Leaves, ſuch as A B of Fig. 71. and as many Stalks on the other Side, ſuch as A C, of the ſame Figure, each of theſe Branchings A B, ſeemed divided into 16 or 18 ſmall Joints, out of moſt of which grew long ſlender Fibres, as are expreſſed in the Figure by a b c d, ſeveral of which terminated in a Hook; thoſe on the other Side were much ſhorter, the Stalks A C were divided into as many knotted Joints, but without Strings or Hooks, being divided at D into two Parts, one Side extended from D towards C, in Length equal to A C, the other Side at D was very ſhort. The tranſverſe Section of theſe Stems or Branches, were ſhaped like E F G H, whoſe Covering appear'd like Horn, and the Pith like that of the main Stem of the Feather; theſe Stems or downy Branches are ſo ranged, that the Leaves or hairy Stalks of the one, lie at Top, or are incumbent on the Stalks of the other, and croſs each other, much after the Manner of Fig. 72. by which Means, each of thoſe little hooked Fibres get between the naked Stalks, which being full of Knots, and a pretty Way disjoined, the two Parts are ſo cloſely and admirably wove together, as to reſiſt the Air; and are ſo extreamly ſmall, that the 500th Part of an Inch exceeds them in Thickneſs.

The Parts of the *Feathers* of a *Peacock*, appear through the Microſcope no leſs beautiful than the whole *Feather* does to the naked Eye; the Stem of each *Feather* in the Tail, ſends out Multitudes of lateral Branches; ſuch as A B, of Fig. 73. which repreſents $\frac{1}{32}$ Part of an Inch, each of theſe



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theſe lateral Branches emits Numbers of little Sprigs or Hairs, on each Side as C D, C D, C D, each of which in the Microſcope appear to conſiſt of a Multitude of bright ſhining Parts, which are a Congeries of ſmall Plates, as e, e, e, e, e, *&c.* each ſhaped like a, b, c, d, of Fig. 74. a c being a Prominency or Stem; and d and b the Corners of two ſmall thin Plates, that grow into the ſmall Stalk in the Middle, making a Kind of little Feather, and lie cloſe to, or rather upon each other in the Manner of Tiling; they grow on each Side of the Stalk, oppoſite to each other, by two and two in the Manner expreſſed by Fig. 75. the Tops of the lower ones covering the Roots of thoſe next above them; the under Sides of each of theſe Plates are very dark and opake, reflecting all the Rays caſt upon them; much like the Foil of a Looking-Glaſs; but their upper Sides ſeem to conſiſt of a Multitude of exceedingly thin plated Bodies, lying cloſe together, and thereby like Mother of Pearl Shells do not only reflect a very briſk Light, but even tinge that Light ſo reflected in a moſt curious Manner, which by various Poſitions of the Light, reflect firſt one Colour and then another, in a moſt vivid and ſurprizing Manner. And that theſe Colours ariſe only from the Refraction of Light: He found that wetting the colour'd Parts with Water, deſtroyed their Colours, and though he was not able to ſee thoſe Hairs at all tranſparent in common Light, yet by looking at them againſt the Sun, found them to be tinged with a darkiſh Red, not at all reſembling the curious Greens and Blues they exhibit.

The changeable colour'd *Feathers* of *Ducks*, and ſeveral other Birds, he found upon Examination with the Microſcope to proceed from the ſame Cauſes and Textures.

The beſt Way to apply one of theſe ſmall downy Fibres to the Microſcope, is to pinch them between the Nippers.

Mr. *Derham*, in his Deſcription of the Vanes of a Flag *Feather* of a *Gooſe's Wing*, obſerves theſe two Particulars, 1. That the exterior or narrow Vanes bend downwards; the interior, wider Vanes upwards; by which Means they catch hold, and lie cloſe to one another, when the Wing is ſpread, ſo that not one *Feather* may miſs its full Force and Impulſe. 2. That the very Tips of theſe *Feathers* are alſo neatly ſloped to a Point, towards the outward Part of the Wing. The exterior Vanes towards the Body.

The Vane or Web of a *Feather*, conſiſts of ſeveral Laminæ, which are thin, ſtiff, and ſomewhat of the Nature of a thin Quill, towards the Shaft of the Feathers (eſpecially in Flag *Feathers* of the Wing) thoſe Laminæ are broad, and of a ſemicircular Form, which ſerves for Strength, and alſo for ſhutting theſe Plates cloſe to one another, when Impulſes are made upon the Air. Towards the outer Part of the Vane, theſe Laminæ grow ſlender and taper, on their under Side they are thin and ſmooth, but are

parted

parted into two hairy Edges on the Upper: Each Side having a different Sort of Hairs laminated, or broad at Bottom, and ſlender and bearded above the other half.

The uppermoſt Edge of one of the Laminæ, with ſome of the Hairs on each Side, is repreſented in Fig. 76. as it appears a little magnified in the Microſcope. Theſe bearded Briſtles, or Hairs, are ſtreight on one Side thereof, as Fig. 77. thoſe on the other Side have hooked Beards on one Side of the Briſtle, and ſtreight ones on the other, as Fig. 78. both theſe Briſtles magnified (only ſcattering, and not cloſe) are repreſented, as they grow upon the upper Edge of the Laminæ ſ t, in Fig. 76. and in the Vane, the hooked Beards of one Laminæ, always lie next the ſtreight Beards of the next Laminæ, and by that Means lock and hold each other, and by a pretty Mechaniſm, brace the Laminæ cloſe to one another. And if at any Time the Vane happens to be ruffled and diſcompoſed, it can by this eaſy Mechaniſm, be reduced and repaired.

CHAP. XVII.

Of Flies.

SECT. I.

THE common *Fly* is an Object beautifully ornamented with a Mixture of Silver and Black, and thick ſet with Briſtles, pointing from its Head towards the Tail; in its Head are two large hemiſpherical Eyes, embroider'd with Silver Hairs, a wide Mouth, an hairy Trunk, and a Pair of ſhort Horns. Its Trunk has two Parts folded over each other, and ſheathed in the Mouth, whoſe Extremity is ſharp. In thoſe *Flies* which are of a light Colour and more tranſparent than others, the Motion of the Inteſtines may be plainly ſeen, and alſo the Motion of the Lungs, as they alternately dilate and contract themſelves.

In general, the Female *Fly* is ſupplied with a moveable Tube at the End of her Tail, by the Extenſion of which ſhe can convey her Eggs into convenient Receptacles, ſuch as may afford a proper Nouriſhment to the Young. From theſe Eggs proceed minute Maggots or Worms, repreſented in Fig. 79. which after feeding voraciouſly for ſome Time, arrive to their full Growth, and are transform'd into little Aurelias as in Fig. 80. whence after a longer Space of Time, they iſſue forth perfect Flies, as Fig. 81.

SECT.

SECT. II.

Of the Feet of Flies, &c.

FIG. 82. A, is a microſcopick Repreſentation of the *Foot* of a *Fly*, in which is ſeen three of its *Joints*, the two *Talons*, and the two ſkinny *Palms* or *Soles* in a flat Poſture. Fig. 82. B, ſhews only one *Joint*, the *Talons*, &c. in another Poſture, which is ſo admirably and curiouſly contrived, as to enable the *Flies* to walk againſt the Sides of Glaſs, and to ſuſpend themſelves under the Surface of a Ceiling, with the greateſt ſeeming Facility and Firmneſs. The two *Talons* A B, A C, are very large in Proportion to the *Foot*, the biggeſt Part of them from A to I I, is all hairy, their Points C and B ſmooth, and bending inwards. Each of theſe *Talons* are jointed at A, ſo that the *Fly* is able to open and ſhut them at Pleaſure: The Claws readily enter the Pores of moſt Subſtances, at which Time, as the *Fly* endeavours to ſhut them, the Claws C B, do not only draw towards, but fix each other; and alſo draw the whole Foot G G A D D forward; ſo that on a ſoft Body, the Points G G G G (of which the *Fly* has about ten to each Foot) enter. This is ſenſible to the naked Eye, in the Feet of a Chaffer, and if you ſuffer him to creep over the Hand, he makes his Step as ſenſible to the Touch alſo.

But as this Contrivance often fails the Chaffer, ſo would it the *Fly*, had not Nature furniſhed his Feet with another curious Contrivance, which is the *Palms* or *Soles* D D. They are two ſmall, thin, flat, and horny Subſtances, that ariſe from the under Part of the laſt Joint of the Foot, and are ſeemingly flexible; ſo that their two Sides do not always lie in the ſame Plain, but may be ſhut cloſer, and as it were graſp a Body of themſelves: Beſides, the under Sides of theſe Soles are all beſet with ſmall *Briſtles*, like the Wire Teeth of a Card, whoſe Points tend forward. Hence the *Talons* drawing the Feet forward as before, and theſe *Soles* being applied to the Surface of the Body, with all its Points looking the contrary Way, if there be any Irregularity, or yielding therein; the *Fly* ſuſpends itſelf very firmly and eaſily. That the *Fly* is enabled to walk on Glaſs, proceeds partly from a Ruggedneſs of the Surface, or a Kind of Tarniſh or dirty ſmoaky Subſtance, adhering to the Surface of that very hard Body; and tho' the pointed Parts cannot penetrate, yet they may find Pores enough in the Tarniſh, or at leaſt make them. This Structure Mr. *Hook* ſurveyed with great Diligence, becauſe he could not comprehend, that if there was any ſuch glutinous Matter in thoſe ſuppoſed Sponges (as moſt that have obſerved that Object in a Microſcope, have believed) how the *Fly* could ſo readily unglew and looſen its Feet; and alſo becauſe he had found no other Creature any Ways like it.

A Contrivance nearly alike to this is to be found in all Kind of Flies, and Caſe winged Inſects, and in the Flea, in Mites, *&c.* ſome of which have only one ſharp *Talon* at the End of each Leg. Which drawing towards the Center or Middle of their Bodies, enable theſe exceeding light Bodies to ſuſpend and faſten themſelves to almoſt any Surface. This will not ſeem ſtrange; if we conſider firſt how ſmall their Bulk is when compared to their Superficies, their Thickneſs frequently not amounting to the 100th Part of an Inch. Secondly their Strength and Agility compared to their Bulk, which in that Proportion perhaps may be an 100 times ſtronger than an Horſe: Thirdly, if we conſider that Nature always appropriates the Inſtruments in the moſt fit, eaſy, and ſimple Manner poſſible to perform their Office; which is alſo verified in the Foot of a Louſe, each of his Legs being footed with two ſmall Claws, with which it graſps, and thereby moves itſelf to and fro upon the Hairs of the Creature it inhabits.

The Legs of Flies are beſt applied to the *Univerſal Microſcope*, by being either ſtuck upon the Point, or held between the Nippers. Though we frequently place them between two Talcs in an Ivory Slider.

SECT. III.

Of the Eyes and Head of a Grey Drone Fly.

THE Structure of the *Eye* in all Creatures, is an admirable Piece of Mechaniſm; but the beautiful Contrivance of the *Eyes* of Inſects is ſo peculiar, that it muſt excite our Admiration, ſo fenced with its own Hardneſs, that its own accurate Viſion is a good Guard againſt external Injuries; its outward Coat being all over beſet with curious lenticular Inlets; enabling thoſe Creatures to ſee very accurately every Way, without any Interval of Time, or Trouble to move the Eye towards Objects *.

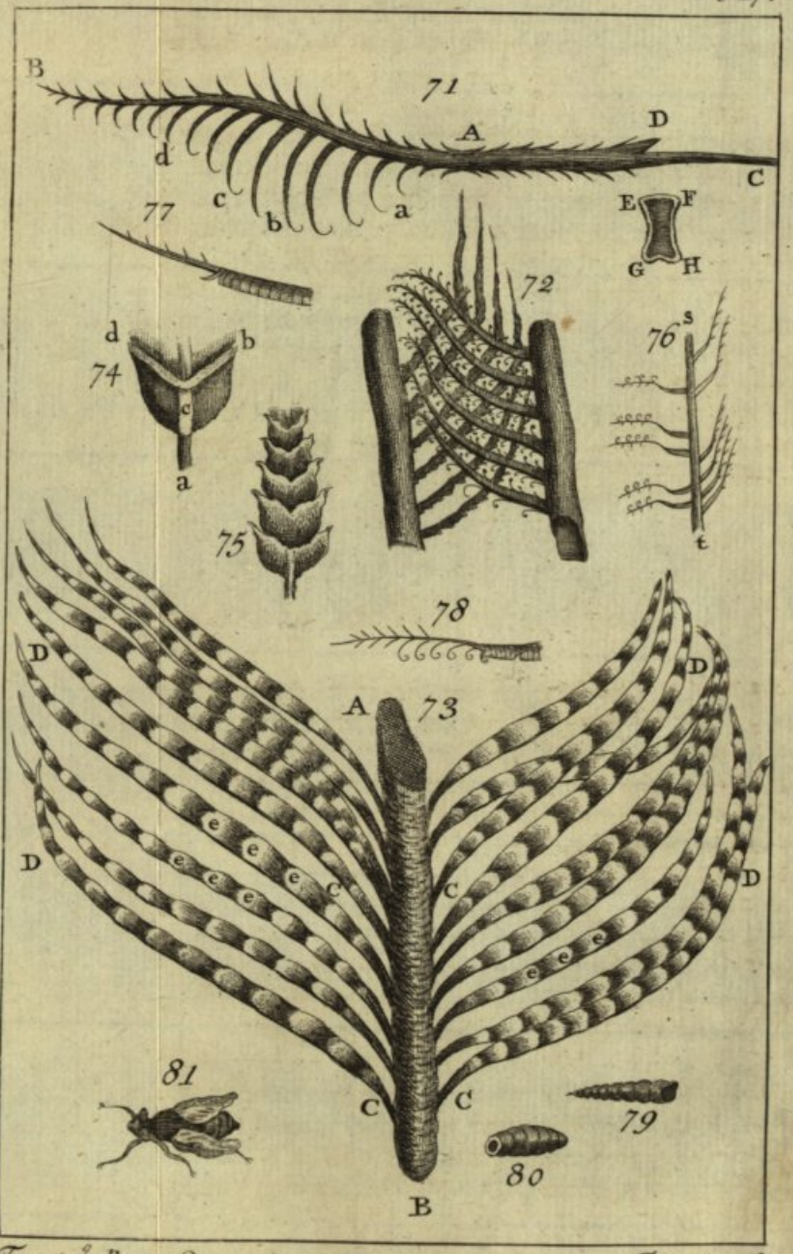
See Fig. 83. This *Fly* was made Choice of, becauſe the Inquiry being chiefly about the *Eyes*, it was found to have the biggeſt Cluſter of *Eyes*, in Proportion to its Head, of any other ſmall *Fly*. It inclining ſomething towards the Make of the large *Dragon Fly*, which is the moſt remarkable of all other Inſects for its fine *pearled Eyes*.

The greateſt Part of the Head was nothing elſe but two large Protuberances, A B C D E, whoſe Surface was cover'd over with a Multitude of ſmall Hemiſpheres, placed with the utmoſt Regularity in Rows, croſſing each other in a Kind of Lattice-Work.

That half of them C D E, C D E, which looked towards its Legs, were

* *Derham's Ph. Th. p.* 171.

obſerved



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obſerved to be ſmaller than the other half A B C E, A B C E, which looked upwards and ſideways. The Surface of theſe Hemiſpheres were ſo exceeding ſmooth and regular, that in each of them Mr. *Hook* was able to diſcover a Landſcape of thoſe Things which lay before his Window, Part of which was a large Tree, whoſe Trunk and Top he plainly ſaw. Alſo the Motion of his Hand and Figures, if moved between the Object and the Light. Theſe Rows of *Eyes* were ſo diſpoſed, that no Object was viſible from his Head, but ſome of theſe Hemiſpheres were directed againſt it: And further, that where the Trunk of the Body ſeem'd to hinder the Proſpect, theſe Protuberances were elevated, ſo that a *Fly* may be truly ſaid to have an Eye every Way. Theſe little Hemiſpheres have each of them a minute tranſparent Lens in the Middle, each of which hath a diſtinct Branch of the *optick Nerve* miniſtring to it, and rendering it as ſo many diſtinct *Eyes*; ſo that as moſt Animals are binocular, *Flies*, *Beetles*, &c. are multocular, having as many Eyes as there are Perforations in their *Cornea* *. By which Means as other Creatures are obliged to turn their Eyes to Objects, theſe have ſome of their Eyes ready placed towards Objects nearly all round them.

Two of theſe optick Nerves are repreſented as delineated by Mr. *Leeuwenhoek*, in Fig. 84. And in Fig. 85. are exhibited † a great many of them in a Cluſter, as they appeared before the Microſcope, whereof that Part of them which was ſituate next the Cornea is ſhewn by the Letters N O P; it is alſo obſervable, that thoſe Nerves, which were neareſt to the Circumference of the *Cornea*, were ſhorter than thoſe next within them; and ſo on, till they arrive at the *central Nerve*, which is the longeſt of all.

The Number of the Pearls in this *Fly*, Mr. *Hook* reckon'd to be 14000. Mr. *Leeuwenhoek* computed 6236 in a *Silk-worm*'s two Eyes, when in its *Fly* State; 3181 in each Eye of a *Beetle*; and 8000 in the two Eyes of a common *Fly*.

Cut off the Eye of any *Fly*, and with a Pencil, and ſome clean Water waſh out all the Veſſels; thoſe Veſſels may be examined by the Microſcope, and then if you carefully dry the outward Covering, ſo as not to let it ſhrink, it will be rightly prepared for making Experiments; and upon viewing it, we ſhall diſtinguiſh the numerous Protuberances or Hemiſpheres divided from one another with a ſmall Light, iſſuing between them, and ſix Sides to each. Mr. *Leeuwenhoek* having prepared an Eye in this Manner, placed it a little farther from his *Microſcope* than when he would examine an Object, ſo as to leave a right and exact focal Diſtance between it and the Lens of his Microſcope; and then look'd thro' both, in the Manner of a Teleſcope, at the Steeple of a Church, which was 299 Feet high, and 750 Feet from the Place where he ſtood; and could plainly ſee through

* *Derh. Phy. Theo. p.* 372. † *Arc. Nat. Ep.* 111.

every little Lens, the whole Steeple inverted, tho' not larger than the Point of a fine Needle; and then directing it to a neighbouring Houſe, ſaw thro' Abundance of the little Hemiſpheres, not only the Front of the Houſe, but alſo the Doors and Windows, and was able to diſcern diſtinctly whether the Windows were open or ſhut.

An Eye of a *Fly* thus prepared, may be held between the Nippers for Examination. But the Head of any *Fly* is beſt ſeen when ſtuck upon one of thoſe Ivory Slips, or Pieces of Card, or Holly, with ſome ſtrong Gum Water, and applied to the Microſcope under the Silver Reflecter, which Slips may be held in the Nippers.

N. B. The Horns F F, the Feelers G G, the Proboſcis H H, and the Hair and Briſtles K K, ſhall be deſcribed in Sect. V. of this Chapter.

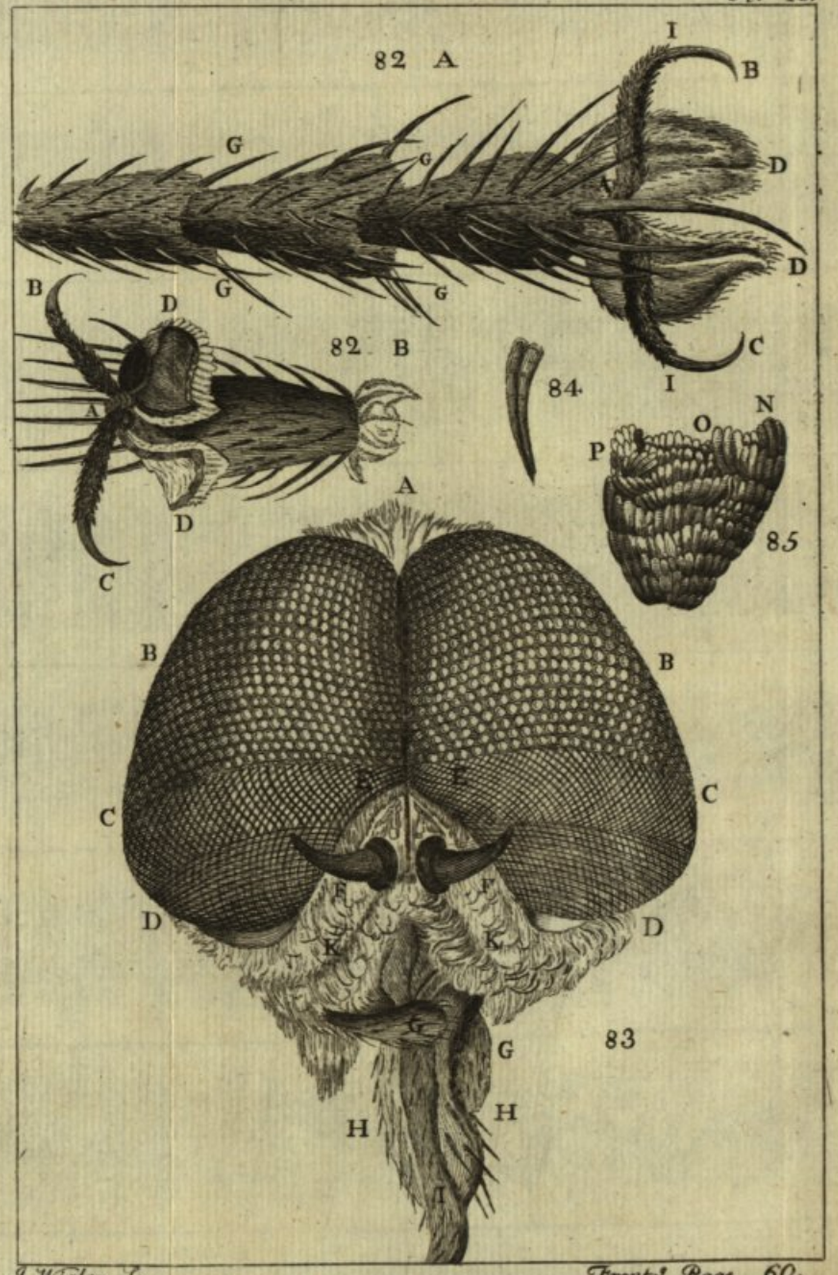
SECT. IV.

Of the Wings of Flies.

THE *Wings* of all Kinds of Inſects afford an infinite Variety, no leſs agreeable to the Mind, than pleaſing to the Eye; being diſtended and ſtrengthened by the *fineſt Bones*, and cover'd with the *lighteſt Membranes*. Some of them are adorned with neat and beautiful Feathers, and many of them provided with the fineſt Articulations and Foldings, for the Wings to be withdrawn, and neatly laid up in their *Vaginæ* and Caſes, and again readily extended for Flight.

This of the *blue Fly*, Fig. 86. here exhibited, is not without its peculiar Ornaments; it grows out of the middle Part of the Body of the *Fly*, and is ſeated a little beyond the Center of Gravity thereof, towards the Head; but that is curiouſly ballanced by the expanded Area of the Wing, which conſiſts of ſeveral *bony Ribs*, that give Strength to the filmy Parts; which are thickly beſet with innumerable ſmall Briſtles, intermixed with as many dark Spots, which ſeem to be the Roots of the Hairs that grow on the other Side.

Of other *Flies*, ſome of their *Wings* are *filmy*, as the *Dragon Flies*; others ſtuck over with ſhort *Briſtles*, as the *Fleſh Fly*; others have divided *Wings*, as the *grey* and *white feather'd Moths*; many Sorts of *Gnats Wings* are adorned with Rows of Feathers along their Ridges, and Borders of Feathers round their Edge; ſome have Hairs, and others Hooks, placed with the greateſt Regularity and Order. In the *Butterfly* and ſome *Moths*, there are an infinite Number of ſmall Feathers, which cover both the under and upper Surfaces of this thin Film, not only ſhaped much like the Feathers of Birds, but alſo variegated with the greateſt Variety of curious bright


82 A
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bright and vivid Colours; which is evident to the naked Eye, but much more entertaining when viewed thro' the Microſcope; by which we are informed, that theſe curious colour'd minute Feathers end in Quills, and are placed in orderly Rows with great Exactneſs, as the Holes they come from ſhew when they are rubb'd off.

Fig. 87. repreſents a ſmall Piece of a *Butterfly's Wing*; A B ſhews one of thoſe *bony Ribs* that gives it Strength, along whoſe Sides are ſuppoſed to branch out various *Blood-Veſſels*, conveying Nouriſhment to the intermediate Parts; although no Circulation can be diſcern'd therein, we can ſcarce doubt but that a continual Supply of Juices muſt be carried on to theſe minute Quills, Hairs, and Briſtles; C, C, C, exhibits three of theſe ſingle Plumes, with their Quills adhering to the tranſparent Membrane of the Wing, in which Membrane G, G, G, when diveſted of its Feathers, may be ſeen, the Order of Pits or Holes where the Quills are rooted, and from whence they ſhoot, D, E, F, ſhews a few of the Feathers exactly in the Form as they cover the whole Wing.

Some *Flies* have Hairs, and all the Scarab Kind have Elytra, or Caſes into which their Wings are folded and preſerved, till they want to employ them, as in Fig. 110. ſome of theſe Caſes reach almoſt to the Extremity of their Tail, as in moſt Kinds of *Beetles*; and in others are very ſhort, as in the *Earwigg*. They do by a very curious Mechaniſm extend and withdraw their membraneous Wings. It is very curious to ſee them prepare themſelves for Flight, by thruſting out, and then unfolding their Wings; and again withdraw thoſe Joints, and neatly fold in the Membranes, to be laid up ſafe in their Elytra or Caſes; for which Service the Bones are admirably placed, and the Joints miniſtring thereto are accurately contrived for the moſt compendious, and commodious folding up of the Wings.

Mr. *Hook* hath obſerved the Motion of theſe filmy Wings in ſome minute ſpinning Flies, which naturally ſuſpend themſelves as if pois'd and ſteady in one Place of the Air, in which by a faint Shadow he could perceive the utmoſt Extremes of the vibrative Motion; which Shadow, while they endeavour'd to ſuſpend themſelves, was not very long; but when they endeavour'd to fly forward, it was ſomething longer; he alſo fixed the Legs of a Fly with Glew or Wax, upon the Top of the Stalk of a Feather, and then making it endeavour to fly away, was thereby able to view it in any Poſture; and found the Motion of the extreme Limits of the Vibrations, to be about the Length of the Body diſtant from each other; and concluded by the Sound, that the Wing was moved forwards and backwards with an equal Velocity, (and comparing it with a muſical String tuned Uniſon to it) the Vibrations whereof are ſo ſwift, that it is probable there are many hundred, if not thouſand Vibrations in one Second of Time, and ſuppoſes them the ſwifteſt Vibrations in the World; whence he reflects on the Quickneſs of the animal Spirits, which ſerve to ſupply this Motion.

It

It is obſervable that moſt Inſects are provided with a little Ball, * or Bladder under each Wing, fix'd at the Top of a ſlender Stalk, moveable every Way at Pleaſure; in ſome they ſtand alone, in others (as in the whole *Fleſh Fly* Tribe) they have little Covers, under which they lie and move; with theſe Poiſes, and ſecondary leſſer Wings, they obviate all the Vacillations of their Body, and poiſe it in Flight, as a Rope-Dancer ballances himſelf by his Pole loaden at each End with Lead.

If one of theſe be cut off, the Creature flies aukwardly for a while, and at laſt falls to the Ground. Theſe Bladders being hollow, may ſerve likewiſe to produce the Noiſe many Sorts of Flies make by ſtriking their Wings againſt them; Inſects that have four Wings ballance themſelves with the two leſſer ones.

The Wings of Flies are beſt applied to the Microſcope between two *Muſcovy* Talcs, in an Ivory Slider.

If with an Hair Pencil, or Point of a Penknife, you gently bruſh or ſtroke off ſome of the minute Feathers from the Wings of *Butterflies*, and ſome Sort of Moths; then breathe upon a ſingle Talc in one of your Sliders, and apply it to the Feathers, which ſeem only like a fine Duſt, they will immediately adhere to it; if upon their Application to the Microſcope they lie not to your Mind, wipe them off, and put on others in the ſame Manner, till they lie fair for Examination, then cover them with another Talc, and faſten them down with a Ring.

SECT. V.

Of a Blue Fly.

FIG. 86. repreſents a microſcopical Picture of this *Fly*; it has many Things about it worthy of Note; ſeveral of which are already deſcribed, *viz.* the Head, Eyes, Wings, and Feet.

The Cluſters of Eyes in this *Fly* are much ſmaller than that of the *Drone Fly* in Proportion to its Head. Between theſe two Cluſters of Eyes appear'd a ſcaly Prominency B, armed and adorned with black Briſtles, ſharp, and tapering, growing in Rows on either Side, and bending towards each other, formed a Kind of briſtly Arbor, which almoſt cover'd the fore Front; at the End of this Arch, and about the middle of the Face on a riſing Part C, grew two oblong Bodies D D, which through the Microſcope looked not unlike the Pendants of Lillies, and appear'd to be jointed on two ſmall Parts at C, each of which ſeem'd again jointed into the Front: Out of the upper Part of each of theſe Horns grows a Feather, or bruſhy Briſtle E E,

* *Der. Phy. Th. p.* 377.

on

on the under Part of the Face F F, were ſeveral of the former Sort of bended Briſtles; and below all is the Mouth, out of which grew the Proboſcis G H I; which by Means of ſeveral Joints, the *Fly* was able to move to and fro, and to thruſt in and out as it pleaſed. The End of this hollow Body, which was cover'd over with ſhort Hairs, ſeem'd bent at H, and the foremoſt Side of the bended Part ſlit into two Chaps * H I, H I. Theſe he could open and ſhut very readily, and when he ſeem'd to ſuck any Thing from the Surface of a Body, he would ſpread thoſe Chaps, and apply the hollow Part of them cloſe to it.

From either Side of the Proboſcis, within the Mouth, grow two ſmall Horns K K, which were hairy and ſmall in this Figure, but of another Shape, and bigger in Proportion in Fig. 83. where they are marked G G, which two are generally called, the Antennæ or Horns of Inſects; Mr. *Derham* imagines them to be abſolutely neceſſary to the ſearching out and finding their Way, † as their Eyes are immoveable; ſo that no Time is requir'd for their turning them to Objects; there is no Neceſſity that the Retina, or optick Nerve, ſhould occaſionally be brought nearer to, or removed farther from the Cornea, as it is in other Animals; but their Cornea and optick Nerve being always at the ſame Diſtance, and fitted only to ſee diſtant Objects, they would be inſenſible of, and apt to run their Heads againſt Bodies very near them, were they not aſſiſted by their Feelers: And that this, rather than wiping the Eyes, as ſome have imagined, is the particular Uſe of the Feelers, and is apparent from the *Fleſh Fly*, and many other Inſects, which have their Antennæ ſo ſhort and ſtreight, as not to be capable of being bent unto, or extended over the Eyes.

The middle Part of this *Fly* was caſed with a firm Coat of Armour, the upper Part of which was thickly beſet with conical Briſtles, pointing backwards; from its under Part ſprang ſix Legs, three of which are apparent in the Figure at M, N, O; they were all of the ſame Structure, being cover'd with an hairy Shell, and compoſed of eight Joints, to the laſt of which grew the *Soles* and *Claws* before deſcribed in Page 57. From the upper Part of the Trunk grew the two Wings, which are deſcribed Page 60; the hinder Part of his Body was of a moſt curious ſhining Blue, and exactly like poliſhed Steel, brought to that Colour by Nealing.

The lamellated *Antennæ* of ſome, the cavelated of others, the neatly articulated of others, and the feather'd or tufted of others, are exceedingly beautiful when viewed through a Microſcope.

And in ſome theſe *Antennæ* diſtinguiſh the Sexes, ‖ for in the Gnat Kind all thoſe with Tufts, Feathers, or Bruſh Horns, are *Males*; and thoſe with ſhort ſingle ſhafted *Antennæ*, are *Females*.

* *Hook's Mycro. p.* 183. † *Derham's Phy. Theo. p.* 372. ‖ *Derham's Phy. Theo. p.* 373.

Flies

Flies of any Kind may be examined in the Microſcope, by ſticking them upon the Point, or pinching any Part of them between the Nippers, and ſo applied to the Magnifier under the reflecting Concave, if it be opake. And if you are deſirous to keep its Head, or any other Part, it may be ſtuck with Gum Water upon a Piece of Card, or upon one of thoſe Ivory or Holly Slips, mentioned before in Page 31.

It is very obſervable, that *Inſects* take particular Care to depoſite their *Eggs* or *Seed* in ſuch Places, where they may have a ſufficient *Incubation*, and where the Young, when hatched, may have the Benefit of proper Food till they become able to ſhift for themſelves. Thoſe whoſe Food is in the *Water*, lay their Eggs in the Water; thoſe to whom *Fleſh* is a proper Food, in Fleſh; and thoſe to whom the *Fruits* or *Leaves* of Vegetables are Food, are accordingly repoſited, ſome in this Fruit, ſome in that Tree, and ſome in that Plant, and ſome in another, but conſtantly the ſame Kind in the ſame Tree, *&c.*

As for others that require a more conſtant and greater Degree of Warmth, they are provided by the parent Animal with ſome Place in or about the Body of other Animals; ſome in the Feathers of Birds, ſome in the Hair of Beaſts, ſome in the Scales of Fiſhes, ſome in the Noſe, ſome in the Fleſh, nay ſome in the Bowels and inmoſt Receſſes of Man, and other Creatures. And as for others, to whom none of theſe Methods are proper, they make them Neſts by Perforation in the Earth, in Wood, in Combs, and the like, carrying in, and ſealing up Proviſions that ſerve both for the Production of their Young, and for their Food when produced.

In *Flies*, *Butterflies*, &c. it is obſerved there is a kind of Gluten, by which the Female faſtens her Eggs to the bearing Buds of Trees, *&c.* ſo that the Rains cannot waſh them off, nor the ſevereſt Froſt hurt them.

SECT. VI.

Of Inſects that infeſt Fruit and other Trees.

THESE *Inſects* are of the Ichnumon Fly Tribe, that generated in the Plumb, is black, of a Middle Size, its Body near $\frac{3}{10}$ths of an Inch long, its Tail not much leſs, conſiſting of three Briſtles, wherewith it conveys its Eggs into Fruit, its Antennæ long, ſlender, recurved; its Belly longiſh, tapering, ſmall towards the Thorax, Legs reddiſh, Wings membraneous, thin and tranſparent, in Number four.

The *Bloſſoms* of *Apples* and *Quinces* are infeſted with Multitudes of ſmall Animals, ſo likewiſe are the green Leaves of *Gooſe-berry*, *Currant*, *Cherry*, *Grape*, *Plumb*, and other *Trees*, overſtock'd with infinite Numbers of theſe minute Flies. Some blackiſh, others green, ſome winged, others without Wings;

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Wings; ſeveral of which bring forth their Young alive and perfect; for if their Bodies be opened, ſeveral imperfect Embrio's may be found therein. Alſo Inſects of a greeniſh Colour of the Shape of Fig. 88. but no bigger than a Grain of Sand when firſt hatched, which at full Growth appear to the naked Eye of the Size of Fig. 89.

Theſe little Inſects *Leeuwenhoek* calls *Pediculus*, * or *Louſe*, who on plucking a Leaf from a *Plumb-tree*, and putting it into ſuch a Glaſs Tube as is deſcrib'd Page 30, which he applied to his *Microſcope*, and found thereon 36 black Flies, and ſeveral hundred of theſe *green Lice*, and among them many which were but juſt hatched. In a ſhort Time theſe green Lice died, and from their Carcaſe came forth a black Fly. Fig. 88. repreſents the Carcaſe of one of the *green Lice* as it appear'd before the *Microſcope*. The Shell or Skin of its Back had ſeveral Rows of Knobs upon it; its Eyes A B were like thoſe of other Flies; C D ſhew its two Antennæ articulated and ſet with Hairs. E F G H I K ſhew the Legs, having at their Extremity two hooked Nails, and ſhort Hairs. L M repreſents the Aperture, from whence came out the Worm, from which the Fly was produc'd, having firſt eaten up all the Inſide of the Body of the *green Louſe*.

Fig. 90. exhibits one of theſe minute *black Flies* thus produced from a Worm, which had increas'd itſelf by deſtroying its foſter Parent, and then changed into a Nymph, and at laſt from that to a Fly, furniſhed with all thoſe minute Organs as are expreſſed in the Figure; whereof A B ſhews its two Eyes, C D its Antennæ, which afford a pleaſant Sight in the *Microſcope*, its curious Joints being finely beſet with Hairs.

E F are two Organs, through which it ſucks its Nouriſhment, its long Tail G H I, K L M N, its four Wings bedeck'd with exceeding fine Hairs and a much finer Membrane, O O O O O O its ſix Feet, which were alſo furniſhed with many Joints, and thickly ſet with Hairs. The Letters P Q R expreſs the Point of the Nippers which held the Fly before the MICROSCOPE. Theſe Lice are alſo to be found upon the Leaves of *Filberd-Trees*, with this Difference, the former being *green*, and the latter *white*.

Upon the *Leaves* of *Apples* and other *Trees* are found a curious *Fly*, † the exquiſite Make and Form of its Parts are not to be diſcerned without a *Microſcope*, Fig. 91. repreſents the Size and Shape it appears of to the naked Eye. And Fig. 92. a Part of its Head, whereof A B are its two protuberant Eyes, C D E its Snout, furniſhed with various Forceps or Teeth, with which it perforates the Buds of Fruit and Flowers; this Snout is flexible and capable of bending every Way, C F and D G are the two Horns which adorn the Snout. Fig. 93. is almoſt a fourth Part of the Leg of this Fly, which conſiſts of four Joints. H I are two Nails which appear

* *Arc. Nat. Ep.* 135. † *Leeu. Ex. & Con. Epiſt.* 89.

in the Microſcope, as Horn does to the naked Eye, and K L ſhews its two ſkinny *Palms* or *Soles*.

There is another Sort of Animalcule found in the Wrinkles and wreathed Curls of *blighted Leaves* *, and in the *Extremity* of the *Sprouts* of *Leaves*, as in Garden *Currants*, *Cherries*, *Peaches*, *Nectarines*, &c. may be found great Swarms of theſe minute Inſects, no bigger than an half-grown Louſe, one of which is repreſented by Fig. 94. of its full Growth, and of the Size it appear'd of to the naked Eye. Fig. 95. ſhews the ſame magnified and near its laſt Change, the folded Wing juſt beginning to appear at A B. It had ſix ſmall jointed Feet, fenced with ſhort Hairs, and two Nails on each; C ſhews one of its Eyes, which was of a ſurprizing Make. D F repreſents the Proboſcis, with which it perforates the Leaves and Buds of Trees, and then thruſts out its Dart E and ſucks their Juice. From its Tail proceeds two upright Parts G H, out of which a tranſparent Liquor is frequently diffuſed as at H. I K L is the Needle's Point, upon which the Animal was ſtuck; and Fig. 94, as before hinted, the ſame Animal when changed into a Fly.

Mr. *Derham* could never obſerve any other kind of Fly but the leſſer *Phalenæ* † about $\frac{4}{10}$ of an Inch long to be bred in *Pears* and *Apples*; it is whitiſh underneath, greyiſh brown above, ſpotted about one Third with Waves of a Gold Colour, its Head ſmall, a Tuft of whitiſh Brown on its Forehead, and Antennæ ſmooth. The Aurelia of this Moth is ſmall, of a yellowiſh Brown.

SECT. VII.

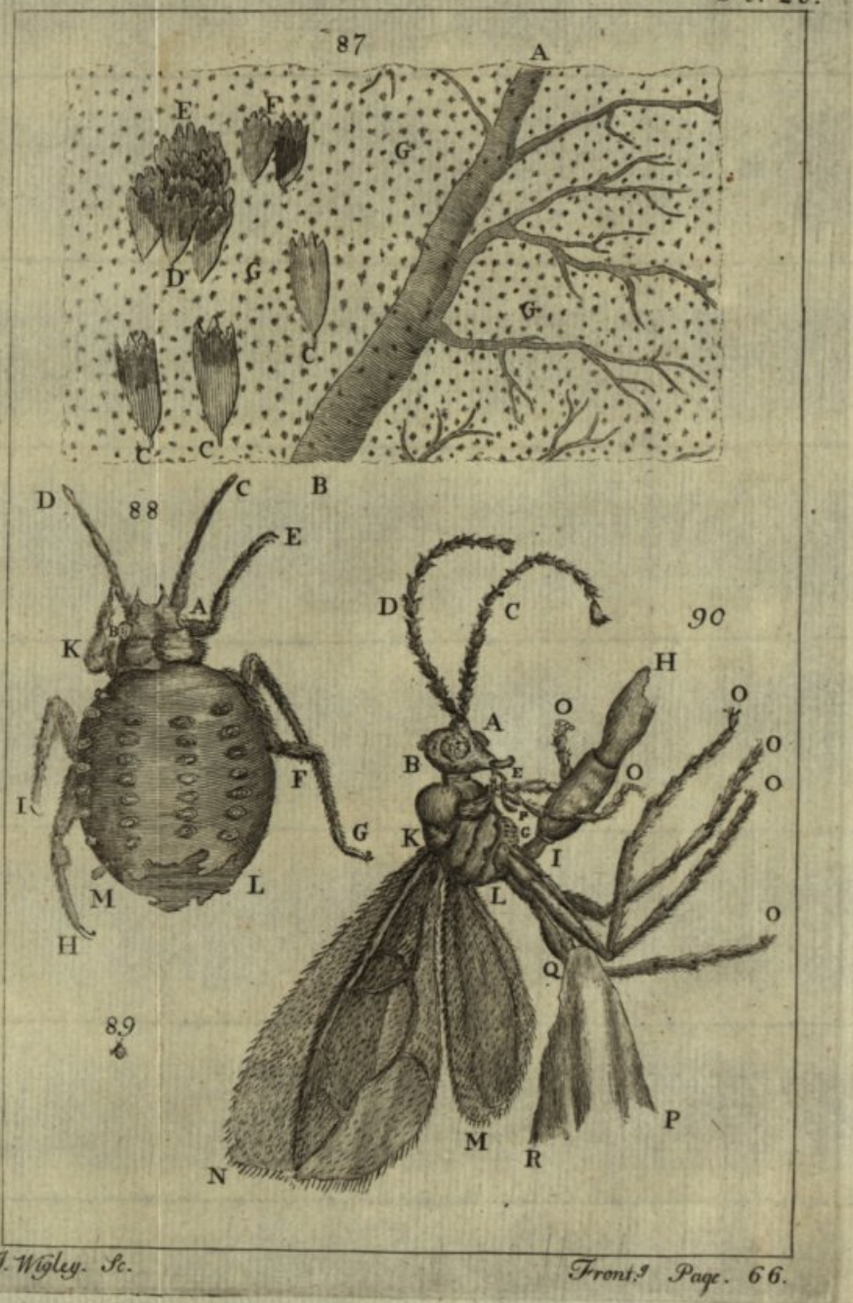
Of Excreſcencies growing on Willow-Leaves, and a ſmall Fly bred thereon.

MR. *Leeuwenhoeck* frequently diſcovered more than one Sort of Worm upon opening the knotty Part of *Willow-Leaves*, and having put ſeveral of theſe Knots, whoſe contain'd Worms were not full grown, into a large Glaſs Tube, that the Worms might attain their full Growth, could not find that any of them did ſo; obſerving at the ſame Time ſeveral of theſe Knots to have none of the Worms in them, but almoſt full of the Excrements of the Worms which had been therein, and were diſlodged, through a ſmall Hole he could perceive in the Knots.

Fig. 96. A B repreſents a *Willow Leaf*, in which are ſeveral *Excreſcencies*, ſome of them with Holes as F, others as C D E; G H ſhews two of theſe Knobs cut open, and the Poſture of the Worm therein, ſeveral Worms lay dead

* *Leeu. Ex. & Con. Epiſt.* 90. † *Ph. Theo. p.* 387.

in



J. Wigley. Sc.

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in the Knobs ſuppoſed to be killed by other leſſer Worms, produced from an Egg depoſited by another Fly ſince the Production of the former, which devoured and lived upon the larger Worm.

In the Middle of *July* Mr. *Leeuwenhoeck* cropt ſeveral *Willow-Leaves*, in which were ſuch like Knobs *, and diſcovered ſeveral Worms nearly arrived to their full Growth: After theſe Knobs had been in the Glaſs Tubes about eight Days, upon opening one of them he found, that the Worm was turned into a *Tonnekin* or *Aurelia*, and in ſome others 13 or 14 more of the ſame; in ſome of the Knobs he found the ſmall *devouring Worms* above-mentioned, being ſo far advanced in Growth that they were ready to be chang'd into flying Inſects; he put theſe alſo into Glaſs Tubes. After ſome Weeks certain *black Flies* proceeded from thoſe Tonnekins, their hinder Parts of an oblong Figure, and faſhioned like a Hook. He alſo ſaw two of theſe ſmall Worms (which devoured the large ones) endeavouring to encloſe themſelves in a Web; but by reaſon of the large Space in which they lay, could not bring it quite round them, having made it only on one Side, and their Change happened in ſo ſhort a Time that he could not make his Remarks thereon.

Fig. 97. repreſents the aforeſaid Fly as it appears to the naked Eye. A B ſhews the long, ſlender and hooked Part; on examining this little Inſtrument in the *Microſcope*, it appear'd to be hollow, and was cover'd with a great Number of fine Hairs, as in Fig. 98. and on endeavouring to ſplit it, the Dart, Fig. 99. appear'd, whoſe Point is only jagged with ſaw like Teeth, which being alſo ſplit, two other diſtinct Hooks † were taken out of it both of the ſame Shape, a ſmall Part of one of them is repreſented by Fig. 100. each of them being fortified with ſaw-like Teeth, and the Dart Fig. 101, was found to be only a ſecond Caſe or Sheath for the two Hooks, wherein the Hollowneſs does plainly appear, which is filled with a corroſive Water. The Fly makes uſe of this Auger to prepare a convenient Lodgment for her Eggs (and chooſes thoſe Leaves that are moſt lacteous and juicy) under the Skin of the Leaf, from whence the Worm upon gnawing the Veſſels for its Suſtenance, occaſions the Sap to flow out of them and to coagulate into that knotty Subſtance. Mr. *Leeuwenhoek* took a ſmall devouring Worm from a larger that lay dead by it, and put it upon a living one to which it immediately faſtened, whilſt the other at the ſame Time uſed all Means, by bending, ſtretching, contracting, and winding its Body, to free itſelf from this troubleſome Gueſt, but in vain, the ſmall one ſtill keeping its Hold.

Fig. 102. exhibits a *Tonnekin*, which was a Worm but the foregoing Evening, and had caſt off a very thin Skin, this alſo conſiſted of ſeveral Rings and Circles as when in the Worm State. The Feet and Joints there-

* *Ph. Tranſ. No.* 269. † *Arc. Nat. Epiſt.* 136.

of were very viſible; A B and A C repreſents its two Antennæ; and although they were incloſed in a thin Membrane, yet all the Joints might be clearly ſeen. The Change of this Worm was ſo ſudden, that Mr. *Leeuwenhoek* was never able to ſee it.

Not only the *Willows* and other *Trees*, but Plants alſo have Caſes produced on their Leaves, as *Nettles*, *Ground Ivy*, &c. by the Injection of the Eggs of an *Ichneumon Fly*. Theſe Caſes are generally obſerved to grow near to ſome Rib of the Leaf, and their Production thus. The Parent Inſect with its ſtiff ſetaceous Tail, terebrates the Rib of the Leaf when tender, and makes way for its Egg, into the very Pith or Heart thereof, and probably lays in therewith ſome proper Juice of its own Body to pervert the regular Vegetation of it. From this Wound ariſes a ſmall Excreſcence which (when the Egg is hatched into a Maggot) grows bigger and bigger, as the Maggot increaſes, ſwelling on each Side the Leaf between the two Membranes; and extending itſelf into the parenchymous Part thereof, until it grows as big as two Grains of Wheat; in this Caſe lies a very ſmall white rough Maggot, which turns into a beautiful green ſmall Ichneumon Fly.

SECT. VIII.

Of the Crane-Fly, or Father Long-legs.

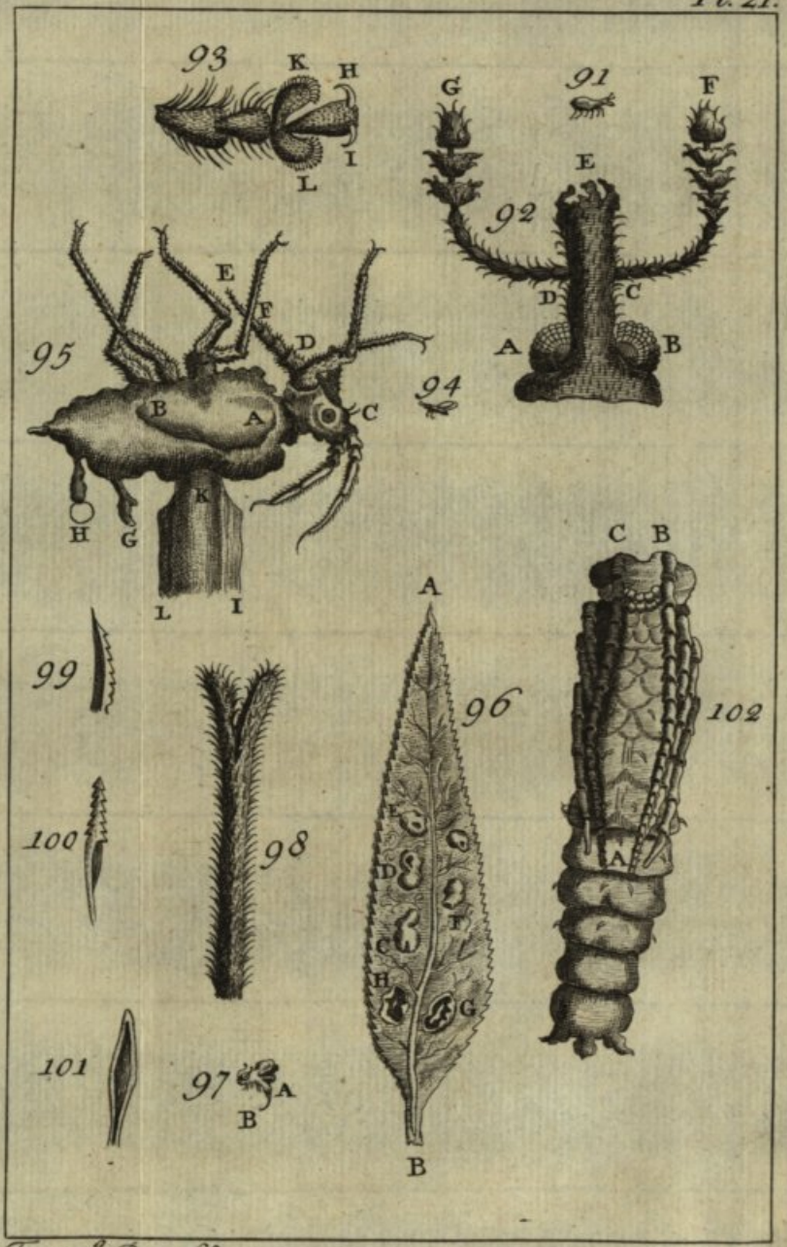
THIS little Creature, though but ſeldom taken Notice of, affords an agreeable Variety of Subjects, when examined by the *Microſcope*. It is produced from a Worm hatched in an Egg, depoſited by its Parent under the Graſs in Meadows.

Theſe Worms are to be met with but in the hot Weather upon the Ground under the Graſs in the Meadows and Fields. Fig. 103. repreſents one of them, which could not be diſcerned to change or increaſe between the Months of *May* and *Auguſt*.* Fig. 104. ſhews the Worm changed into a Nymph, and at its firſt coming forth greatly agitated. Fig. 105. ſhews the caſt-off Skin, which in its Change the Worm forſook, after which it took Wing and flew away in the Form of Fig. 106. which repreſents one of theſe male Flies, as does Fig. 107, alſo ſhew the *Female*.

The Tails both of the Male and Female are of a curious Structure, that of the Female is ſharp, and of the Conſiſtence of Bone, wherewith ſhe perforates the Ground, and depoſites her Eggs under the Graſs in a moiſt Place. This acute Tail of the Female is ſhewn at N, Fig. 107. which ſhe can open into four diſtinct Parts †. Upon opening one of theſe Females

* *Leeu. Ex. & Contemp. p.* 347. † *Leeu. Ex. & Contemp. p.* 349.

Mr.



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Mr. *Leeuwenhoek* counted upwards of 200 Eggs of a blackiſh Colour and ſmooth, like poliſhed Glaſs, and about twice as long as they were thick. The Inteſtines of this little Creature are alſo very curious, which when opened with unſpeakable Admiration he ſaw them by the Aſſiſtance of the *Microſcope*, as plainly as the Bowels in larger Animals can be ſeen by the naked Eye.

In the Feet of this Fly, if diſſected in a Drop of Water upon the Glaſs R, Fig. 2. of the *Univerſal Microſcope*, the fleſhy *Fibres* may be ſeen to diſtend and contract themſelves in a moſt ſurpriſing Manner, and to continue ſo for the Space of three or four Minutes. The Eggs alſo after Diſſection may be applied to the ſaid Glaſs, and eaſily examined by the Microſcope, or on dipping the Point of a very fine ſewing Needle (it being firſt fixed in a wooden Handle) into ſome Turpentine, and applying that to the Eggs, they will be glued thereto. The Needle itſelf muſt be held between the Nippers, and by its Handle may be turn'd round at Pleaſure.

It is very wonderful how ſo ſmall a Creature as ſome of thoſe newly hatched Maggots, that are found in the Ends of blighted Leaves, can be able to convolve the ſtubborn Leaf, and then bind it with the Thread or Web it weaves from its own Body, alſo to line the Inſide of it with the ſame, and ſtop up the two Ends thereof to prevent its own falling out.

In the Bodies of many *Caterpillars*, and other Nymphs of Inſects, are frequently found to be generated great Numbers of ſmall *Flies*, whoſe parent Animal had wounded the *Caterpillar* *, and darted its Eggs into it; and ſo made it the foſter Mother of its young.

Some Inſects lay up their Eggs in Cluſters, as in Holes of Fleſh, and ſuch Places, where it is neceſſary they ſhould be crowded together, which without doubt contributes towards the hatching †.

Other Inſects obſerve great Order in the Diſpoſition of their Eggs, which may be found upon the Poſts and Sides of Windows, very neatly laid, being round and reſembling ſmall Pearl, which Eggs produce a ſmall hairy *Caterpillar* ‖. The white *Butterfly* alſo lays its Eggs on Cabbage-Leaves, and always glues one certain End of them to the Leaf. If theſe Eggs be applied to the *Univerſal Microſcope* on the Glaſs R, Fig. 2. you will find them curiouſly furrowed and handſomely adorn'd.

The *Peaſe Ichneumon Fly* § is very ſmall, its Wings large, reaching beyond the *Podex*; Antennæ long, Alvus ſhort, ſhaped like an Heart, with the Point towards the *Anus*, it walks and flies but ſlowly. No Tail appears, but they have one concealed under the Belly.

Ichneumon properly ſignifies the *Egyptian* Rat **, which has its Name from

* *Ph. Th. p.* 390. † *Ph. Th.* 393. ‖ *Ph. Th. p.* 393. § *Ph. Th.* 387.
** *Philoſ. Tranſ.* No. 77.

its

its hunting or tracing out the Eggs of Crocodiles and Aſps: A like Obſervation made by ſome of the Ancients on certain Inſects of the Waſp-Kind, occaſioned the Application of that Name to Waſps, as well as the *Egyptian* Rat; there is but one Paſſage in all Antiquity concerning theſe Waſps, *viz.* in *Ariſtot. de Hiſt. Anim. Lib.* 5. *c.* 20. which *Pliny*, *Lib.* 11. *c.* 21. hath render'd thus, *Veſpæ Ichneumones vocantur (ſunt autem minores quam aliæ) unum genus ex aranes perimunt, phalangium appellatum, & in nidos ſuos ferunt, deinde illinunt, & ex iis, incubando, ſuum genus procreant*; that is, the Waſps, called *Ichnumons*, and which are ſmaller than other Waſps, kill a Species of Spiders, called *Phalangium*, and carry them to their Neſts, after which they beſmear them, and by Incubation produce their own Species out of them.

There is alſo a certain *black* and curious *Fly*, which proceeds from the gouty Excreſcencies of the *Briar Stalk* *, with red Legs. Black, ſmooth jointed Antennæ, large Thorax, and Belly in the Shape of an Heart. It leaps like a Flea.

The *Excreſcencies* of the Roots of *Cabbages*, *Turneps*, and divers other Plants, have always a Maggot in them, not yet ſufficiently obſerv'd.

Caterpillars, and divers others Inſects, can emit Threads or Webs for their Uſe. In this their *Nymph State*, they ſecure themſelves from falling, by letting themſelves down from the Boughs of Trees, and other high Places, with one of theſe Threads, and ſecure themſelves in their Aurelia State, in Caſes of their own Weaving.

Some of the *Fly Tribe* are alſo endowed with this textrine Art, of theſe one Sort ſpins a long milk white ſilken Web as big as the Top of one's Finger, woven round bent Stalks of *Ribwort*, &c. in Meadows. The other is a Lump of many yellow ſilken Caſes ſticking confuſedly together on Poſts, under *Coleworts*, *&c.* theſe Webs contain in them ſmall whitiſh Maggots, which turn to a ſmall *black Ichneumon Fly*, with long capillary Antennæ, tan-colour'd Legs, long Wings, reaching beyond their Body with a black Spot near the Middle, the Alvus like an Heart, and in ſome a ſmall ſetaceous Tail. Some of theſe Flies are of a beautiful ſhining green Colour. The Flies coming from theſe two Productions are nearly alike.

Many of the *Ichneumon Waſps* † are remarkable for the Nidification and Proviſion of their Young. Thoſe which commonly have golden and black Rings round their *Alvi*, line the Cells they perforate in the Earth, lay their Eggs therein, and then carry into them Maggots from the Leaves of Trees, and ſeal them up cloſe and neatly; theſe Waſps have their Jaws not only very ſtrong but nicely ſized, curved, and ſet for gnawing, and ſcraping. Thoſe little Holes they perforate in the Earth and Wood, as well as the ſe-

* *Ph. Th. p.* 250. † *Ibid. p.* 228.

veral

veral Parts of the Waſp itſelf, are a pleaſant Object for the Microſcope.

The Bearers of Fruit-Trees are full of Aſperities, and not ſo ſmooth on their Bark as the other Parts of the Tree are. If after Harveſt, and any Time in Winter, you view theſe Bearers in the Microſcope, their Cavities will be found to be full of Eggs, of an oblong Figure, and citron Colour, eſpecially in thoſe Years wherein the *Caterpillars* * have been numerous. Out of theſe they are hatched in the Spring. The Seaſons which uſually deſtroy them, are ſuch as come in with early Heats, before the coming out of the Buds and Bloſſoms, and on which a nipping froſty Air enſues, which ſoon kills them.

SECT. IX.

Of Oak Cones.

THESE *Cones* are to Appearance, perfectly like *Gems*, only bigger, being nothing elſe than theſe increaſed in Bigneſs, inſtead of Length. The Cauſe of this Obſtruction in the Vegetation is this, into the very Heart of the young tender Gem or Bud, (which begins to be turgid in *June*, and to ſhoot forwards towards the latter End of that Month, and the Beginning of the next) into this Bud the parent Inſect thruſts one or more Eggs, and perhaps not without ſome venomous † Ichon therewith; this Egg ſoon becomes a Maggot, and eats itſelf a little Cell in the very Heart or Pith of the Gem, which is the Rudiment of the Branch together with its Leaves and Fruit. The Branch being thus deſtroyed, or at leaſt its Vegetation obſtructed, the Sap that was to nouriſh it is diverted to the remaining Parts of the Bud, which are only the ſcaly Integuments, by this Means growing large and flouriſhing, becomes a Covering to the Inſect Caſe, as before they were to the tender Branch and its Appendage.

The Caſe lying within this Cone, is at firſt but ſmall, as the Maggot included in it is, but by Degrees, as the Maggot increaſeth, it alſo grows bigger, to the Size of a ſmall Pea, long and round, in the Shape of a long Acorn.

The Inſect produced from theſe Cones, hath four membraneous Wings, reaching a little beyond the Belly, articulated Horns, large Thorax, Belly ſhort and conical, Legs partly whitiſh, partly black, of a beautiful ſhining green, in ſome tending to a dark Copper Colour.

The *Aleppo Galls*, wherewith we make Ink, are no other than Caſes in which Inſects breed, which when they come to Maturity, gnaw their Way

* *Philoſ. Tranſ.* No. 237. † *Ph. Th. p.* 397.

out

out of them, which occaſions thoſe little Holes obſervable in them; See *Philoſ. Tranſ.* No. 245.

Of this Sort alſo are the little ſmooth Caſes, about the Size of large Pepper Corns, which grow cloſe to the Ribs, under oaken Leaves, at firſt of a bluſhing red, afterwards growing brown, hollow within, but an hard thin Shell without, in which commonly lies a rough white Maggot, afterwards transformed into a black *Ichneumon Fly*, that eats a little Hole in the Side of the Gall, and ſo gets out.

Some of theſe Balls are tender, as thoſe of a yellowiſh green Colour with a reddiſh Caſt, about the Size of a ſmall Muſket Bullet, growing cloſe to the Ribs, under Oaken Leaves, their Skin ſmooth with frequent Riſings therein, inwardly they are very ſoft and ſpongy; and in the very Center is a Caſe with a white Maggot therein, which becomes an *Ichneumon Fly*.* This Gall is remarkable for the *Fly* lying therein all the Winter in its infantile State, and comes not to its Maturity till the following Spring. In Autumn and Winter thoſe Balls fall down with their Leaves to the Ground, in which the incloſed Inſect is fenced againſt the Winter Froſts, partly by other Leaves falling pretty thick upon them, and eſpecially by parenchymous ſpongy Walls, afforded by the Galls themſelves.

From the large Oak Balls, called *Oak Apples*, which grow in the Place of the Buds, out of theſe Galls, come another Species of *Black Flies*.

The gouty Excreſcencies in the Body, and Branches of the Black-berry Buſh, produce a ſmall ſhining black *Ichneumon Fly*, about a Tenth of an Inch long, with red jointed Horns, four Wings, red Legs, and a ſhort Belly. They hop like Fleas.

All theſe Inſects afford an entertaining and agreeable Variety when viewed through a *Microſcope*.

SECT. X.

Of an Inſect found upon the Leaves of Spices and in Woods of ſeveral Kinds.

MR. *Leeuwenhoek* diſcover'd upon the Leaves of ſome white Nutmegs, an *Animalcule* or minute Worm, which appeared to the naked Eye of the Size of Fig. 108. but is repreſented in Fig. 109. as it appear'd when placed before the *Microſcope*. Its Body was jointed in ſeveral Places, and thickly ſet with Hairs; it had ſix ſhort Feet, which end with a ſhining Nail, toothed like a Saw, as at A, B, C, D, the hinder Part of its Body was very full of Blood Veſſels, as appears at E, F, G, H.

* *Ph. Th. p.* 400.

At

At I K are two ſhining Horns jointed and beſet with Hairs. At L are repreſented its Forceps, with which the Worm eats its Way into Leaves or Wood, *&c.* M N ſhew the two leſſer Horns which adorn the Head of the Worm. This Worm after ſome little Time was changed into a flying Inſect, as exhibited in Fig. 110. whereof L M, B N are its two Horns, which conſiſted of divers Joints and Hairs, B L its Eyes furniſhed with a Number of little *Lenſes*, as the Eye of the Drone Fly before deſcribed. It had alſo ſix Feet armed with *Talons*, as before ſhewn: Theſe Legs had ſeveral Joints, and were cover'd with Briſtles or Thorns, two of theſe Feet and Nails are ſhewn by the Letters C O, D P. D E, and K I repreſents the two Caſes or Shields under which the Wings are folded. Theſe Caſes are moſt curiouſly adorned with ſtrait Rows of Rings throughout their whole Length. The hinder Part of its Body is jointed as it were with hollow Notches, much after the ſame Manner as the Worm from which it was produc'd. If the Wing be conſidered, it will be found to conſiſt of ſeveral ſmall Veſſels or Nerves that aſſiſt in the Expanſion thereof. The exquiſite Neatneſs with which this minute Wing was folded under the Shields, is ſurprizingly beautiful, as appears between G H, with what wonderful Nerves muſt theſe minute Wings be ſtrengthned, that can enable this Inſect ſo readily to fold up the Extremity of this filmy Membrane in ſo neat a Manner, and to expand it again, as it were inſtantaneouſly, whenever it is inclined to fly? That the curious Folding of theſe ſort of Wings might be comprehended, Mr. *Leeuwenhoek* took off one of the ſhelly Caſes and placed the Wing before the Microſcope, which appeared as in Fig. 111. Q S T V W X Y repreſent the Wing as it lay cover'd under its Shield. It was broadeſt about V; the ſecond Wing, which I ſuppoſe to be its Ballance or Poize, is ſhewn at S T. The Extremity W X Y, ſhews thoſe neat Foldings before ſpoken of, which, together with the Strength of the Nerves, diſcover the Almighty's Wiſdom in their Contrivance.

I have found of theſe Inſect Flies in Summer-time flying about my Work-ſhop, and have obſerved them to anſwer all the above Deſcription. They are ſo ſmall, that I have applied them to the Microſcope in the Ivory Sliders, but they are better ſeen when applied in the Nippers V, of Fig. 2.

There is likewiſe a ſmall *Scarab* in the very Tips of *Elm-Leaves*.* In the Summer many of theſe Leaves may be obſerved to be dry and withered, and alſo turgid, in which lies a dirty, whitiſh, rough Maggot, from which proceeds a *Beetle* of the ſmalleſt Kind, of a Weeſel-Colour; it leaps like a *Graſhopper*, although its Legs are but ſhort, black Eyes, Vaginæ thin, and prettily furrow'd, with ſeveral Cavities, ſmall dubed Antennæ, and a long Proboſcis.

* *Ph. Theo. p.* 251.

The ſame, or one much like this is found on the Tips of *Oak* and *Holly Leaves*.

The *Horſe-Fly* is alſo a curious Object, its Eye is in the Form of other Flies, but is as it were indented all over with a pure emerald Green, its Body like Silver in Froſt-Work *, fringed all over with white Silk. If the Head of this Fly be cut off juſt at the ſetting on of the Neck, a pulſing Particle may be ſeen beating through the Skin for half an Hour together.

The *Trunk* or *Proboſcis* of a *Butterfly*, which lies wound up like an Helix or ſpiral Spring, gradually growing ſlender as at Fig. 113, ſupplies the Office both of Mouth and Tongue, it may with a Pin be eaſily drawn out to its full Length, if it be cut off and laid upon the Object carrying Glaſs R, of Fig. 2. and ſo applied to the Microſcope you will ſee it wind and coil † itſelf up, and then to open itſelf again for a long Time together, Nature having made it of a ſufficient Length, that when extended it may reach into the Hollows of Flowers, and from thence extract their Dews and Juices. It conſiſts of two Tubes near its Extremity, as repreſented at A C, Fig. 113. the Cavities of which unite at D, and from thence to the Throat of the *Butterfly* form but one Channel ‖. Theſe tubular Extremities are unfolded in the Manner expreſſed at B T N, Fig. 114. in order to extract the Dews, *&c.* from Flowers; after which it is immediately drawn back and coil'd up into an Helix. M M, Fig. 115. repreſents one of the extreme Parts viewed with a greater Magnifier, and delineated exactly in the Manner as it is applied to Leaves and Flowers. Whence it appears, that it is not the extreme End of the Proboſcis, which extracts the Dews and Juices; but ſeveral Nipples D E F, that are applied to the Leaf A C, at the Points i i i.

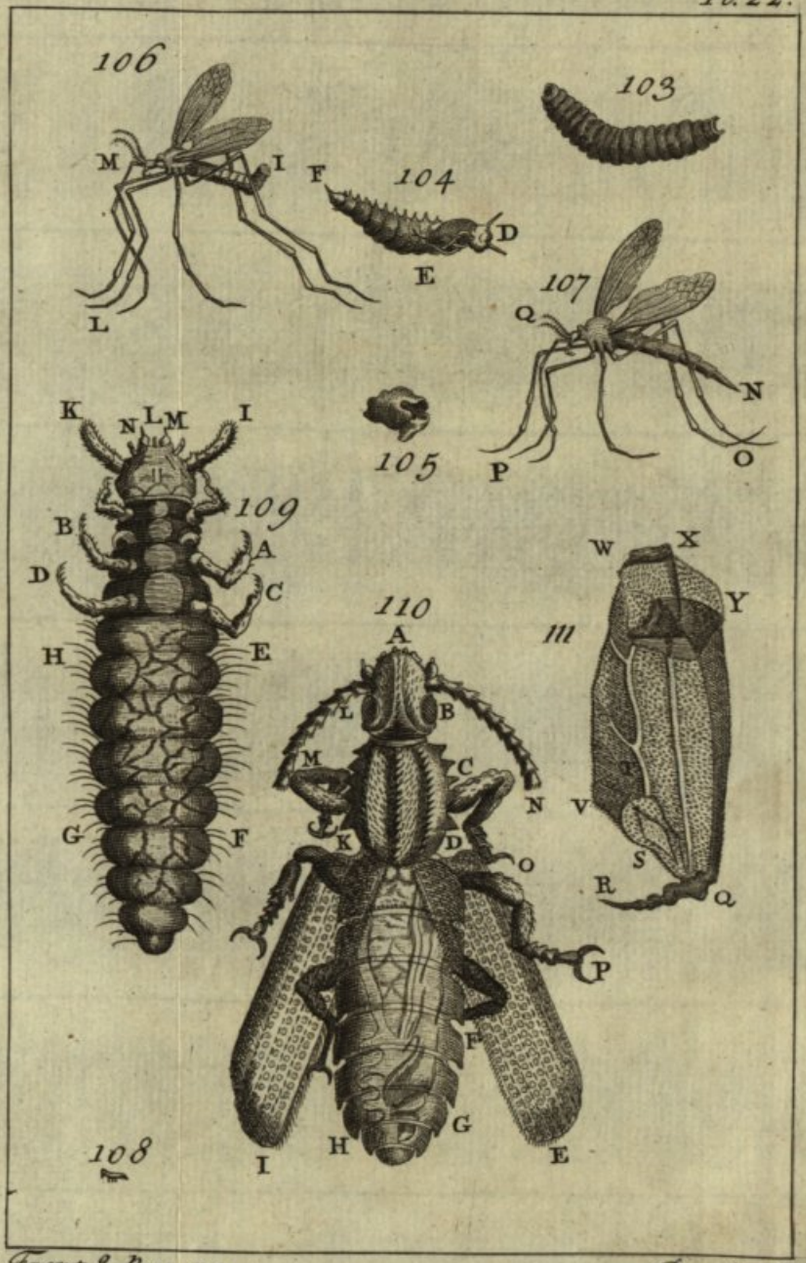
In all *Graſhoppers* there is a green Film or Plate (like a Croſlet) which covers the Neck and Shoulders; if you raiſe it up with a Pin you may ſee their *Heart beat* § for a long Time together. The *Graſhopper* is beſt held between the Nippers V, and ſo applied to the Magnifier.

There is a pretty Object, which is a white oblong Inſect that ſticks to the Back-ſide of *Roſe-tree Leaves* ** in *Auguſt*, of a perfect white, it changes into a ſmall yellow Locuſt, with two white Wings longer than its Body, and two Pointers in the Snout like a Pair of cloſed Compaſſes, and may be plainly ſeen when the Fly is laid upon its Back.

Upon the Backſide of the Leaves of *Gooſeberries*, *Sweet Briar*, and *golden Mouſe-ear* in *April* and the Beginning of *May*, is a greeniſh *Graſhopper* or *Locuſt* ††, which is a pleaſant Object; when placed before the *Microſcope* it hath two Horns and four Legs, and two curious black Eyes.

* *Power's Micro. Obſ. p.* 7. † *Ibid. p.* 8. ‖ *Microgra. de Bonan. Pars* 2. *p.* 48. § *Power's Micro. p.* 24. ** *Ibid. p.* 27. †† *Ibid. p.* 26.

On



Front.g Pag. 74.

Bowles Sc.

On *Sycamore Leaves* there is a yellow Inſect *, which at firſt hath no Wings, but ſix Legs and two Horns which are ſlit; it runs nimbly, the Eyes are globular and red, pearled and prominent; near the Shoulders are two Stumps, whence two long Wings come forth, when it changes into a Fly or Locuſt, it conſiſts of annulary Circles, and is hairy towards the Tail.

There is to be found a ſmall long black Inſect, creeping and leaping amongſt *Pinks*, *Gilly-Flowers*, *Roſe-leaves*, &c. with a *Waſp-like Body*, with ſix or ſeven annulary Diviſions; two curious Horns ariſing from a black knobbed Root, two fine long yellow Wings, black Eyes, and ſix black Legs, they are kill'd with the leaſt Touch imaginable; their Size is leſs than that of a Louſe: * They may be taken up with the Point of a Pin dipped in Spittle, and by that Means placed, or as it were glewed to a very ſmall Bit of Card, which may be applied to the Microſcope in the Nippers of Fig. 2. And ſtronger Inſects may be ſtuck to a larger Piece of Card with a Touch of Turpentine, and applied to the Magnifier in the Nippers as before.

On the *Froth*, which hangs on the *Leaves* of *Lavender*, *Horſe-mint*, *Roſemary*, &c. ‖ (by ſome called *Cuckow-ſpit*) is always found a little Inſect of a golden Colour; it hath ſix Legs, with two black Claws at the End of each, which it can open and ſhut at Pleaſure; its Eyes are pearled and of a duſky Red, a long reddiſh Proboſcis is ſituated between its fore Legs; its Tail had ſeveral annular Diviſions that ended in a Stump, which it could at Pleaſure thruſt out or draw back, it firſt creeps, then leaps, and at laſt flies.

The *Cow-lady*, *Lady-bird*, or *ſpotted Scarabee*, is a very nimble Animal; cut off its Head, and erect it perpendicularly upon the Neck (which may be faſtened to a Bit of ſoft Wax firſt ſtuck upon the Point, or by a Drop of Gum-Water upon a Piece of Card, which may be held in the Nippers, and ſo applied to the Microſcope) and you'll ſee two ſmall black Eyes ſet upon three white Plates like poliſhed Ivory, two ſmall ones on one Side, and a large one on the other; pull off both the cruſtaceous and filmy Wings, which are a Fence to a thin tender black Skin, under which the *Pulſation* of the *Heart* § may be ſeen to beat vigorouſly for 12 or 14 Hours, after the Head and Neck are ſeparated.

There is a *Fly* with *grey* and *black Streaks* on the *Shoulders* **, and *chequer'd* on the *Tail* with the ſame Colours; upon opening the Female of this Fly, which may be diſtinguiſhed by a Redneſs on the Extremity of the Tail, you will find two Bags of live white Worms **, long and round in Shape, with black Heads, moving both on the Hand and in the unopened Veſicles

* *Power's Mi. Ob. p.* 32. † *Ibid. p.* 31. ‖ *Ibid. p.* 28. § *Ibid. p.* 30. ** *Phi. Tranſ. No.* 72.

backwards and forwards, being diſpoſed in Cells according to the Length of the Animal's Body.

SECT. XI.

Of the Cochineal Fly.

THE *Microſcope* hath diſcovered to us that *Cochineal*, ſo valuable for its Uſe in dying *Crimſon*, *Scarlet*, and *Purple*, is an Inſect bred upon the Plant called *prickly Pear*, or *Indian Fig* †; and upon the Leaves or Twigs thereof are ſmall *Knobs* or *Protuberances*, which produce little Worms that in Time become Flies, reſembling *Cow-ladies*, or *Lady-birds*; which, when arrived at their full Growth, are taken by the Inhabitants (of the Iſlands of *Cuba*, *Hiſpaniola* and *Jamaica*, from whence it moſt commonly comes) and expoſed to the Heat of the Sun to dry, and rubbed between the Hands till their Wings, Legs, *&c.* fall off. Upon ſteeping ſome of the Grains of *Cochineal* 24 Hours in Water, a Trunk with Scales and Legs will appear; and if their Bodies be opened, many Eggs of different Sizes may be alſo found.

Fig. 116. repreſents a Grain of *Cochineal*; Fig. 117. another Grain, as it appear'd through a *Microſcope*, in which at the extreme Parts C and E F, an Orifice appears, from whence the String was broken off, whereby both Parts of the Body were joined together. The concave Arches D G, *&c.* are not natural, but adventitious to the ſame Grain, proceeding only from the drying or ſhrinking up of the great Number of Eggs that lie within the Animalculum; for if the ſame Grain was well ſoaked in Water, the concave Parts would become convex. Fig. 118. ſhews an Egg with its Membrane, as it was taken out of a Grain of Cochineal ſteeped in Rain-Water for about 24 Hours; in which might be ſeen the young one, and its Shell ſurrounding it. L M N, Fig. 119. repreſents one of theſe unborn Animalcula. Fig. 120, ſhews the Body of another *Animalcum* which was taken out of the Egg-ſhell, in which not only the Body was diſtinctly ſeen, but alſo the Parts thereof divided into ſeveral Circles, and likewiſe the two Horns with the Joints wherewith Nature hath provided all thoſe unborn *Animalcula*, were plainly viſible when placed before the Microſcope. B H, D I, and D K, ſhew its four Legs, the other two being hid from the Sight. F G repreſent the Horns, at the Extremity of each of which are three ſmall Hairs.

† *Phi. Tranſ. No.* 292.

SECT.

SECT. XII.

Of the Death-watch.

THERE are two kind of Inſects which make a regular clicking Noiſe like the Beats of a Pocket Watch; one of them called by *Swammerdam*, *Scarabeus Sonicephalus*, and the other called by Mr. *Derham*, *Pediculus Pulſatorius*.

The firſt of them is a ſmall *Beetle*, about $\frac{5}{16}$ of an Inch in Length, * of a dark brown Colour, with Spots ſomewhat lighter irregularly placed. It is repreſented of its natural Size at Fig. 121. Under its Vaginæ are pellucid Wings, the Head large, by reaſon of a Cap or Helmet which covered it, only a little turned up at the Ears; under this appear'd its Head, which was flat and thin, the Eyes forward, the Lips hard and ſhining, the Bars of the Helmet greyiſh; two Antennæ proceeded from under the Eyes, the Head all hairy, and Face thick of curled Hair; on the Belly was a little Hair, but thinly ſet; its Eyes like thoſe of a Fly. Fig. 122. is a Microſcopick Picture of it; between the Eyes the Face riſes in a little Ridge, which is the Noſe; and juſt below it the Noſtrils are covered with ſtrait pendulous Hair, the Lip-ſhades ſhew the more depreſſed Places; under this Lip are four viſible Forceps, two on each Side to lay hold on its Food. They make a Noiſe juſt like the Beats of a Pocket-Watch. Mr. *Derham* has often cauſed one of them to beat when he pleaſed by imitating its Beating, and this he kept in a little Box about three Weeks; and imagines, that theſe Pulſations is the Way theſe Inſects woo each other, and invite to Copulation; and that it always draws back its Mouth, and beats with its Forehead †.

The other *Death Watch* is an Inſect different from the foregoing, that beats only about ſeven or eight Strokes at a Time, whereas the former will beat ſome Hours together without Intermiſſion, and its Strokes ſlower, and like the Beats of a Watch. It is a ſmall greyiſh Animal, much reſembling a Louſe; for which Reaſon it is called *Pediculus Pulſatorius*. It is very nimble, but extremely ſhy when diſturbed; it will beat freely enough before you, and alſo anſwer you when you beat, if you can view it without giving it any Diſturbance, or ſhaking the Place whereon it lies. It is not certain whether they beat on any other Thing but Paper, their Noiſe being heard only in or near it.

Fig. 123. repreſents the ſecond Sort of *Death Watch* ‖, as it appears to the naked Eye. Fig. 124. ſhews it a little magnified; its Shape and Colour

* *Phil. Tranſ. No.* 245. † *Phil. Tranſ. No.* 271. ‖ *Phil. Tranſ. No.* 291.

is

is not much unlike a Louſe; it is common in moſt Houſes in the warm Months, but in the cold Seaſon of the Year it hides itſelf in dry obſcure Places, and is ſeldom ſeen; ſome Time after Copulation, they lay their Eggs in dry duſty Places; they are much more minute than the Nits of Lice, of a whitiſh Colour, and are hatched by the Warmth of the approaching Spring, which to them is all the ſame as an Incubation: The Inſect is fully hatched, and can creep about at the Beginning of *March*, or ſooner if the Weather be warm; at their firſt quitting the Egg-Shell, they are ſo exceeding ſmall, as ſcarce to be diſcern'd, without the Aſſiſtance of a convex Glaſs: In this State Mr. *Derham* could find no other Difference between them and Mites in Cheeſe, when viewed with a Microſcope that magnified much, but only that Mites had more Briſtles about the Breech: In this Shape they continue ſix Weeks or two Months, feeding on divers Things they can meet with; after which they gradually increaſe towards their more perfect State, when they become like the old ones.

Mr. *Derham* has plainly ſhewn, that their ticking Noiſe is a wooing Act, and that it is commonly about *July*; * he never found them in *Coitu*, till about a Week or a Fortnight after their ticking; tho' it is probable they copulate at that very Time. He has ſeen the old *Death Watches* feed upon dead Inſects, as the young ones do, and alſo upon Biſkets, Tallow, *&c.* nay Duſt itſelf, and hath obſerved them thro' a Microſcope to ſelect ſome Grains thereof, and reject others.

CHAP. XVIII.

Of a Gnat.

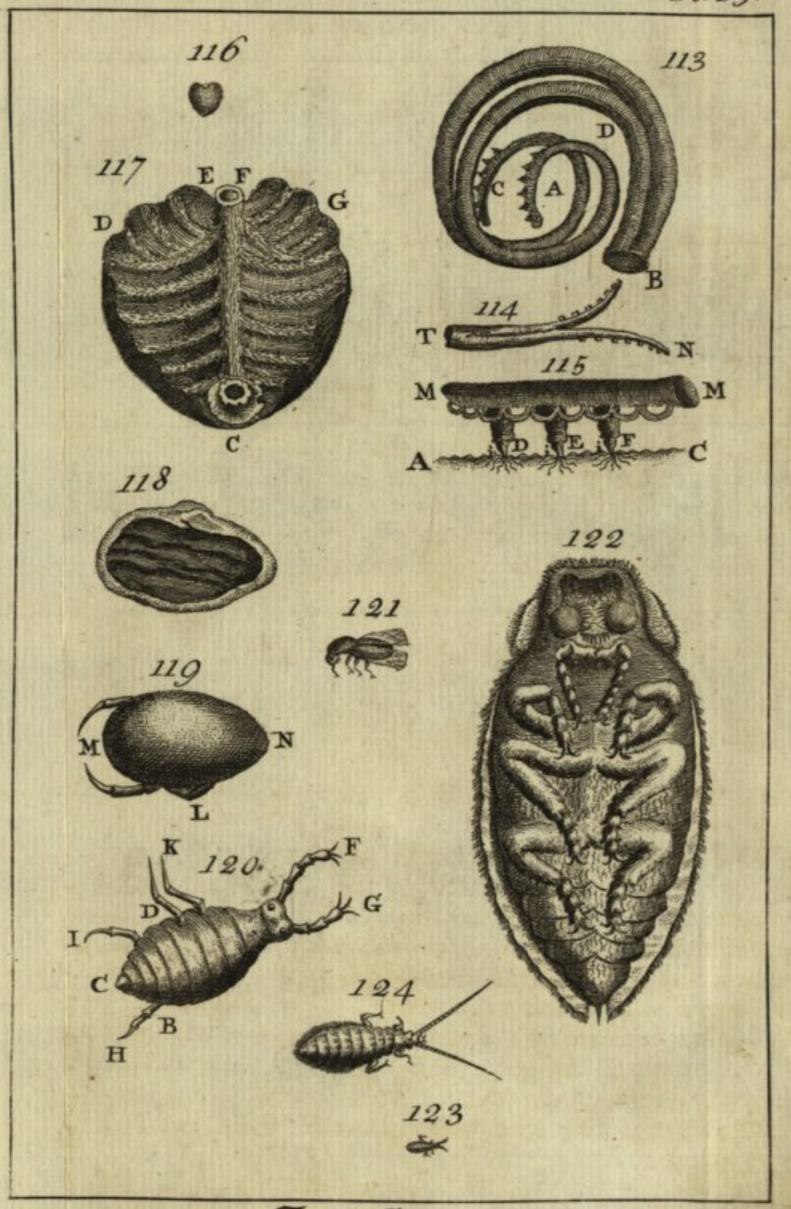
SECT. I.

THE firſt obſervable in the Generation of this Inſect, is its vaſt Spawn, ſome of them being 1½ Inches long, and ⅛ of an Inch broad, floating in the Water, but being made faſt to ſomething to prevent its being waſhed away; in this tranſparent Spawn the Eggs are neatly depoſited, in ſome a ſingle, in others a double ſpiral Line †, running from End to End, as in Fig. 125, and 126. and in ſome tranſverſly, as in Fig. 127.

When the Eggs are by the Heat of the Sun, and Warmth of the Seaſon, hatched into ſmall Maggots, theſe Maggots deſcend to the Bottom; and by Means of ſome of the gelatine Matter of the Spawn, which they take along with them, they ſtick to Stones, and other Bodies at the Bottom,

* *Phil. Tranſ.* No. 271. † *Phi. Theo. p.* 394.

and



Front.ª Pag. 78.

and there make themſelves little Caſes or Cells, which they creep into, and out of at Pleaſure, till they arrive at a more mature Nymph State, and can ſwim about here and there in Queſt of Food; at which Time they are a Kind of red Worms about half an Inch long, but of the Shape of Fig. 128.

It has a very large Head, in Proportion to its Body, which is all covered with a Shell; ſeveral Tufts of Hair on ſeveral Parts, two Horns, a large Mouth, *&c.* The Form of the whole Creature will be better perceiv'd by a Deſcription of Fig. 128. the hinder Part or Belly conſiſts of eight ſeveral Joints. From the Midſt of each of which, on either Side, iſſue out three or four ſmall Briſtles. The Tail was divided into two Parts, very different in Make; one of them A, had ſeveral Tufts of Hair or Briſtles, with which it could ſteer itſelf as it pleaſed, and was enabled to ſwim about by Curvations and flapping its Body ſideways, this Way and that, and keep itſelf near the Surface of the Water: The other Part B appeared to be the ninth Diviſion of its Body, and on each Side had many ſingle Hairs. From the Part C to the Head, appeared a darkiſh colour'd Gut, through which the periſtalſtick Motion was very diſcernable. The Cheſt D E of this Creature, was thick and ſhort, and ſo tranſparent, that its white Heart could be ſeen to beat: Its Cheſt was ſtuck with ſeveral Tufts or Briſtles, and the Head was alſo adorn'd with the ſame, it had two black Eyes, and two ſmall Horns F G.

Both the Motion and Reſt of this Creature are ſurprizing and pleaſant. The Tail ſeems much lighter than the reſt of its Body; and being a little lighter than the Water in which it floats, buoys it up to the Top thereof, where it hangs ſuſpended with its Head downwards; they lift their Heads ſometimes into the Air, at other times plunge them into the Water, their Tails all the while ſliding along its Surface.

After having lived in this Manner the Time which Providence has allotted them, a ſtranger Change ſucceeds; they appear in Form of Fig. 129. and then they caſt off their whole Skin, Eyes, Horns, and Tails; and iſſue forth as Inſects of a quite different Element: The moſt beautiful and elegant Plumage adorns their Heads; their Limbs are of the fineſt Texture; their Wings are curiouſly fringed and ornamented; their whole Bodies are inveſted with Scales and Hair; and they are actuated by a ſurprizing Agility; in ſhort, they become *Gnats*, and ſpring into the Air; and what is moſt amazing, a Creature, that but a Minute ſince was an Inhabitant of the Water, would now be drown'd if it were plung'd therein.

It is very probable, that many Sorts of the Animalcules in Fluids undergo ſome ſuch like Change.

SECT.

SECT. II.

Of the Tufted, Bruſh-horn'd, or Male Gnat.

ITS ſurprizing and particular Beauties are only to be diſcover'd by the MICROSCOPE; and is exactly of the Shape of one of thoſe which Mr. *Hook* obſerved to be generated out of one of the little watery Inſects juſt deſcribed.

Nature has adorned it in a moſt ſurprizing Manner: Its Head A is exceeding ſmall in Proportion to its Body, which conſiſts of two Cluſters of pearled Eyes, Fig. 130. curiouſly ranged like thoſe of other Flies; between which, upon two blackiſh Balls, are placed two long jointed Horns D, tapering towards the Top; from whence iſſued out in a circular Manner, Multitudes of ſmall ſtiff Hairs from its ſeveral Joints, exactly reſembling the Sproutings of the Herb *Horſe-Tail*. There are alſo two other jointed and briſtled Horns or Feelers D. And a Proboſcis F, underneath which is the Sucker or Sting, which in ſome *Gnats* is very long. This ſmall Head, with its Appurtenances, is joined by a ſhort Neck to the Thorax G, which is large, and as it were caſed with a black Shell; out of its under Part proceeded ſix long ſlender Legs H H, *&c.* much like thoſe of other Flies, but longer and ſlenderer, which are not expreſſed in the Figure, becauſe of their great Length. From the upper Part proceeds two long ſlender tranſparent Wings, ſhaped ſomewhat like thoſe of a Fly; underneath which, as is obſervable in many Sorts of Flies, are placed two ſmall Bodies, which are its Ballances or Poiſes. Its Belly large, and extended into nine Partitions, each being armed with Rings of Shells; ſix of which were ſo tranſparent, that the periſtaltick Motion was plainly viſible. A ſmall clear white Part at I, ſeem'd to beat like the Heart of a larger Animal; the three laſt Diviſions of the Tail were cover'd with opake Shells.

SECT. III.

Of the great belly'd or Female Gnat.

ALthough this *Gnat*, as repreſented in Fig. 131. differs from the former in Shape, yet this Sort alſo has been found to be generated out of the Water Inſect before deſcribed: Its Wings were larger than thoſe of the other; its Belly bigger and ſhorter; its Thorax not much unlike that of the other, having a ſtrong rigid back Piece and Breaſt Plate; its Head larger and neater ſhaped; the Horns, that grew out of thoſe two little Balls,

Balls which were between its Eyes, was of a different Shape from the Tufts of the other Gnat; these having but a few Knots or Joints and a few short Bristles; the foremost Horns or Feelers like those of the former.

In different Species of *Gnats* their Wings are also different; some having a Border of long Feathers, others of short ones, and others none at all: The Rib-work of the Wings is feathered in some and scaled in others, and in some beset with Prickles.

Mr. *Hook* suffered one of these *Gnats* to pierce the Skin of his Hand, and thence to draw out its Fill of Blood, which made it appear very red and transparent, and this without any further Pain, than whilst the Sting was entering; a good Argument that these Creatures do not wound the Skin out of Revenge, but for mere Necessity to satisfy their Hunger.

This Piercer, Sting or Sucker, as represented by F G H I, Fig. 132. is a Case cover'd with long Scales and Hairs; it lies concealed under the *Gnat's* Throat, when not made use of; but when it is, the Side G H opens, and four Darts are thrust out therefrom occasionally; one whereof H K (minute as it is) serves for a Case to the other three; the Sides of which towards the Point K are barbed or indented. F I shew that Part of the Sting where it was cut off from the Gnat's Throat.

Fig. 133. represents Part of the second Sheath, whose Sides near the Top are barbed, but not here expressed. This also opens Side-ways for a Passage to the three included Stings.

Fig. 134, shews all the Parts of the Stings wherein two of the interior ones might be seen barbed and indented towards the Point; their Fineness is almost inexpressible, they have three Sides, as represented in Fig. 135, whose Edges seemed to join alternately (which when so united resemble a three edged Sword, or Dagger.) Fig. 136, shews another Part of one of those interior Stings, which is remarkably small and somewhat curved. Its Top on the plain Side is shewn at Fig. 137. which Top is represented in another Position, Fig. 138. A. and in the Position of B its Hooks might be seen. When these Darts are thrust into the Flesh of Animals either successively or in Conjunction, the Blood and Humours of the adjacent Parts must flow to, and cause a Tumour about the Wound, whose little Orifice being closed up by the Compression of the external Air can afford them no Outlet. When a Gnat finds any tender juicy Fruits, or Liquors, she sucks up what she likes through the outer Case, without using the Darts at all; but if it is Flesh, that resists her Efforts, she stings very severely, then sheaths her Weapons in their Scabbard, and through them sucks up the Juices she finds therein. Upon Dissection many curious Things may be discovered, *viz.* numberless Animalcules in the Semen of the Male *, and in the Female a surprizing Quantity of Eggs.

* *Arc. Nat. Tom.* IV. *p.* 22.

There is a kind of *Gnat* which lays its Eggs frequently in dead Beer, *&c.* and ſome Time after this the Maggots are ſo numerous, that the whole Liquor ſeems to be alive, being full of Maggots; the larger Sort being the Offſpring of this Gnat*; and the ſmaller that of a ſmall dark coloured Fly, tending to a reddiſh Colour, frequent in Cellars and ſuch obſcure Places; they turn to Aurelia, and the larger Sort from that to a Gnat of a brown Colour. The chief Difference between the Male and the Female is, that the Male is leaſt, hath a ſlenderer Belly, and its Podex not ſo ſharp as the Female's is. This Gnat hath no Spear in its Mouth.

Theſe Inſects may be applied to the *Univerſal* MICROSCOPE, by pinching them between the Nippers, or ſticking them upon the Point; their Stings when cut off may be beſt examined upon the Glaſs R of Fig. 2. when placed between the Object-Plate and Springs.

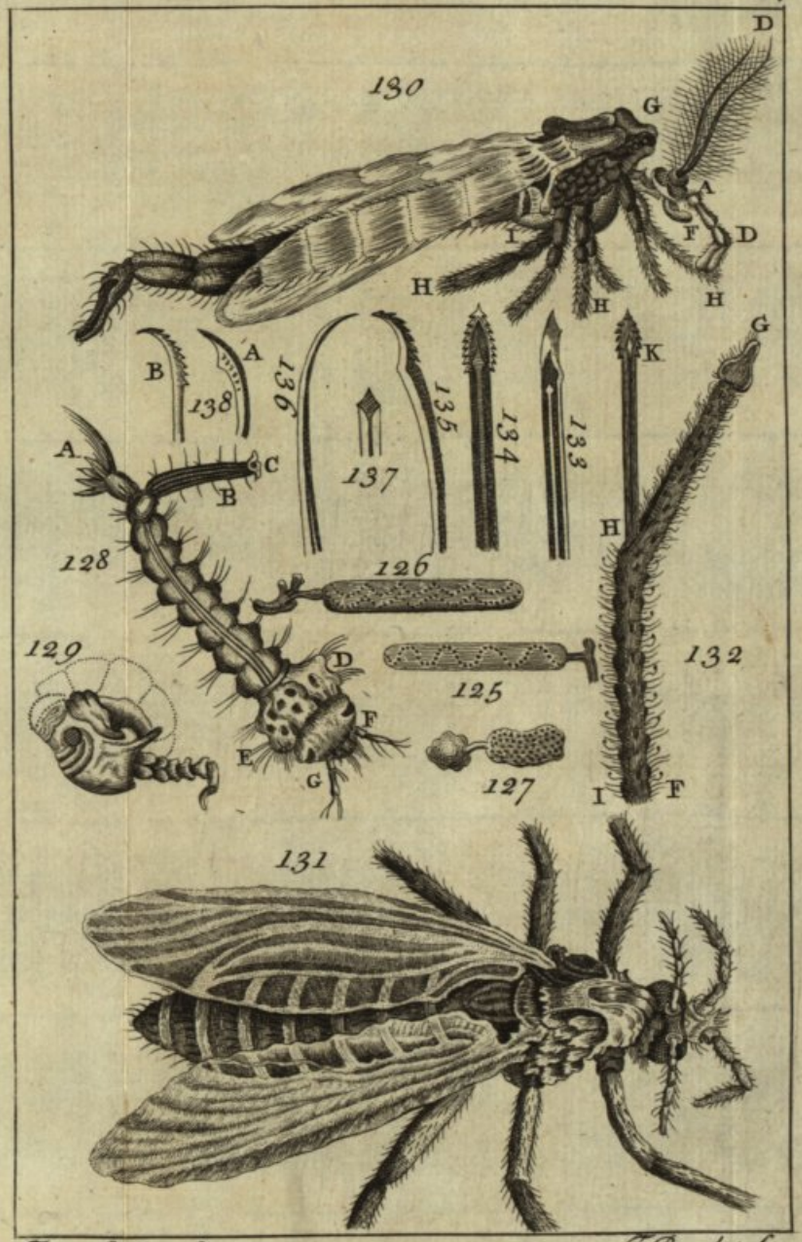
CHAP. XIX.

Of the white feather'd winged Moth.

SECT. I.

IT appears to the naked Eye to be a ſmall milk-white *Fly* with four Wings, the two foremoſt ſomewhat longer than the hindermoſt, and theſe about half an Inch in Length, each of theſe Wings conſiſts of two Feathers, as repreſented in Fig. 139, very curiouſly tufted or hair'd on each Side, with exceeding white but minute Hairs; its whole Body, Legs, Horns, and Stalks of the Wings were cover'd over with various Kinds of white Feathers, which rub off between the Fingers when touched. Underneath theſe Feathers this curious Inſect was covered all over with a cruſted Shell. It had alſo different Feathers, that covered ſeveral Parts of its Body; the Tufts or Hairs of its Wings, when viewed in the Microſcope, appear as repreſented in the Fig. by D. The Feathers which covered a Part of its Body, like A, conſiſting of a Stalk and a ſeeming Tuftedneſs on each Side; others which covered ſome Part of its Body, and the Stalks of its Wings much like Fig. B, thoſe which covered its Horns and the ſmaller Parts of its Legs, in the Shape of Fig. C. Mr. *Hook* obſerved, that the ſmooth winged Inſects have the ſtrongeſt Muſcles; and even this very Inſect had a very ſmall Body, if compar'd to the Length and Number of his Wings; which therefore as he moved them very ſlowly, conſequently moved them as weakly; which laſt Property is in ſome meaſure obſervable

* *Ph. Theo. p.* 386.



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in the larger Kind of flying Creatures, as Birds, *&c.* So that by the Aſſiſtance of the *Microſcope* we find, that the Wiſdom and Providence of the all-wiſe Creator, is no leſs ſhewn in thoſe deſpicable Creatures, Flies, Moths, *&c.* than he is in the larger Parts of the Creation.

Theſe little Animals may be pinched in the Nippers, or ſtuck upon the Point, and ſo applied to the Microſcope; and its Feathers may be placed between two *Muſcovy* Talcs.

SECT. II.

Of the Wolf, or ſmall Moth.

THIS *Inſect* is a little *white Worm*, which infects *Granaries* and *Corn-Chambers*. In its perfect State it is really a *Moth*, of the Size and Form repreſented at Fig. 140. it has four whitiſh Wings ſpotted with black Spots.

When in the Reptile State, it appears as repreſented under Fig. 141. a magnified Repreſentation of which is ſeen at K L, the fore Part of its Body had ſix Feet, which were not diſcernable till the Worm was turned on his Back, with its Belly upwards in this Poſition, Part of its Body is repreſented at M N, Fig. 146. wherein its ſix Feet may be ſeen. As it creeps along, an exceeding fine Thread or Web iſſues from its Mouth, by which it hangs to every Thing it touches, its Mouth is armed with a Pair of reddiſh Forceps, wherewith it gnaws its Way, not only into Wheat, and other Grain, but even perforates into Wood, and almoſt any Thing it meets with.

In theſe *Corn-Chambers* that are infeſted with this Vermin, they may be ſeen near the Decline of the Summer, crawling up the Walls in great Numbers, ſearching out for Places where they may abide in Safety, during their Aurelia State: For when the Time of undergoing a Change into that State approaches, they forſake their Food, and thoſe little Cells they had formed of hollow'd Grains of Corn, clotted together by Means of the Web coming from their Mouths; and wander about till they find ſome wooden Beam, or other Body to their Mind, into which they gnaw Holes with their ſharp Fangs, capable of concealing them; and there envelope themſelves in a Covering of their own ſpinning; where they ſoon become metamorphoſed into dark colour'd Aurelias *, and continue ſo all the Winter unactive and harmleſs: But about *April* or *May*, as the Weather grows warm, they are transformed into *Moths* of the Kind before deſcribed. Then are they to be ſeen in great Numbers taking little Flights, or creeping

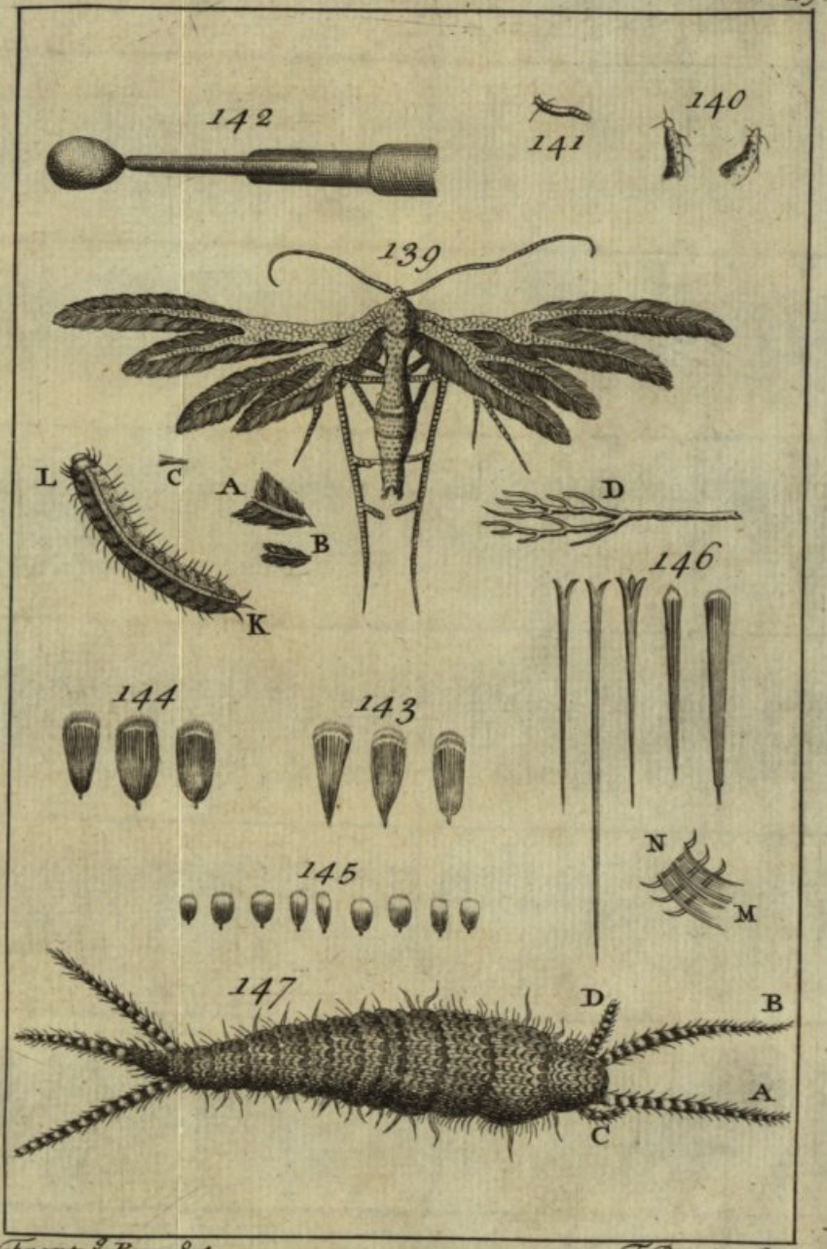
* *Leeuwen. Exp. & Contemp. Epiſt.* 71.

along the Walls; in the Fly-State they eat nothing, therefore are not miſchievous, but ſoon copulate and lay Eggs, not larger than a Grain of Sand, in Shape like thoſe of an Hen, each Female *ſixty* or *ſeventy*, which by Means of a Tube at the End of her Tail, repreſented by Fig. 142. as it appears in the Microſcope, ſhe thruſts or inſinuates into the little Wrinkles, Hollows, or Crevices of the Corn; where in about ſixteen Days, they hatch, and then the Plague begins: For the minute Worms or Maggots immediately perforate the Grain where they are hatched upon, eat out the very Heart of it, and with their Webs cement other Grains thereto, which they likewiſe ſcoop out and devour, leaving nothing but Huſks and Duſt, and ſuch a Quantity of their Dung, as ſhews them to be more voracious Inſects than the *Weevil*, hereafter to be deſcrib'd.

Theſe *Worms* or *Maggots* may be kept all the Winter in Glaſs Tubes, that are ſtopped at each End with a Cork and Wax, having firſt a Bit of a very ſmall Glaſs capillary Tube, put thro' the Cork to give them Air. In this Manner Mr. *Leeuwenhoek* confin'd ſome of theſe *Moths* with a few Grains of Corn, and ſaw them lay their Eggs in the Crevices of the Corn; alſo in this Manner he obſerved all the above Particulars. Therefore as theſe *Glaſs Tubes* may be readily applied to the *Univerſal* MICROSCOPE, and are alſo very commodious to confine any Kind of Inſect, in order to obſerve their Manner of Propagation, I apprehend it will not be improper to exhibit a Drawing of one of them in this Place, Fig. 25. A, B, C, D, repreſents a Glaſs Tube A D and B C, its Extremities ſtopped with Corks and Wax. E G and F H are two exceeding ſmall Glaſs Tubes, cemented in the Corks, but ſo that the Air may have a free Paſſage quite thro' them. Theſe Tubes are to be placed between the Object-Plate I, and Springs b, of the *Univerſal* MICROSCOPE, Fig. 1. ſeveral Dozens of them will be neceſſary to confine a few out of the great Variety of Inſects that one Summer Seaſon produces, therefore any Gentleman may be ſupplied with more or leſs of them as he pleaſes, at my Shop at the Sign of *Tycho Brahe's Head*, in *Fleet-Street*, LONDON, where I always keep them ready prepared.

Theſe little Moths are cover'd all over with an infinite Number of little Feathers joined to their Wings, and other Parts of their Bodies by a Quill, as thoſe of Birds are, but ſo extremely different in Shape, that ſcarce two of them can be found alike. Fig. 144. ſhews three of the larger Sort, ſomewhat blackiſh towards the Top, but tranſparent near the Stalk. Fig. 143. ſhews three others perfectly tranſparent, ten of the ſmaller Sort are exhibited at Fig. 145. but all of them of a different Shape. Theſe Feathers which compoſe the Borders of the Wings, but eſpecially thoſe which grew upon that Part of the Wing which was near the Body of the Moth, were alſo of different Faſhions, and much longer than the former. Five of this Sort are ſhewn at Fig. 146.

The



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The Methods of deſtroying this Vermin is, when they forſake their Food, and aſcend the Walls, or when they appear in the Moth State; at both theſe Times they may be cruſhed to Death by clapping Sacks upon them: But they may ſtill be more effectually deſtroyed by cloſing up all the Doors and Windows, and filling the Corn-Chambers with the Fumes of Brimſtone *, by leaving it burning on a Pan of Charcoal, without giving it any Vent for 24 Hours: However, after that great Care muſt be taken to open them all again for ſome Hours, that the Fumes may be entirely gone before any Body enters.

N. B. The Fumes of the Sulphur are not hurtful to the Grain.

The *Nymph* of the *Cloaths Moth*, called by Mr. *Hook*, the ſilver colour'd *Book-Worm*, is a curious Object. It is a ſmall ſilver colour'd ſhining Worm, and is often found ſcudding among *Books* and *Papers*. Fig. 147. repreſents this Worm as it appears in the Microſcope, having a conical Body, divided into fourteen ſhelly Partitions, each of which are cover'd with a Multiplicity of thin tranſparent Scales, which from their ſeveral reflecting Surfaces, make the whole Animal appear of a perfect Pearl Colour: The ſmall blunt Head of this Inſect is furniſhed on either Side with a Cluſter of Eyes, (but fewer in Number than thoſe of other Inſects) each of which was beſet with a Row of ſmall Briſtles. It has two long Horns A B, ſtrait and tapering towards the Top, curiouſly ringed and briſtled, with a Girdle of ſmaller Hairs at each Ring, and ſeveral larger Briſtles here and there diſperſed among them, alſo two ſhorter Horns or Feelers C D, knotted and fringed like the former, but without Briſtles; its hinder Part terminated in three Tails, reſembling the two long Horns in every Particular. It had ſix Legs ſcaled and hair'd, which could not be repreſented in this Poſition. Theſe little nimble Animals are beſt applied to the Microſcope, upon a ſingle Piece of Talc, or a thin Slip of Glaſs, pinched in the Nippers, having firſt ſtuck them thereto with a ſlight Touch of Turpentine, or a Drop of Gum Water.

CHAP. XX.

Of the Weevil, or Corn-Beetle.

THIS little *Inſect* is ſomewhat bigger than a large Louſe of the Scarab Kind. It does much Harm to many Sorts of Grain, by eating into them, and devouring all their Subſtance: As many People are unacquainted with the *Weevil*, I have exhibited a Picture of it, in Fig. 148. of the full Size it appears of to the naked Eye. It has two jointed Horns, which are repreſented as they appear when viewed through a Microſcope, at

* *Leeuwen. Exp. & Contemp. Epiſt.* 71. *p.* 246.

E, H, G, Fig. 149. Its Trunk at E D B, and its Forceps or ſharp Teeth D, with which it gnaws its Entrance into the Heart of the Grain, either for Food, or to depoſite its Eggs. Between the Forceps at D, appears a Kind of Sucker, with which it licks up the Flower or Duſt of the Grain.

If ſome of them are kept in Glaſs Tubes, prepared as before deſcribed, that the Air may have a free Paſſage into them, with a few Grains of Wheat, their Copulation may be diſcover'd, and alſo their Manner of Generation, which is thus performed. * The Female perforates a Grain of Wheat, and therein depoſites a ſingle oblong Egg or two at the moſt, and this ſhe does to five or ſix Grains every Day, for ſeveral Days together; theſe Eggs, which are not above the Size of a Grain of Sand, in about ſeven Days produce an odd Sort of white Maggot, which wriggles its Body very much, but is ſcarce able to move from Place to Place, the Maggot turns into an Aurelia, which in about fourteen Days comes out a perfect *Weevil*.

CHAP. XXI.

Of the Flea.

THESE little Creatures are a ſurprizing Object, when examined by the Microſcope; they are *Male* and *Female*, and undergo the ſame Changes as the Silk-worms do. They depoſite their Eggs at the Roots of the Hair † of *Dogs*, *Cats*, and other Animals, and by a glutinous Matter ſtick them faſt thereto; one of theſe Eggs is repreſented magnified in Fig. 150. and at 151. the ſame Egg broken by the Worm, Fig. 152. hatched therein. This Worm § contains the *Flea*, and is compoſed of ſeveral annular Diviſions, thinly ſet with long Hairs, having at its Head two extremely minute Horns at A; theſe Worms feed upon the Juices of the Body whereunto they cloſely adhere. They are very nimble, but if diſturbed, roll themſelves ſuddenly into a round Figure, and continue motionleſs for ſome Time; after which they open themſelves by Degrees, and crawl ſwiftly away. They endeavour to conceal themſelves when their Change draws nigh, eat nothing, lie quiet, and appear dying, but if placed before the *Microſcope*, will be found with the Web in their Mouths, weaving a Covering round them; the Inſide of which is perfectly white, but its Outſide as it were ſoil'd with Dirt. In this Bag they put on the *Chryſalis*, which is repreſented at Fig. 153. diveſted of its *Vermicular Skin*. About two or three Days before they break forth from this Confinement, their

* *Leeuw. Ep.* of 6 *Aug.* to the *Royal Society*. † *Phil. Tranſ.* No. 249. § *Arc. Nat. Tom.* IV. *Epiſt.* 76.

Colour

Colour darkens, and as ſoon as they iſſue from the Bag, are perfect *Fleas*, and able to leap away. A *microſcopick* Picture of a perfect *Flea* is repreſented by Fig. 158.

It is all over adorn'd with a curiouſly poliſhed Coat of Armour, or hard ſhelly Scales, neatly jointed and folded over each other, and beſet with long Spikes, almoſt like Porcupines Quills: Its Neck bears ſome Reſemblance to a Lobſter's * Tail: Its Head is adorn'd on either Side with a beautiful quick and round black Eye; behind each of which appears a ſmall Cavity, in which moves a thin Film, ſet with many ſmall tranſparent Hairs, which may probably be its Ears †. From the fore Part of its Head, proceeds a Pair of little jointed hairy Horns, or Feelers A B. Between theſe and its two fore Legs C D, is ſituated its *Piercer* or *Sucker*, that includes a Pair of Darts, which after the Piercer has made its Entrance, are probably thruſt farther into the Fleſh, to make the Blood flow from the adjacent Parts, that it may be ſucked up; and ſeems to occaſion that round red Spot, with a Hole in the Center of it, which we commonly call a *Flea-bite*. This Piercer, its Sheath opening ſide ways, and the two Lancets within it, are very difficult to be ſeen, ‖ unleſs the two fore Legs, between which they are uſually folded in, and concealed from View, are cut off cloſe to the Head; for a *Flea* rarely puts out its Piercer, except at the Time of feeding, but on the contrary keeps it cloſely folded inwards; one Way therefore of coming at it, is by cutting off the Head firſt, and then the fore Legs; ſince in the Agonies of Death, it may eaſily be managed and brought before the *Microſcope*. But this requires a great deal of Patience and Dexterity. Therefore another more likely Way to ſucceed in this Experiment, is, when the *Flea* is juſt dead, to take hold of its Back with the Nippers m, of the Apparatus V, Fig. 2. and then apply it to the ſixth Magnifier; and having a ſmall ſewing Needle ready fixed in a Handle, I have been able to preſs the Horns forward with the Point of the Needle, and its two fore Legs nearer to the Body; and this whilſt I was looking thro' the *Microſcope*; by which Means I could then exactly ſee where to place the Point of the Needle, ſo as to raiſe up the Piercer in the Situation D E, as expreſſed in Fig. 154. which repreſents a Part of the *Flea*'s Head; and at the ſame Time I have open'd the Piercer, and ſeparated its two Lancets, and this without cutting off any Part of the *Flea*, Fig. 154. A B C are the two Horns, and D E are the two Sides of the Piercer, which are partly hollow, that they may the better include the Lancet, or Dart, which in this Figure appears to be but one, but if carefully ſeparated, will be found to conſiſt of two Parts, as in the next Figure 155; whereof G K and G I repreſent as before the two Parts of the Piercer be-

* *Powr. Mic. Obſ. p.* 2. *Phil. Tranſ.* No 249. † *Hook's Mic. p.* 210. ‖ *Act. Nat. Tom.* IV. *p.* 332.

ſet

ſet with ſeveral Hairs, and G H ſhews the two Darts, but not ſeparated. At Fig. 156. they may be ſeen aſunder, whereof L O, L N, are the two hairy Parts of the Piercer before ſpoken of, and L M, O L P the Darts, in L M may be ſeen the Cavity, which includes or receives the other Dart L P, when they are ſhut up between the *Fleas* fore Legs, all the four make but one Proboſcis.

Beſides theſe two Legs before ſpoken of, which adhere to the Head of this little Creature, it has four others, which are join'd to its Breaſt; theſe ſix Legs the *Flea* clitches up altogether; and when he leaps, ſprings them all out at the ſame Inſtant, and thereby exerts his whole Strength at once, which carries him to a ſurprizing Diſtance, above 100 times its own Length. Its Legs have ſeveral hairy Joints, which terminate in long hooked Claws; as in Fig. 158.

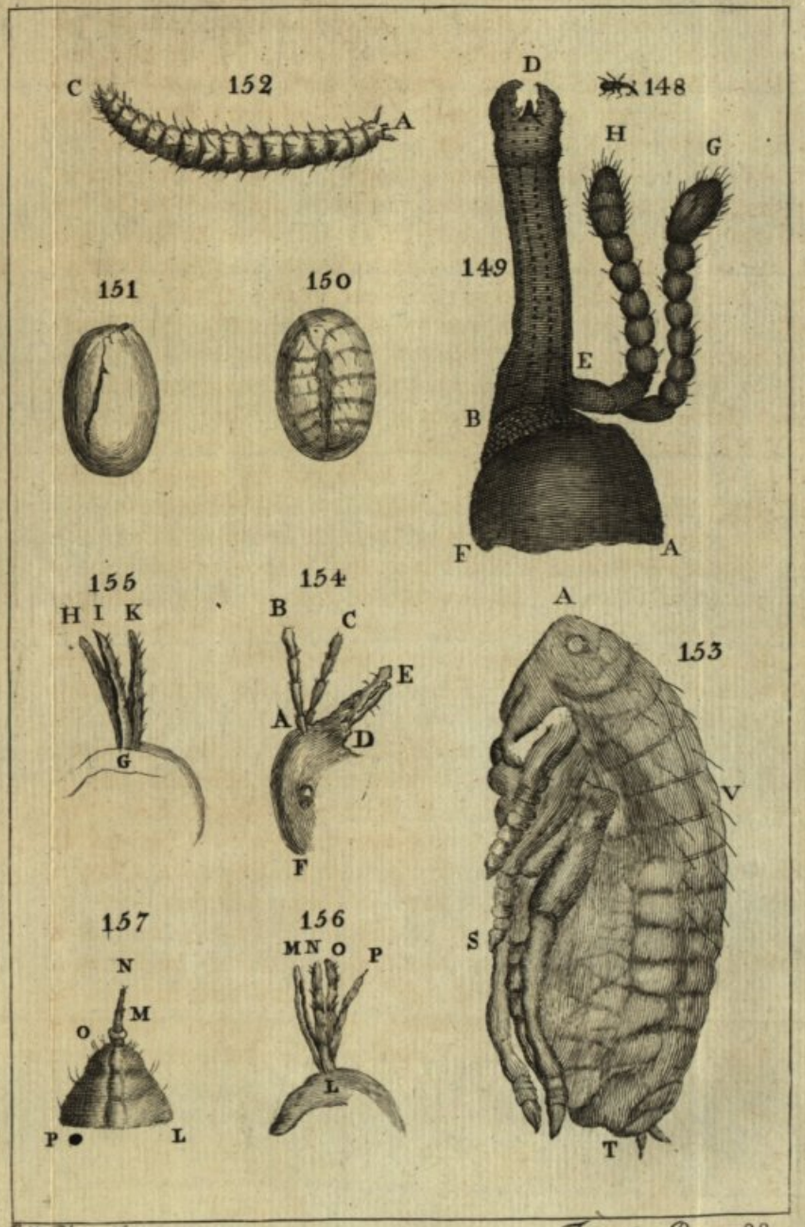
If the Eggs of *Fleas* be kept conſtantly warm in one's Boſom (it has been obſerved that) in the Midſt of Summer, they hatch in four Days; then feed the Maggots with dead Flies, which they greedily ſuck. In eleven Days they come to the full Perfection of the Reptile State, when the Maggot ſpins its Bag, and in four Days more changes into a *Chryſalis*; after lying in which Condition nine Days, it becomes a perfect *Flea*. It is then immediately capable of Coition, and in three or four Days lays Eggs; ſo that in * 28 Days, a *Flea* may come from its Egg, and propagate its Kind; and their vaſt Increaſe will not ſeem ſo great a Wonder if we conſider, that from *March* to *December* there may be ſeven or eight Generations of them; after having laid their Eggs they ſoon die, as all Creatures do that undergo ſuch like Changes.

If you keep *Fleas* in ſuch a Glaſs Tube, as is before deſcribed, ſo as to admit freſh Air, their ſeveral Actions may be obſerved, and particularly their Way of Coupling, which is performed Tail to Tail. The Female (which is much the larger) ſtanding over the Male: They will alſo be ſeen to lay their Eggs, not all at once, but ten or twelve in a Day for ſeveral Days ſucceſſively; which Eggs hatch in the ſame Order.

A Diſſection of the *Flea* may be effected in Water, the † Stomach and Bowels, with their periſtaltick Motion, may plainly be diſtinguiſhed, and alſo the Teſtes and Penis, together with Veins and Arteries, minute beyond Conception. Mr. *Leeuwenhoek* affirms, that he has likewiſe diſcover'd innumerable *Animalcules*, ſhaped like Serpents, in the Semen Maſculinum of a *Flea*.

* *Arc. Nat. Tom.* IV. *p.* 325. † *Ibid. p.* 335.

CHAP.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T. Wigley. Sc.

CHAP. XXII.

Of the Louſe.

THE Tranſparency of its Skin enables us by the Help of the *Microſcope*, to diſcover the Motion of the Muſcles, * (which unite in an oblong dark Spot in the Middle of its Breaſt) as the *Louſe* moves its Legs; and alſo in the Head, when the Horns are moved, and in the ſeveral Articulations of its Legs. The periſtaltick Motion of the Inteſtines is really ſurprizing, which is continued from the Stomach thro' the Guts to the Anus. The various Ramifications of the Veins and Arteries, which are white, and a regular Pulſe may be alſo diſcern'd. From its Head proceeds two hairy Horns B B, Fig. 159. with four Joints. Its two black Eyes are ſhewn at C C, fenced round with ſeveral ſmall Hairs; it has ſix Legs, cover'd with a very tranſparent Shell, and jointed exactly like a Crab's or Lobſter's Claws; each Leg hath five Joints with ſeveral ſmall Hairs interſpers'd about them; at the End of each is two ſharp hooked Claws, as may be ſeen in the Figure, unequal in Length and Size; one of which reſembles that of an Eagle, but the other of the ſame Foot † ſtands ſtrait out, and is very ſmall; between theſe two is a raiſed Part or Knob, moſt exquiſitely contrived for performing thoſe Motions of walking and climbing up the Hairs of the Head; for when it walks, by having the leſſer Claw G ſet ſo much ſhort of the bigger H, that the former does not touch, and by Means of the ſmall Joints in the latter, it is able to bend it round, and ſo with both Claws to graſp and hold faſt the Hairs ‖. From its Snout at the Hole D, when the *Louſe* is going to feed, it puſhes out a pointed Part, which is repreſented at Fig. 157. whereof L O P is the Snout Part of the Louſe's Head. At O is the Nipple, from whence the Sheath, or Caſe M, and from within this alſo, the Piercer § or Sucker N is puſhed out; at N, its Point is ſomewhat cleft. Theſe are thruſt into the Skin to draw out the Blood and Humours it feeds on; for Mr. *Hook* placed a *Louſe* upon the Back of his Hand that had been faſting two or three Days, which immediately thruſt its Sucker into the Skin, and he could plainly ſee a ſmall Current of Blood come directly from its Snout in a fine Stream to the fore Part of the Head, and then to fall into a roundiſh Cavity; it paſſes again in a like Stream to another circular Receptacle in the Middle of the Head at A, from thence through a ſmaller Veſſel to the Breaſt; and then to a Gut that reaches to the hinder Part of the Body, where in a Curve it turns a

* *Philoſ. Tranſ.* No. 284. † *Ibid.* No. 94. ‖ *Hook's Microſ. p.* 212. § *Leeuwenh. Exp. & Con. p.* 354.

little upwards. In the Breaſt and Gut the Blood without Intermiſſion is moved with great Force, and in the Gut with ſuch a ſtrong Propulſion downwards, and ſuch a Contraction of the Gut as is ſurpriſing. In the upper Part of the crooked aſcending Gut the propelled Blood ſtands ſtill, and ſeems to undergo a Separation; * part of it becoming clear and wateriſh, while certain little black Particles paſs downwards to the Anus. The Thorax is caſed with a tranſparent horny Subſtance, through which the Blood was variouſly diſtributed; and at I, appeared a pretty big white Subſtance; many very ſmall milk-white † Veſſels were diſcernable between its Legs, out of which on either Side were many minute Branchings. The Belly is covered with a thin tranſparent Skin; at the upper End of this its Stomach K K is placed, and the white Spot L; at the Extremity of the Tail are two ſemicircular Parts covered all over with Hair.

Place a *Louſe* on its Back and two darkiſh bloody Spots will appear; the larger in the Middle of the Body, and the leſſer towards the Tail. In the larger Spot a white Film ‡ or Bladder contracts, and dilates upwards and downwards from the Head towards the Tail; the Pulſe of which is followed by a Pulſe of the dark bloody Spot, in or over which the white Bladder ſeems to lie. This Motion of Syſtole and Diaſtole is ſeen beſt when the Louſe is grown weak; the white pulſing Bladder ſeems to be the Heart, for on pricking it the Louſe inſtantly dies. The lower darkiſh Spot is thought to be the Excrement in the Guts.

The Males have Stings ‖ in their Tails, the Females none: The Females lay Eggs or Nits, from whence Lice are produced perfect in all their Members, and undergo no farther Change.

Mr. *Leeuwenhoek* obſerved that in ſix Days one of them had laid 50 Eggs, and diſſecting it, he ſaw as many more in the Ovary; concluding from thence that it would have laid 100 Eggs in 12 Days. Theſe Eggs hatch'd in ſix Days, would probably produce 50 Males and as many Females; and theſe Females coming to their full Growth in 18 Days, might in 12 Days more probably lay 100 Eggs alſo, which Eggs in ſix Days farther, the Time required to hatch them, might produce a young Brood of 5000; ſo that in eight Weeks a *Louſe* may ſee 5000 ** of its own Deſcendants.

Upon the oblong Slip of Glaſs R, Fig. 2. a *Louſe* may be eaſily diſſected in a ſmall Drop of Water and applied to the *Microſcope*; thus five or ſix Eggs ready to be laid may be found in the Ovary of a Female, with many other of a leſs Size. In the Male the Penis is remarkable, and alſo the Teſtes, whereof it has a double Pair. The Females appear very white if faſting, and even when fed are leſs red than the Males.

* *Phi. Tran. No.* 102. † *Hook's Micro. p.* 213. ‡ *Pow. Mi. Ob. p.* 9. ‖ *Arc. Nat. Tom.* II. *p.* 77. § *Ibid. p.* 77. ** *Ar. Nat Tom.* I. *p.* 78.

The

The Vermin adhering to and feeding on the Bodies of different Animals, are commonly called Lice.

Inſects are infected with Vermin that feed * on and torment them; ſever-Beetles have Lice on them.

The Earwig is troubled with minute Inſects, which ſtick like Lice on the ſeveral Parts of the Body, eſpecially under the ſetting on of its Head. They are white like Mites, but ſmaller; are round back'd, flat bellied, long legged, eſpecially the two foremoſt, the ſame has not been obſerved on any other Animal.

Snails of all Kinds have Inſects feeding on them. Small red Lice are frequently to be ſeen about the Legs of Spiders.

White Lice are commonly found on Humble-Bees, on Ants, on Fiſhes, *&c.* and probably very few Creatures are free from them.

The Polipe alſo is not exempt from Vermin of this Sort.

There is another Sort of Louſe found about unclean People, called a Crab-louſe.

Seignior *Redi* at the End of his Treatiſe *de Generatione Inſecto*, hath obliged us with Microſcopick Drawings of ſeveral Sorts of Lice, that feed upon the Bodies of different Animals, to which I refer the Reader.

In the Hawk and Turkey Hen he obſerved three Sorts, four in the Wild Duck, in the Wild Gooſe, Swan, Keſtrel and Plover two; yet there are ſeveral Sorts of Birds, which have either the ſame Sort of *Lice*, or ſome nearly like them. The Keſtrel hath a ſort of *Lice* differing only in Colour from thoſe of the Raven; and the Raven others, like thoſe found upon the Egret: On the Wood-pecker and Chafinch are ſome reſembling thoſe of the Starling; on the large Wild Duck are ſome much like thoſe of the Wild Gooſe. It is alſo obſervable, that the Bigneſs of each Bird's *Lice* bears no adequate Proportion to the Bigneſs of the Birds they are found upon; but that on the largeſt Birds both large and ſmall *Lice* of different Kinds may be found; for on the Black-bird hath been ſeen ſome as large as thoſe on the Swan.

There is alſo a little Animal in Shape and Colour like a Louſe, commonly found among the Leaves and Covers of Books, and in rotten Wood; it has a ſwift Motion and runs by Starts; it is called a *Wood-louſe* † or *Wood-mite*. If this Animal be ſtuck upon the Point of a very fine ſewing Needle with a little Turpentine, it will be found a very curious Object; its whole Body being caſed in annulary Circles, full of Silver Hairs, eſpecially towards the Tail, with ſix Legs, that terminate in two Talons; it hath two Horns, but pointing backwards; its Eyes are of a golden Colour, and puſhed out or drawn in at Pleaſure; it hath alſo two Pointers before like a Pair of Pincers.

* *Phi. Tran. No.* 288. † *Powr. Mi. Ob. p.* 10.

CHAP. XXIII.

Of Mites.

SECT. I.

THEY are cruſtaceous Animals, having a ſmall Head in proportion to their Bodies, a ſharp Snout and Mouth like that of a Mole, * when open it appears red; they have two little Eyes, ſome have ſix Legs, others eight, each of which terminate in two hooked Claws: The Diviſions of the Head, Neck and Body are eaſily diſcernable by the Microſcope; the hinder Part of its Body is plump, and of an oval Form, with a few exceeding ſmall Hairs iſſuing therefrom, and from other Parts of its Body alſo. The Female lays Eggs, the young ones iſſue forth with all their Members perfect, though extremely minute; they caſt their Skins ſeveral Times before they attain their full Growth.

Fig. 160. repreſents one of the *Mites* in *Cheeſe*; its Head is ſeen at A, and exactly anſwers the Deſcription before given. One of a Mite's Eggs is ſeen at Fig. 165.

They may be kept alive many Months between two concave Glaſſes, and applied at Pleaſure to the Microſcope; by often looking at them they may frequently be ſeen *in coitu*, † conjoin'd Tail to Tail, for though the Penis of the Male be in the Middle of the Belly, it turns backwards like the Rhinoceros. The Coitus is performed with an incredible ſwift Motion. In warm Weather their Eggs hatch in 12 or 14 Days; but in Winter-time and cold Weather not under ſeveral Weeks: The young ones may be frequently ſeen near a Day ſtruggling to get clear of their Egg-ſhell.

SECT. II.

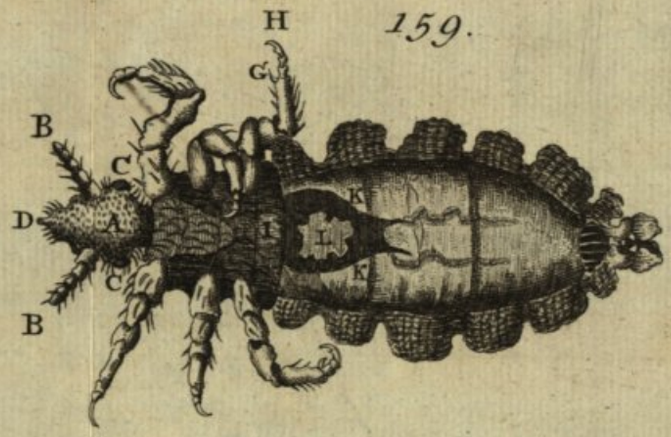
Of the wandering Mite.

THESE Creatures appear to the naked Eye to be a kind of *black Mite*, though much nimbler and ſtronger than the Cheeſe *Mites*, but on viewing them in the *Microſcope*, they will be found to be a very fine cruſtaceous Inſect, like Fig. 161. with a protuberant oval Shell indented with ſeveral ſmall Pits, covered all over with white Briſtles, they have eight Legs, each of them furniſhed with a ſharp Claw at the End. The

* *Pow. Mi. Ob. p.* 16. † *Arc. Nat. Tom.* IV. *p.* 360.

Thorax

159.



158.

Front.ª Pag. 92.

T. Bowles sc.

Thorax was cover'd by two Shells, its Snout taper with a knobbed Ridge * running along the Middle of it; juſt over each of its Eyes aroſe two very long and ſtrong Briſtles, its Eyes black and ſmooth like thoſe of bigger Inſects. Theſe Mites are to be met with on almoſt any Subſtance where they can get Food.

Another Sort of *Mite* as delineated by Dr. *Hook*, is repreſented in Fig. 162, cover'd with a curiouſly poliſhed Shell, which reflected the Light from all Sides.

Theſe Creatures are very much diverſified in Shape and Colour, and in ſeveral other Circumſtances, according to the Nature of the Subſtance out of which they ſeem to be fed, † being in one longer, in another rounder, in ſome more hairy, in others ſmoother, in this nimble, in that ſlow, here pale and whiter, there browner, blacker, or more tranſparent. They are to be met with almoſt on all Kinds of Subſtances, that are mouldy or putrifying, in *Oatmeal*, and in *Malt-Duſt*; there are Mites bred among *Figs*, ‖ in *Hay*, and in the Powder that falls off dried Roots ‡. They are voracious Animals, and devour not only Cheeſe, but alſo all Sorts of dried Fleſh, Fiſh, Fruits, and Grain, and almoſt every Thing beſides that has a certain Degree of Moiſture, without being over-wet. Fig. 164. repreſents a ſmall Hair of a *Mite* as delineated by Mr. *Leeuwenhoek*, which a certain Gentleman compared to an *Indian* or *Japan Cane*, †† with ſeveral Joints, and ſaid it appeared to him through the *Microſcope* as if ſharp Twigs were ſprouting out of each Joint. And Fig. 163, repreſents another Hair or Briſtle of a *Mite* magnified, which was ſpicated, or bearded like the Ear on the Seed-beard ** of ſome Graſs. Every Briſtle on its Body and Legs had the ſame Formation; yet all Mites are not ſo; for of ſeven or eight which were incloſed together, but one of them was found whoſe Briſtles were all of this Make, in the reſt the Horns only were ſpicated.

Their Mouths open horizontally to the Right and Left, like that of a Waſp; ſeveral of them being ſhut up together without Food for ſome Days, ſome were found dead, and the Survivors preying on them; by which Means their manner of feeding ‡‡ was obſerved, which is very remarkable; for they thruſt one Mandible forwards, and draw the other backwards at the ſame Time, and thus they do alternately; ſo that they ſeem to grind their Food. After feeding they munch or chew the Cud.

Mr. *Leeuwenhoek* hath obſerved that *Mites* in Cheeſe turn into *Aurelias*, and from thence to *Flies*; when they turn into *Aurelias* ‖‖ they are incloſed in a thin tranſparent Membrane, which in ſome meaſure ſcreens them from the Inſults of the Maggots that ſwarm in Cheeſes. He alſo obſerved ſome

* *Hook's Mi. p.* 206. † *Ibid. p.* 214. ‖ *Ph. Tran. No.* 333. ‡ *Power's Mi. Ob. p.* 18.
** *Ibid. No.* 284. †† *Ibid. No.* 333. ‡‡ *Ibid. No.* 284. ‖‖ *Ibid. No.* 262.

of

of the Flies produced from theſe Cheeſe-Worms, that he kept in a Glaſs-Tube in which he had put Cheeſe for them to feed upon, had coupled; and ſoon after laid Eggs of an oblong Figure, and then died: From theſe Eggs came young Worms, which alſo fed on the Cheeſe, and when he judged them to be at their full Growth, and the Weather began to be cold, he took ſix of the biggeſt, and carried them about him; and a few Days after he obſerved that four of them were changed into *Aurelias*, that two Worms were dead, and two *Flies* ſkipping about the Glaſs; he repeated the ſame Thing in *January*, and with the like Succeſs; when he kept them in the Cold, little or no Sign of Life or Motion appeared; but as ſoon as he put them into his Pocket, they were as briſk as in Summer. Upon opening an Aurelia that had never produced a Fly, a dead one was found within it, which had been making its Efforts to get out, but was not ſtrong enough to effect it.

Theſe Vermin creep into the Cabinets of the Curious, and deſtroy their choice Collections of Inſects: But to prevent this, keep in your Drawers, *&c.* a continual Supply of Camphire, whoſe hot and dry Effluvia will penetrate, ſhrivel up, and deſtroy the tender Bodies of theſe little miſchievous Plunderers.

SECT. III.

Of a Crab-like Inſect.

THIS Inſect is about the Bigneſs of a large *Mite*, and of a very curious Form, as delineated in Fig. 166, it had ten Legs, eight of which a a a a terminated in very ſharp but double hooked Claws, being thoſe it walked upon, which were ſhaped much like thoſe of a Crab: the two other Claws A A, that were the foremoſt of all the ten, ſeemed to branch out from its Head, and were exactly formed like Crabs, or Lobſters Claws, as are expreſſed in the Figure, whoſe Ends terminated in a Pair of Pincers, (with which I have often ſeen him ſtroke thoſe other Claws E E) which grew out of his Snout; in walking the Creature elevated the former above its Head and Body; its Eyes were ſituated about d d, its Head was covered with a kind of ſcaly * Shell at F, its Thorax G G with two ſmooth Scales, and its Back with eight knobbed ones H H. Theſe Inſects are frequently to be met with amongſt Books and Papers that come from *China*, when firſt unpacked.

* *Hook's Micr. p.* 208.

CHAP. XXIV.

Of the Semen Maſculinum.

SPontaneous *Generation*, is a Doctrine ſo generally exploded, that a Diſproof of it is altogether needleſs in this Place, it being put beyond all Diſpute that all *Animals* and *Vegetables* owe their Production to parent Animals and Vegetables; and that Animals are from *Animalcula*.* Theſe *Animalcula* being originally in the *Semen* of the *Male*, and not in the *Female*; therefore can never come forward or be formed into Animals of their reſpective Kinds, without the Ova in the Female †.

By the Aſſiſtance of a good Microſcope, Myriads of *Animalcules* may be diſcovered in the *Semen Maſculinum* of Animals, alive and vigorous; though ſo exceedingly minute, that it has been computed 3,000,000,000 of them are not equal to a Grain ‡ of Sand.

The general Appearance of the *Animalcules* in the *Semen Maſculinum* of different Creatures is very much the ſame, that is, their Bodies all ſeem to be of an oval Form, with long tapering ſlender Tails iſſuing therefrom, ſomewhat reſembling Tadpoles: Though their Tails in Proportion to their Bodies are much longer than thoſe of Tadpoles. And the *Animalcules* in the *Semen* of *Fiſhes* have Tails ſtill longer and ſlenderer than either, inſomuch that the Extremity of them is rarely to be diſcerned. Their general Appearance as above deſcribed is ſhewn Fig. 187.

Mr. *Leeuwenhoek*, upon viewing the Milt of a *Cod Fiſh* ‖ with a *Microſcope*, obſerved therein ſuch prodigious Numbers of living *Animalcula*, with long Tails inceſſantly moving to and fro, (he obſerved the ſame Thing in the Milts of Pikes or Jacks) that according to his Computation 10,000 of them might be contained in the Quantity of one *Grain* of *Sand* §. Whence he argues, that there are more living *Animalcula* in the *Milt* of one *Cod-fiſh*, than there are *People* alive upon the Face of the whole *Earth*, at one and the ſame Time. He computes one hundred Grains of Sand to make the Diameter of an Inch, then a cubic Inch will contain a Million of ſuch Sands. And as he found the Milt of the Cod-fiſh to contain 15 Inches, it muſt contain 15 Millions of Quantities as big as a Grain of Sand; and if each of theſe Quantities contain 10,000 *Animalcules*, the whole muſt contain one hundred and fifty thouſand Millions. Then to calculate the Number of People, he reckons a great Circle to contain 5,400 *Dutch* ſquare Miles: Whence he calculates the Earth's Surface to contain 9,276,218 ſuch ſquare Miles: And ſuppoſing one Third of the whole or 3,092,072 Miles

* *Phi. Tr.* No. 192. † *Vide Harris's Lex. Tech. under the Word* Generation. ‡ *Vide Keil. Anat. p.* 116. ‖ *Ph. Collections*, No. I. *p.* 3. § *Arc. Nat. Tom.* I. *Par* II. *p.* 9.

to

to be dry Land; and of this $\frac{3}{4}$ or 2,061,382 Miles to be inhabited. And ſuppoſes farther, that *Holland* and *Weſt-Friseland* are 22 Miles long, and 7 broad, which make 154 ſquare Miles: The habitable Part of the World is then 13,385 times the Bigneſs of thoſe Places.

If the *People* in theſe two *Provinces* are ſuppos'd a Million, and that all the other Parts of the World are as populous as theſe, which is improbable, there would be 13,385 Millions of People on the Face of the whole Earth: But the Milt of this Fiſh contain'd 150,000 Millions of *Animalcules*, which is 10 times more than the Number of Mankind.

The *Seminal Veſſels* of a *Cock** being opened, and a ſmall Drop of the *Semen* ſqueezed out, and apply'd to the *Microſcope*, great Numbers of Animals were ſeen ſwimming therein in Legions, and croſſing one another like Clouds in a ſtormy Day, as briſk as if the *Cock* was but newly dead, † altho' it was killed the Day before; they appear as at Fig. 168. if viewed with due Attention, and with the greateſt Magnifiers, otherwiſe only in the Form of Eels.

Mr. *Leeuwenhoek*, in the Spring-time, when the *Frogs* engender, open'd the Teſticles of the Male, ‖ and on applying ſome of the *ſeminal* Matter to the *Microſcope*, Multitudes of *Animalcules* appear'd therein, about $\frac{1}{1000}$th Part of the Thickneſs of a human Hair; and there ſeemed to be ten thouſand of them at leaſt to each one of the Female *Ova*, their Form is as repreſented in Fig. 169.

Mr. *Leeuwenhoek*'s Method of computing the Size of *Animalcules* was this, he placed an Hair § of his Head near them, which Hair appear'd an Inch in Breadth; and being ſatisfied that 60 of theſe Animalcules could lie within that Diameter; whence their Bodies being ſpherical, 216,000 of them are but equal to a Globe, whoſe Diameter is no more than the Breadth of ſuch an Hair. Another Method of his alſo follows.

He firſt ſuppos'd a Drop of Water equal to a Pea; then took a little Quantity of Water, of a round Figure, as big as a Millet Grain; and reckoned this tobe $\frac{1}{91}$ of a Pea; ‡ for when the Axis of a Millet Seed makes 1, that of a Pea will make $4\frac{1}{2}$, whence it follows, that the Seed of a Millet is at leaſt the $\frac{1}{91}$ of a Pea; this ſmall Quantity of Water he put into a very ſlender Glaſs Tube, dividing by this Means that little Water into 25 or 30 Parts, and found more than 100 Animalcula in the $\frac{1}{30}$ Part of Water, equalling the Bigneſs of a Millet Seed. Whence it appears, that if 1000 are to be ſeen in the $\frac{1}{30}$ Part of a Millet Seed, there may be ſeen 30,000 in one ſuch whole Seed; and conſequently in a Drop of Water 91 times bigger, there may be ſeen 2,730,000. Beſides he compared the Water to the Bulk of a Grain of Sand; that if the Axis of a Grain of Sand be 1, that

* *Phil. Tranſ.* No. 279. † *Arc. Nat. Tom.* II. *Part* II. *p.* 369. ‖ *Arc. Nat. Tom.* I. *Part* I. *p.* 51. § *Phil. Tranſ.* No. 270. ‡ *Ibid.* No. 131.

of

of a Drop of Water is at leaſt 10, conſequently a Drop 1000 times bigger than that Grain of Sand, and therefore there are 1,000,000 of Animalcula in one Drop of Water, at the Rate of 1000 little Animals in that Quantity of Water.

* In the ſame Manner he alſo computed that 4,096,000 Eggs were in the Roe of a *Crab*. Each of which received its Nouriſhment by a String from the Crab's Body.

To view the *Animalcules* in the Milt or ſoft Roes of Fiſhes, ſqueeze out a little of it, and putting the Quantity of a Pin's Head upon the Glaſs R, dilute it with River or Rain-Water, till they have ſufficient Room to ſwim freely about, and ſhew themſelves to Advantage.

N. B. The Eggs † in the Roe and Animalcules in the Milt of Fiſhes of one Year old, are as large as in thoſe of the ſame Species of twenty Years old.

Some of the ſeminal Matter taken from the Teſticles of a *Dog*, ‖abounded with Animalcules in Form of Fig. 170. and ſome of them remain'd alive after having been kept ſeven § Days in a Glaſs Tube.

The Teſticles of a *Hare*, altho' four Days ‡ dead, were found to be exceeding full of Animalcules, like thoſe in Dogs, ſwimming in a clear Liquor, but without Motion.

A Female *Rabbit* being killed immediately after the *Coitus*, and the *Uterus* opened, innumerable Quantities of *Animalcules* were found in a ſmall Drop taken from the Mouth of the *Fallopian Tube*, where it opens into the *Matrix*; but none were diſcern'd in the *Uterus* itſelf, or farther along the Tube; they had long Tails, and moſtly ** ſix tranſparent Globules appear'd on the Body of each, as in Fig. 171. A; tho' ſome had only one Globule at the End of the Body, and another in the Tail, as Fig. 171. B.

A *Buck* being killed in Rutting-Time, the *Vaſa Deferentia* were found turgid, and full of a milky Fluid, a Drop of which diluted with a Drop of warm Water, juſt enough to change its Colour, and then applied before the *Microſcope*, appear'd full of *Animalcules* moving very briſkly ‖‖.

A Drop of the ſeminal Matter taken from the Teſticles of a *Ram*, flowed with *Animalcules* in as great Numbers as that of other Creatures; but with this Difference, that they ſwam in Droves together the ſame Way, and ſeem'd to follow their Leader §§ as Sheep do. Mr. *Leeuwenhoek* found ſo much Pleaſure in this Obſervation, that he called in ſome Neighbours to ſhare it with him.

This ingenious Enquirer after Nature, opened the Uterus of an *Ewe*, about ſeventeen Days after ſhe had been coupled with a Ram; and in one

* *Arc. Nat. Tom.* I. *Part* II. *p.* 339. † *Ibid. Tom.* III. *p.* 188. ‖ *Ibid. Tom.* I. *Part* II. *p.* 160. § *Ibid. p.* 150, and 49. ‡ *Ibid. Tom,* I. *Part* II. *p.* 160. ** *Ibid. Tom.* I. *Part* II. *p.* 168. ‖‖ *Phil. Tranſ.* No. 284. §§ *Leeuwenh. Epiſt. Phy. p.* 388.

of the *Cornea* obſerved a little reddiſh fleſhy Subſtance, wherein no Shape could be diſtinguiſhed, which he extended very gently out of the Round in which it lay, and could plainly perceive the Formation of all the *Vertebræ*, with the *Blood-Veſſels* and *Ramifications* paſſing over them, and could ſee the *ſpinal Marrow* in two Places *, and diſtinguiſhed not only the *Head*, but alſo the *Mouth*, *Brain*, and *Eyes*, the Bigneſs of two Grains of Sand, and clear as Cryſtal; he likewiſe ſaw the Ribs and Inteſtines, tho' the whole Creature was no larger than the eighth Part of a Pea. After which he open'd the *Uterus* of another *Ewe*, † three Days from the *Coitus*, and ſearching the Liquor coming therefrom with a magnifying Glaſs, obſerved a little Particle the Size of a Grain of Sand; and examined it with a very good *Microſcope*, and with great Pleaſure found it to be an exceeding minute *Lamb*, lying round in its Integuments, and could plainly diſcern its Mouth and Eyes.

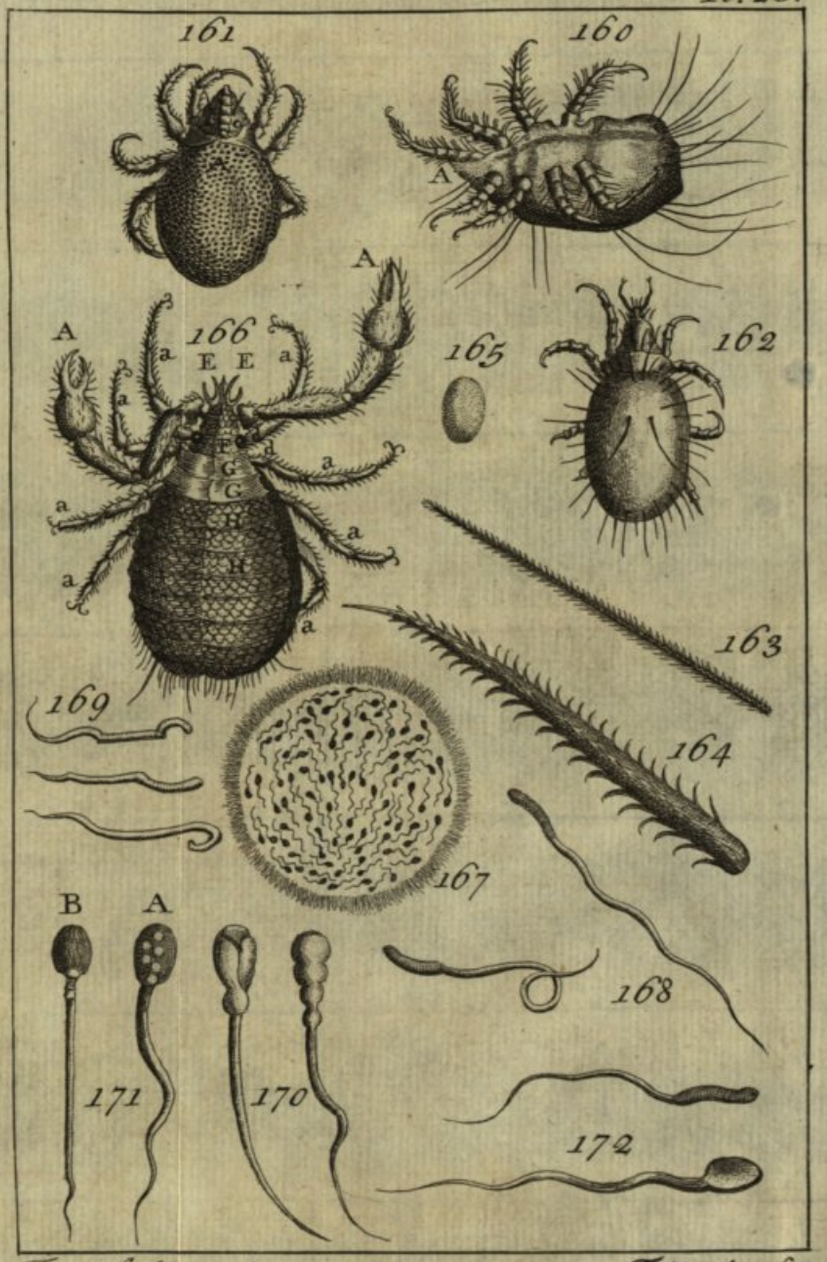
The *human Semen* has alſo been viewed by the *Microſcope*, and found to be as plentifully ſtocked with *Animalcules*, as that of other Animals: Mr. *Leeuwenhoek* has ſeen more than 10,000 living Creatures moving in a Quantity of the fluid Part thereof, no bigger than a Grain of Sand: And in the thicker Parts, they were ſo thronged together, that they could not move for one another; their Size was ſmaller than the red Globules of the Blood, and even leſs than a millionth Part of a Grain of ‖ Sand, their Bodies roundiſh and flat before, as in Fig. 172. but ending ſharp behind. Their Tails are exceedingly tranſparent, and five times longer, and ſlenderer than their Bodies. They move by the Agitations of their Tails in various Bindings, after the Manner that Eels ſwim.

The § *Animalcules* in the *Semen Maſculinum* of all Creatures differ but little in Shape or Bigneſs, for which Reaſon it follows, that the *Animalcules* may be diſcover'd in the *Semen* of the ſmalleſt *Birds*, *Quadrupeds*, and *Fiſhes*; nay, and even in Inſects to. For Mr. *Leeuwenhoek* affirms, that he found in the white Matter he had ſometimes ſqueezed from the hinder Parts of *Male* ‡ *Spiders*, a prodigious Number of *Animalcules*. He found them alſo in the *Semen* of the (a) *Dormouſe*, in (b) *Oyſters*, in (c) *Silk-worms*, in the (d) *Labella minima*, or *ſmall Dragon Fly*, the common (e) *Fly*, in the Male (f) *Flea*, in (g) *Gnats*, and many other Inſects.

It is obſervable that amongſt the many Species of *Animalcules* found in Waters, and other Infuſions, there are none like thoſe in *Semine*; but that theſe laſt, in all Sorts of Creatures, have a general Likeneſs to each other, and

* *Arc. Nat. Tom.* I. *Part* II. *p.* 164. † *Ibid. p.* 173. ‖ *Arc. Nat. Tom.* II. *Part* II. *p.* 61, 96, 286. § *Ibid. Tom.* IV. *p.* 30. ‡ *Phil. Tranſ.* No. 279. (a) *Arc. Nat. Tom.* I. *Part* II. *p.* 27. (b) *Ibid. Tom.* II. *Part* I. *p.* 144. (c) *Ibid. Part* II. *p.* 442. (d) *Ibid. Tom.* IV. *p.* 19. (e) *Ibid.* (f) *Ibid. p.* 20. (g) *Ibid. p.* 22. (h) *Ibid. p.* 294.

appear



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appear in continual Motion without any Intermiſſion, if the Fluid be but ſufficient for them to ſwim in.

It is farther obſervable, that no *Animalcules* can be found in the *Blood*, *Spittle*, *Urine*, *Gall*, *Chyle*, or any other of the *Humours*, except the *Semen* only.

CHAP. XXV.

Of the Oyſter.

MANY little round living *Animalcules* have been found in the clear Liquor of an *Oyſter*, * ſuppoſed to be the *Animalcules* in the *Roe* or *Semen*.

Mr. *Leeuwenhoek* open'd an *Oyſter* on the 4th of *Auguſt*, (which is the Time that *Oyſters* are ſuppos'd to breed) and took out of it a prodigious Number of minute *Oyſters*, all alive and ſwimming briſkly in the Liquor, by the Means of exceeding ſmall Organs, extending a little Way beyond their Shells, which he calls their Beards; in theſe he could diſtinguiſh the joining of the Shells, and perceived ſome that were dead, with their Shells gaping, and as like large *Oyſters* in Form as one Egg is like another.

Upon opening a Female *Oyſter*, incredible Multitudes of minute *Oyſters*, cover'd with little Shells, perfectly tranſparent, were plainly ſeen therein; in another they were found of a browniſh Colour, without any apparent Life or Motion.

Monſ. *Azout* obſerved a ſhining clammy Matter, which ſtuck to the Shells of *Oyſters*, and being drawn out, ſhone † in the Air its whole Length, which was four or five Lines, and continued ſo for a conſiderable Time when laid on the Obſerver's Hand, and afterwards opening more than 20 Dozen in the Dark, and then examining ſome of this ſhining Matter with a *Microſcope*, he found it to conſiſt of three Sorts of real Worms. One was whitiſh, having 24 or 25 forked Feet on each Side, with a black Speck on one Side of the Head, taken by him for a Cryſtalline. Its Back like an Eel ſtripp'd of its Skin; the ſecond was red, reſembling the common *Glow-worm*, with Folds on its Back, Legs like the former, and a Noſe like that of a Dog's, and one Eye; the third Sort was ſpeckled, with a Head like a Soal, and many Tufts of whitiſh Hair on its Sides. There was a bigger Species, that was greyiſh with a big Head, and two Horns like thoſe of a Snail; it had ſeven or eight whitiſh Feet, but theſe ſhined not.

The two former conſiſt of a Matter eaſily diſſolvable, the leaſt Touch turning them into a viſcous and aqueous Matter, which falling from

* *Arc. Nat. Tom.* II. *Part* I. *p.* 52. † *Phil. Tranſ.* No. 12. *p.* 203.

the Shell, ſtuck to the Obſerver's Fingers, and ſhone there for 20 Seconds. If any Part of it fell to the Ground it appeared like a ſmall Piece of flaming Brimſtone, and when ſhook off nimbly, it ſeemed a ſmall ſhining Line, which was diſſipated before it reached the Ground. Some of it was whitiſh, ſome reddiſh, but both afforded a violet Colour to the Eye. The Worms give no Light when irritated; and if they do, it laſts but a little while: Whereas in thoſe that are not provoked, it continues a good while.

As tainted *Fleſh*, *rotten Wood*, Bodies of *Lobſters*, and ſome other Kinds of *Fiſhes*, and other Subſtances, are ſometimes found to ſhine with a Light reſembling the foregoing, may it not probably proceed from the ſame Cauſe, *viz.* from *Animalcules?* Some have alſo ſuppoſed, that the *Ignis Fatuus*, *Will in a Wiſp*, or *Jack in a Lanthorn*, is nothing elſe but a Swarm of minute Inſects, that emit Light round them in the Manner *Glow-worms* do.

CHAP. XXVI.

Of the Muſcle.

IN a Diſſection of the *Ovarium* of a *Muſcle*, Mr. *Leeuwenhoek* diſcovered Numbers of *Embrio Muſcles*, * which appeared as plainly in the *Microſcope* as the Muſcle does to the naked Eye; lying with their ſharp Ends faſtned to the Strings or Veſſels whereby they received their Nouriſhment. Theſe minute Embrio Muſcles are in due Time laid or placed by the Parent, in a very regular and cloſe Order, on the Outſide of the Shell; where, by means of a glewy Matter, they adhere very faſt, and continually increaſe in Size and Strength; till becoming perfect *Muſcles*, they fall off and ſhift for themſelves, leaving the Holes where they were placed behind them, as Abundance of Muſcle-ſhells when viewed by the *Microſcope* can ſhew. Two or three thouſand of theſe Eggs adhering ſometimes to the Shell of one *Muſcle*; it is not certain they are all fixed there by the *Muſcle* itſelf, but are frequently placed there by another Muſcle. The fringed Edge of the *Muſcle*, called by Mr. *Leeuwenhoek* the Beard, has in every the minuteſt Part of it ſuch a Variety of Motions, as is unconceivable; for being compoſed of longiſh *Fibres*, each Fibre has on both Sides a vaſt many moving Particles, which one would almoſt imagine to be *Animalcules* †.

The Strings or Threads, which we term the Beard, are compoſed of a Glew, which the Muſcle applies by the Help of its Trunk to ſome fixed Body, and draws out as a Spider does its Web, thereby faſtening itſelf,

* *Ph. Tran.* No. 336. † *Phi. Tran.* No. 336. *Arc. Nat. Tom.* II. *p.* 19. *& Tom.* IV. *p.* 423.

that

that it may not be waſh'd away. If *Muſcles* be put into Salt and Water, they will faſten themſelves to the Sides of the Veſſel we place them in.

Scallops, *Cockles*, *Limpets*, *Perriwinkles*, and Abundance of other Shell-fiſh, are Objects that have as yet been very ſlightly examined by the *Microſcope*; and therefore the ſerious Enquirer into Nature's ſecret Operations may here be certain of diſcovering Beauties, which at preſent he can have no Conception of.

CHAP. XXVII.

Of the Itch.

DOctor *Bononio* hath diſcovered that this Diſtemper owes its Riſe to little *Inſects* * under the *Cuticula*, whoſe continual Bitings cauſe an Ouſing of the Serum from the *Cutis*, and produce thoſe Puſtules whereby the Diſeaſe is known.

For on obſerving People in this Diſtemper pull out of the Scabs, little Bladders of Water with the Point of a Pin, and crack † them like Lice upon their Nails, from a Place ſcabbed over, and where there was a grievous Itching, he picked out a little *Puſtule*, and from thence ſqueezed a thin Matter, in which he could but juſt diſcern a ſmall white Globule; but on applying it to his *Microſcope*, found it to be a minute *Animal* of a whitiſh Colour, in Shape reſembling a Tortoiſe, but ſomewhat dark on its Back; it is repreſented in Fig. 173, at A and B, they have ſome long Hairs, ſix Legs, a ſharp Head, and two Horns, and are very nimble. He repeated this Experiment on Perſons of all Ages, Sexes, and Complexions, and at all Seaſons of the Year, and found the ſame Sort of Animals in moſt of the watery Puſtules; they begin to enter in the Furrows of the Cuticula by gnawing and working in their Heads till they are quite got under, where they cauſe a grievous *Itching*, and force the infected Perſon to ſcratch, which only heightens the Malady: From his frequent Obſervations he alſo ſaw one of them drop an *Egg*, almoſt tranſparent, from the hinder Part of its Body, and afterwards ſaw ſeveral others of the ſame Sort, one of which is repreſented at C, Fig. 173.

Hence follows the Reaſon why this Diſtemper is ſo very catching, ſince by ſimple Contact theſe Animals can readily paſs from one Perſon to another, not only from their ſwift Motion, but by their clinging to every Thing they touch; and crawling as well upon the Surface of the Body, as under the outward Skin. A few being once lodg'd, they multiply apace by their Eggs; nor is it any Wonder if this Infection is alſo propagated by the

* *Bonani Micro. p.* 91. † *Ph. Tran.* No. 283.

Sheets,

Sheets, *Towels*, *Handkerchiefs*, or *Gloves*, uſed by itchy People; ſince theſe Animalcules may eaſily be harboured in ſuch Things, and will live out of the Body two or three Days.

This Diſcovery alſo accounts why this Diſtemper is never cured by internal Medicines, but requires *lixivial Waſhes*, *Baths*, or *Ointments*, made up of *Salts*, *Vitriols*, *Mercury*, *Sulphur*, *Precipitate* or *Sublimate*, or ſuch kinds of corroſive and penetrating Remedies as can powerfully kill theſe Vermin in their Skin. It is neceſſary to continue the Anointing for ſome Days after the Cure ſeems perfected; for though the Ointment may have deſtroyed all the living *Animalcules*, it may not probably have killed their Young in the Eggs, which are laid in Neſts in the Skin, which if ſuffered to be hatched may renew the Diſtemper.

CHAP. XXVIII.

Of Animalcules in the Teeth.

THESE are to be found in great Numbers of different Kinds, in the whitiſh Matter, that ſticks between the Teeth of *Men*, *Women*, and *Children*; * but eſpecially between the Grinders, although they waſh their Teeth frequently; but from People that are more careleſs a Sort of Eels are found. The firſt Sort A, Fig. 174. move along very ſwiftly, in Spittle or Water without Bubbles. The ſecond Sort ſeen at B, Fig. 174. move in the Direction of the doted Line. The third Sort is ſeen at E, and the fourth Sort at F.

They all die if Vinegar be put to them; from whence it ſeems probable, that if the Teeth and Gums be frequently waſhed with it, it may be a Means to preſerve them from theſe Creatures.

CHAP. XXIX.

Of the Snail.

THIS ſlow paced ſlimy Animal hath many curious Obſervables. The firſt are its four *Eyes*, like atramentous Spots, fixed at the Ends of its Horns, or rather at the Ends of thoſe black Filaments, or optick *Nerves* † that are ſheathed in its Horns, which it can thruſt out, draw in, turn, or direct as it finds Occaſion. If when the Horns are fully extended, you nimbly clip off their Extremity, and place them before the *Micro-*

* *Leeu. Ex. & Cont. p.* 40. *Tom.* IV. † *Pow. Mi. Ob. p.* 36. *Spect. de la Nat. Dialo.* XI.

ſcope,

ſcope, either upon the Object carrying Glaſs R, Fig. 2. or ſtick the End of them with a little Turpentine to the Point, they may eaſily be examined in the *Univerſal Microſcope*, with all the Magnifiers, and will be found to be two *Hemiſpherical Eyes*. And when the Stump is re-extended, it will appear evidently hollow, or tubular to the naked Eye.

Snails partake of the Nature of both *Sexes*, inſomuch that as ſoon as one has impregnated the other, the ſame Act of Generation is immediately returned; each of them, eighteen Days after theſe Approaches, drop and conceal their Eggs in the Earth; the Young of which, when hatched, appear with Shells compleatly formed *.

If you would view the internal Fabrick of this Animal, the *Microſcope* will after a dextrous Diſſection diſcover to you the *Heart*, juſt againſt a round Hole near the Neck, which probably is the Place of Reſpiration, the Heart may be ſeen to beat near a Quarter of an Hour after Diſſection.† Its Guts are green (from the Herbs it eats) and curiouſly branched over with fine capillary white Veins. This Creature, how contemptible ſoever it may ſeem, hath a compleat Sett of the ſame Parts and Organs with other Animals, as *Heart*, *Liver*, *Spleen*, *Stomach*, *Guts*, *Veins* and *Arteries*.

If the Head be cut off, a little Stone will be found, ſaid to be of a diuretick Quality, and of ſingular Service in gravelly Diſorders.

They have a Mouth like a Hare or Rabbit, and Teeth as repreſented in Fig. 175. whereof A B C ſhew the upper Jaw, which is white and of a ſemicircular Form; the lower black Part C D E, hath ſeveral prominent Parts or Teeth F F F, but all fixed together ſo as to compoſe the ſame Bone. Mr. *Hook* obſerved this very *Snail* (of which the Figure now before us is a Picture of its Teeth) to feed on the Leaves of a Roſe-tree, and to bite out half-round Bits of the Size and Shape of the Letter C.

If a *Snail* be ſuffered to creep upon a Bit of Glaſs, you may by the naked Eye (but better if you apply the Hand-Glaſs of your Microſcope to view it through) obſerve a little cloudy Stream paſſing from its Tail to the Head, that never returns the ſame Way; and this as long as the *Snail* is in Motion.

CHAP. XXX.

Of the Scales of Fiſhes.

THE outſide Coverings of Fiſhes are *Scales*, formed with inconceivable Beauty and Regularity; ſome longiſh, ſome round, ſome triangular, ſome ſquare, and ſome or other of all the Variety of Shapes imagin-

* *Nat. Delin. p.* 148. † *Pow. Ob. p.* 38.

able.

able: Some again are armed with ſharp Prickles, as thoſe of the *Perch*, *Soal*, &c. others have ſmooth Edges, as the *Cod-Fiſh*, *Carp*, *Tench*, &c. There is likewiſe a great Variety even in the ſame Fiſh; for the *Scales* taken from the *Belly*, the *Back*, the *Sides*, the *Head*, and all the other Parts are very different from each other.

The *Scale* of a Soal Fiſh is delineated, as it appear'd in the *Microſcope*, at Fig. 176. whereof C D E F repreſents that Part of the *Scale* which ſhews itſelf on the Outſide of the Fiſh, and A B C D, the Part which adheres to the Skin, being as it were furrowed, that it might hold the faſter, * each of which is terminated on the Outſide by pointed Spikes, and every other of theſe much longer than the interjacent ones.

Mr. *Leeuwenhoek* ſuppoſes theſe *Scales* not to be ſhed during the whole Life of the Animal; but to have an annual Addition of a new Scale growing over the old one, and extending every Way beyond its Edges, in Proportion to the Fiſhes Growth: Somewhat in the ſame Manner as the Wood of Trees enlarge yearly by the Addition of a new Circle next the Bark; and as the Age of a Tree may be known by its Number of Ringlets; ſo in Fiſhes the Number of Plates † compoſing their Scales, denote to us their Age.

To prepare Scales for the *Microſcope*, take them carefully off with a Pair of Nippers, and waſh them very clean, and place them in a ſmooth Paper, between the Leaves of a Book to make them dry and flat, and then place them in Sliders between the Talcs for Examination.

The *Eel*, *Snake*, *Viper*, *Lizard*, *Slow Worm*, and the *Eft*, &c. afford a great Variety of Scales. The *Dog-Fiſh Scales* conſiſt of a great Number of horny Points, which appear in the *Microſcope* to be curiouſly ridged or carved.

CHAP. XXXI.

Of Spiders.

THERE are ſo many different Sorts of *Spiders*, and their Form ſo generally known, that a Deſcription of them in this Place, cannot be expected. I ſhall therefore proceed to deſcribe ſome of thoſe Particulars of this Creature, that are only to be diſcover'd with the Aſſiſtance of the *Microſcope*.

Some *Spiders* have ſix Eyes, others eight, others fewer, and ſome more. They all ſeem to be Creatures of Prey, and to feed on other ſmall Inſects, but their Ways of catching them are very different. The *Shepherd Spider*

* *Hook's Myc. p.* 162. † *Leeuw. Epiſt. Phyſol. Epiſt.* 24. *Mai.* 1716.

by

by running on his Prey; the *Hunting Spider* by leaping on it; other Sorts weave Nets, or Cobwebs, whereby they enſnare them. Nature having equipped them both with Materials and Tools, and taught them how to *work* and *weave* their Nets, and lie Perdue, and to watch diligently, and run on any Fly, as ſoon as ever entangled.

Their Eyes are immoveable and tranſparent, but not pearl'd; they are ſituated in a moſt curious Manner, and deſerve the ſtricteſt Examination.

The Way to view them is to cut off the Legs and Tail, and bring only the Head Part before the *Microſcope*, upon the Glaſs R, of Fig. 2. or to ſtick them upon the Point l, or pinch them between the Nippers of the ſame Figure, and ſo apply them to the *Microſcope*.

They have all eight Legs, and two Arms, or ſhorter Legs near their Mouth, that aſſiſt in taking their Prey; they are beſet thickly with Hairs, have each ſix Joints, and end with two hooked Claws, ſerrated, * or having Teeth on their Inſide, whereby they cling faſt to any Thing; and may be often ſeen to hang down from the Branch of a Tree, on a Thread of their own making, aſſiſted by the Help of theſe Claws.

Fig. 177. repreſents Part of the Leg of a *Spider*; B, C, D, ſhew the two extreme Claws armed with Teeth like Saws; E, the third that hath no Teeth. It is certain, that when the *Spider* does not wind itſelf by its Thread upwards, but runs along its Web, it then takes hold of the ſpun Thread with this third Claw. This *Spider* had eight Eyes, two of which were on the Top of the Head, to ſee what paſſes before him; below theſe two others, which look ſtrait forwards; on each Side of the Head were two more, the two foremoſt to ſee collaterally before him, and the two hindmoſt to ſee backwards.

Fig. 182. repreſents that Part of the Head, which contain'd the Eyes ſeparated from the Membrane in which it lay. P Q, the Eyes that look upwards, K L thoſe that look ſtrait forward, I M thoſe that look ſideways forward, H N thoſe that look ſideways backward. They have no Eye-lids, but are fortified with a hard, poliſhed and tranſparent Cruſt: As theſe Eyes are immoveable, Nature hath indulged them with ſo large a Number, to give them Information of any Thing that any Ways concerns them.

Every *Spider* is furniſhed with a Pair of Forceps, repreſented at A B, and C D, Fig. 183. in the fore-part of its Head. They ſtand horizontally, and when not made Uſe of, they let the Claw of them fall down on their reſpective Branches, like a Knife claſped upon its Haft, as at C D, and there they lie between two Rows of Teeth, that are likewiſe employed to hold faſt its Prey.

Authors are divided in their Opinions on the Poiſon of Spiders, ſome calling theſe Forceps Stings; as Mr. *Leeuwenhoek*, who calls the hooked

* *Phil. Tranſ.* No. 272.

Claws A B and C D Stings; and ſays, that towards their Extremity at B and C are two ſmall Holes, from whence, according to all Appearance, when it ſtrikes its Enemy, it therefrom ejects a liquid Matter, we call Poiſon.

He put a Frog and a Spider together into a Glaſs, and having made the Spider ſting * the Frog divers Times, the Frog died in about an Hour's Time.

Dr. *Mead* believes this to be a Miſtake, and that while the Spider bites, a ſhort white Proboſcis † is thruſt out from the Mouth, which inſtils a Liquor into the Wound.

They frequently caſt their Skins, which are to be found in Cobwebs, in which the Forceps may be examined, being always ſhed with the Skins, and eaſier ſeparated than when alive. They are commonly ſpread out to View, and by their Tranſparency, every minute Part is ſeen with much Diſtinctneſs.

The *Microſcope* hath alſo informed us of the Manner how the Spiders weave their *Webs*, and of their *Contexture*, for the Performance of which, Nature hath endowed them with five little *Teats*, or *Nipples*, near the Extremity of the Tail; whence a gloomy Liquor proceeds, which adheres to any Thing its preſſed againſt ‖, and being drawn out, hardens inſtantly in the Air, and becomes a *String* or *Thread* ſtrong enough to bear five or ſix times the Weight of the *Spider's Body*; this *Thread* is compoſed of ſeveral *finer ones*, that are drawn out ſeparately, but § unite together at two or three Hair's Breadth diſtant from the Body of the *Spider*. The Threads are finer or coarſer, according to the Size of the *Spider* that ſpins them.

Fig. 178. repreſents a Part of the Threads, which came out of two of their working Inſtruments, and were divided from each other, juſt as they iſſued from the Body; and R S T V, Fig. 179. repreſents one of the four outermoſt Inſtruments or Nipples, with its Quills or Reeds, which put together, is not ſo large as a common Grain of Sand; from whence it is eaſy to conceive, how ſmall thoſe Inſtruments muſt be, and how fine the Threads encaſed within them: At W theſe working Inſtruments ſtood as thick by each other, as they are repreſented between R and S. And that Part of the Figure, from the Sight, was not cover'd with thoſe Sort of Quills, but with Hairs only: It is alſo obſervable, that a few of theſe Inſtruments are bigger than the reſt, and conſequently produce a larger Thread. C F, Fig. 180. repreſents one of theſe between two others of the ſmaller Sort D E and A B, one of which had a wrinkled or harled Thread.

Spiders emit their Eggs, not out of the hinder Part of their Body, as in all other Animals, but under that upper Part of the Belly, near the hind Legs, where grows a Kind of Hook, of a particular Figure, which partly

* *Phil. Tranſ.* No. 272. † *Mead* of Poiſon. ‖ *Phil. Tranſ.* No. 272. § *Ibid.* No. 325.

covers

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covers the Aperture, from whence the Eggs iſſue. Fig. 181. repreſents a *Spider* of an ordinary Size, with its Legs contracted, as if it was dead, in order to ſhew the above-mention'd Aperture; and at D the Hook is ſeen.

Fig. 184. G H I K ſhews the Hook ſeparated from the *Spider*'s Body, as it appear'd through the *Microſcope*; between I and K are ſeen the Wrinkles or Folds, which Mr. *Leeuwenhoek* ſuppoſes are made to produce a more than ordinary Motion: E F ſhews the Part that join'd it to the Body, and between F and G are two round Balls. The Uſe of which he could not diſcover.

The Eggs of ſome *Spiders* are a good Object, being flattiſh at one End, and round at the other, with a Depreſſion at the Center of the flattiſh End, and a yellowiſh Circle round it; their Colour is a blueiſh white like counterfeited * Pearl; when they hatch, the little *Spiders* come out perfectly form'd, and very nimble. They depoſite their Eggs to the amount of five or ſix hundred, in a Bag ſtrongly compos'd of their own Web, which the *Spider* either carries under her Belly, and guards with the greateſt Care, or elſe hides it in ſome ſafe Receſs. When juſt hatched, the young *Spiders* make an entertaining Object for the *Microſcope*.

The *Current* of the *Blood* may be ſeen in the Legs and Body of *Spiders*, as has been before hinted; many other Wonders will be diſcover'd by the Curious in the Diſſection and Examination of their ſeveral Parts.

The *Carter*, *Shepherd*, *Field*, or *Long-legged Spider*, is different from moſt other *Spiders* in two Particulars, the firſt, which is only diſcoverable by the *Microſcope*, is the curious Contrivance of its Eyes; it has only two, and thoſe placed upon the Top of a ſmall Pillar, riſing perpendicularly out of the Middle of its Back, or rather the Crown of its Head. † The two Eyes, B B, Fig. 185. were placed Back to Back, with the tranſparent Parts or Pupils more protuberant than the reſt of the circumambient Matter, ‖ looking towards either Side, but ſomething more forward than backwards. C, Fig. 187. ſhews the Column on which they ſtood, and D D the Crown of the Head.

The ſecond Peculiarity is the prodigious Length of its Legs, which are eight in Number, in Proportion to its ſmall round Body. Each Leg of this, of which the Figures 185, and 186, are a Repreſentation, was above 16 times the whole Length of its Body; they are jointed juſt like thoſe of a Crab; each of which proceeds from a ſmall ſhell-like Caſe, of a conical Figure, as at I I I I, *&c.* of Fig. 186. which repreſents the under Part of its Belly, theſe are faſtned on to the protuberant Body of the Inſect, forming a Kind of blunt Cone, whoſe Apex is at M, about which the ſmaller Cones of the Legs are placed, each of them reaching almoſt to the Top, in ſo admirable a Manner, as does not a little manifeſt the Wiſdom of

* *Pow. Mycr. Ob. p.* 15. † *Hook's Mycr. p.* 198. ‖ *Pow. Myc. Ob. p.* 14.

Nature's Almighty Architect, in the Contrivance thereof. It has two fore Claws K K tipped with Black like a Crab's, which open and ſhut exactly like thoſe in a *Scorpion*, and are Saw-like or indented on the Inſide. Its Horns are ſeen at A A and Mouth at L.

The beſt Way to obſerve this Spider is to cut off all its Legs, and place it before the Microſcope upon the Object carrying Glaſs R, of Fig. 2, or upon the black and white Object-Plate.

The little white *Field-Spider* with ſhort Legs, found plentifully among new Hay, whoſe Body appears like white Amber, emboſſed with black Knobs, out of each whereof grow Prickles like Whinpricks, ſome have ſix, ſome eight Eyes, that may be diſtinctly ſeen, quick and lively; each Eye has a violet blue Pupil, * clear, and admirably ſurrounded by a pale yellow Circle.

The wandring or hunting Spider, who ſpins no Web, but runs and leaps by Fits, has two Tufts of Feathers fixt to its fore Paws, which, together with the great Variety of Colouring all over this Animal, affords a beautiful and delightful Proſpect for the Microſcope.

There is a red Mite or Louſe often found feeding upon Spiders, in Shape much like a Tortoiſe, † with a little Head, and ſix long but ſmall Legs; and about the Legs of the Field-Spider they cling exceeding cloſe whilſt the Animal is alive, but when dead they all fall off and creep away.

Mr. *Bon* hath made ſeveral Pair of Stockings and Gloves, from a Silk ‡ wound off from the Egg Bags of ſhort legged Spiders.

CHAP. XXXII.

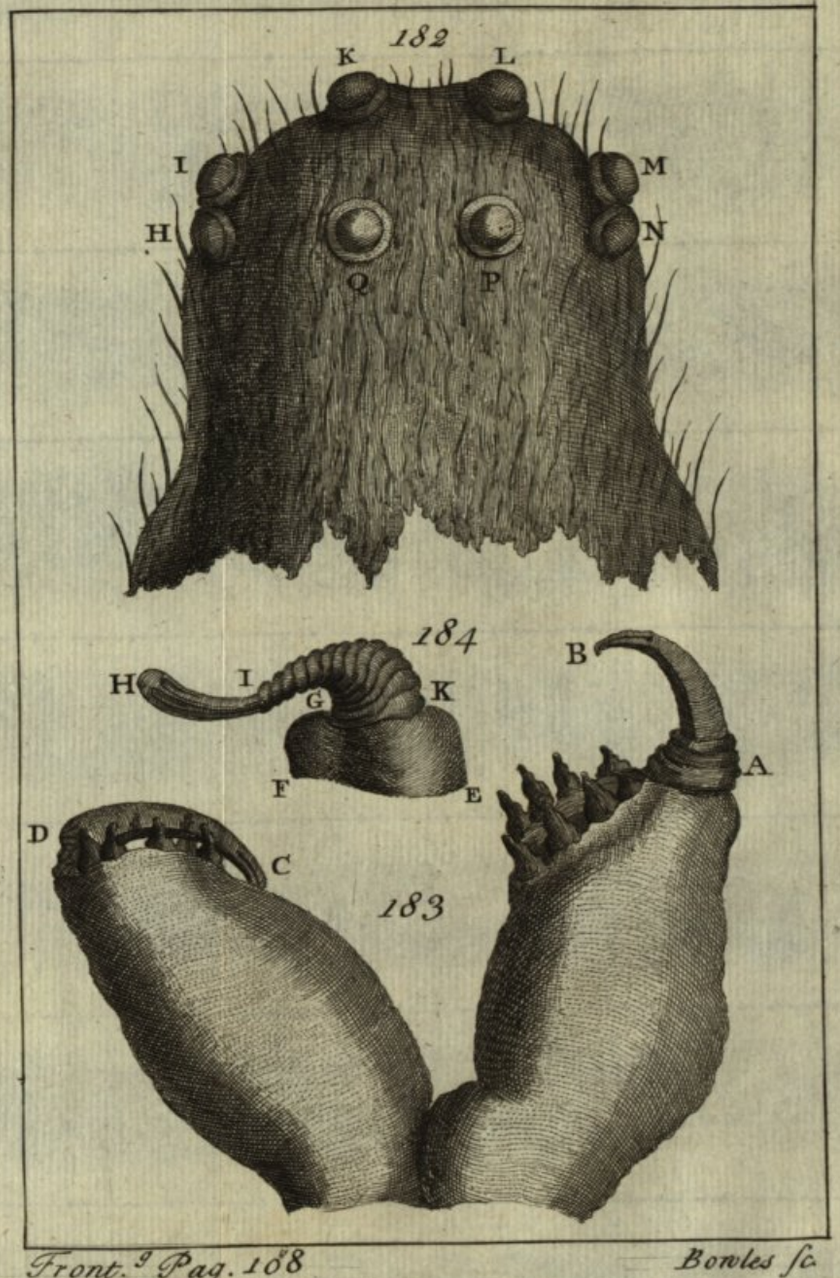
Of the Sting and Scraper of a Bee.

AS the Contrivance and Structure of the Stings of moſt Inſects are nearly alike, they will be ſufficiently underſtood by a Deſcription of that of a Bee, as diſcovered by the Microſcope.

A *Bee's Sting* is a horny Sheath or Scabbard, that includes two bearded Darts; this Sheath ends in a Point, near the Extremity whereof a Slit opens, through which at the Time of ſtinging, two bearded Darts are protruded beyond the End of the Sheath, one whereof being a little longer than the other, fixes its Beard firſt, but the other immediately after; they penetrate alternately deeper and deeper, taking hold of the Fleſh with their Hooks till the whole Sting becomes buried in the Wound, and then a venemous Juice is injected through the ſame Sheath, from a little Bag at the Root of the Sting, which occaſions an acute Pain, and a Swelling of the Part continues ſometimes for ſeveral Days after. This is beſt prevented by

* *Pow. Mi. Ob. p.* 13. † *Pow. Mi. Ob. p.* 19. ‡ *Phi. Tran. No.* 325.

enlarging



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enlarging the Wound immediately to give it ſome Diſcharge, and anointing it with a little common Oil.

A B C, Fig. 188. repreſents the Sheath or Caſe, out of which the two *Stings* or rather *Spears* are protruded. * E the Cavity, in which they lie. C the Thickneſs of the Caſe below; and about C, A, the two Spears ſhew themſelves each in a ſeparate Place. Fig. 189, ſhews Part of the *Sting* taken out of the Sheath, K its Edge or bearded Part, L its Back without Beards. M N, Fig. 190, repreſents the whole *Sting* taken out of the Sheath with its Back that is without Beards next the Eye; the upper Part M O is incloſed round about and hollow within, the lower Part O P open; P N ſhews Part of the broken Nerve, Q R is Part of the Body faſten'd to the Sting, and placed in the thicker Part of the Caſe D C A, Fig. 188. A B C, Fig. 191, repreſents both the *Darts* as they lie together cloſe againſt the Sheath ‖; yet one of them with its Point a little before that of the other, to be ready (as I conceive) to be darted into the Fleſh. And Fig. 192 ſhews both the Darts in part out of the Sheath; and one a little higher than the other, as if it were at work.

Fig. 193, repreſents one of the two *Arms* wherewith Mr. *Leeuwenhoek* thinks the Bee makes her Honey-Combs, and are furniſh'd with three peculiar Joints as at D, A, B. Fig. 194, is one of the *Scrapers* placed on the fore Part of the Head, by which ſhe ſcrapes the *Wax* from *Flowers*. Fig. 195, is the *Wiper* placed forward on the Head, and with it ſhe wipes the *Honey* off the *Flowers*; all which Inſtruments when the Bee hath done working are ſkilfully ſheathed under her Head. Fig. 196 repreſents the *Scraper* of a *wild Bee*.

When the *Darts* are ſtruck deep in the Fleſh, if the *wounded Perſon* ſtarts before the *Bee* can diſengage them, ſhe leaves her *Sting* behind in the *Wound*; but if he has Patience to wait until ſhe withdraws the *Spears* into their Scabbard, the Wound becomes much leſs painful.

If you divide a *Bee*, eſpecially an *Humble Bee*, § near the Neck, you will ſee the *Heart* beat moſt lively, which is a white pulſing Particle.

Within the *yellow Pluſh* or *Fur* of humble *Bees* you may frequently find a ſmall whitiſh very nimble Animal, ** not much unlike the Shape and Form of a Cheeſe Mite.

The Way to view a *Bee's* Sting with the Microſcope, is to cut off the End of its Tail, and then touching it with a Pin or Needle, it will thruſt out the Sting and Darts, which may be ſnipt off with a Pair of Sciſſars and kept for Obſervation; or if you catch a Bee in a Leather Glove, its Sting will be left therein, being unable to diſengage its Hooks from Leather: And when it is quite dead, which it will not be till after ſeveral Hours,

* *Arc. Nat. Tom.* III. *Ep.* 133. *Phi. Tran. No.* 97. ‖ *Derham Ph. Theo. p.* 240.
§ *Petv. Mi. Ob. p.* 4. ** *Ibid. p.* 20.

you

you may quite extract it with its Darts and Hooks; by ſqueezing the Tail, pulling out the Sting *, and preſſing it at the Bottom, you may likewiſe puſh up the Darts; but without ſome Practice this will be a little difficult.

The poiſonous Juice may eaſily be found in the Bag which contains it; and by letting the Bee ſtrike its Sting upon ſome hard Body, enough of the ſaid Juice may be obtained to put upon a Slip of Glaſs, in order to view the Salts floating therein at firſt, and afterwards ſhooting into Cryſtals; or if you gently ſqueeze its Tail, you may perceive a Drop of this diaphanous Liquor at the very End of the Sting, which if wiped off will be immediately renew'd.

The Stings of Scorpions may be examined in the like Manner.

The Poiſon of Vipers has alſo been viewed by the Microſcope, but for a Deſcription of this I ſhall refer the Reader to Dr. *Mead*'s Eſſay on Poiſons.

CHAP. XXXIII.

Of Animalcula in Fluids.

SECT. I.

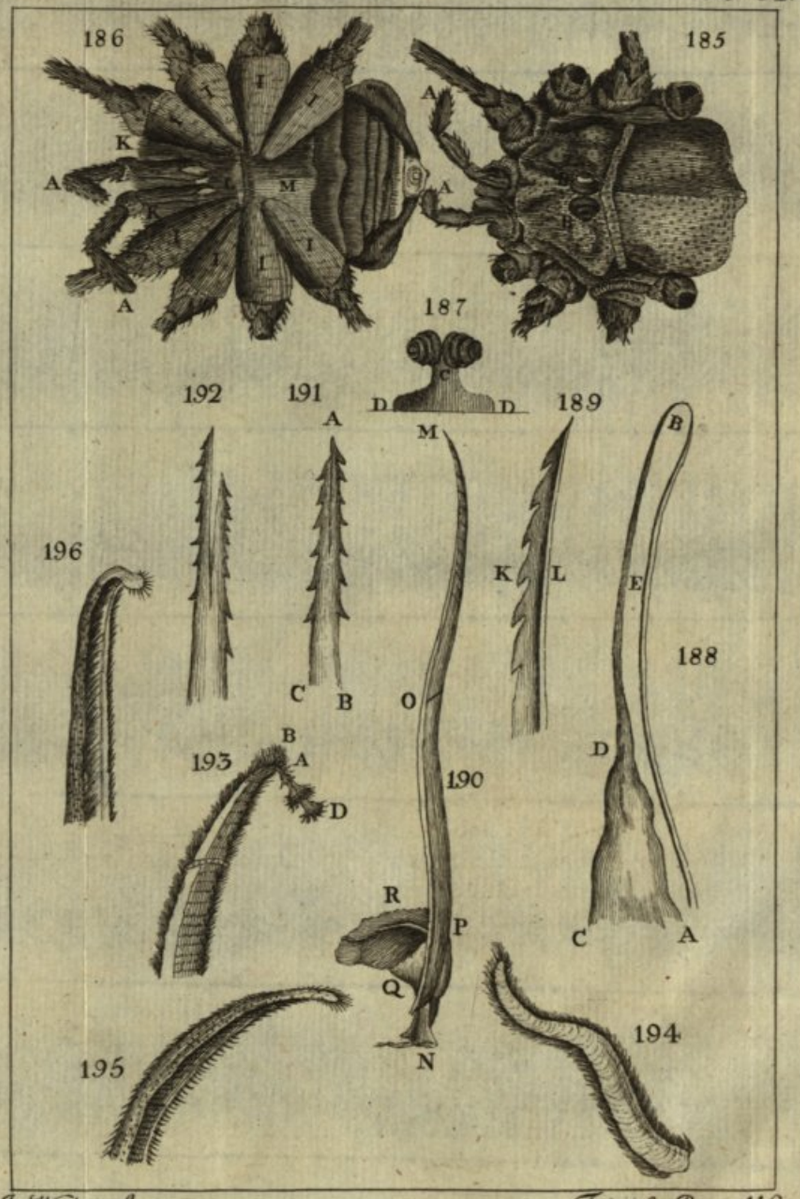
THE Microſcope hath diſcovered to us that the ſmalleſt of all *living Creatures*, we have been able to trace, are the *Animalcula* in Fluids, which would for ever have remained inviſible, had it not been for the Aſſiſtance of that Inſtrument.

If *Pepper*, *Paſte*, *Vinegar*, *Hay*, *Straw*, *Graſs*, *Oats*, &c. or any other vegetable Production be infuſed a few Days in Water, expoſed all that Time to the open Air; they will abound with inexpreſſible Numbers of minute living Creatures peculiar to themſelves, but of various Forms and Sizes.

Whereof ſeveral of the ſame Species of *Animalcula*, are frequently to be met with in different Infuſions, and even in Waters, that have been expoſed, eſpecially in *September*, without any Mixture; ſuch have been frequently found therein, as are found in the Cavity of a *Cabbage leaf*, or on the *Dipſacus*, † &c. and that certainly ſeveral of theſe are the ſame Animals under different Forms, ſuch a regular Proceſs being obſerved in them, and conſtant Uniformity in their Appearance, makes it probable that moſt of them are produced from the Spawn of ſome inviſible volatile Parents, and generated like *Gnats* and ſeveral other Sorts of Flies, which are bred and undergo ſeveral Changes in the Water before they take Wing; that ſome of them originally may be Water Inſects, or really Fiſh, ſmall enough to

* *Pow. Mi. Ob. p.* 4. † *Ph. Tran.* No. 284.

be



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be raiſed in Spawn with the Vapours, and to fall down again in Rain, and to grow and breed in Water that is kept.

It has been thought that theſe minute Flies, which hover every Way in the Air, when they find a Fluid ſtored with a convenient Nouriſhment for their future Offspring, reſort to it in Swarms to lay their Eggs, which being ſoon hatched, the Animalcula produced therefrom ſwim about, and live happily, till grown to a certain Size, change their Forms, take Wing and fly away.

If the Infuſion is covered only with a fine Lawn or Muſlin, few Animalcules will be found therein; but if it ſtands open it will be full of Life in a few Days: In the leaſt Drop taken from the Surface of ſuch Infuſion, the *Microſcope* will diſcover Millions of living Creatures.

SECT. II.

Of Eels, Serpents, or little worm-like Animalcula, found in Vinegar and Paſte.

IF *Vinegar* be expoſed to the open Air but a few Days in hot Weather, it will abound with *Eel-like Animalcula*, repreſented by Fig. 197, two of which are ſeen at A, making equal Undulations, ſometimes four or five are ſeen to move in the ſame Manner; at B, B, B, B, are ſhewn four others differently coiled, they coil and uncoil themſelves with a ſurpriſing Swiftneſs, at C is a Repreſentation of one with a forked Tail. Monſieur *Joblot* ſaw but one of theſe in 36 Years Obſervation: However, the ſolar Microſcope ſeldom fails of diſcovering ſome of them every Obſervation. That marked D, although its Mouth ſeems different from the reſt, is not ſo, but owing to its not being repreſented in the ſame Poſition. They are to be applied to the Univerſal Microſcope, by taking up a Drop of the Vinegar on a Pin's Head, and placing it upon the Object carrying Glaſs R, Fig. 2. When this Drop begins to evaporate, their Motion will be conſiderably retarded, at which Time their Mouths may be ſeen, and many other Particulars may be obſerved in them.

Some People have imagined, that the Sharpneſs of the Vinegar, is occaſioned by the *Eels* ſtriking their pointed Tails againſt the *Tongue* and *Palate*; but it is very certain that the ſoureſt Vinegar hath none of thoſe Eels, and that its Pungency is intirely owing to the pointed Figure of its Salts, which float therein.

Animalcula in the Shape of Eels are often found in many Infuſions but of a different Size.

* *Joblott's Ob. p.* 2. *Imprimé à Paris.* 1718.

Dr. *Powers* obſerves, that if *Vinegar*, in which theſe *Eels* abound, be but moderately heated *, they will all die, and ſink to the Bottom. But Cold does not hurt them, for after ſuch *Vinegar* had been expos'd a whole Night to the ſevereſt Froſt, and was frozen and thawed, and frozen again, and ſo ſeveral Times over, they were as briſk as ever: He alſo tells us, that he put ſome *Vinegar* full of theſe *Eels* into an Eſſence Glaſs, and poured thereon about the ſame Quantity of Oil, which floating on the *Vinegar*, all the *Eels* would conſtantly creep up into the Oil, when the *Vinegar* began to freeze, but when it thawed, they as conſtantly returned to it again.

To furniſh yourſelf with minute *Eels*, always ready for the *Microſcope*, boil a little *Flour* and *Water*, till it comes to the Conſiſtence of ſuch *Paſte*, as the *Bookbinders* and *Shoemakers* uſe; expoſe it to the Air in an open Veſſel, and to prevent its hardening, or becoming mouldy on the Surface, beat it well together whenever you find it tends that Way; after a few Days it will turn ſour, and then if it be examined with Attention, you will find *Thouſands* of thoſe *Eels* on the Surface thereof. To preſerve them all the Year, you need only put a little Water to them, if the Paſte grows dry, or a Supply of other Paſte, always obſerving to keep the Surface in a right Condition, which will be eaſily done when it is once ſtored with theſe *Animalcula*. Their continual Motion will prevent any Mouldineſs thereon.

Apply them to the Microſcope upon the Object carrying Glaſs R, Fig. 2. firſt putting on it a Drop of Water, taken up upon the Head of a Pin, for them to ſwim in, and if the Paſte be thick, it muſt be diluted with a ſufficient Quantity of Water to diſentangle the *Eels*, and render them diſtinctly viſible.

They are very entertaining Objects, but more particularly ſo if examined by the ſolar Microſcope, with which they may be magnified to an Inch or more in Diameter. The internal Motion of their Bowels may be very plainly ſeen, and their Mouths to open to a conſiderable Width.

SECT. III.

Of Animalcula in ſeveral cold Infuſions of whole Pepper.

B, D, K, H, O, R, L, Fig. 198. exhibits the firſt Sort of them, each having ſeveral little Spots more tranſparent than the reſt of their Body. The Regularity of the Figure, under which theſe *Animalcula* generally appear, and the Rapidity of their Motion, prevents us from diſcovering on

* *Pow. My. Ob. p.* 34.

what

what Part of their Body their Head is placed, but after a little Time we are enabled to do it, altho' they continue in Motion; for when the Drop of Water in which they ſwim, is grown thick by the inſenſible Evaporation of its ſubtle Parts, it gradually retards the Motion of theſe minute Fiſh; and affords us ſufficient Time to obſerve many Things, that will teach us to admire the Creator's Wiſdom, even in the ſmalleſt Part of theſe minute Creatures.

You may then perceive that as two of theſe *Animalcula* are advancing forward, one moving along the Line from A to B, and the other from C to D, in turning about the firſt follows the dotted Line B E, and the ſecond moves from D to F.

You may alſo frequently ſee that of two of theſe *Animalcula*, one of them will run as it were along the Line G H, and the other over that of I K, leaving a ſmall Space between them, yet too little for a third L, to find a Paſſage, which thus incloſed between them, ruſhes forwards to ſave himſelf in the Direction of the dotted Arch towards M. Others after having moved along a ſtrait Line, as H G to O, turn about ſo ſwift upon a Point at O, which is their Head, that their oval Figure appears almoſt circular, after which they launch out with an extremely ſwift Motion towards P. Others alſo having run along a Line as Q R, and as it were turning upon their own Center at R, deſcribe ſeveral Circles, then ſhoot forwards with an extraordinary Swiftneſs along the Line S T.

Fig. 199. repreſents another Sort of *Animalcula*, whoſe Head is adorned with Hairs, and Motion generally circular, called *Copple Crown* *. A third Sort repreſented at Fig. 200. called a ſilver Bag-pipe †. A fourth Sort is a Kind of *Water Spider*, with its Mouth open, as at Fig. 201. Two of them are repreſented at Fig. 202. conjoined and turning upon their common Center. Fig. 203. ſhews two more of them alſo coupled as they ſwim in a ſtrait Line. Another Sort is repreſented at Fig. 204. in ſome Meaſure reſembling a Weaver's Shuttle; its hinder Part is tufted with Hairs, which aſſiſt him in ſwimming. Fig. 205. exhibits a Swarm of exceedingly minute Inſects of different Sizes and Shapes, which ſerve for Nouriſhment to the larger Sorts.

* *Jobl. Ob. p.* 14.

† Theſe Names were given to the *Animalcula* of the ſeveral Infuſions, by Monſ. *Joblot*, who endeavour'd to call them after the common Names of Things and Animals, to which theſe *Animalcula* bore ſome Reſemblance.

SECT. IV.

Of White Pepper.

INfuſions made of *whole white Pepper*, produce finer *Animalcula* than the foregoing, but not in ſo ſhort a Time. The large *Bag-pipe* of this Infuſion advances and recedes by Turns, as it ſwims before the *Microſcope*; and juſt before the Water is totally dried, a great Number of Eggs may be ſeen within them, and in the next Moment they will be all dried up, and appear like a confuſed Maſs.

SECT. V.

Of Long Pepper.

LOng Pepper put whole into common Water, produces *Animalcula* no leſs ſurprizing than the two foregoing; in this is ſometimes found an *Animalcule* ſomewhat like a *Caterpillar*; and a different Sort of *Eels*, from thoſe found in *Vinegar* and *Paſte*, being thicker and ſhorter than they, but do not live near ſo long.

On repeating theſe Experiments at different Seaſons in the Year, and in different Years, other Sorts will be found not here repreſented.

Take common *black Pepper* groſly pounded, and put it into a Glaſs Veſſel, as much as will cover the Bottom thereof, about half an Inch thick, on which pour about three or four Times that Depth of Rain or River-Water, ſhake and ſtir the Pepper and Water well together at firſt, but afterwards not at all, and expoſe the Veſſel to the Air uncover'd; in a few Days a little Skin may be ſeen on the Surface of the Water, which, examined by the *Microſcope*, will be found to contain Millions of *Animalcula*, at firſt ſcarce diſcernable, but continually increaſing in Bulk, till they arrive at their full Size. Their Numbers too increaſe prodigiouſly, till at laſt the whole Surface of the Fluid ſeems alive.

This Experiment will ſucceed in Winter, if the Water is not frozen.

The *Animalcula* repreſented by Fig. 206. are very common, and are deſcribed by Mr. *Leeuwenhoek*, who hath ſeen the Tails of ſome of them 9 or 10 times longer than their Bodies, * which are about one Third of an Hair's Breadth, but in general they are 4 or 5 times as long. In moving they

* *Phil. Tranſ.* No. 284.

commonly twitch up their Tail into a ſcrew-like Form, as at b, Fig. 206. and this Spring is ſo ſtrong, that when the Tail is entangled, as it frequently is by the Extremity, they bring back their whole Bodies by the Jerk and Convolution of the Tail, which quickly returns to its firſt Straitneſs. When they lie ſtill, they thruſt out and pull back again a bearded Tongue, and a Current conſtantly runs towards them, occaſioned probably by the Motions of ſome Fins or Legs too fine to be diſcerned.

Thoſe *Animalcula* exhibited by Fig. 207. abound in all Waters, and are largeſt of all; their Length is about an Hair's Breadth, and three or four Times more than their own *, they are very thin and tranſparent, and turn themſelves very quick, ſhewing both Back and Belly, their Edges are adorn'd with a great Number of minute Feet, ſeen chiefly at the two Extremities; at one End there is a Kind of Bruſh reſembling a Tail; they are ſwift in Motion, and by their Turns, Returns, and ſudden Stops, ſeem to be continually hunting for Prey. a repreſents one of them on its Back; b one on its Belly; at c and d, is ſeen how they often appear in other Poſitions.

There is generally another Sort of an oval Shape, as at Fig. 208. a b c, lengthening and ſhortening themſelves as Occaſion requires, and ſometimes two of them may be ſeen conjoined, as at a.

Another Sort are a Kind of *capillary Eels*, they wave their Bodies but little, move equably and ſlow, and ſwim as well backwards as forwards. See Fig. 209.

Several Kinds of Mixtures put amongſt them, while they are before the *Microſcope*, produce different Effects. The ſmalleſt Drop of Spirit of Vitriol, upon the Point of a Pin, being put to them, they immediately tumble down dead; diſſolved Salts kill them, but with this Difference, inſtead of being flat as in the former Caſe, they ſhrink into oval Forms. Tincture of Salt of Tartar throws them into convulſive Motions, after which they ſoon grow languid and die, without changing their Shape. Ink kills them, and ſo does freſh Blood, Urine, Spittle, and diſſolved Sugar †.

There is alſo another Sort of *Animalcule*, frequently found in this Infuſion, of a ſpherical Figure, only pointed like a Pear, as at Fig. 210. in which are a vaſt Number of dark Spots, in a confuſed Agitation, they chiefly turn as it were upon a Center, firſt one Way, and then the contrary, ſometimes they take a large Circuit, but always with their pointed End foremoſt.

Another Sort repreſented at Fig. 211. is alſo found in great Numbers, they move briſkly, are very active, contracting, and dilating as they ſwim along, they have ſeveral Feet in their fore Parts very viſible; when the Drop of Water is almoſt evaporated, they ſhrink up into a globular Form,

* *Phil. Tranſ.* No. 284. † *Ibid.* No. 203.

then their Feet ſtanding out, may be ſeen to move nimbly, a, ſhews them at their Length, and b when contracted.

Fig. 212. repreſents another *Animalculum*, not uncommon amongſt the reſt; its Motion very nimble, always keeping its ſharp Extremity foremoſt; ſome are clear and ribb'd from the Point to the thick Extremity, others tranſparent only at the fore Part, as at a and b.

The Water which drains from *Dunghills*, and is of a brown Colour, is generally ſo prodigiouſly ſtored with various Sorts of *Animalcula*, that it muſt be diluted with Water before they can be ſufficiently ſeparated, to diſtinguiſh their different Kinds; one particular Sort is found amongſt theſe, which is very rarely to be met with elſewhere, and are ſhewn at Fig. 213. their middle Part dark, and beſet with Hairs, but both Ends tranſparent, their Tails tapering with a long Sprig at the Extremity thereof, their Motion ſlow and wadling.

SECT. VI.

Of Animalcula in a cold Infuſion of Senna.

ABout the Middle of *July*, as much as could be taken up with two or three Fingers of the *Leaves*, *Stalks*, and *Branches* of *Senna*, was put into cold Water, and in about eight Days, the Surface thereof was ſtored with extremely minute longiſh Bodies, ſeparate from each other, but without Motion. The Corpuſcles repreſented at Fig. 214. were thought to be nothing elſe but Pieces of the Bark from the Branches of the *Senna*; but in about eight Days after, they all diſappear'd, and a ſurprizing Number of worm-like *Animalcula* ſucceeded them, but leſs than the firſt, being alive, and ſwimming a little below the Surface of the Water; one of theſe Worms is ſeen at Fig. 215. Its Head round at I, its Body compos'd of eleven Ringlets, the loweſt Extremity of which ends ſometimes in a Plain perpendicular to its Body. At other Times with three round Protuberances, as at M.

Through the Skin there appears a very white Fibre, branching as it were from each Side of the Tail, in a ſtrait Line towards the Head, where they unite in an Arch, as at N, Fig. 216. This Fibre extends and contracts itſelf alternately, by which Means the Ringlets are drawn nearer to, or puſhed farther from each other; Part of the Water being evaporated by its ſtanding ſeveral Days. A little freſh Water was poured thereon, which cauſed the Skin that ſwam on the Surface of the Infuſion to ſink to the Bottom of the Veſſel; the Infuſion was thereby refined, and more tranſparent than it was before, which occaſioned the Diſcovery of two new Sorts of *Animalcula*, and this in the leaſt Drop that could be applied to the *Microſcope*,