

EPHEMERI VITA:
OR THE
Natural History
AND
ANATOMY
OF THE
EPHEMERON.

A Fly that Lives but
FIVE HOURS.

Written Originally in Low-Dutch
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L O N D O N.

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TO THE
READER:

THE account of so wonderful an Insect (and what is there indeed in the whole Creation, if curiously examined, but would excite our greatest Admiration, and force us to adore the Infinite Wisdom of the Maker?) I doubt not but will be acceptable to the Ingenious. Our Author, the Accurate and laborious Dr. *Swammerdam*, as by his other Treatises so well received, so no less by this, hath highly deserved of the Learned; it containing so many Curious and New Discoveries. It was Printed in Low-Dutch in octavo. Anno 1675. containing above 420 pages: what made it so large, was his frequent, Pious Meditations, and Poetry upon the various accidents of the Life, and extraordinary Mechanism of this Creature: so natural a guide such Philosophy is to Divinity, that the Apostle himself * tells us, τὰ γὰρ ἀόρατα αὐτοῦ ἀπὸ κτίσεως κόσμου, τοῖς ποιήμασι καὶ ἀκαθάρτα, ἢτε αἰδοῦν αὐτοῦ δύναμις καὶ Θεότης, εἰς τὸ εἶναι αὐτὸς ἀαπολογία. "The Wil-

* 1 Rom. 1. 20.

The Preface

“dom of God receives small honour from those
“vulgar heads, that rudely stare about, and with
“a gross Rusticity admire His Works; Those
“highly Magnifie him, whose judicious inquiry
“into his Acts, and deliberate research into his
“Creatures, return the Duty of a devout and
“learned Admiration *.

But the Contemplations for some reasons are omitted in this Translation; and we here only present you with the Philosophical part, the Natural History and Anatomy of this strange Fly: a Fly that in all Ages has exercised the Pens of the most Ingenious; but never any with that success and happiness, as our Authors.

My chief design in the Publication is the improvement of Natural History; which is better written from Natures own Copy, than the faulty Transcripts of her many Commentators. Besides, the most that hitherto we have had, is but the Shell; far greater Treasures lye hid within; and if we would understand how 'tis that Nature gives Life and Motion to these *Automata*, we must unloose the Case, and take asunder the several Wheels and Springs, and carefully observe how she joyns them all together. Not only || Physick, but a great part of Philosophy will receive a vast improvement from such an *Analysis* of Animal bodies: And an History of Animals can't rationally be writ without their Anatomy; unless we

* *Religio Medici*, p. m. 10. || See the Preliminary Discourse to the Anatomy of the Porpoise.

would

To the Reader.

would content our selves in admiring their Clothing and Paint, and still remain ignorant how 'tis they live and differ from one another.

Of late several things have been done this way; enough to encourage a farther prosecution of it; and a great means to it. I think, may be, to make common, such helps and assistances, as others labors and travails in it, have already furnished. The Anatomy of one Animal, will be a Key to open several others; and until such time as we can have the whole compleated; 'tis very desirable to have as many as we can of the most different, and anomalous. This curious piece being in a Language less known to the generality of the Learned here, a Translation of it was undertaken, (tho' otherwise out of his way) by a person of my acquaintance, who had no other design than to gratifie the Ingenious and Curious in these Studies, that are unacquainted with that Language; and since this was his aim, 'tis hoped he may receive a favourable Censure, if in all things he have not so fully answered Expectation.

I doubt not but upon a strict enquiry we may meet with *Ephemerons* here in *England*; if not the **haft** of the *Dutch*, which is here described, yet several other sorts. Our *May-fly* will well deserve to be examined; and what is here performed, will very much facilitate the Anatomy of other Insects too: Which if it shall have
that

The Preface, &c.

that success as to encourage other undertakers in such pleasant and no less useful Studies, however Ignorance may deride the Curiosity, I shall have fully attained my aim in handing this Translation to the Ingenious Reader.

Edw. Tyson, M. D.

On the History of the Ephemeron.

Although the Great Creators Wisdom shone
Both in his Foot-stool, and his Throne,
Though greater Bodies make the louder noise,
Yet in the lesser is a Voice,
A Voice, though still
That doth the mind with Admiration fill,
And gives to man the Product of his will.
The Insect-world but lately known,
Doth both his Skill and Glory too, declare,
They a Creator own
No less than does the Sun,
Their Rise, their Life, their End,
Sparks of Wise pow'r comprehend.
Nay, if we Great with Small compare,
We find these Little-Heraulds too, Proclaim
Jehovah's Mighty Name,
They tell his praise,
And Trophies to his Wisdom raise,
That does in Little much express,
Like the best Limners art, that most affects the less.
The smallest Ant does Providence Teach,
Does Foresight to the Sluggard Preach,
And here in this Ephemeron we see
An Embleme both of Change, and of Mortality.
How strong must be the Plastick force
That the small Eggs contain?
That Water makes not worse,
A Body fluid, cold;
Nay hatches 'em at last,
As well as gentle heat of Hen, or Sun,
A thing so strange, so bold,
As scarce perhaps no Author ever told,
Or heretofore was done:
Truth in new moulds is cast,

And

*And Future Age may more unfold,
 What from the Former we expect in vain,
 This Treasure, where's enough, we from the Deep regain.
 What instinct has the Worm to bore a Cell
 Wherein he may securely dwell?
 Whose hard fare, joyn'd with Ease, and Sloth,
 Perhaps does something to retard his growth.
 Though meat be dry, yet drink there is good store,
 Tipple still streaming by his door,
 Like other Natives both begot and bred,
 Where Thetis shews her Briny head,
 And Neptune swaggers o'r the dead.
 Well may both Worm and Man that Element desire,
 Both moistening so require,
 Which is so natural nought can be more,
 Congenial to their first beginning
 As to a Spider is her Spinning,
 And is a means to both of getting higher.
 After a long Subaqueous abode,
 The Watry Native longs to range abroad,
 Shoots through his liquor, and no sooner spies
 The Stranger Element, the Skies,
 The Poets Metamorphosis
 Was not more strange, more quick than this,
 Unstrips, his burthen leaves, and then more nimbly Flies.
 How many parts the Inside does contain?
 All here made plain
 And obvious to the mean'st Capacity,
 What parts the Worm, and Fly,
 What makes the Change of Name,
 What parts are alter'd, what the same,
 Into all which he that desires to pry,
 Needs now no Microscope, but sees with half an eye.*

T. GUIDOTT.

EPHE-

EPHEMERI VITA
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Natural History
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A Fly that lives but Five Hours.

CHAP. I.

That the Ephemeron is Produced out of an Egg.

AS all Vegetables proceed from a known Fructifying Seed ; so is also the Production of all Animals and Insects, viz. out of a Seed or Egg : So that nothing we discern to have life, but it proceeds from an Egg, Man as well as all other Creatures. And notwithstanding the Common Opinion that many Insects named Exanguious, are chance-births, taking their original from Corruption, that is, out of the motion of the moisture and warmth which proceedeth from Corrupting matter, either in Inanimate or Sensitive Bodies, or Vegetables ; constant experience teacheth us the contrary, as, among other, appeareth in this account of the Production of the *Ephemeron*, which proceedeth from a Visible and
B known

known Seed, contrary to that false opinion of men prejudiced to the contrary, who believe they are Produced out of putrifying Clay and Water; as if such a *chance-Productor* had the power to produce a Creature in all Ages to be admired, and hardly by the most Ingenious and Wise to be described.

This (a) *Ephemeron* is a Four-winged creature, furnished with Two small Horns, Six Legs, Two very long and straight hairy Tails, and living at longest in this shape or form but Five Hours; is found yearly in all the mouths or entrances of the *Rhine*, as the *Maes*, the *Wael*, the *Leck*, and the *Isel*; about Midsummer flying on the Surface of the water for Three dayes succeeding; but with this difference, that those which have lived and flown the First day, die the same Evening; and the same happens the Second and Third day, and then ceaseth till next Year and Season when the like happens again. (a) Tab. 8. Fig. 2.

At the same time the (b) Female *Ephemeron* being risen out of the water, and in the rising, having shed her Skin, and having for some time flown, and as it were sported above the Surface of the water, she shooteth her double (c) Egg cluster, or Ovarium in the water; after which the (d) Male also being risen out of the water, and as before in the rising having shed his skin, and afterwards on Land stript another (e) thin Film, also shooteth his Seed on the Female Seed, and thereby fructifieth it. But how properly this Generation is effected, and how these Insects rise out of the water, and how in the water and on the land they shed their Skins, shall be in this following relation more largely and circumstantially described. (b) Tab. 6. Fig. 1.
(c) Tab. 4. Fig. 3.
(d) Tab. 8. Fig. 2.
(e) Tab. 7. Fig. 1, 2.

This very wonderful flight of this Insect, living in this form and shape but Five Hours, I have for the first time seen in a Branch of the *Rhine*, running by *Cuilenborch* in the Year 1667. I find also in *Clutius*, who hath writ of these Insects, that they are also found at *Arnhem*, *Zurphen*, at the *Cut* by *Utrecht*, at *Rotterdam*,

terdam, and several other places. As also that D. de Mey hath given a particular narration thereof, as may be found at the end of the Historical Observations of Goedert. And not only in our Age, but in some Ages past mention hath been made of these or the like Insects by the Philosophers, as by *Pliny*, *Aristotle*, *Ælian*, and others, who have made search into the nature of Insects, and by whom this Insect is described under the name of *Hemerobius*, *Ephemerus*, and *Diaria*, as appeareth in their writings; as also in the forementioned Book of *Augerius Clutius*, published An. 1634. But what degree of knowledge they have had of this Insect, and what for truth they have recorded thereof, will appear to those who shall take the pains to examine them according to this Treatise.

(f) Tab. 4.
Fig. 1.

The Eggs of the *Ephemeron* being in the forementioned manner shot in the water, and besprinkled with the Milt or Seed of the Male, they sink gradually, and are by means of the streaming water spread here and there on the clay or ground; as also for that by their shape, which is a (f) flattish round, they are fitted for a spreading in their sinking; and therefore if with the point of a knife you shall let them down leisurely in the water, you will find them neatly separate one from the other.

How long these Eggs remain under water unhatched, or in how many days the tender limbs of the worm are so far grown as to have strength to break through the shell or skin, is very difficult to be declared, notwithstanding by often digging in the Clay, in search for them, or by keeping some of their Eggs in a vessel with Water and Clay, some knowledge thereof might be attained. It shall suffice for the present to say, that the Egg of the *Ephemeron* produceth a Six-legged Worm, which the Seamen and Fishermen name *Deber Aas*, or *Shore-baite*, as hereafter shall be mentioned.

CHAP. II.

Out of the Egg of the Ephemeron proceedeth a Six-Legged Worm.

THE Time when the Worm is hatched and named *Gas*, or *Bait*, being to me unknown; I will proceed in my discoveries; and first, if after some considerable time you dig in the Clay about the places where these worms are, you will find a great number of Six-legged and very small worms; which differ not in form and shape from those which are bigger: I said, a considerable time, because they grow but slowly, for in the following year in the month of *June*, when the full grown Worms shed their Skin, these Worms are in size but of about (a) one *Holland* inch long, viz. (a) *Tab. 1. Fig. 1.*; part of the length of the (b) full grown Worm. (b) *Tab. 1. Fig. 3.*

Besides these Two sorts of Worms so considerably different in size, there is at the same time also found in the Clay a (c) third sort, which exceed the smallest (c) *Tab. 1. Fig. 2.* sort, being double the size of them, and are less than the full grown. Besides, those of each Size and Age differ somewhat in length and thickness among themselves. So that whereas the full grown Worm at the time that it is ready for flight is about Three *Holland* inches long, the middle sort are about Two of the same inches long, and the smallest about One inch.

There is also this further difference as to their Age, that those of the (d) first size have not only no wings, (d) *Tab. 1. Fig. 1.* but also no appearance of them; but in the second size (e) the wing-cases appear, which in the third size are (e) *Tab. 1. Fig. 2.* fully and plainly visible, (f) and as a flower in its bud, (f) *Tab. 1. Fig. 3.* growing on, and as it were creeping out.

CHAP.

CHAP. III.

The Worm being hatched what its First Action is, and what its Food.

HAVING observed what kind of Worm is hatched out of the Egg of the *Ephemeron*, I shall next describe what the Worms thus hatched first do, and what is their Food.

It is very requisite to know that the Worms rarely or never are found on the ground of the Rivers, or Swimming in the body of the water, for notwithstanding they Swim indifferently swift, and make a kind of a Snake-like motion in the water, bending sometimes their heads downward and sometimes upward, which waved motion the body followeth, yet they keep themselves always close the sides or banks of the Rivers, in the stillest places of the water where they have their Cells. And where the places dug for finding them are most Clayie, there are they found in greatest number; yet are they seldom found on the outsides of the Clay, but they have their habitation within the body thereof, and that in oblong round cavities which themselves have made, not sloping downwards, but straight and horizontal, and therefore *Vander Kracht* in *Clutius* saith true, that these Insects have each its proper Cell.

As the Bees by an admirable and possibly inimitable art make their own Cells out of Wax; in-like manner are these excavated (a) Cavities like Tubes made by these Worms, and digged out according to the size of their bodies: wherefore as soon as these Worms are forced out of their Cells and have nothing to creep on but the Surface of the Earth, having no support for the sides of their Bodies, they soon lose their readiness and swiftness of motion, notwithstanding they are surrounded

(a) Tab. 2.
Fig. 2.

rounded with water, and by means of Swimming can keep themselves up; yet have I found when I had taken a great number of these out of their Cells for to Dissect them, that they always fell on their backs, where they seemed to ly as unable to raise themselves again on their Legs; whereas on the contrary they being in their Tube-like Cells, move very swiftly backwards and forward and all manner of ways. And the same I have also found common in all sorts of worms, that live in such excavated Cells, which move very swiftly in them, but taken out seem to lye as fainting away. As I have also found in the Worms which live in excavated holes of Trees; as also in those which are found in Fruits, Excrecences of Leaves, and in the wart-like Excrecences of Plants. It is very observable that a Wood-worm when drawn out of its Cell, immediately spins a web about its whole body, by which means it is assisted to make a new opening or Cell in the Wood, which without this support of its body it could not do, having herein need thereof to press its body against it.

The Worm out of its Cell is so weak, that Swimming in the water, and resting there a small time, immediately and without order it sinketh to the ground and there remaineth lying on its back.

But to proceed, the Worms as soon as hatched betake themselves to bore their Cells, the which as is said they make in the Clay, oblong, sometimes straight & sometimes crooked, which they by degrees enlarge according to the increase of their body in bigness; so that the old Worms live in (b) wider Tubes or Cells, and the young Worms in (c) narrower.

(b) Tab. 2.

Fig. 2.

AAA

(c) Tab. 2.

Fig. 2.

BB

To this purpose the wise Creator hath furnished them with fit members; for besides that their Two Fore-legs are formed somewhat like those of the ordinary Moles or the *Che-Chur*, or *Gryllo-talpa*, he hath also furnished them with two Toothy Cheeks, somewhat like the Sheres of Lobsters, which serve them more readily to bore the Clay.

The

The Worms being placed in a Vessel with Clay mixed with some water, you will immediately see them begin to make their Cells, and if it happen you provide them not Clay enough, they cannot hide their design, but will be continually wrooting the Clay through and through, and hiding under the Clay sometimes their head, sometimes their body, and sometimes their tail, always endeavouring to make new Cells.

The Fishermen assure us from their experience that when the water of the River falleth or runneth off, they then bore their Cells lower and deeper in the Clay, and when the water again riseth they also rise higher; which I judge to them most needful, in consideration of the many Lungs and Air-Vessels in these Worms, for to supply which they must oft take fresh air, which they could not do, if they remained in the depth when the water rose.

I have often experienced that these Worms taken out of their holes and placed in wet sand, do then rather creep out of the water than go downwards toward the bottom under the sand, which they seem to do as well for want of Clay, as for the warmth of the water which seemeth hurtful to them.

Concerning what their Food is, is difficult to find out except by help of Anatomy, which hath taught me their Food to be only Clay: for at what time soever they are opened, in their Stomach is found Clay, as also in the thick and small guts, in the same manner likewise is always found in the Intestines of Earth-worms, earth and sand; of which when they have fed, they eject the remainder in a Crooked knobby form, as is to be seen in the entrance of their Cells.

As for the *Moths* which eat Wool and Furr, there are two things very considerable, and suiting very well with this relation; the first, that the Cells they make to themselves, wherein they live, and with which as their house, *Tortoise*-like, they move from place to place, they

they make of the matter next at hand ; the second is, that they feed also on the same : therefore when you find their Cells, or rather coats or cases to be made of Yellow, Green, Blew or Black cloth, you will also find their dung of the same colour : So that desiring to have most fine Chopt Cloth, you need but seek it in their dung, and it were not possible to find finer shred flowers or herbs than in the dung of those Insects that feed on them. Which possibly might be of good use for the better extracting the Colours and Vertues of Vegetables, which appeareth after it hath rained for some days, at which time the dung of these Insects is in that manner melted, that then walking through the Gardens, you will discern on the Linnen laid on the ground for Whitening, spots of several colours which are very hard to be got out again. In those Boxes in which the *Druggists* and *Apothecaries* keep their Drugs, you will sometimes find some Ounces of these Evacuations, out of which might be extracted the vertue and colour of the Vegetable, whereas mistakingly they are often sold for the Seeds of those Drugs.

Like as the *Moth* feedeth on the same substance whereof it maketh its Cell or Case, so do also our Worms ; but as I said, this is not to be discovered but by Dissecting them : which way of certainly knowing the Food of any Insect or other creature, hath not its only use in these Insects, but also in Fowls, Fishes and other Animals, which we may desire to preserve and nourish. And for the knowledge of what their food is, we may in the ordinary way be much to seek. It hath also its use concerning hurtful and much damage-causing creatures whose destruction we therefore are desiring. In this manner I find commonly in the stomach of the *Mole*, parts of Ground-worms, which they very greedily eat, and for which cause alone they seem thus to wroot in the earth. It will be therefore an easie way to destroy them, if with the blood of a *Mole* you mix some *Ratsbain* and chopt Ground-worms, as experience

perience hath taught: to get the blood of a *Mole*, clip off a piece of his Nose, whereat much blood will issue.

CHAP. IV.

*How long this Worm feedeth: why named ~~Ass~~ or Baite:
And how strong its life is.*

HAVING described the Egg, the Worm, and its Nourishment; the next thing remarkable will be, to consider how long it feedeth. For notwithstanding it may seem strange to limit the duration of a Creatures feeding, whose life is as to us wholly hid in the earth and water; yet it is not unfeasible by considering the differing sizes of these Worms. For whereas the smallest size worms after one years feeding, are in length $\frac{1}{2}$ of one *Holland* inch; and that the second size are then in length $\frac{1}{3}$ and $\frac{2}{3}$ of the same inches, it followeth by consequence that every Worm is Three years feeding, before it is fitted for its change, at which third year the Worm now full grown is $2\frac{1}{2}$ inches long.

These full fed and full grown Worms now quit their Cells and the water to fly in the air, as following I shall describe. But as no creature is without its enemy, in like manner these Worms when they take the water to attain their flight, are immediately preyed on by the Fish; and although they have escaped that danger and attained the use of their wings, yet are they not free from a second danger, namely, of being preyed on by Birds; which hath given occasion to some Seamen, Fishermen and other people, dwelling on the Banks of the *Rhine* observing the same to use these Worms for a bait to fish with; which therefore is the

C

true

true reason why these Worms are named **Aas** or **Bait**, and **Oever Aas** or *Shore-bait* by those who live about *Wyk te Deursted*, *Cuilenborch*, and other places. And from hence also it is that when these Worms are become Fledg'd and have taken the Air, they are in the aforefaid places named **vluchtich aas** or *Flying bait*, whereas by those of *Rotterdam*, *Schoonhoven*, and *Dordrecht*, the oldest City in *Holland*, this Worm being Fledg'd is named **Haft**, from whence that so much known Low-Dutch Proverb is derived, **Het iller so dicht als Haft**, they are in multitude like *Haft*, for these Worms thus fledg'd flie in multitudes like the falling Snow.

At all times of the Year when the Season is fit for Fishing, these Worms make a good Bait ; for because they live Three years in the water and clay before they take their flight, they may at all times of the year be dug out of the clay in those rivers for that use.

When the Fishermen bait their hooks with these Worms, they fix their hook in the head of the Worm where it is hardest and strongest, and for that it lives long, it is the more useful by its motion in the water to allure the Fish, to swallow the hook.

The strength of this Worms life may be discerned by this Experiment, that when once for drying and preserving one of them, I had pierced the head through with a pin, it yet lived the next day, notwithstanding I had put it the whole night before in a Vessel with Urine for to kill it : yet nevertheless being taken out of their Clay Cells, and put in a Vessel with water and clay, they live not two days. When these Worms therefore are to be preserved, they must only be placed in moist sand or wetted clay, in which I have found the greatest sort to live Four days, and the small worms Eight days, but wholly under water they cannot subsist.

For sending these Worms elsewhere, there is no better way than to bind some of the greatest hollow Reeds,

Reeds together, and to cause the worms to run in them, wherein they will remain without hurting one another, which otherwise they are subject to do, when moving nigh one the other; and this way they might be removed into other Rivers, as Fish are removed.

CHAP. V.

A Description of the members, or outward parts of the Worm, its Colour, and Nature.

BY a strict examination of the Worm, I find it distinguished into Fourteen annular incisures or divisions, whereof the First containeth the Head, the Three following the Breast, and the last Ten the Belly, with its appendant Tails.

(a) Tab. 2.
Fig. 1.

A

BB

C

D

In the (a) Head are observable the (A) Eyes covered with an entire smooth Film, having on each side its brushy hairs. When the Worm sheddeth its Skin, this Film sheddeth also gradually from the Eyes, which eyes when the worm is fledged appear like a net. Somewhat lower under the eyes appear the two tender and sharp-ending (BB) horns, which are as it were distinguished into several Joints. Next appear the (C) Toothlike spheres or cheeks which constitute the Beak, at whose beginning underneath appear several other hairy and filmy parts, which have some similitude with those found in *Lobsters* and *Prawns*.

At the first ring in the Breast are joyned the (D) Two foremost legs, in which is observable their shape and their Joints. Their shape is somewhat like those creatures which wroot in the Earth, and therefore these feet have their strongest motion outwards, whereby like *Moles* they may the better dig away the earth.

Every Leg hath four joynts and one Nail; the first joynt is joynted to the Breast; the second joynted to the first, is somewhat bent, as is also the third; but with all of a more horn-like substance than the other, and having small points sticking out like teeth of a sad Red colour, and with many hairs on the sides. The fourth joint is very small and armed with a Nail, in which are very neatly placed the small muscles with their insertions, which very curiously move the joints of the horn-like bony legs.

At the Second ring of the Breast, being the third of the body, which seemeth most properly to represent the Back, and which is covered above, and under with a horn-like bone, appear fastned the (D) second pair of Legs, containing each five joints, and one nail, here and there beset with hairs. Somewhat more backward appear on each side the (E) knobs, or wing-cases, in which are inclosed the first pair of wings: These are here and there interwoven with Air-vessels which appear on the outside like common Veins, or Nerves. When the Worm is ready for shedding its Skin, these inclosed wings neatly and curiously folded appear through these inclosing films or cases.

At the Third Ring of the Breast being the Fourth of the Body, appear the Second pair of wings which are much smaller, and wholly covered with the first pair, which also in a manner cover the last pair of Legs, containing also each five joints and one nail, and beset with several hairs for adornment.

The First Ring of the Belly, or the Fifth of the whole body, appeareth smooth and even, without conjunction of Legs, Wings, or ought else: To the Six following Rings on either side of the Belly are neatly adjoynted (FF) the always trembling and moving Gills, with which according to *Clutius* the Worm swimmeth; but mistakingly, for these parts are truly the Gills of this Worm: in *Crabs*, *Lobsters*, and the *Zeehatten*, which

which in many things agree with the form of these Worms, are found the same parts, and placed almost in the same manner, however with this difference, that in the *Lobsters* and *Crabs* they are inclosed in the hard Scale that covereth its back, and that in them they are placed higher in the body than in our Worm, as it also is in the *Zeckatten*. In the Figures of *Kracht* are Twelve of these Gills, represented on each side, but by mistake, for there are in all but Twelve, viz. Six on each side.

The Eighth and Ninth Rings of the Belly, or the Twelfth and Thirteenth of the Body, are wholly smooth and even, but the Tenth Ring of the Belly, and Fourteenth of the Body is adorned with (G) three hairy and bushy Tails, besides two crooked appendices which in the Females are not so visible, and in the Males have some other appendices.

As to the Colour of the Worm, the smallest are of a pale Blue, somewhat inclining to Grey, which rather proceedeth from the transparent Intestines, than from the true Colour of the Worms outside; also the eyes in all these Worms are a Brown black, and the Black is speckt with pale Brown specks, the which according to the age of the Worm grow blacker. The Beak of these Worms is pale, with sad red teeth, as are also the Two tooth-like Sheres or Cheeks, which are as it were a part of the mouth: the hornlike bony parts of the Legs and the Nails of the feet, are likewise a sad Red.

The Wings which as it were bud forth change gradually from a Pale into a Yellowish Colour, which in time further changeth into a Brown blue, till at length it becomes of a Brownish black. The whole Worm in time attaineth a pale Yellow, and the Blackish spots on its back, which constitute the upper parts of the Belly, are gradually changed into a deeper Colour.

(a) Tab. 2.
Fig. 1. Next in this Worm is to be considered the Sex. The (a) Male hath its Eye in largeness double to that of

of the (b) Female. The body of the Male is commonly much less than that of the Female, which according to my observation is the same in all Insects, and is so contrived by Nature, or rather by the Omniscient God of Nature, that for the great number of Eggs the Female beareth, it might have a sufficient containing place. The Tails of the Male are the longest; besides they have three or four other appendices which in the Female are hardly visible, and of which some appear on the sides, and some under. The Male represented in the first Figure of the second Plate is the biggest I have ever seen, notwithstanding of Females many larger are found. (b) Tab. 1.
Fig. 3.

Concerning the Nature of this Creature, I pretend to little experience thereof, only I can assure you that among all the diverse sorts of Insects I have been acquainted with, I never met with one better natured and more harmless than this; for how often or how much soever it is touched or handled, it seemeth always to be well pleased; and left at rest, it immediately betaketh to its work of making its Cell. Only I have observed in the smallest sort, that when they are handled somewhat too hard, they bend their head toward their breast, and thereby make themselves as it were stiffer: Among all its actions, none is more strange than the motion of its Gills, of which it hath on each side of its body (c) Six, which are moved so orderly and continually trembling, that it is admirable. (c) Tab. 2;
Fig. 1.
FF.

C H A P. VI.

The Anatomy of the inward parts of this Insect.

HA V I N G describ'd the Egg, the Worm, its Nourishment, & duration of Life, its outward parts and its nature; I could now fitly proceed to its Change; but for that this Change is so extreme sudden as consisting alone in the shedding of two Films, and some members, I judg'd it better for the more clear understanding of the difference between the Insect swimming, and the same Flying. (that is, between the Worm and the Ephemeron) first to consider the inward parts, the rather also for that we discern the same parts in both forms of this Insect.

And now that I have undertaken to describe the inward parts of the Worm, and that to effect it, I enter in a path untrod before, yet will I not with *Clutius*, bewail the want of Books Treating hereof: for besides that Nature it self best discovereth its wonders, and the Books are so far only to be received, as they agree with the truth of the natural appearances of things; I therefore pity those who depending on the experiences of others receive also therewith their endless untruths, and therewith deceive their Readers. Secondly it is impossible, in the variety of Experiences, by our Conceptions and Reason alone to keep the right path of truth, and with a clear Judgment to pass a true sentence on the observations of others; the more for that we find the most certain Experiences not agreeing with our judgment, or rather prejudice, to be obstinately rejected: wherefore I appeal to the Experiences themselves, notwithstanding I might complain, that for want of a sufficient number of Worms, I could not Anatomize their parts to a full exactness, nor to
my

my own satisfaction. But afterwards I have learned that the Works of God are unsearchable and incomprehensible as is his Being. Wherefore we need not further search into these his Works, than with admiration of our ignorance in the same, to Praise and Love their Maker.

That I may as much as is possible clearly represent my Observations, I shall withal describe the manner I have used in the Year 1670. to attain the true Dissection of the parts of the Worm, for I will at no hand either deceive my self or others. But before I proceed to the description of the Intestines, I shall to assist the memory, in short, enumerate all the outward parts observable in the Worm, and then, which are the inward parts in the Male, and which in the Female.

The outward parts of the Worm are the Head, the Scull, the Horns, the Eyes, the Teeth, the Beak, the Tongue with its hairy Films, which appear in the Worm in the same manner as in the *Lobster*; the Breast, the Legs, the Nails, the Wings, the Belly with its appurtenances, the uppermost twelve Gills, and the under ten Finns, the Tails with their appendices, and lastly the openings of the Air-vessels under the breast.

The Inward parts in the Male besides the Bloud and the Films, are the Muscles, the Fat, the Stomach, the Guts, the Lung-vessels, the Heart, the *Medulla spinalis*, and the Seed-vessels.

In the Female having the same parts, is alone this difference, that in stead of the Seed-bladders or Milt, is found the Egg-cluster, which is inclosed with thin Films, throughout woven with very many air-vessels.

But whereas for want of a sufficient number of Worms, I have not exactly enough examined the inward parts of the Head and Eyes, I shall therefore speak little of them, as also of the parts of the Breast which for the most part is filled with the Muscles of the Legs and Wings.

When

When a Male Worm (easily distinguished by the largeness of its eyes) is placed on a small Deal board, covered either with black paper or linnen which spot-teth not, with its belly upwards, and there fixed with a very fine Needle, you will find immediately issue out of the wound in the Skin, a thin watery moisture which is the true blood of this Worm, however it appeareth not of a Red colour as in Earth-worms, in which, as in Four-footed Animals it is Red. To open the Skin, there is nothing more fit, than a very sharp and fine small Scissers, for that the Lancets, although never so sharp, are not in this work useful, for they alwayes tear up some of the parts and strain them asunder; especially when they are of unequal hardneses.

When with a sharp fine Lancet, or the point of a sharp grounded Needle, you leisurely and with patience separate the upper Skin from the under parts, then appeareth immediately the under Skin very thin and filmy, which, raised with discretion, the Muscles of the Belly appear, and not only those Muscles which extend in a straight line from one Ring of the Body to the other, but also those which are placed oblique, and transverse, and others also which serve to the motion of the Gills, the second Film appeareth also like threads, and seemeth to be fast joyned with the forementioned Muscles.

Next the Muscles, appeareth and is fast joyned to them a very fine and thin Film, which I judge to be the *Peritoneum*, above and under the same appeareth the Fat, which is composed of small and very thin White bladders, which contain in them the true Fat, in the form of a liquid Oil; when these bladders are viewed without a Microscope, it would easily be judged they were the Fat it self, whereas they are but as the thin and extreme tender Vesicles thereof, which contain that liquid Fat. Like as it is also in man, and all other beasts, as will appear when these Fat-containing Vesicles, which are of a like proportionate magnitude

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shall

they are named by Anatomists *Annular* or *Conniventes*. Somewhat lower where it formeth the (E) thick Gut appear somewhat long strokes, which are very neat and lively, like so many long and extended Musculous threads in the hollow thereof, which agrees somewhat with the **Boeck**, which in four-footed Creatures is a part of the Paunch; next followeth the (F) straight Gut which appeareth very neatly pleated, till it extendeth as it were out of the body with an indifferent opening at that end by which the Excrements are sent forth.

c
4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14. The (C) Stomach is placed between the 4th and 5th Ring of the body, where with the thin Gut it takes up all the remaining part of the Belly, as the 6, 7, 8, 9, 10, and 11th Rings, whereas the three last of the body as the 12, 13, and 14th contain the thick and straight Gut. Like as the Stomach is furnished with a great number of Air-vessels, so also are the Guts, and especially the straight Gut, and that chiefly in that part, where it is furnished with (a) two Muscles for pressing out its Excrements.

(a) Tab. 4.
Fig. 1. ii.

And because the Worm is fed with Clay, the Stomach and Guts commonly appear filled therewith. This Clay doth almost always appear through the Stomach, the Guts, and also through the whole body, but it is most visible through the back; by which transparency of the Worms body, it hapneth that the Worm at different times appeareth of different colour, according to the colour of the Clay it feedeth on, viz. Paler, Greener or Wanner; or more or less digested or changed in the Guts.

When the time approacheth that the Worm is to Change into a Flie, then appeareth no Clay at all in the Guts, the same also hapneth in Wood-worms, the Worms of Bees, Silk-worms, and several other Insects, which at the time of their Change become as clear and transparent as Crystal, and some other Insects are thus transparent during their whole life, so that their Veins

and Intestines with the motions of the same within their body can be clearly discerned.

Among the inward parts of the *Ephemeron*, are very considerable the (a) Lung-pipe, the Air-pipe, or Wind-pipe, as the same part is named in Birds, Beasts and Man; this Air-pipe or vessel is not constituted of one single trunk, as in the forementioned Beasts and Man, but of two chief Trunks, which are placed on each side of the body, curving Snake-like, and that not only in the Breast, as in our bodies, but also in the Head, the Belly, the Legs, and the Wings; so that the Stomach and the Guts, together with the Muscles and Sinews, are as it were fed with Air, which truly is very wonderful, for that the Reason for which it is so formed, is to us wholly incomprehensible; and teacheth us that God in the incomprehensibleness of his works is to be adored.

(a) Tab. 3.
Fig. 1.
AA

The Fabrick of the Lung-vessels in this Insect, as in all other Insects I am acquainted with, is constituted of innumerable stiff and curled-like parts, which in the form of knotted Rings are joyned together, and so close united by means of very thin films drawn over them, that they very fitly contain the Air in them, and send it to all the parts of the body backwards and forwards.

When the Worm sheddeth its Skin, I believe, the Lung-vessels also shed a Skin, notwithstanding I have not yet seen it, for at that time when I hapned to make these observations, I knew not of it. In the Silk-worms is this shedding of the Skin of the Lung-vessels so considerable, that all humane understanding must stand amazed thereat: for in that very small time when the Silk-worm sheddeth its Skin, several hundreds of Air-vessels in its body also shed their Skins, being very thin films, all made up of those Rings before-mentioned, which would seem incredible in the Relation if I my self had not seen it distinctly, and had shewn it also to others.

The

The Colour of these Lung-vessels is a Pearl colour somewhat Grey, which as they come to change their Skin, changeth into a clear and shining White, for which cause they are much Whiter in the Flies than in the Worms; they spread throughout the whole body, to Communicate Air to all the parts outwards and inwards, so that those two great and remarkable (a) Air-vessels, which appear placed on each side of the Worm, send to all parts of the body their Branches, as in the Head (BB) to the Nerves and Brains; in the Breast (CC) to the Muscles of the Legs and Wings; in the Belly (DD) to the oblique and straight thread-like Muscles. As also to the (EEE) *Medulla Spinalis*, to (FFF) the Milt or Seed-vessels of the Male, to (GG) the hairy Gills, to (b) the Stomach and (c) Guts, to (III) the outward Skin, to (KK) the Film of the wings, to (d) the Egg-cluster in the Female, to the Film (MM) that covereth the Egg-cluster, to the (e) Eggs, as they are taken out of the body, and to the (f) heart.

(a) Tab. 3.
Fig. 1. AA
BB
CC
DD
(b) Tab. 4.
Fig. v. C.
(c) Tab. 3.
Fig. 1. H.
(d) Tab. 4.
Fig. 1. LL.
(e) Fig. 7.
N.
(f) Fig. 4.
II.

I have had much trouble to discover the outward openings of the Lung-vessels, for they open neither in the Mouth or Throat as in other Creatures, and for that Reason they lessen gradually as they nearer approach the Head, whereas otherwise they ought there to widen, after a long search they seem to me to have their openings, under and in the sides of the Breast, almost in the same manner as I have afterwards observed it in *Grasshoppers*, where these openings are easier to be seen; but here in our Worm, by reason of its living in the Water and Clay, are less, and therefore more troublesome to discover. In the Silk-worms these openings of the Air-vessels are more visible, for they have Ten on each side of their body, viz. Eighteen large ones, and Two lesser, which last not having any Brown spots are not so visible, and never appear clearer to sight than when the Worm sheddeth its Skin, when out of all these Twenty openings of these Air-vessels the shed Films thereof may be seen to issue out,

From

From these Observations, appeareth very clearly the reason why our Worms rise higher into other Cells when the water of the River increaseth, for that sometimes they must draw fresh Air, and breath, for which cause it may also be said, that they follow the falling water, lest they should be too much dried up by the surrounding Air, and that their vessels through the dripping out water might be in danger of closing.

These Lung-vessels are best discovered when the Worms have been dead for some days, and that their inwards are become blackish, for then they appear very clear to the sight, which happens for that they are of a Pearl colour, and like new boil'd Silver, and also for that through their stiff and hard matter of which they are made, they are not so subject to rot, for which reason also at that time they better keep their Figure and roundness.

When with a Microscope you view these Worms on their Breast and Belly, the whole belly seemeth as interwoven with Silver-white vessels: But now to know truly whether they contain Air in them, lay them only in a drop of water, and then close or press them with the point of a Needle whereby the inclosed Air will presently appear; when these Creatures are Dissected under the water, and that with fine Scissors you clip off some of their Lung-vessels, they rise immediately to the Surface of the water, which also do all the parts of the vessels broken off, with their ends upwards; in a dried Worm Dissected, these Vessels are very easily discovered, because by their curled-like Rings they remain constantly open, how much soever the other parts dry up.

One of the most remarkable things observable in these Lung-vessels is the great number of them extending to the (a) Gills where are (PPPP) three chief of them represented as cut off; the midd'emost is always (QQ) black, which notwithstanding just in the middle appeareth transparent White, the other two appear

(a) Tab. 3.
Fig. 1.
PPPP
QQ

appear on each side of the middlemost which is Black, and they shoot out a great number of Silver white Vessels (GG) in the Gills, which vessels are not very visible by their Colour, by reason of the very bright appearance of the Gills, which are in number Six (b) on each side of the body, and are pure shining White, under the same, on each side are the Five (c) Finns of a Yellow Colour with which the Worm swimmeth.

(b) Tab. 2.

Fig. 1.

FF

(c) Tab. 3.

Fig. 1.

RRRR

SS

(d) Tab. 4.

Fig. 4.

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TT

VV

I had made some other Observations concerning the Gills and their Vessels, which are missing, and which I cannot now find, and the Contents of them is wholly out of my Memory; so that I remember not what is the use of (SS) that Feather-like hairy part which is seen under the first and uncut pair of Gills, as also whether it is found under the other Gills, what Communication those Gills have with the Lung-vessels, and the (d) Lung-vessels with (TT) the heart, I know not, so that I can relate no more thereof than what is represented in this Delineation, where all the Air-vessels about the heart are not represented, to prevent confusion, only some are represented whole, and the others (VV) as cut of.

I have also in all my delineations, not observed an exact proportion as to the size of the parts, for that seemed to me a too tedious labour and of small use; so that I have delineated one part somewhat larger than the other, never thinking to have made these my Observations publick, till I had anew more examined them all over, which I also afterwards found more necessary, as well for the greater knowledge I afterwards attained concerning the parts of Insects, and also a greater readiness in the Anatomizing of them, but the kind Reader is desired to pardon what is wanting, which I am conscious is very much; and who is able in many years to describe this Insect, and the wonders therein observable, which is the reason that I Communicate it thus to the world; the more for that I now am resolved to addict my thoughts more to love the Crea-

tor

tor of these things, than to admire him in his Creatures.

The (a) heart appeareth placed above in the back as it is in Silk-worms, the Worms of Bees, Wood-worms, Caterpillars, and other like Insects, here and there it appeareth somewhat (XXXX) swelling out, like as in Silk-worms, and noted by *Malpighius*, and from whence he concludeth, but not rightly, as I conceive, that in the same Worm should be more than one heart; I have seen this heart move in the *Ephemeron*, but very disorderly, and what I have here represented in the Figure is but a part of it, and I have wholly forgotten in what part or division of the body it is placed.

The (b) *Medulla Spinalis* in this Insect, is like that in all the other sorts that I have yet dissected, very wonderful and observable; it contains Eleven Swellings Oblong and Oval, the First of which representeth the Brains where the ** Optick Nerves very visibly appear shooting forth in the same manner like as the other Nerves of the Body shoot out from the other Ten Swellings, but in greater number from the upper Swellings than from the under. Here and there the *Medulla Spinalis* appeareth very neatly fastned as it were with (ZZ) bands, which are made partly of an horny bone, and partly of a Sinewy substance, as is chiefly appearing in the Breast, where the *Medulla Spinalis* shooteth forth very strong Nerves to the (aa) Muscles which move the Leggs and the (bb) Wings in like manner as it doth to the (cc) Muscles of the Gills and the Finns.

Out of every Swelling or Node of the (d) *Medulla Spinalis* shoot always two very strong Nerves which joyn in the next Swelling, and enlarges the same whereby the *Medulla Spinalis* appeareth throughout as if Split and Gaping; but as it is naturally placed in the body that gaping appeareth not, for whereas there the arising Nerves lie close one to the other, they seem not gaping, as *Tab. 4. Fig. 6.* may be seen where the *Medulla Spinalis* is represented, as it appeareth naturally

(a) Tab. 4.
Fig. 4.
TT

XXXX

(b) Tab. 3.
Fig. 1.
TTT

**

ZZ

aa
bb

(cc) Tab. 4.
Fig. 1. CC
(d) Tab. 3.
Fig. 1.
EE

in the body, as also the Fourteen divisions corresponding to those of the body in which it is placed.

When you would see the *Medulla Spinalis* without hurting the Worm, you must blow the same up with Wind from behind, whereby the Swelling Guts will press so strongly against the transparent Skin that you may very conveniently see the Natural position, or shape thereof, and that as well without as with a Microscope, but this is chiefly practicable in the Male.

As all the other parts of the body have their Air-vessels, so hath also the *Medulla Spinalis*, and that in a great number, so that even the Brain and the Nerves, receive a continual refreshment of Air. Whether it hath Veins and Arteries I have not seen, yet I firmly believe it; but in the Silk-worms I have seen it very plainly, viz. several Vessels and Veins issuing out of the heart, which I filled with a Coloured Liquor, notwithstanding I cannot hitherto certainly affirm whether they are Veins or Arteries.

(a) Tab 3:
Fig. 1.
FFFFF

Concerning the (a) Seed-vessels, or Genital parts, they are as visible in the Male-worm the day before he sheddeth his Skin, as in the Male of the *Ephemeron*, which hath shed his Skin; on both sides of the Stomach and the Guts appear these Seed-vessels, which wholly agree with the Milt of Fishes, notwithstanding like the Seed-bladders in men, they are somewhat crumpled and Pipe-like in shape.

FFFFF

In which they also agree with the Seed-bladders of some Four-footed Animals, as with the Moles, Hedgehogs, and the like. The shape of these Seed-vessels are (FFFFF) oblong, taking up the whole belly as may be seen in the Figure thereof, where some of them is represented without the body and somewhat greater than that in the body, those Vessels contain a very white Milky liquid substance which is the Seed, the Vessels themselves also are very white and constituted of a thin Film, having here and there many Air-vessels interwoven in the same.

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In the nethermost Rings of the Belly appear two other (a) parts also, as it seemeth pertaining to the Seed-vessels, which seem to have the same opening with the Seed-vessels, and with the (e) Guts, which I could not so exactly observe when I made the Dissection, for that a great number of these Insects are requisite to be opened, to repeat the same search, and to find that in the following which could not be found, or was omitted in the former, but this number of these Insects is not always attainable.

The (b) Egg-cluster in the Female is double, and placed in the Insects in the same manner as the Roe in Fishes. When with a fine sharp-pointed Scissors the Skin of the Belly is a little clipt off, the (c) Egg-clusters appear immediately, which are placed on each side of the Flank of the Belly. In the middle between the same appear the (ff) Stomach, and the Guts shining through, but somewhat darkly, which are indifferently fast joyned to (MMM) the Films of the Egg-clusters; the Stomach and Guts appear the clearer by how much they are more filled with Clay, their nourishment; whereby also the Eggs are more visible, which by that difference in colour appear the Whiter.

This double Egg-cluster is supplied with an innumerable number of Air-vessels, which are as it were knit together with a thin Film, enclosing the Egg-cluster, and by which those Air-vessels are conducted to the enclosed Eggs. When the Film is separated by the point of a sharp and a well cutting Needle, and that a part thereof with the Eggs is laid in a Spoon with water, the Eggs immediately separate one from another, and there remaineth a tender bunch (d) of very thin Veins as their Fibres, Pearl coloured, which Fibres I conceive for the most part to be constituted of Air-vessels.

The (a) Magnitude of the Egg is so small, as to be hardly visible, and therefore ought to be viewed by a Microscope, being laid on Black or Blue paper which much

much assisteth to the clear perception of them.

The Form of the Egg is a flattish round and oblong, and inclosed in a reasonable strong Skin, which viewed through a Microscope appears cloudy; its Colour is White, like the inward Film of an Egg-shell: The smallness of the Egg seemeth to be the reason why the Worms are Three years growing before they come to their full growth and ready for change.

CHAP. VII.

Signs of the Worms being ready for Change; what is hurtful to it; and to which order of Natural Change it pertaineth.

THE common preceeding signs of the Worms Change at the exact season of the year, are a Warm and dry Spring, a Mild Winter, little Rain and Snow, and a soft gliding water. The particular signs that the Worm will soon fly, are the swelling of the Wing-cases on the back, which at that time attain a thicker and rounder form than formerly; whereby the watery Gluiness which otherwise is found in the Wing-cases is now become tougher and thicker, so that it now beginneth to attain the shape of the Wing, and appear through (*b*) the transparent Wing-cases.

(*b*) Tab. 3.
Fig. 2.

AA

These signs are yet more apparent when the Colour of these inclosed Wings change from a Pale Yellowish

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into

into a Grey colour; and yet more certain, when the Wing-cases can be separated from the Wings, without hurting them; as in *Tab. 3.* (*bbb*) is represented, where the Wing is represented at large with its natural but rare pleatings.

A further sign thereof is, when Dissecting the Worm the Eggs are found to be full grown, hard, and Oval, and also when the outward case may be clearly separated from the Worm and thereby cause it to attain the form of the flying *Ilust* or *Ephemeron*.

At this time all their Intestines are cleared of all feces; the Stomach and Guts containing nothing but transparent and purified liquor, which the further from Change they are, the more Clouded and Coloured they are found; their Colour being sometimes Yellowish, and sometimes dark and Rusty; at other times there is found backward in the thick and straight Gut a little Clay, whereas being now ready for Change, they are very clear and transparent.

That which retardeth the Change of the Worm, killeth it, and hindreth its Change, is a hard and long Winter, much Snow and Rain, whereby their Cells are closed, broke, or covered with Sand, whereby they come forth both fewer in number, and later in the one year than the other. They are also hindered by too much drought, which forceth them to leave their Cells, and bore new ones, from all which may be discerned what hindereth or furthereth the Worm's growth.

Many water and other Insects are found to be infested with Lice; which extendeth so far, that even no Creature living either on Land or Water, that hath not its peculiar Louse, which feedeth on its blood and moisture, even from the great Whale to the small Ant.

From what hath been now related of the Signs of the full growth of the Worms Wings, it clearly appeareth to which of the Four Orders of Natural Change, or slow growing on of the Limbs it pertaineth; *viz.* to the Second Order, for all the Insects there-
unto

unto belonging, change in the same manner like our Worm: Which Second order of Change is, *That the Worm of the Ephemeron having quitted its Egg or Shell, comes forth a Six-footed Worm, and by nourishment received; increaseth in all its Limbs to a full growth; so that now on its back appear the Wings budded out; until it be grown to a Nympha, which loseth not its motion, and afterwards attaineth the shape of a Flying Creature, by the shedding of its upper Skin or Coat, whereby it now becometh fit for Generation.* As of this and other like Changes I have treated more at large in my Treatise of Insects, where I have enumerated a great number belonging to this second Order.

Angerius Clutius supposeth that our Worm Changeth into a *Nympha* of the Third Order, and then like the *Nympha* of the Silk-worm it loseth all motion, which he also representeth in Figure, although in truth it is otherwise; from whence may appear how easily they may be mistaken, who declining the Truth of Experience, only depend on their own Reasonings or the Affirmations of others.

C H A P. VIII.

In how wonderful a manner the Worm Changeth into the Haft or Ephemeron.

(a) Tab. 5.
Fig. 2. AA

THE time of the Worms Change being come, and their Wings in their (a) Cases, having attained their full stiffness and Colour, and that the Worm is forced as it were naturally to a Change; all the Worms thus fitted and prepared, leave their Cells, betaking themselves to the water, and out of the water to flight, which commonly hapneth in the Evening between

between the hours of Six and Seven, as I have observed it in the year 1671. the 13th of June.

Those other Worms that have not attained that maturity and growth remain yet in their Cells, but those that have quitted their Cells and betaken themselves to the water, make all the speed possible to attain the Surface of the water, which the one attaineth sooner than the other, and then each Worm (a) immediately changeth into a (b) Winged Creature, which Change or shedding its Skin is so sudden, that by the strictest observation it would be judged that they flew through the water as they are.

(a) Tab. 5.
Fig. 2.
(b) Fig. 1.

All the Insects that I hitherto am acquainted with have a certain time by the God of Nature allowed them, to stretch out their Wings and to dry them before they betake themselves to flight: and notwithstanding the conceived King of Bees, like our Worm suddenly leaveth his Cell, yet not before he hath for some time in his Cell spread out his wings and dried them.

But on the contrary our *Haft* or *Ephemeron* is almost in the same Minute a Worm and a Fly, for where you cast your Eye on the Surface of the water, and perceive the water to bubble, you see them as it were flying out of the same.

When in a Boat you lye cross the stream, you may best perceive the bubbling of the water, and the rise of the Worm changed into a Flie, out of the water; but how swift soever the hand is in Catching the Worm yet swimming in the water, yet can it not bring it unfledg'd to sight; but if you bruise it a little about the Breast you may bring it unfledg'd out of the water, which practice is wholly necessary if you desire to view it unfledg'd and in its Skin.

But how this sudden expansion of the Wings can be effected is strange to consider, for that they have neither Muscles nor Joints in the midst, being only neatly foulded and pleated together in their cases, and which

which in a very short time must shed another Film, but how 'tis is difficult to answer; for my Conceptions were that these Wings ought to have been furnished in their middle part with Muscles and Joints as we find in other Insects, by which means they very neatly fold up their Wings in a small room, and by means thereof also expand them again; as is chiefly observable in the Ear-worm, or *Forfica*, which hide very large Wings under a small Shell or Case, as if they had none at all; and like as the Ear-worm by means of Muscles and Joints placed in the midst of its Wings, can fold them in a small compass in manner like the wings in our Worm, and suddenly expand them again: I conceive the same need of like Muscles and Joints in the wings of our Worm, but it hath otherwise pleased the great Creator who is various and wonderful in all his works, and not to be tyed to the same means in effecting the same thing in the one as in the other.

But yet to say something of my own observation in relation to the swift expansion of its Wings, I conceive that the water pressing on all sides, and being warmer on its Surface than in the body thereof, may much assist to this expansion, by reason that the blood at that time moving from the heart to the wings; to aid or effect that expansion, by the warmth may receive a more vigorous motion; as for instance, when one hath a Vein opened in his foot and holding the same in warm water, by the warmth of the water his blood becometh more briskly moved and runs swifter out. So also while all the blood and moisture of this Insect when it swimmeth and shedderh its Skin is briskly moved, the surrounding water may be very assistant to add to the motion of the inclosed moisture, and so cause a more vigorous expansion of the wings: Therefore if at that time their Wings are hurt or cut, they soon bleed to death, or at least the Wings flag and spread no more. And as assistant to the ready spreading out of the wings is also the Air which is conveyed into them by a
great

great number of Air-vessels, which may be useful to stiffen them, and cause the moisture to exhale out. If the Wing of the Worm when it is ready for flight be cut off and laid in a small vessel with water, it will immediately spread it self in the same till in a short time it be fully expanded, that it would be ready for flight if it were but dry and stiff. I have several times reiterated this Experiment, and thereby learned in what manner they do expand, for being laid, as before, in the water, (a) First the great folds do open, where-
 upon (b) the Wing by degrees becometh extended in its length, and then are expanded the (c) long folds of the Wing very wonderfully, till at last the (d) Wing spreads out in its full dimensions as is represented in the (e) Figure of the Insect according to the life, but the representation of the Wing in its folds, and the manner of unfolding was taken by the help of a Microscope. When the Wings are yet in their folds their Colour is a dark Grey, but as they expand they become lighter Coloured.

(1) Tab. 3.

Fig. 1.

bbb

(b) Tab. 6.

Fig. 2.

(c) Fig. 3.

(d) Fig. 4.

(e) Fig. 1.

The manner of the Expansion of the Wings in other Insects is quite different from this last mentioned as in those of the Dragon-flie, or the *Libella* or *Perla*, as also the *Tipula terrestris* or *Culex Maximus*, and the *Locusta* or Locust, which Insects have their Wings placed in their Cases in a very crumpled manner, being neither long-wise folded, nor again, Snake-like, as in our Worm, for which reason their Wings are expanded with more trouble, and require more time thereto.

In the *Schoen-lapper*, the *Witkens*, or the *Capellen* (which are some sorts of Butter-flies) is yet another manner in the fold of their Wings, for they are close rumpled together, so that no pleats, folds or rumples appear, and neither having in their middle part or sides any Joints or Muscles, as hath the Ear-worm, as before is mentioned: besides the Wings of the *Capellen* are beautified with an infinite number of small Scaly Feathers, which are so curiously placed one above

above the other, and do so wonderfully move the one from the other when the Wing is expanded, that it would deserve an intire Treatise: so wonderful is the wisdom of the great Creator seen in the shape of these Wings, and indeed what would not be wonderful of which he is the Author?

(a) Tab. 5. Fig. 1. The (a) *Ephemeron* having thus quitted the water endeavoureth with all possible speed to attain a resting

(b) Tab. 7. Fig. 1, 2. place on land, which having attained, it there (b) sheddeth a second Skin, a very thin Film from its whole body, viz. from its Head, Breast, Belly, Legs, Tails, and Wings. And this second Skin shedding on land differeth from the first in the water; for in the first Skin-shedding the Worm loseth wholly its former shape, which it doth not in this second shedding.

In the first Skin-shedding, the Skin of the Worm bursting open on its Head & Back, suddenly falleth from its body and it as suddenly betaketh to flight, but withal loseth considerable parts, (c) all the Gills on both sides with the Ten Finns under them, besides these Gills thus shed there remain no hairs, which disappear so intirely as to leave but very small Signs or points thereof, which on the side of the Belly make a kind of a small list. It looseth also (C) its Teeth or Sheres, the shape of its (DD) Legs, the (E) Wing-Cases, the (G) Tails, &c. So that by this First Skin-shedding, it cometh forth wholly like (d) another Creature.

(c) Tab. 2. Fig. 1. FF
C
DD E
G
(d) Tab. 5. Fig. 1.
Tab. 6. Fig. 2. But although this order or method is very difficult, if not impossible to be observed, in this so sudden Change of the Worm; yet may it with much ease be discerned, if of a Worm thus ready for Change the Skin be slowly and with Art and Care taken of; for then the shedded Gills may be clearly seen remaining in the shed Skin; also there may be seen the remaining points thereof sticking out in the Flie; there may also be seen in the Skin the pits in which they stuck; in the same is also visible the shed Skins of the Air-vessels of the Muscles, the Arteries, Veins, Nerves which separate

parate one from the other, like ripe fruit that falleth from the Tree.

Further, whereas the Flie in this First Skin-shedding hath all its Joints and parts more extended in length, yet the horns barely shed their Skin without any further extrusion, and become much tenderer and shorter in the Fly than they were in the Worm. But more considerable is the Change about the Eyes, for the horny Film of the Eyes which in the Worm appeared even and smooth, after the Skin is shed in the Fly appeareth like a Net, being an aggregate of many Eyes. The Legs and two Tails after the Skin is shed, become double the length, and the third or middle Tail is also shed with the Skin.

When I say that the two Eyes in this Insect are made of an Aggregate of many small Eyes, which in some of these Insects, I have found to be 6 or 7000. and in some Insects spread up and down their body, as in *Spiders*, and the *Scorpion* Flie, it must not therefore be conceived that they are in Form or make like the Eyes of other known Creatures, or men, for in these is found no Humour, but from every Globular partition of the same issueth a Sexangular Filament which terminates on the Net-like Film of these Eyes, and that in the Nerve and Brain, so that the manner of seeing in these Insects is wholly different from what it is in us, in whom it is effected by a Collection of Raies in the Eye, but in them by means of a Collection of Nervous Filaments, which when they see are only touched at the ends of their Convexities by the Visible qualities and Raies of Light and Colour, as I have mentioned at large in my Treatise of *Bees*.

Concerning the second Skin-shedding of the *Ephemeron* which soon succeedeth the first, it is observable that the *Ephemeron* in seeking a resting place for to shed its second Skin is wholly incurious, resting on whatsoever is in its way, whether Wood, Stone, Earth, Beast or Man, and it is thus effected.

It

(a) Tab. 7.
Fig. 1, 2.

It fixeth its Feet armed with sharp Nails on what it first lighteth on, then being seized as with a cold shivering, the Skin splitteth open in the midst of the back in the horny integument of the same, which split increases forwards so far that the Flie can put forth its head, then it (a) draweth forth its Legs out of the Skin, while the Nails of the feet remain fast to that whereon the Flie had taken hold, which Nails remain with the shed Skin, and thereby further and facilitate the stripping thereof, First the Head and Legs are drawn out of the Skin, as you would pull your foot out of your Shooe, or Head out of a close sticking Cap, and then the Skin is drawn off the remaining parts of the body, by turning the inside of the same outwards, as we usually flea Eeles, or pull off a Glove the inside outwards, and when the Skin is half way over the Wings they are like (b) captivated and bound, and so remain a small time without any perceptible motion: the remaining part of the body in this second Skin-shedding is considerably extended, and the Tails become a third part longer than in the first shedding, so that the Tails and Legs at the first shedding which became a Third part longer than before; are become in this second shedding; longer than they were in their first shedding, which yet is more considerable in the Tails, than in the Legs, for because it is composed of many hollow Rings which by extrusion shove one from the other, and thereby this stretching out is more visible in them than in the Legs which only lay bent in the Skin, and by the shedding thereof become extended in their full length. Further the hairs which in the Worm did thick beset the Tail, do stand now in the Tail of the Flie more thin set, and are become finer and thinner, for that they have now also twice shed their Skins.

(b) Tab. 7.
Fig. 1.

The *Ephemeron* having now a Second time shed its Skin flyeth again to the water, on whose Surface it flyeth sportingly, sometimes higher sometimes lower,

Sometimes swifter sometimes slower, and between whiles resting on its Tails beateth its Wings together, in the mean while its Tails supporting it which are hollow and beset with hairs, and being fill'd with Air, drive and Swim the better on the water without sinking, the which also happens to other Insects which by means of hairs in and between which the Air being inclosed they easily Swim on the Surface of the water as appeareth in the Worms of the *Gnat* and *Gadfly*, yet remain not these Tails always thus filled with Air, but become empty thereof if a pin be run through them to dry them, for by that means the Air issuing out, they fall in lank and crumpled: there is yet another reason that our Flie thus lightly driveth on the water, which is, that in its body it hath a fine bladder filled with Air, except it be said to be the Stomach, now only filled with Air, which I cannot strictly say, having not fully satisfied my self therein.

To proceed, this is here observable, that the (a) Male twice sheddeth its Skin, and the (b) Female but once which I cannot confidently affirm, yet have not hitherto observed ought to the contrary, for this cause the Tails of the Female are $\frac{1}{2}$ shorter than the Males. Another and more considerable difference is, that the Eyes in the Male are double in largeness to those of the Female; the third difference is, that the Gold colour of the body draweth somewhat more to Red in the Male, than in the Female. Add hereto, that to the great Tails of the Male are four Appendices, which appear like crooked Tags, which in the Female are not so visible.

The *Ephemeron* Copulateth neither in the body of the Water, nor on Land, nor in the Air; only the Female shooteth her Eggs on the Surface of the Water, on which the Male shooteth or casteth its Milt or Seed; to which end possibly it is provided with larger Eyes, that it might the better discern the Eggs of the Female in the water. As in like manner many sorts of

(a) Tab. 5.

Fig. 1.

(b) Tab. 6.

Fig. 1.

of Fish, without any Copulation, cast their Seed in the water, which they eject not all at once in one body, but sparsedly as loose and separated Seeds. That the *Ephemeræ* Copulateth not in the water appeareth hence, for that they come not out of their Cells till such time as they are ready for Change, except they come out to take Air, and it were impossible for them to Copulate in the body of the water, for that they cannot keep themselves up in the water without constant motion; for at any time ceasing their motion they immediately sink to the ground, where they have no firm abode, till they have bored themselves new Cells. Add hereto as the strongest reason, that no Insect ever Generateth till having shed its last Skin, at least not by any observation of mine.

Neither do they Copulate in the Air, as may easily be perceived at the time when they flie; as also that it were impossible for them to Copulate in the Air, in consideration that after the last Skin-shedding the Legs of the Male are extended to that length that *Clutius* judged them to be horns. Consider also what requisites are necessary for to Copulate flying in the Air, as is observable in Flies, and chiefly in the *Dragon-flie*, which perform the Act of Copulation very wonderfully flying in the Air.

I conclude therefore my Observation, that the *Ephemeræ* never Copulateth either in the water or in the Air, but only that the Female having shed its Eggs in the water, the Male sheddeth thereon its Milt or Seed as before is said. All which in that short time of their life in this state is effected in that haste and swiftness that it is impossible to make a narrower search therein.

During the whole life of this Flie it eateth nothing, as is common to many other kinds of like Insects, and in some others, this not eating continueth for some weeks, yea months; as in Frogs, Lizards, Snakes and Camelions, as I have observed.

What

What I have thus observed concerning the Generation of the *Ephemeron*, is very considerable, but yet that is more considerable in the *Snail*, whereof each is both Male and Female together ; which I doubt whether it is so in any other Animal. And although there are many Relations of those they name *Hermaprodites*, yet doubt I whether ever any such hath been seen. I opened once a Child reputed for such, but well examined, it was found a real Female ; notwithstanding that above the Female parts it had a rising, out of which it evacuated its Urine, which hapned for that it had no Urine-bladder, and the passage of the Kidneys for evacuation was in that place, which caused the easie-believing and not considering people to believe this Child was of both Sexes. Among the Bees are Males and Females, and a sort that are neither ; that we name among them the *King*, is a Female ; the Breeder which is a Male, and the common Bee which is neither. The same is also among Ants. Again those Animals which grow fast to the Rocks, or live in hard Shells, and so remove not from their place, must needs have another manner of Generating ; all which compared with the Generation of Vegetables having both Sexes in the same body, and the power to Generate without Copulation, we may observe that the Omnipotent God can produce the same thing by several means and ways.

C H A P. IX.

How long the Ephemeron liveth, and what it is which hasteneth its death.

THE *Ephemeron* as before is said, flying up and down on the Surface of the water, liveth in that state but between 4 and 5 hours; that is from 6 a Clock, or half an hour after in the Evening, till Eleven of the Clock in the night following; which I have observed by inclosing one in a Box in my Chamber, and with some care observed the time of its life; in that very short time they all die, and that which is observable, none of them all die a natural death on Land; for as soon as they have shed their second Skin, immediately they flye to the water.

Besides that the life of the *Ephemeron* in the state of a Flie is so short, an infinite number die ere they come out of the water, being devoured by the Fish; and of the other who escape that danger by flight out of the water, many are devoured by the *Sea-Meaves*, *Swallows*, and other like Birds, while they are shedding their Skins and flying; and having escaped these two dangers, if in their flying they come too nigh the water, or play therein on their Tails, they are caught by the Fish; and flying too high in the Air they are caught by the Birds.

When the *Ephemeron* is fledg'd, then are the *Roach* which feed thereon very fat, and of a sweet and pleasant taste, as Dr. *Nic. Tulp* Burgomaster of *Amsterdam* hath assured me.

If the reason be asked (the forementioned dangers excepted) of the short life of this Flie, it is to be considered that the Eggs in the Worm, while yet in the water are perfect, so that as soon as the Flie by shedding
its

its Skin, and extending its members is as it were New-born, the Eggs are ready for ejection. Add hereto that these Eggs when first hatched have no need of the Parents care as in other Animals: and because the only reason of their Change into a Flie seemeth to be for Generation, which effected, the Flie dyeth; and to this end it is for three years growing in the water and Clay, in the form of a Worm, as also to this end it Changeth its Form into a Flie, till having cast its Seed, it endeth its life.

Other Insects, as the Flie of the *Silk-worm*, which are longer-liv'd, appear with their Eggs yet very imperfect and weak, and bear them so long, till they are hard and fit for ejection, and then they also end their life.

Some other Insects, although in time they lay their Eggs perfect, as the *Ants* and *Bees*, whereof the Female-Bee, vulgarly named the *King*, layeth in one year about 6 thousand Eggs, and yet they dye not then, for they must feed their young, and daily with much care and labour provide them food; which labour and Care not being the duty of their Males, they soon die after they have Generated, or else are miserably kill'd by their Consorts.

So that if we should rank all Animals, the Rational or Man not excepted, under one of these Three forenamed Orders of Living; we should reduce Man under the Third sort; for 12 or 13 years pass, before Man is fit for Generation; and also more number of years are required for the Second, Third, 5th, 10th and last Birth: the rest of the years are required to the necessary Education and Instruction of the Children. So that all well considered, we may say, that for Generation is the Beginning, Middle, and end of Man's life.

C H A P. X.

The Ephemeron does flye Three days, and sometimes on the Fourth day. Other sorts of Ephemerons.

THE *Ephemerons*, as was said at first do flie for Three dayes on the Surface of the water; but with this distinction: that those which have risen many thousands of them out of the water, and flown the first day, die the same day: living out of the water in the whole but about Five hours; on the Second day a great number rise again out of the water, and flye and die the same day, and so on the Third day; and then all cease till the same season the next following year.

The truth hereof is known to many persons, who live near those Rivers, who see the same yearly; yet I have seen them also flie the Fourth day, but in no great number; as on the Fifth day also; and therefore I judge these Worms were later fitted for flight than those that flew before; or were letted by sickness or otherwise. As also that those which appeared sooner, were sooner fit for their flight; and for this reason I see not but that the *Ephemeron* might appear some few days sooner or later than the precise time; for that by experience it is found that they sometimes appear about 14 days sooner or later, according as the season of the year is more or less agreeable.

The other sort of Insects have almost a like set time for their Change, which being come they cannot hinder, as I have often found, and have indeavoured by several ways to retard their Change but in vain; for the time being come they will force it forward although by the endeavoured obstruction, it prove their hurt or destruction: at which time notwithstanding by these endeavoured obstructions their Limbs are so compressed, that

that being dead all the pleat-folds of their inward and hidden parts may easily be examined, which is of no small use for those who labour in the search of these things.

If all what is hitherto related of the *Ephemeron* be well considered, the saying of *Monfret* will prove true, viz. *Ἐφίμερον sive Diaria mirabilis Musca est, sive formam sive vitæ brevitatem spectemus.* That the *Ephemeron* is a wonderful Flie if its Form and brevity of life be considered; but what he farther saith thereof, as also *Aldrovandus*, *Jonstonus* and *Clutius*, with those other Writers that have writ thereof, agreeth not much with truth; except that the Insect they have described be some other than what we have described; for there are different kinds of *Ephemerons*, only I advise that whoever in these matters desireth truth, that himself seek it in nature, which exceedeth all Writers, and teacheth us more in a minutes time, than in years can be learned in Books without her. Nature is an open book, in which her wonders are more intelligible than in the relations of men subject to many mistakes, from which I acknowledge my self not free.

I wondered to observe in the book of *Angerius Clutius*, that the *Ephemeron* of *Dortman* is only drawn from a weak Memory or fancy, which observed by *Goedard* who was informed by many observations of that kind, he hath endeavoured to mend, by his own conceit and judgment, but very badly, for he hath changed nothing therein but what he judged to be mishaped; having left the whole draught which was first made only by Memory, as it were; whereby appeareth how inconsiderately the error committed by the one hath been endeavoured to be mended by the other: which for that he only endeavoured to do by his conceit, hath consequently doubled the error, for that he endeavoured to make it to appear more true-like, and yet he acknowledgeth never to have seen the Insect. Wherefore the great *Harvey* hath well said, *Ex sensu permanet sensatum; ex permanentia sensati fit memoria:*

memoria: ex multiplici memoriā experientia: ab experientia ratio universalis; definitiones & maxima, sive axiomata communia, cognitionis certissima principia.

At the time when I was searching and examining the nature of this Insect, I have seen several sorts of *Ephemerons*, but I have never seen that of *Hoefnagel* represented by *Clutius*, and which also is to be found in the Figures of the said *Hoefnagel*, except once in the way to *Diemermeer* I found the *Nympha* thereof, which was hurt by being trodden on, I judg'd it then to be derived from a black and toothed Water-worm which hath a thick rump'd Skin, and arrived to its full growth, leaveth the water, and creeping on land, there changeth into a *Nympha*; which in time attaineth the shape of the *Ephemeron* represented by *Hoefnagel*, and afterwards shooteth again its Eggs in the water. That there are also other sorts of Insects, and also some kinds of *Ephemerons* which I can shew, as among other, some sorts which I have met with, and caught in *France* in the River *Loire* by *Saumeur*, which in shape differ little from those with us, only much smaller. I have once seen the same Flie in great troops; chancing to walk one Evening on the Bridg over the River by *Saumeur*, some of those which flew had yet fast on their Tails, the Second Skin which they were shedding, with which they flew to and again over the Bridg; I cannot relate more of this sort; nor of the other sorts, of which I have kept some, and of which there are none which live so short a time as doth our *Ephemeron*. Some of those kinds live longer than others do, which causeth me to conclude that there are yet more differences to be observed in them; and therefore that the Writers are not wholly to be rejected that write somewhat of these, and other like Insects they have seen in other Countries, not wholly agreeing with our *Ephemeron*: and it would be a great presumption in us to conclude otherwise, for God is endless in the variety of his Works, which notwithstanding

standing they here and there differ in some accidents, yet in the chief parts they all agree, which is one of Gods greatest wonders in nature; so that it might be said that he had Created but one Animal hidden under several outward shapes, and endless wonderful accidents.

Being in the year 1670. in the Village *Slouton* by *Amsterdam* in the month of *June*, where as I walked towards the Evening through the Fields, I met with such an infinite number of small Insects somewhat bigger than *Gnats*, which rested on my body, that I was even covered therewith. Every one of these while resting on my body shed a thin Film, which done they immediately repaired again to the waters, where they, like the greater *Ephemeron* sport above the Surface of the water. The Original of these Insects is not much unlike that of our *Ephemeron*, for that they also live in Ditches and Trenches of water, which also at their set times Change by shedding two Skins; the one in the water, the other on Land. The Worms of this small *Ephemeron* differ herein from the greater, in that they live not in the Clay, or in Cells, but on stony and Sandy ground, and are therefore of a stronger Constitution, than the larger *Ephemérons*, and their Skin agreeing more with that of the *Lobster* and *Prawn*. They have also on the sides of their bodies Gills and Finns, when in the middle of Summer if you take a stone out of the *Rhine* or *Leck*, as also out of some Inland waters, you will find some of these Worms sitting thereon; which is also found in other Countries and Rivers: as I have found in the *Loire*, the *Seine*, and other Rivers of *France*: Whereby it appeareth that there are many sorts of *Ephemérons*, and that therefore those Authors are not to be rejected when they describe an *Ephemeron* differing from ours. The said Worms with what I have besides represented of the *Ephemeron*, I can for the most part shew any one to the life; for that I have hitherto kept them by me, for a clearer demonstration of what I have writ.

THE

THE

Explanation of the several TABLES.

The First Table.

Fig. 1.

IN the First Figure is represented the Worm one year old, being in length $\frac{3}{4}$ of an Holland inch; it appeareth wholly without Wings or any signs thereof; it hath on each side 6 continually moving Gills turned over on its back each against the other; whereby the 10 under placed Finns may be clearly seen.

Figure 2.

In the second Figure is represented the Worm Two year old, in length $1\frac{1}{3}$ of an Holland inch; the signs of its Wings or their Cafes, wherein the Wings are inclosed, appearing; the two uppermost of them, much bigger than the two lowermost; it hath its Gills in a different manner turned over its back, than in the first figure, which I therefore note, for that all these Worms are represented to the life, and withal to signifie how wonderful the mo-

tion is, which they without ceasing make with these constantly trembling Gills.

Figure 3.

In the third Figure is represented the Worm Three years old, in length about $2\frac{1}{2}$ Holland inches, but among those of this age there is much difference between the length and thickness of the one and the other. The Worm here represented is a Female, and one of the smallest size of that Sex, which difference of Sex is to be discerned in the eyes, which in the Females are much smaller than in the Males; the Wing-cases, in which the wings are inclosed, appear now very plain, notwithstanding the upper pair so much cover the under pair, that at first sight they are not visible, except the uppermost are lifted up; here is also represented very clearly the 6 Gills, on each side of the body turned over the back, whereby the undermost Ten Finns of each side are made visible; at this time these Gills are never without motion, yea even
out.

The Explanation of the several Tables.

out of the water, wherefore some have judged that the Worm swims by the help of them: But I judge that is performed only by the Finns, as I have named them, placed under them; while for many reasons I believe that the uppermost, which I name Gills, and which agree with the Gills in Fish, do cool the blood in this Worm, as is done in Fish.

thousands of fine hairs like Fur, the same are here very neatly represented. The Finns in this Figure are not visible (being covered by the Gills) but are already represented in the first and third Figure of the first Table.

G. The three Tails, beset with Brushie hairs, with their Tag-like appendices.

Figure 2.

The Explanation of the Second Table.

Figure 1.

Here is represented one of the biggest Male worms, in which all its parts are very neatly and distinctly represented, as its

A. Eyes double in size to those of the Female.

BB. The horns with their differing Articulations or Joints.

C. The Sheeres, Beak, or toothy Cheek-bones, wherewith they root up the earth.

DD. The First, Second and Third pair of legs with their joints.

E. The Cases of its Wings in which the first pair are inclosed, like a tender flower in its bud.

FF. The always moving or trembling Gills which are shining and pure white, and beset with

The long hollowed Cells in the Clay in which the Worm liveth, moveth, creepeth, & is fed, almost in the manner as the Worms of the Bees in the combs or wax-cells, are here represented.

AA. The Cells of the greatest sort of Worms in the Clay.

BB. The Cells of the smallest Worms.

The Explanation of the 3d and 4th Tables.

I have in both these Tables used the same letters, for that the Explanation required it; as also for that they represent the entire dissection of the Worm; so that what letters are wanting in the third Table may be found in the fourth: as also those which are wanting in the fourth may be found in the third.

Expla-

The Explanation of the several Tables.

Explanation of the 3d Table.

Figure 1.

AA. **T**He Lung or Air-vessels of the Worm, which are two very remarkable & constantly open Air-vessels, composed as it were of some thousand of curled-like stiff-rings, by which the Air is conveyed to all the inward parts of the Worm; the same are placed on both sides, the length of the Worm, and waved Snake-like.

BB. The Air-vessels in the head of the Worm; the same are branched out of the two first mentioned great vessels, AA, and run to the Brain and Nerves.

CC. Branches of the Air-vessels running to the Muscles of the Breast.

DDDD. Branches of the Air-vessels running to the Muscles of the Belly. The said Muscles are represented on the other side of the body, wholly void of vessels, where the oblique ascending Muscles in some manner cover the straight Muscles; the use whereof is to move the rings of the belly; for driving forward the blood and humours; and for discharging the Guts, in that they assist the Guts in their motion.

EEE. The Lung-vessels running to the Medulla Spinalis;

where, about the globular parts thereof, they are very visible.

FFFFFF. The Lung or air-vessels running to the Milt, or Vesiculæ feminales of the Male-worm, one of these Vesiculæ or Bags are represented in the body, as it is there naturally placed; the other is placed out of the body, and delineated somewhat bigger than naturally it is, or than that which is represented in the body.

GGGGG. The air-vessels running to the Gills, which appear white like new-boil'd Silver; two of these Gills only are represented; for that the other ten are represented as cut off, to shew the ten Finns. See RRR.

H. The air-vessels running to the lower part of the Guts; as also to the seed-vessels next to them dd.

III. The air-vessels running to the fat, the films, and the outward skin, to cool and supply them.

KK. The air-vessels running to the Wing-cases, and appear outwardly like ribs or sinues; their chiefest use I believe is, by the air conducted there to assist the expansion of the wings; to which purpose the wings themselves are supplied with a great number of these air-vessels.

PPP. Three chief air-vessels running without the body to the Gills, the same are here represented.

The Explanation of the several Tables.

ed as cut off, the better to shew the under placed Finns, beset with brushy hair, RRRRR.

• QQ. The middlemost of the three forementioned air-vessels, of the perfect white Gills; which is of a black colour, and appearing through almost in the midst of the transparent white Gills, whereby it seemeth as if the black stroke or line of the Gills, were marked with white pricks.

RRRRR. The five Finns on each side of the body, beset most on one side with dark gold-yellow, and stiff brushy hairs.

SS. A feather-like hairy part, placed under the first pair of Gills; of which I have no remembrance, neither what it is, nor also whether it is found about the other Gills.

TTY. The Medulla spinalis constituted of eleven Nodes or globular partitions, from whence are derived the Nerves running through the whole body; and impart unto it sense and motion; see further concerning this in the 6th figure of the 4th Table.

ZZ. The places where the Medulla Spinalis as with strong ligatures is kept in its place.

** The Optick nerves arising out of the brain, or otherwise out of the beginning of the Medulla Spinalis, at the first globule thereof.

aa. The Muscles of the breast,

moving the legs; whither also some Nerves run from the Medulla spinalis which communicate to them life, motion and sense.

bb. Some other Muscles of the breast, but cut through, which move the wings; to which also the Medulla spinalis sends its Nerves.

dd. Two members which I conceive are pertaining to the seed-vessels of the male; of which yet I am not very certain.

e. The Rectum or straight Gut cut off; which is better and neater represented in the fourth plate, Figure 5.

hh. The very artificial foldings of the wing, as it is folded in the wing case KK. and is not to be seen but about the time when the Worm is ready for Change, by this wonderful manner of folding, and pleating of the wings, they can be again readily unfolded, and expanded as is in some manner represented in the 6th plate, in the 2d, 3d & 4th figures.

Figure 2.

Here are represented all the described parts in their natural bigness.

Figure 3.

The natural representation of the Cell or nest of a Caterpillar, which

The Explanation of the several Tables.

which is wonderfully formed; it is somewhat more than a fingers length; at the close end, somewhat sharp, and Pyramidal; it is built or framed of a great number of small round sticks, bitten much of a length, which are piled the one upon the other like the Beams of a Russia-house, the ends laid the one over, or resting on the other, and are fastned together with a fine Web, instead of Lome or Clay. The true bottom or foundation sticks, have twice the length and thickness of the other, which are thereon piled tower-like. Besides this Nest is also surrounded or covered over with a Web, thick, tough, and of equal thickness, and lined within with a soft down to lye in.

The Explanation of the Fourth Table.

Figures 1, 4, & 7.

LL. **S**ome branches of the air-vessels, AA. represented in the former plate, running to the Egg-cluster, or Ovarium.

MM. The air-vessels as they are seen in, and upon the film which covers the Egg-cluster.

N. The same air-vessels together with a part of the egg-cluster, taken out of the body; where very neatly is represented how these

air-vessels are joyned to the Eggs, like as the stalk of a bunch of grapes is joyned to each grape.

OOOO. The air-vessels running to the heart; where I have not delineated all the vessels, which are sent from the two great trunks of the air-vessels AA, to prevent confusion, by reason of the very great number that run thereto.

TT. A part of the heart which here and there swelleth out; its natural place in the body is in the back, and runs along the whole back.

VVVV. Some air-vessels cut and broke off which run to the heart and other parts.

XXXX. The parts where the heart swelleth out and wideneth.

cc. The Muscles moving the Six Gills, and five Finns placed on each side of the body, to which do run considerable Nerves to communicate to the same, life and motion.

ff. The Stomach and the Guts, as they appear and swell through the Egg-cluster; the Stomach and Guts are very neatly represented in the 5th figure of this same Table.

g. The form or shape of the Eggs, which are flattish and oblong round.

ii. The Muscles of the Rectum, or straight Gut, which serves for

H eject-

The Explanation of the several Tables.

ejecting out of the body, the superfluities of the inward parts.

Figure 2.

Representeth the Eggs of the Ephemeron, as the same appear to the naked sight without help of a Microscope, whereas all the other parts have been viewed and delineated by help of the Microscope.

Figure 3.

Representeth the double Egg-cluster of the Worm, made up of an infinite number of very small Eggs, which at the time when the Worm is changed into the Ephemeron, and flyeth on the Surface of the water, are by the Female shot out on the water, and are besprinkled by the Male Seed. So that these Insects are Generated without Copulation.

Figure 4.

The Explanation of this Figure is comprehended in the explanation of the first Figure of this plate.

Figure 5.

A. A part of the throat-gut, or Gula, (which conveyeth the food into the Stomach) cut off close to the same.

B. The lower Orifice of the Stomach or Pylorus, through which the food is sent into the Guts.

C. The Stomach it self wherein are represented some of its

air-vessels which run thereto from the great Trunk, as they are represented in the first Figure of the third Plate. AA.

DD. The thin gut, which is as a branch of the Stomach, immediately annexed thereto, so that the Stomach as it were narroweth into the same.

E. The thick or crumpled gut, wherein some long strokes or striae are observable, which from within appear through it.

F. The straight gut, which appeareth very neatly rimped.

G. Some transparent Valves, like half moons, which appear in the thin gut, and are seen through it.

4. 5. 6. &c. These Figures denote eleven of those annular divisions of the body of the Worm; and also shew where the Stomach and the Guts have their natural place.

Figure 6.

The Brain, the Medulla spinalis, and the Nerves arising out of the same are here represented, according to the life; so that the Nerves of the Medulla spinalis appear not so gaping, as is represented in the first Figure of the 3d plate TT. for there they are represented, as they appear in a Microscope, when with a fine Needle, they are separated, which can easily be done without cutting or tearing.

The Explanation of the several Tables.

1, 2, 3. &c. The Figures, 1, 2, 3, &c. represent the natural place and posture of the Medulla spinalis in the body; and in what manner it is distinguished by the Ring-like indentings, in relation to the head, breast and belly.

Figure 7.

The Explanation hereof is contained in the Explanation of the first Figure of this plate.

The Explanation of the Fifth Table.

Figure 1.

THis is the Figure of the Male Ephemeron, having shed its first Skin; or representation of the Ephemeron as it first cometh out of the water, where it hath lost its first Skin, and from a Worm is become a Flie, as a Worm it is represented. Tab. 2. Fig. 1.

Figure 2.

The Female Worm as it is immediately before its Change, is here shewn; in which the Wings are now visible, appearing through their Cases.

AA. The cases of the Wings; which appear through the same very visible. How these Wings appear, when the Case is shed, see in the 3d Table, fig. 1. in

the letters hhh, where they are at large represented.

The Explanation of the Sixth Table.

Figure 1.

REpresenteth the Figure of the Female Ephemeron, just as it rises out of the water, and hath quitted its Skin, and from a Worm swimming, is become a Flie; and its Skin now shed, may be seen driving on the water; as is represented in the 5 Tab. fig. 2.

I have dryed some of these shed Skins, which represent the Worm so naturally and to the life, as if you saw the Worm alive before you.

Figure 2.

Representeth in some manner how the wings do expand, which to apprehend more clearly, it ought to be known that the wing represented in the first Figure of the third Plate, with the letters, hhh, is there represented with its natural foldings; and is here represented in the manner how it by degrees doth expand, and loseth its neat pleats and folds.

Figure 3.

Representeth the same wing losing first its Snake-like foldings, and then its long folds, which are

The Explanation of the several Tables.

in the manner of a Brabants huth, or Vest, first pleated in the length, and then folded again cross-ways.

Figure 4.

Representeth the same Wing almost fully expanded.

The Explanation of the Seventh Table.

THe several appearances of the Ephemeron, shedding or stripping off its Skin, like a very thin shift or shirt, are here represented to the life.

Figure 1.

The Male endeavouring to shed its second Skin on land much more leisurely, than it shed its first Skin in rising out of the water, which as is before said, happeneth in a moment. Here is represented the body half stript, the head, the breast and the legs, in the manner as we pull our feet out of our Shoes or Boots: but the Wings are in that manner stript, that the inside of the Skin turneth outwards, and the outside inwards; which is wonderfully effected: for the Flie is at that time, like a captiv'd and bound bird; for the Skin thus drawn off, shutteth close to its body, like a strong Swath wound about,

which keepeth it as a prisoner, and causeth it to shiver and quake.

Figure 2.

Representeth the Male Ephemeron almost uncased, so that the two outermost Wings and the Tails, by a small stripping off the Skin will become wholly freed.

The Explanation of the Eighth Table.

Figure 1.

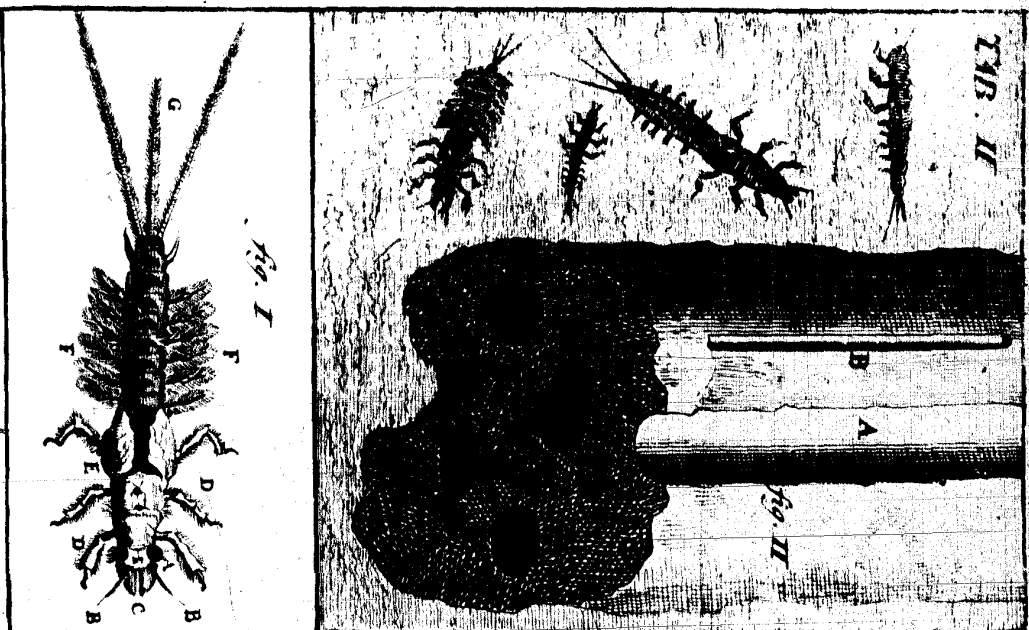
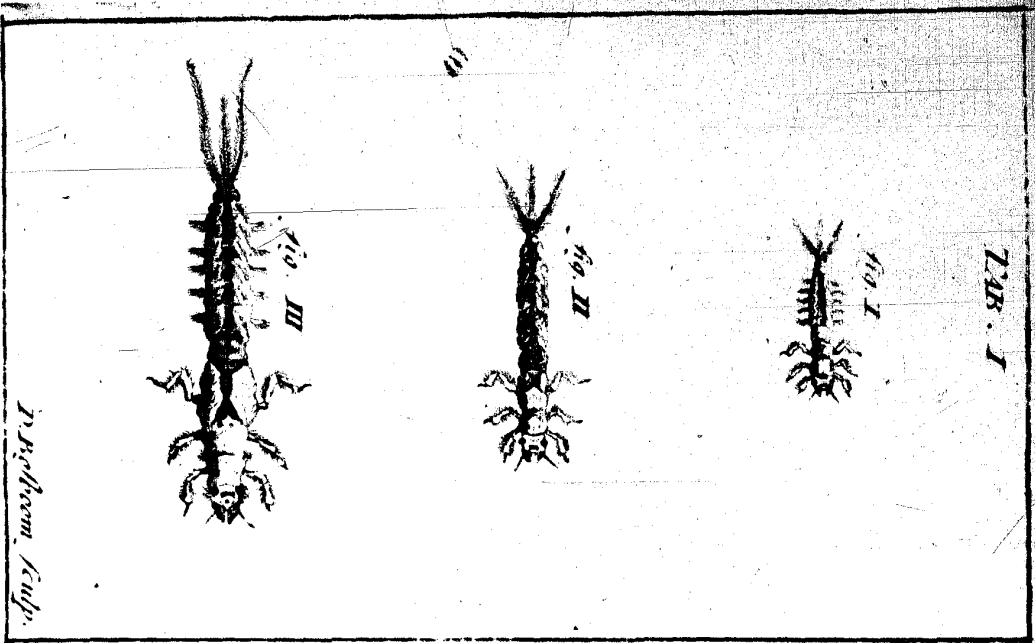
Representeth the thin Skin or film of the Ephemeron in this manner shed.

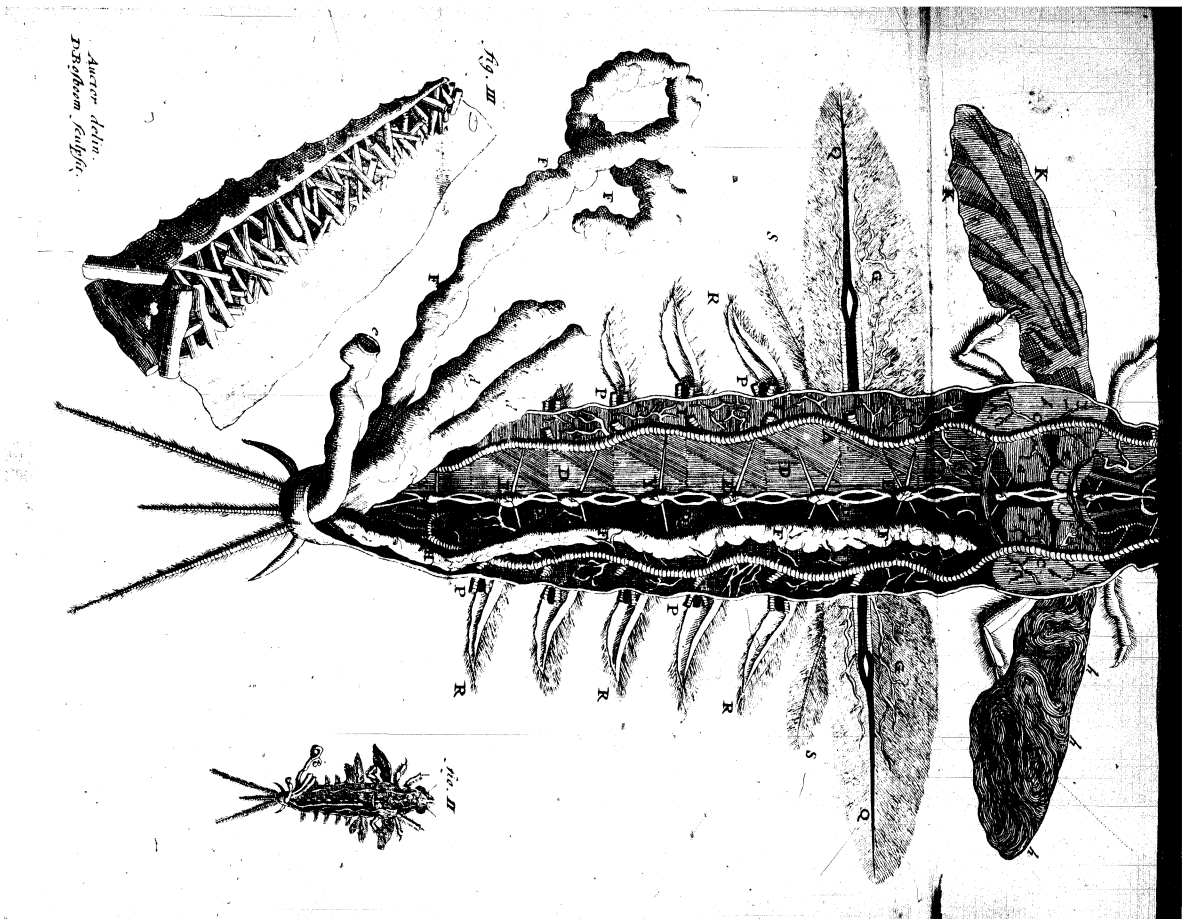
This film thus shed, remaineth not in the form as is here represented; for the parts that did inclose the wings shrink commonly up together, and so come to appear in another form.

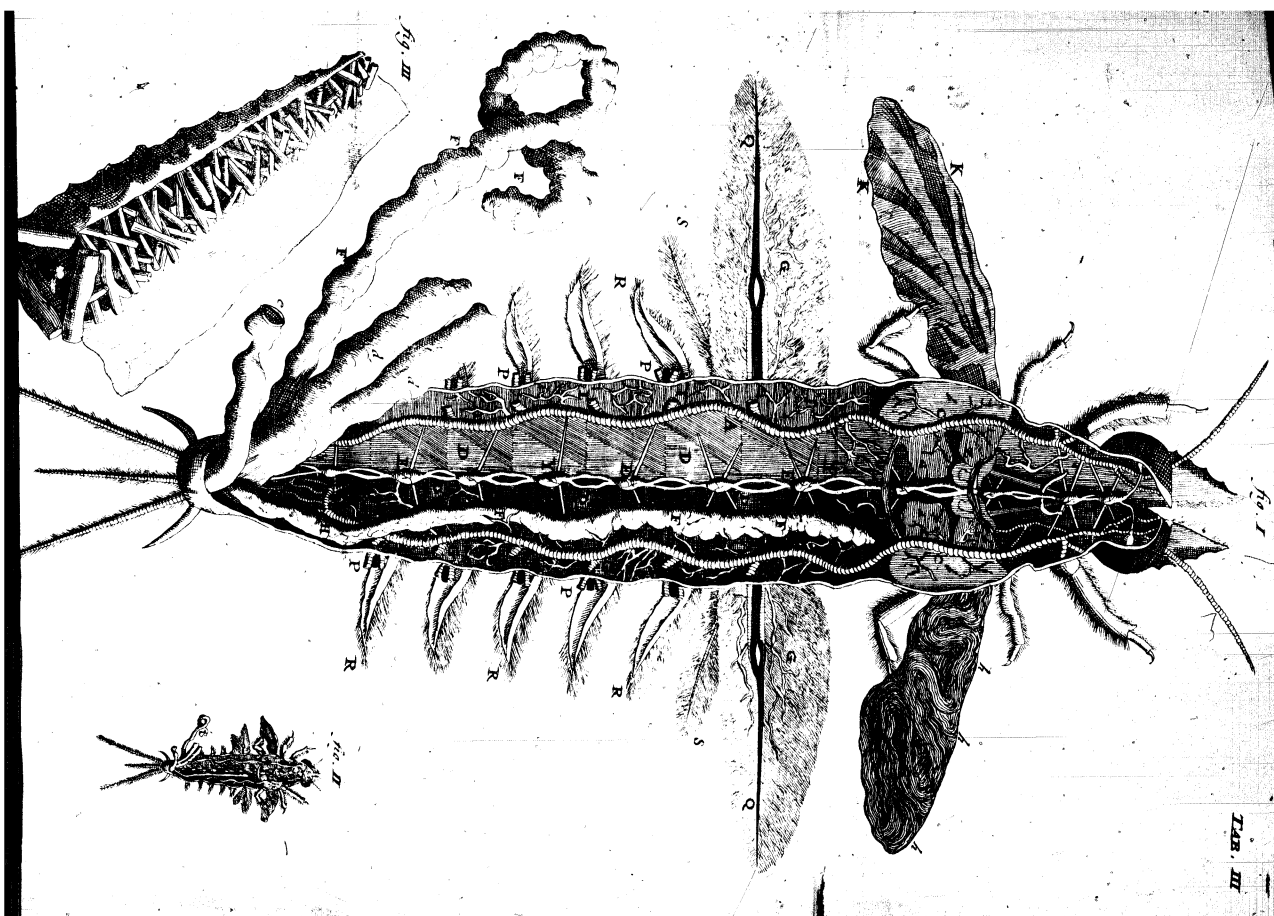
Figure 2.

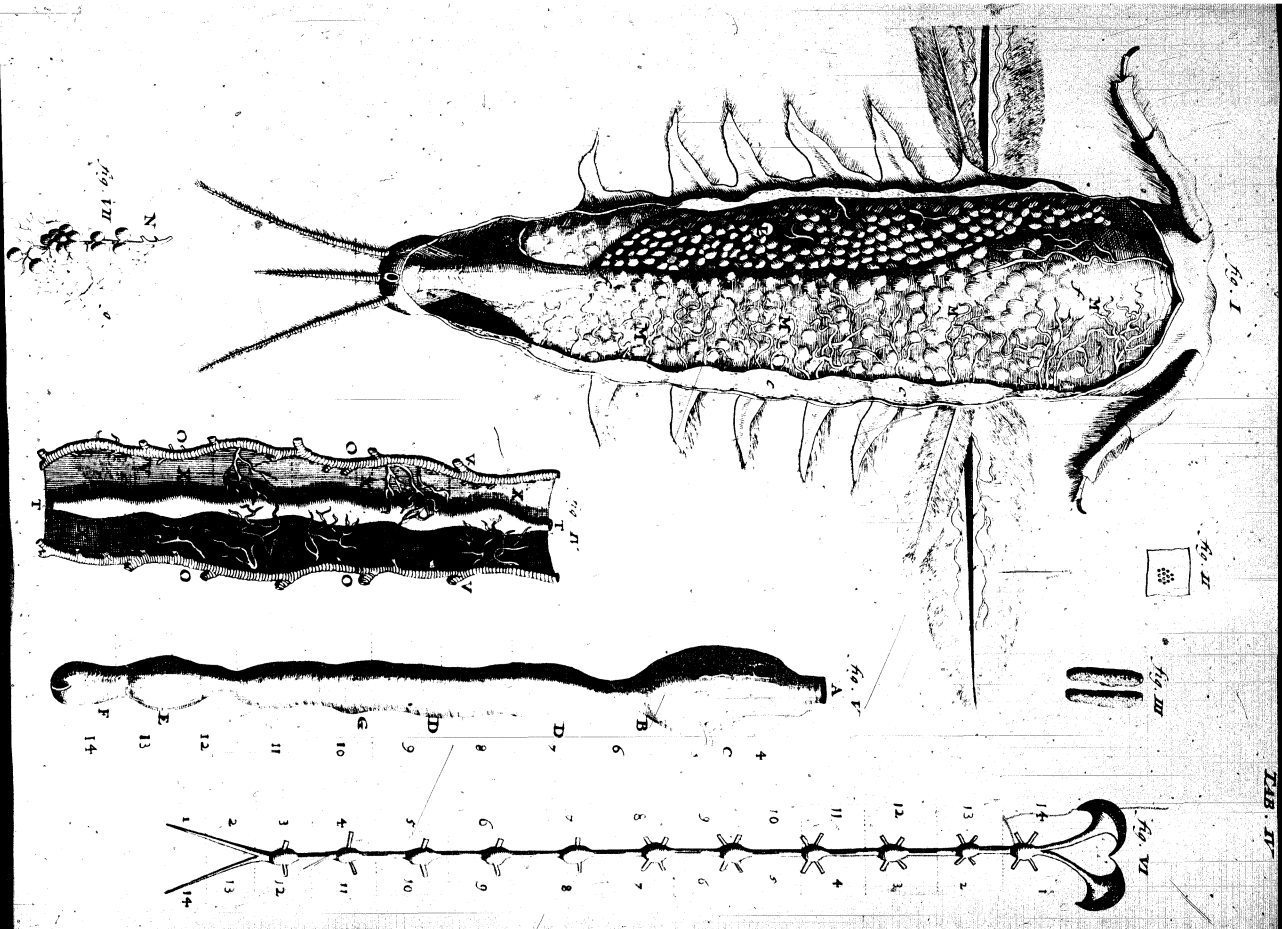
The Male Ephemeron having now shed two Skins successively, and assumed the shape of a flying Insect; the Legs which in the Worm were short, are now extended to about twice the length; which chiefly is visible in the Tails, whose length by these two extensions, are now become three times longer than they were in the Worm.

F I N I S.

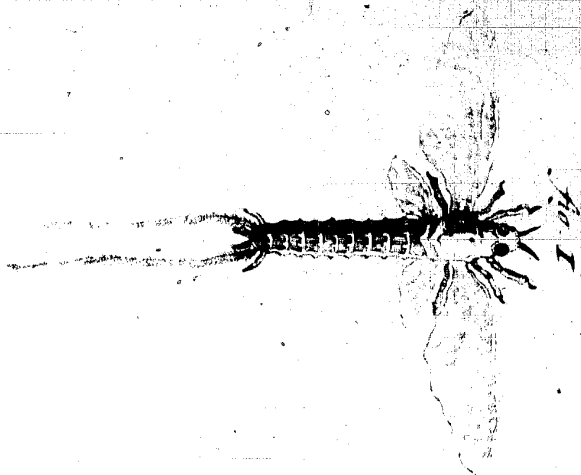




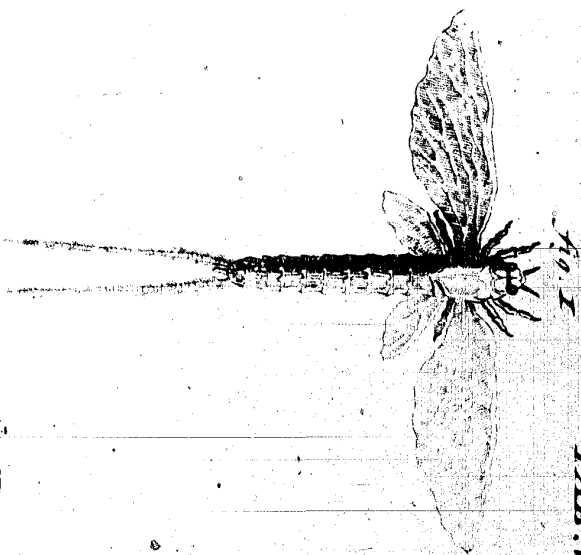




TAB. V



TAB. VI



TAB. VII

fig. I

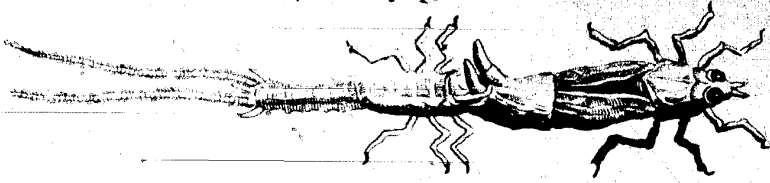
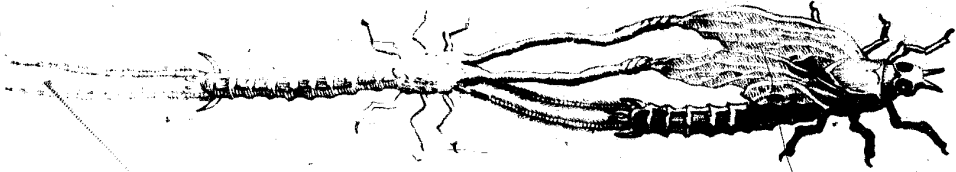


fig. II



TAB. VIII

fig. II

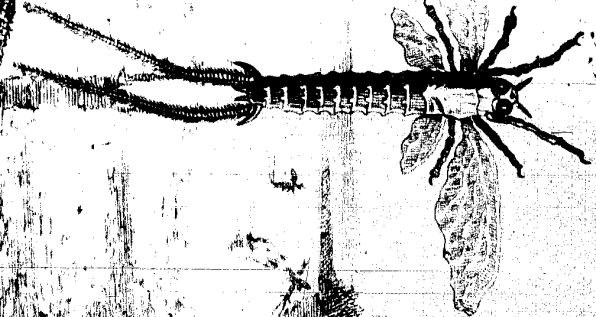


fig. I

