

Itaque Cometa Viennæ postremum visus est prope prædictam stellam, cujus longit. $13^{\circ} 16' 28''$. μ . & latit. Bor. $17^{\circ} 30'$. Ab hac stella 21 Febr. vesperi hora 8. $8' 22''$. Cometa declinabat versus Septentr. $28' 16''$. occidentalior $1^{\circ} 15' 12''$.

II. *An Abstract of some new Observations upon Insects: By M. Charles Bonnet of Geneva. Communicated in a Letter to Sir Hans Sloane, Bart. late President of the ROYAL SOCIETY, &c. Translated from the French by P. H. Z. Esq; F. R. S.*

Upon CATERPILLARS.

Read at different times
from March
10. to April
28. 1743.

I. **I**T is well known, that among *Caterpillars* there are several Species, which like to live in Society, and which know how to build Nests wherein to shelter themselves against the Injuries of the Air. Of this Sort are those* to which Gardeners have given the Name of *Liverymen*, by reason of the Distribution of their Colours. They may be ranked among the Processioners, or those that follow one another. They all go about, spinning, with great Order: But what is most surprizing, is to see them straggle very far from

* *Memoires pour servir à l'Histoire des Insectes.* Tom. I. and II. of the Paris Edition.

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their

their Nest, and this often by several Windings and Turnings, without losing their Way. Their Art in doing it deserves notice: It is the same that *Ariadne* made use of to bring *Theseus* out of the Labyrinth in *Crete*: They spin over all the Places where they go. The 1st leads the Way; the 2d follows, spinning; the 3d spins after the 2d and 1st, and so on with the rest. All these Threads form by degrees a small shining Track, a little Path, a *Line* or Two *Lines* broad; and all these Paths meet at the Nest, the Centre, as it were, of all those several Rays.

But to be plainly convinced of the Use of these Threads, let one but break off the Continuation of them in some Place or other, one will see with Astonishment the little *Caterpillars* turn back as at a Loss, without daring to proceed, till one or other, of more Courage than the rest, has restored the Communication, by spinning new Threads.

II. *Caterpillars*, like Men, have particular Tastes (I take the word *Taste* here in its proper Sense): I have observed some, to whom even the Shell of the Egg they were come out of, was agreeable Food. This Fact is not absolutely new. *M. de Reaumur* informs us*, that *M. Maupertuis* has made the like Observation.

But what I have seen more, and which will appear singular, is, that certain *Caterpillars* are not content with gnawing the Shell of the Eggs they came out of themselves, but will gnaw also those of other *Caterpillars* of their own Species, that are near upon hatching.

* *Memoires sur les Insectes*, Tom. II. p. 165.

Another yet more remarkable Singularity in the Taste of certain Kinds of *Caterpillars*, of the Species of smooth ones, some of the First Class, and others of the Second, is, that they are fond of eating their own *Exuviae*; they have scarcely cast them off but they fall to devouring them. And this will appear still more surprising, if one considers the Condition in which the *Caterpillars* then are. Every one has learnt from *Silkworms*, that, after the moulting, these sort of Insects are extremely weak; and that for a considerable time they remain without any Nourishment, to give time to their new Organs, particularly their Teeth, to strengthen themselves: Yet here you see *Caterpillars*, which, immediately after this critical Operation, greedily devour not only the soft or rather tough Part of their Skin, but even all that is scaly in it, as the Skull, the Legs, &c.—I have even observed some, which seemed to seize upon those, preferably to the rest, and to devour those almost bony Parts, before they fell upon the others, that are much less hard.

III. Nothing surprises more in Insects, than their Industry; and *Caterpillars* yield to none in this respect: Not to speak of those which build for themselves Sheaths or Cases, in which Silk, their own Down, Bits of Bark, Pieces of Paper, &c. are so artfully wrought together; there is one* which builds in Wood, and is able to give to its Case a Hardness greater than that of Wood it self. I shall mention in

* The extraordinary horned *Caterpillar* of the *Willow*, *Memoires sur les Insectes*, Tom. II. p. 264. *seq.* *Goedart. Albin. Mrs. Merian.* This *Caterpillar* is of the Kind which eat their own Skin.

few Words, how this Insect goes to work : It cuts the Wood with its Teeth, which are very sharp, and severs small Fragments from it, which it binds together with a Silk of a particular Nature, and which seems to differ in several respects from that of other *Caterpillars*; it is properly nothing but a viscous Substance drawn into Threads, which, like Glue, grows hard by degrees.

But, probably, this would not suffice for giving to the whole Work the Solidity that is required, if the industrious *Caterpillar* did not, in some measure, prepare the Fragments of the Wood, before it employs them; and this it does by keeping them in its Mouth for some time, to soak and better fit them for joining themselves into one Body.

This Solidity of the Case of our *Caterpillar* is not what we need further trouble ourselves about; it suffices that the best Care is taken of that Particular: But this *Caterpillar* is also to become a *Butterflie*, and we know, that *Butterflies* have neither Teeth nor Feet to dig withal: How then will this contrive to cut its Way through a Case that is so hard, and so exactly closed up on all Sides? One guesses, perhaps, that it uses a Liquor which softens that sort of Glue which binds the Bits of the Sawdust together. But what is the Nature of this Liquor? *M. de Reaumur* † has judged, that it must be of a singular Kind. In dissecting some of these *Caterpillars*, I have found near the Mouth, under the *Oesophagus*, a sort of Bladder, of the Bigness of a small Pea, full of a limpid Liquor, and of a penetrating Smell,

† In the Place quoted above.

which I found by divers Trials to be a very active Acid, and which, among other Proprieties it has in common with true Acids, sensibly softens the Glue of the Case. It remains now to shew, that this Liqueur is not only of Use to the *Caterpillar*, but is also that very Dissolvent which enables the *Butterflie* to cut its Way through: And this I am not without Hopes of being able to compass.

A Notion adopted by Dr. *Boerhaave* *, that there are no true Acids in Animals, except in the Stomach or Intestines, renders this little Discovery of the more Concern.

IV. We have seen from the foregoing Observation, that *Caterpillars*, though one of those Insects the Structure of which has been most searched into, have yet something still new to present in this respect. And I shall further add, that I have discovered in these Insects a Part of some seeming Consideration, which is a sort of Nipple, or fleshy Protuberance, placed near the Head, under the First Ring; which is commonly concealed in the Inside of the Body, but is forced to shew itself by squeezing the Insect. This Nipple, or Protuberance, which at first I only found single in several *Caterpillars*, I have since met with in others double, and even quadruple; as in that singular horned *Caterpillar* of the *Willow*, which I have already mentioned, and this with some remarkable Varieties. However, they are not all provided with them: I have not found them as yet, for Instance, in those of the First Size, that is to say, the very large ones, nor in those that are very hairy.

* Praxis Medica. Elementa Chem.

But I have observed it in all those *Caterpillars* which, from the Figure and the Stiffness of their Hairs, have been called the *Thorny-ones*. The Use of this Part remains yet unknown to me: All that I know, and that I have learnt by my Experiments, is, that it is not essential to the *Caterpillar*.

V. *Caterpillars* are of those Insects for which one has naturally such an Aversion, that it will easily be believed there are some that have an offensive Smell; and I have actually observed a small Kind of them that smell so like a Bug, that I have thought fit to give them that Name. But what perhaps will appear more strange, is, that there is also a sort of a middling Size, which are smooth, and on the Approach of their Metamorphosis, have a very sweet Rose-like Scent; and whose Cases, being made of Earth and of Silk, preserve that Smell for Years together. The *Butterfly* of another *Caterpillar* *, of the middle Size also, but hairy, gave, upon its coming out of its Case, a very sensible Scent of Musk.

Of the FORMICA-LEO.

I. There are few Insects that have been so much and so deservedly admired as the *Formica-Leo*. That excellent Work the *Spectacle de la Nature* has been so universally read by the Curious, as hardly to let any one be ignorant of its History. However, a little Particular, curious enough, has yet escaped the most diligent Inquiries; and that is the Manner in which he goes to work, when he finds Stones in

* Memoires sur les Insectes, Tom. I. Pl. 16. Fig. 8

his Pit, too big to be thrown out with his Horns. Does he then forsake the Place where he settled at first? and does he go somewhere else to set a new Ambuscade? Or, does he remain in his Pit, leaving the Stone there, which he has not been able to remove? Or, after all, does he at last contrive to get rid of it? and what Means does he use to bring this End about? By unwearied observing, I have at last had the Fortune to discover the Secret of his Management. I have seen, that in such Cases the *Formica-Leo* knows how to vary his ways of working: He comes out of the Ground, gets his hinder Parts under the Stone, so that it rests upon his Back, and then by degrees pushes it towards the Top of the Opening, keeping all the while his Poise with great Care. Having thus forced it to the Edge of his Pit, he does not leave it there, for it might roll back again; he therefore pushes it farther off, and then retires to his Pit again.

But sometimes it will happen, that the poor *Formica-Leo* has not the good Fortune to keep the Stone in Poise all the Way; and it rolls back again to the Bottom of the Pit, the Moment it was got to the Brink. This unlucky Accident does not, however, discourage him, but he goes patiently to his Work again, till he gets the Stone out. *Solomon* sends the Sluggard to the *Ant*; and we might in like manner send to the *Formica-Leo* those impatient People who give over their Labours upon the first Difficulties they find in them. I have seen some of these Insects, that, after Five or Six Misfortunes like those I have mentioned, did not yet lose Courage. I have thought I saw the wretched *Sisyphus* as condemned
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to Hell, in the Poets, rolling a great Stone to the Top of a high Hill, which no sooner was at the Summit, but it slipt down again.

The Naturalists will have us admire the Strength of the *Ants*, in transporting their Materials: That of the *Formica-Leo* is doubtless no less worthy of the Attention of all who shall see, as I have done, these little Animals carry to the Brink of their Pit, notwithstanding the Steepness of the Slope, and the Crumbling away of the Earth, Stones Three or Four times as big as themselves.

II. All the *Formica-Leos* that have been hitherto observed, move only backwards; but I have also discovered a Species that move forwards with Activity. These do not, like the others, lie in Ambush for their Prey, but seize on it by mere Force and Dexterity.

Of the PUCERONS, or VINE-GRUBS.

I. The *Pucerons* are pretty well known, so that it will be sufficient to take notice they are that sort of *Gnats*, or *small Flies*, which stick in great Numbers to the Leaves and Stalks of Plants, and cause great Destruction among them. What they present most curious, and which hitherto has been a sort of *Ænigma*, is their way of multiplying. “In every
“ Family of the *Pucerons*, says M. *Reaumur* *,
“ there are some with Wings, and others without.
“ According to the usual Analogy, the winged ones

* *Memoires sur les Insectes*, Tom. III. in the Preface, pag. 15.

“ should be the Males, and those without Wings
 “ the Females: But what is a great Singularity in
 “ the History of Insects, is, that here both Sorts are
 “ Females. I have not been able to find out the
 “ Males who impregnate both the one and the other
 “ sort. They all bring forth alive,” &c. Is there
 therefore no Copulation among *Pucerons*? Or are
 they Hermaphrodites like Muscles? In order to
 know this, I tried an Experiment proposed by M.
Reaumur †. I brought up, in perfect Solitude, a
Puceron from the very Instant of its Birth. The
 Expedient I had recourse to for this, was different
 from that which M. *Reaumur* had pointed out. It
 was such as gave me a Facility of observing the little
Puceron at any time, without Fear of letting in
 another. I constantly watched it from Day to Day,
 and from Hour to Hour, for above a Month, usually
 beginning my Observations about Four or Five in the
 Morning, and scarcely discontinuing them till to-
 wards Nine or Ten at Night: I took care to keep
 an exact Journal of its Life, wherein I noted even its
 least Motions, and the most trifling Circumstances.
 At the End of about 12 Days it began to breed, and
 has since brought forth 95 young ones, all alive, and
 most of them under my own Eyes. I have drawn
 up a Table, in which I have marked, with the greatest
 Exactness possible, the Day and the Hour when every
 one of them was brought forth.

I have already repeated this Experiment, Three
 several times, and with equal Success. I have even

† Pag. 329.

brought them up successively in Solitude, as far as the Fourth Generation; and all of them have brought forth.

II. Perhaps one is already from hence inclined to think, that there is in general no Copulation among the *Pucerons*. But there will yet be some room for Surprise, when I say, that I have also observed a Species of them where Copulation does obtain, as it does among so many other Species of Insects or Animals. The Male, like that of the Gall-insects, has Wings, and is a good deal less than the Female. It is, perhaps, one of the most eager Creatures in that respect that is in Nature: I have seen it copulate a great many times in one Day, both with the same Female, and with others.

The ordinary Distinction of the Sex is not the only Singularity I have met with in this Species of *Pucerons*: It has shewn me another no less remarkable. The Females, instead of bringing constantly forth live *Pucerons*, sometimes produce only *Fætuses*, which they lay one alongside of the other, as *Butterflies* do their Eggs.

Besides what relates to Generation, the *Pucerons* have offered me many other curious Particulars. I have seen, for Instance, some, which to cast off their Coats, have given themselves Motions analogous to those of the *Chrysalis* of the *thorny Caterpillar* of the *Nettle*: But to enter into all the Particulars I have met with in these small Insects, would require a Volume.

*Of Insects which are multiplied, as it were,
by Cuttings or Slips.*

M. *Trembley*, a Relation of mine, and an excellent Observer, wrote to me some time ago from the *Hague*, that he had discovered a sort of aquatic Production* of a Nature between a Plant and an Animal; that is to say, which moved, and which had the outward Appearance of a Plant, together with the Property of reproducing what was wanting, after being cut or divided into Two or Three several Parts. So extraordinary a Production could not fail exciting my Curiosity, so much the more, as my Friend did not enter into any Particulars. I spared no Pains to get some of these little Bodies, but all in vain. I only discovered a sort of a long Worm, extremely nimble, upon which I resolved to try the Experiment. As nothing could leave the least Doubt, but that this Insect was truly an Animal, I was assured, that, if my Experiments succeeded, I should fully make out, that there are really Insects to which Nature has given that strange Prerogative of being multiplied, as it were, by Cuttings, and thereby strongly confirm M. *Trembley's* noble Discovery. The Success perfectly answered my Expectation, and I soon had the Pleasure of seeing Two Worms made out of One. But before I enter into farther Particulars, it will perhaps not be amiss to give a slight Idea of the Structure of those Worms. Simple as they seem at their first Appearance, we no sooner examine them with Eyes prepared and armed with Magnifying-glasses, but we discover Parts no less proper to excite and fix our

* See these *Transactions*, N^o 467. and 469. p. 422.

Attention, than in those Animals we call the most perfect.

I. Their Colour is generally a reddish-brown, or, more exactly, that of the first Peel of an *Onion*. Their Length is about Two or Three Inches; their Thickness that of a common Wire: They are slender, composed of a Series of membranous Rings, continually growing less and less as they approach the Extremities; each of these Rings is furnished in its inferior Part with Four, Five or Six different sorts of whitish Thorns, supplying the want of Legs. Besides these, the Outside of the Worms still presents some other remarkable Particulars, and which afford an agreeable View to the Microscope; these are the Muscles that serve for the Motion of the Rings, and which form an infinite Number of circular Lines or Folds, parallel to each other, which, from the Clearness of the Skin, appear to great Advantage: The Head has not a constant Figure, like that of other Animals; the Insect stretches it, shortens it, enlarges it, and contracts it at Pleasure: Sometimes it shews Two small Elevations one on each Side, which one would think should be the Places of the Two Eyes; what is beyond, terminates in a Point, to make it more easy for the Worm to pierce the Mud. At the Place where the Head is biggest, between the Two Elevations just now mentioned, the Mouth is placed, terminated by Two brown Strokes, which may be compared to the Figure of a Half-moon, or rather that of a reversed Circumflex. When the Insect opens this Mouth, the Opening, which then appears distinctly, is of a circular Shape, and garnished all round with a pretty thick Muscle; it is in great measure this
Muscle,

Muscle, that, by applying itself exactly with its Circumference to a smooth and perpendicular Surface, enables the Insect to make its Way in such Cases. At the other Extremity of the Body, is an oblong Opening, the greater Diameter of which runs parallel to the Length of the Animal, and this gives Passage to the Excrements.

But there is nothing more remarkable than the great Artery in these Worms. This Vessel, which the famous *Malpighi* looked upon as a Chain of Hearts, and which in *Caterpillars*, as well as in many other Insects, extends itself in a strait Line all along the Back, is here more or less folded in different Parts of its Extent; from one End to the other, it is often nothing but Folds and Doublings: Through these crooked Passages, creeps along a Liquor analogous to Blood; from Moment to Moment you may see a Drop of that Liquor, which, setting out from the Extremity of the Tail, runs successively through all those Windings, and at last loses itself in the Brain. It is easy to trace it most Part of its Way, by the alternate Motions of Contraction and Dilatation, which are successively excited from Ring to Ring. It seems as if every Part of this Artery, comprehended in the Breadth of one of those Rings, is really a complete Heart, which pushes on, to that which follows next, the Drop of Liquor it has just received from that which precedes it. One can hardly be tired with Admiration of the Appearance which those continual Motions of *Systole* and *Diastole* afford: But the better to perceive it, one should fix one's Eyes upon the Middle of the Body, where the Artery is largest in Diameter; for towards the Two

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Extremities things are not to be seen so distinctly. Towards the Head, about the Fifth or the Sixth Ring from it, the Artery appears but like a Thread, scarcely discernible, and which, still diminishing continually till near the Mouth, there absolutely ceases to be visible: But what ought most to be taken notice of, is the prodigious Swiftnefs with which the Course of the Blood is accelerated in this Place; it seems as if it were darted forcibly into the Brain. Towards the Tail, for the Length of several Lines, it looks as if there was no longer any of the same Play; those alternate Contractions and Dilatations, so remarkable in the Middle of the Body, here confound themselves with each other, so as to be no longer distinguished: In the stead of them one only sees certain Undulations or Layers, as it were, of Clouds, succeeding one another with great Regularity.

Under every Junction of the Rings, are to be observed small Vessels with several Branches, all which seem to be Productions of the principal Artery.

All along and immediately under this Artery, is extended the Chanel of the Intestines, less visible of itself than by the terrestrial Matters with which it is commonly filled: It is furnished, like the Intestines of larger Animals, with different Orders of muscular Fibres, which serve to push on, and thrust out, the Remainder of the Food. If one does not discover these Fibres by the Eye, one may, at least, know and judge of them by the Effects: One may see with Amusement, how the Excrements are driven on by degrees towards the *Anus*, the Transparency of the Skin discovering easily what is under it. However, by
reason

reason of the various Motions the Insect gives its Body, these others just described appear for some Space retrograde.

The Earth from which these Worms receive their Nourishment, and which they digest, is not however the only Matter which is admitted into their Bodies; the Air often enters also in Bubbles that are very perceptible. But whereas Fishes have the Air in their Bodies at their own Command, and can make use of it for raising or sinking themselves; our Worms, on the contrary, are, in some measure, mastered by it: As soon as they happen to swallow a certain Quantity of it, it is hardly possible for them, notwithstanding their continual Efforts, to get to the Bottom of the Water; and they are forced to remain on the Surface, till they have got it all out again. I have seen some of these Bubbles alternately driven towards the *Anus*, and repelled towards the Head, for several Minutes together.

These are the principal Particulars, which the Microscope enables us to discover in the Structure of these Worms; which being once known to a certain Degree, we shall, without doubt, the more admire the Wonders of their Reproductions.

II. I mentioned above, that I had divided one of these Worms in two. I put these Two Halves into a sort of Glass Cup, filled only with Water, and attentively watched them during the following Days. I observed that the First Moiety, that which had kept its Head, moved as usual; but what seemed to me far more remarkable, was, that the other Moiety, that had no Head, moved almost as if it had one; it went forwards, resting itself upon the antierour Extremity
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of its Body ; and even made its Way with tolerable Swiftnefs. One could fee, that this was not a Motion without Direction, a Motion produced by a Cause like that which makes the Tail of a *Lizard* move, after it has been severed from the Trunk, but a Motion quite voluntary, the Principle of which seemed not to have been destroyed : One saw it turn aside at the meeting of an Obstacle, stop, and then creep forwards again. When these Two Moieties happened to meet, it was as if they had never composed one and the same Insect ; they neither seemed to seek nor to fly each other ; each went on its own Way, or, if they went in Company towards the same Place, the First generally outran the Second. But this latter never seemed to shew a sort of Will of its own more plainly, than when I exposed it to the Sun ; for then it considerably quickened its Pace.

I had many times Opportunities of admiring the extreme Nicety of the Feeling in these Two Moieties, and especially in the Second. When I approached to it the End of a Splinter, at a time when it was quiet, it seemed to wake, as it were, in a Start, even almost before I had touched it.

Two Days being past, I thought fit to put into the Cup a little Duck-weed and Earth : The First Moiety soon thrust itself among it, but the Second was satisfied with hiding itself among the small Roots of the Weed. I then observed, that, at the Place where it had been cut, there was come out a sort of little Swelling, or Knob, analogous to that which commonly comes out on the Branch of a Tree stript of its Bark. I did not distinguish this so well in the other Moiety ; this Knob

seemed to give the Second Moiety more Ease in advancing, and it no longer seemed to be so much affected by all that touched it.

Next Day I took notice, on the Wound of each Moiety, of a small Accretion, distinguishable by the Difference of Colour, which was there much clearer than in the rest of the Body; the following Days it became yet more perceptible. In short, at about a Week's End, each Moiety was again become a complete Worm. The Head that had sprouted out on the Second Part, was, as to its Form, exactly the same with that of the First, and equally fit for all the same Functions. Again, the new Tail of the First was in every respect like the old one. The Heart, the Stomach, &c. had prolonged themselves in one and the other, and the Parts newly produced acted with no less Vigour than the rest; and new Rings had besides been produced successively beyond the old ones.

I took care, from time to time, to measure, with as much Exactness as I could, the Growth of my Two Worms; and I intended to watch them on, with the same Attention; when, at the End of about Eight Days, to my great Surprize, they had found means to escape.

III. This Experiment, which I thus could not pursue as far as I had wished, seeming to require Repetition, I undertook it again, with the same Care: The Success did not fail answering: I soon had the Pleasure to see my Two Moieties recover what they wanted, and become such as they had been before.

IV. I afterwards tried to carry the Division farther, and to divide some of these Worms into Three, Four, Eight,

Eight, Ten, and Fourteen Pieces; and all, or almost all, recovered both Heads and Tails.

In short, to say still more, I cut some of them, even in the midst of Winter, into Twenty-four and Twenty-six Parts: Of the First Division into Twenty-four, there are about Sixteen or Seventeen, full of Life, and most of which begin to complete themselves. Of the Second Division into Twenty-six, there still remain Seven or Eight.

Since my writing what is before, some of these Pieces of Worms have perished, though they had begun to complete themselves. I have Reason to believe, that, when I shall repeat my Experiments in a warmer Season, more of the Pieces will thrive, and become complete Animals: It was proper, however, to try them in Winter, to see the Difference of their Success and Progress. It is worth Notice, that some very small Parts of those Two Worms, one of which was divided into Twenty-four, and the other into Twenty-six Pieces, lived about Three Months, and that in the Winter. For though they were in my Closet, yet the Liquor in *M. Reaumur's* Thermometer did mostly stand between Four and Eight Degrees above Frost, which Degree of Warmth is very inconsiderable; and often, particularly in the Night-time, it was Two or Three Degrees lower.

It is commonly One or Two Days after the Operation in Summer, but about Ten or Twelve in Winter, that the Head and the Tail begin to shoot on those Parts where they were wanting. The Head shews itself first, and lengthens itself continually, for a Week, or more, till it has attained the Length of about a Line and half; and then it ceases to grow. I do

not here mean, that the proper Head has actually that Length; very far from it: But I here give that Name also to Five or Six Rings, which are contiguous to the Head properly so called. It is not so with regard to the Tail, which, having soon surpassed the Head in Length, does not leave off still extending itself; but increases, from Day to Day, so that I do not yet know how far it may go. I shall content myself with saying, that Pieces of those Worms, which, in the Month of *July*, immediately after the Operation, were not quite Two Lines in Length, are at present near Two Inches long: But what may be thought more remarkable, is, that some such Pieces have made in the same time as much Progress, as others Four or Five times as long. I have compared the different Growths of the First Moiety of a Worm about Two Inches long, cut on the 18th of *July*, with those of some of the Pieces of a like Worm cut the same Day into Eight Pieces; and was surpris'd to find the Quantity of Growth near the same in both Cases. However, it appeared that when the Division was yet carried further, the Pieces thence arising reproduced what they wanted more slowly than the others.

But, if, instead of making this Comparison between the Pieces of different Worms, we make it between those of the same Worm, we shall observe Variations which we perhaps would not have expected. Some of these Pieces will be Twelve or Fifteen Lines long, whilst others will hardly be Four or Five. I have done my utmost to find among those Variations some fixed Point, some Rule, not contradicted by Experience; and it has appeared to me in general, that
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the Pieces nearest to the Tail are those which make the least Progress. Among this Number is chiefly to be reckoned the last. As to the First, that which keeps the Head, though that is often the Piece which in an equal Time recovers the longest Tail, yet does not this happen so constantly as to build a Rule upon it. My Observations have furnished me with more than one Proof of this. Neither is it a Rule, that all the intermediate Pieces, which have recovered Heads, will also recover Tails: I have Examples to the contrary. But what seems certain, is, that the State of the Worm, the Number of its Divisions, and other Circumstances, seem very much to influence all those Irregularities.

The want of Nourishment, or of such as is proper, may also be a Cause, and that a very natural one, of like Variations. I said above, that those Worms love to be in the Mud, and that they digest it. Those Pieces which I left purposely in clear Water, have usually very well recovered what they wanted to become true Worms; though afterwards they made but little Progress, and almost all successively perished.

V. The learned Dr. *Hales*, in his excellent *Vegetable Staticks*, relates a curious Experiment; by which he proves, that the Bones of Animals, when they are ossified to a certain Degree, do not grow any longer but at their Extremities. Many Observations have convinced me, that it is the same with our Worms. The old Piece, I mean that which was originally cut from the Worm, does not itself lengthen, but its Increase is only owing to the Growth of those additional Parts, that put out at each Extremity.

VI. It is certainly very singular, that the Circulation of the Blood, the Regularity of which appears so essential, yet in certain Insects suffers considerable Changes. Such are those which *Malpighi* has observed in the Silk-worm. And I do not know if it is not as remarkable, that those I am speaking of, have never shewed me any of those Variations, at whatever Time, or in whatever State I have yet observed them, either whilst intire, or when cut into several Pieces. I have constantly, in all these Cases, seen the Liquor that serves them instead of Blood, circulate from the Tail towards the Head, and that in Pieces which were scarcely half a Line in Length, or which, to speak more properly, were only *Granulæ* of Flesh.

I was, by this, able to distinguish the antierour End from the posterour; and to be as sure as possible, that it is always the antierour, on which the Head appears again.

VII. Among those Plants that may be raised from Slips and Cuttings, there are some that seem to have this Property to such a Degree of Perfection, that the least Twig will become a complete Plant again. Hath the great AUTHOR of Nature, when He ordained, that certain Insects, like our Worms, should resemble those Plants in this Particular, allowed them the Power of being reproduced to the same Degree? Or, which is the same thing, will this Reproduction take place in whatever Part the Worms are cut? I have thought this worth inquiring into. In order to it, I cut off from one of these Worms both the Head and the Tail; that is to say, I parted from each of its Extremities a Piece of the Length of
about

about a Line. Both Pieces perished in about Twenty-four Hours, the Tail first, and the Head after. As to the Body, it continued to move almost as if I had not made the Operation. I have even seen, what appeared to me extremely remarkable, that, a few Moments after, it thrust itself into the Mud, making use of its anterior Extremity, as of a Head, to bore its Way through. I have repeated this Experiment with the same Success: So that I am confident I may assert, that there are in the Body of these Worms at least Two Points, where, if they are cut, the Reproduction will not take Place. The one is about the Fifth or Sixth Ring from the Head; the other, at an equal Distance from the Extremity of the Tail. Is not, perhaps, the Condition of the great Artery in these Two Parts the Cause of it? This indeed seems to me probable; remembering, however, that what I have just said only relates to the Two Pieces detached from those Extremities; for, as to the intermediate Body, it not only continues to live, but it is even not long before it regains all that was taken from it. Where then does the Principle of Life reside in such Worms, as, after having their Heads cut off, still shew not only the same Motions, but even the same Inclinations? Yet what is this Difficulty, compared with many others, that at the same time present themselves to our Mind? This wonderful Reproduction of Parts, is it only a natural Consequence of the Laws of Motion? Or does it rather depend on a Chain of minute Buds or Shoots, a sort of little Embryos, already formed, and lodged where the Reproductions are to begin? Are these Worms only mere Machines, or are they like more perfect Ani-

Animals, a sort of Compound, the Springs of whose Motions are actuated by a kind of Soul? And, if they have within themselves such a Principle, how can this Principle afterwards appear in every distinct Piece? Shall we grant, that there are in these Worms as many such Souls as there are Pieces of the same capable of becoming complete Worms? Shall we believe, with *Malpighi*, that these sorts of Worms are all Heart and Brain, from one End to the other? This may be; and yet we know but little the more for it. After all, we must content ourselves with admiring the astonishing Works of the GREAT CREATOR, and sit down in Silence.

VIII. The Nicety of the Sense of Feeling in Spiders has been much talked of; yet do not I know whether our Worms may not, in this Particular also, shew something still more surprising. I have already observed, that upon bringing near them the End of a Splinter, they begin to frisk about, almost before it reaches them: And I have since made other Experiments, which leave me in doubt, whether it is not rather to their Sight than to their quick Sense of Feeling, that I ought to ascribe what I observed in this respect. I have found, that, when the first Rays of the Sun came to fall upon the Vessels of Water in which I kept those Insects, their Motions seemed presently to become more lively. I have fancied, at least, that I saw the same thing, when, after having put them into the Shade, I threw the Light of the Sun upon them from a Looking-glass, or when I observed them by Candle-light: But what seems less liable to Mistake, is, that I have seen some of them creeping about in the Moon-shine, that in the Day-light
kept

kept themselves constantly folded together. I would not, however, venture to determine any thing upon this, till I am better satisfied by new Experiments.

IX. A Twig of *Willow, Poplar, &c.* planted in the Earth, takes Root there, and soon becomes a Tree, the least Twig of which will, in its Turn, become another. There is no End of this; and it is the same with our Worms. If we cut those that have been produced by Section, and do not carry the Division at once beyond Twelve or Fifteen Pieces, we shall not fail of having so many Animals. I have had Worms from the Fifteenths, and even the Twenty-fourths, of former Halves and Quarters; and I reckon, that in Two Years time I might, if I would, breed after this manner Forty or Fifty thousand Worms from one single one.

X. But how do these Worms propagate? Are they *viviparous* or *oviparous*? I shall just mention an Observation that to me seemed singular: As I divided one of these Worms into Eight Pieces, I saw some earthy Matter ouising out of one of the Pieces near the Head, in the midst of which I perceived something moving like a whitish Thread. I, at first, made no doubt but it was some Vessel, or like Piece of the Body of the Insect, which, not being quite separated from it, might still draw from thence the Principle of its Motion: But, taking to my Assistance a good Magnifying-glass, I was much surpris'd when I saw, that this supposed Vessel was a small Worm, and exactly of the Figure of that, in the Body of which it had before been inclosed. I immediately resolv'd to bring it up; and, to this End set it apart in a small Vessel filled with Water,

into which I put also a little Earth. It was not long before I was sensible, from the Quickness with which it thrust itself into it, that I had satisfied its Wants: However, from time to time, it came out again, and swam about. I could not but admire the Liveliness of all its Motions; and it was much like one of those little *Eels*, which, by the Microscope, are discovered in Vinegar. I watched it thus above Six Weeks, when, by an unforeseen Accident, I lost it: I was, however, already, in part, informed of what I hoped to learn; I mean, whether this Worm, which I had brought into the World by a sort of *Cæsarean* Operation, would not only continue to live, but would also acquire a greater Length; and this I had seen happen; for the Worm, which at first was hardly a Line in Length, was above as long again, when I had the Accident of losing it. It seems therefore natural to think, that if it had lived longer, it would have been a Worm exactly like that it came from. And I have looked upon this as the more probable, because Thirds of those Worms have also produced others and exactly like themselves.

I have examined some of these little Worms with the Microscope, and observed Two Particularities in them, which I have thought worth Notice: 1st, Long Hairs placed on the Sides of the Body, Two at each Joining of the Rings. 2^{dly}, That the Chanel of the *Intestines*, the great Artery, &c. appeared interrupted for about Two-thirds of the Length of the Body, so that for a Space, which to the Microscope appeared of about Two Lines, the Whole was so transparent, that nothing could be distinguished;

guished; whereas every-where else, except about the Five or Six First Rings, the Parts in Question were plainly visible: And especially the Stomach, by reason of the earthy Substance it was filled with. I have Reason to think, that these small Worms, observed again with fresh Attention, will shew me still something new, in their internal Parts. I divided one on the 28th of *March*, in the Place where I have said that the *Viscera* appeared interrupted. Next Day the Two Pieces buried themselves in the Mud; and on the First of *April*, being both applied to the Microscope, the Latter was found to have already got a Head as well-formed as that of the other Piece, and which had already begun to perform its natural Office of giving Admittance to the Food. It is remarkable, that Worms so tender, and so small, go through the Operation so well, and complete themselves so speedily even in cold Weather. This confirms what I shall observe below, that the more slender these Insects are, the sooner they complete themselves.

This unexpected Observation set me upon examining more carefully the internal Parts of these Worms. With the Help of a good Magnifying-glass, I thought I distinguished, in the Inside of one of the biggest on both Sides of the great Artery, small Worms like those I have spoken of above: I saw them move different Ways, extend themselves, and wriggle about. But, having had recourse to the Microscope, I began to doubt whether that I had before seen was really what it seemed to be. It then appeared, that what I had taken for Worms, were rather the Branches of those Vessels, accompanying the great Artery,

and participating of the Motions of the *Systole* and *Diastole* of that Vessel. Nevertheless, having again resumed several times these Trials, I have again been persuaded, I saw the same Appearances of small living Worms; which makes me still uncertain of the Truth of this Particular, and unable to determine what I ought to think.

XI. We cannot enough admire nor acknowledge the wise Conduct of Nature, in the Multiplication of the Species of Animals and Vegetables; forasmuch as we see, that those which are most useful to us, commonly multiply, either in a greater Proportion, or may be raised with greater Ease. But what End could that Wisdom, which does nothing in vain, have proposed to itself, in granting to such Insects as these a Property and Prerogative, which Animals, far more excellent in our Judgment, seem no ways intitled to? It is even certain, that these Insects naturally make use of this Power; and it is really true, that the same Wonders I have seen operated in my Glasses, are also performed every Day in the Brooks where they live. I have there met with Worms, some of which had yet no Heads, and others that only began to recover them. But, which is more, I have found some in the same State as those which had lost both their Heads and their Tails, or which had been divided into more than Two Pieces; and all these have afterwards fully completed themselves under my Eyes. Can this therefore be a natural way of multiplying with these Insects? Is it necessary, that, in order to bring forth new Worms, their Body should be divided and broke to Pieces?

Or

Or those which I have found divided, were they so only by any Accident? I could hardly have hoped, that my Observations would have furnished me with Answers to these or the like Questions: But Worms of this sort, which I kept intire, having divided themselves of their own Accord, have made me think, that this Accident sometimes proceeds from their having thrust themselves too far into the Earth, or from that Earth's being of too hard and resisting a Nature. It may therefore seem the more fit, that these Insects, whose Bodies are very tender, and liable to be separated, should reproduce what they lost in the manner I have been speaking of. I have farther observed, that they are subject also to a sort of Distemper, analogous to the Gangrene, that sometimes rots off considerable Parts of their Body; which, however, they recover afterwards, like those others which have had the same Parts cut away.

XII. Another sort of Worm, upon which I have begun to make Trials, is also found in the Water. It differs particularly from that I have been speaking of, in that it is considerably thicker. I have divided some of these in the Summer Season into Two, Three, and Four Pieces. Some have recovered the Head and the Tail; but that only after the Space of Twenty Days, during which they always lay like dead. They lived above a Month after, in a State very little different, as to outward Appearance; and afterwards perished, without making any farther Progress. The considerable Difference between the Times in which the Pieces of these last Worms complete themselves, and those employed by the former, with the greater Difficulty in their Success, do they not chiefly

proceed from their Thickness? And is it not possibly a Rule, that the slenderer Worms of this Class are, the sooner the Pieces separated from them will resume what is wanting? I should incline to think it is so.

XIII. But if the Water has its Insects, thus produced from Cuttings, the Earth is not absolutely without them. It also contains some perhaps yet more deserving our Admiration, than all that have hitherto been observed in this Kind. Those I mean, are Worms not to be sought for from *Japan* or *China*; but Insects to be met with every-where, and which, in the Eye of the Vulgar, appear the most contemptible. In short, they are only the common Earth-worms. When I began these Inquiries, I judged these Worms more proper than any others to be put to the Trial. Two things persuaded me to it: 1st, Their enormous Size, in comparison of those I had begun to work upon: And, 2^{dly}, The Manner in which they propagate. Every body now knows that these Worms are *Hermaphrodites*, but not such as I have shewn the *Pucerons* to be: That is to say, that an Earth-worm, though it is of both Sexes, cannot ingender without the Concurrence of its like. I have therefore divided some of these into Two, and others into Four Pieces; and some of them, at the End of about Three Months, which they have passed in a sort of Lethargy, did then proceed to resume both Heads and Tails. The Reproduction of the *Anus* is no long Work, a few Days are sufficient for it; but it is otherwise with the Head; that does not seem to perform its Functions in the Pieces of divided Worms, till about Seven Months after the Operation.

Now

Now what further excites my Curiosity, is, to know, whether they will copulate; if they do, the Wonder will be at its highest Pitch. As for what remains, I have made a Remark, not to be here passed over, both upon Earth-worms and Water-insects; which is, that the posteriour Parts always appear to suffer more in the Operation than the anterior. We see the former immediately giving itself, as it were, convulsive Motions, whilst the latter, almost constantly, moves about as usual.

XIV. I have also made Experiments, but without Success, on some sorts of terrestrial Millepedes; likewise on several of those kinds of Worms which metamorphose themselves into *Tipulæ*, or Water-spiders; but no one of them has succeeded.

These are the Observations I have begun to make upon so interesting a Subject. If they are compared with what still remain to be made, they must appear extremely imperfect; and I myself look upon them as no other than a rough Sketch of what others may possibly do hereafter.

Geneva, March
14. 1742. N. S.

Charles Bonnet,
Correspondent of the *Royal*
Academy of Sciences at Paris.

P. S. I should be unpardonable, if I did not endeavour to do all the Justice to Mr. *Trembley's* Observations that is due to them. He has excellently proved, that the aquatic Production, which he wrote to me about, is a true Animal, and of the Species of the *Polypus*, which, besides the surprising Property of reproducing its Parts, has also another

of multiplying itself by Sprigs or Suckers. Nothing can exceed the Sagacity with which he has conducted those Experiments that have led him into the Knowledge of things so very wonderful and surprizing, that they may truly be said to exceed all that Natural History had yet afforded of this Sort.

III. *An Account of an extraordinary Case of the Bones of a Woman growing soft and flexible; communicated to the ROYAL SOCIETY by Mr. Sylvanus Bevan, F. R. S.*

Read May 5.
1743.

THE Wife of one *B. S.* in the Year 1738. was taken with a Diabetes, with the usual Symptoms, *viz.* A frequent and copious Discharge by Urine, a gradual Wasting of the Body, a hectic Fever, with a quick low Pulse, Thirst, great Pains in her Shoulders, Back, and Limbs, and Loss of Appetite. She continued in this manner Two Years, (notwithstanding the Use of Medicines generally prescribed in such Cases) much emaciated; at which time she was attacked with an Intermittent, which soon left her; after which the Diabetes gradually decreased, so that in some few Months she was intirely free from that Disorder, but the Pains in her Limbs still continued. She recovered her Appetite very well, breathed free and easy, and her Hectic very much lessened, though she had some Appearance of it at times.

About Eighteen Months ago, she had such a Weakness and Pains in her Limbs, that it confined her to her

her