

PHILOSOPHICAL TRANSACTIONS.

Monday, January 6. 1668.

The Contents.

New Experiments, to the number of 16, concerning the Relation between Light and Air (in Shining Wood and Fish); shewing, That the withdrawing of the Air from those and the like Bodies, extinguishes their Light, and the readmission of the Air restores it. An Account of two Books: I. PARTHOLOGIÆ CEREBRI & NERVOSI GENERIS SPECIMEN: In quo agitur de MORBIS CONVULSIVIS & SCORBUTO, studio THOMÆ WILLIS M.D. II. ALPHABETUM NATURÆ. Authore F. M. B. V. HELMONT.

New Experiments

Concerning the Relation between Light and Air (in Shining Wood and Fish); made by the Honourable ROBERT BOYLE, and by him addressed from Oxford to the Publisher, and so communicated to the Royal Society.

SIR,

TO perform now the promise I made you the other day, I must acquaint you with what will perhaps somewhat surprise you, by giving you an Account of what I tried on Tuesday night last (Octob. 29. 1667.) and the two or three following nights, about the Relation between Air and Light, as this is to be found in some Bodies.

The occasion of these Trials was this: Having, as you know, long since made some Notes, chiefly Historical, upon particular Qualities, and finding Light to be (how justly I now dispute, not) reckon'd by the generality of Philosophers among Qualities, I handled together what Observations I had either made by my self, or received from some ingenious Travellers (to whom I recommended my Enquiries) about Shining Bodies; and had also prepared several Trials about them, to be made when I should have opportunity, and requisite Instruments to put them in

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practice,

practice, which, as to some of those designed Experiments, have been long denied me. But having at length got hither one of my little Engines, and having also procured, after much enquiry, a few small pieces of Shining Wood, I began on the day abovementioned to try with them an Experiment I found in my List. And though the main Experiment be but one, I intended to set down what occur'd to me about it but as several Phænomena of it; yet finding it requisite to acquaint you with some Tryals that are not so properly Parts of it, I shall for distinction sake propose them as several Experiments; the Narratives whereof are taken, for the most part, verbatim out of the Notes I set down for my own use, when the things to be registred were freshly done. Which Advertisement I give you, both to excuse the carelessness of the Style, and to induce you not to distrust a Narrative that was made only to serve my Memory, not an Hypothesis.

Experiment I.

TO try whether or no a piece of *shining Wood*, being put into a Receiver of our *Pneumatick Engine*, would, upon the withdrawing and readmitting of the *Air*, suffer such changes, as I have often observed a *Live Coal*, placed there, to do; having at length procured a piece of such Wood, about the bigness of a *Groat* or less, that gave a vivid *Light* (for *rotten Wood*), we put it into a middle-sized *Receiver*, so as it was kept from touching the *Cement*; and the Pump being set a work, we observed not, during the *five* or *six* first Exsuctions of the *Air*, that the splendour of the included *wood* was manifestly lessened (though it never was at all increased); but about the *seventh* suck, it seemed to grow a little more dim, and afterwards answered our expectation, by losing of its *Light* more and more, as the *Air* was still further pumped out; till at length about the *tenth* Exsuction (though by the removal of the *Candles* out of the *Room*, and by black *Cloaths* and *Hats* we made the place as dark as we could, yet) we could not perceive any *Light* at all to proceed from the *Wood*.

Experiment II.

Wherefore we let in the outward *Air* by degrees, and had the pleasure to see the seemingly extinguisht *Light* revive so fast and perfectly, that it looked to us all almost like a little flash of *Lightning*, and the splendour of the *Wood* seemed rather

rather greater, than at all less, than before it was put into the *Receiver*. But partly for greater certainty, and partly to enjoy so delightful a spectacle, we repeated the Experiment with the like success as at first. Wherefore being desirous to see how soon these Changes might be produced, we included the Wood in a very small Receiver of clear Gla's, and found; That in this the Light would begin to grow faint at the *second*, or at least at the *third* Exsuction of the Air, and at the *sixth* or *seventh* would quite disappear. And we found by a Minute-Watch, that the sending the Candles out of the Room, the pumping out the Air 'till the Wood would shine no more, the readmitting of the Air (upon which it would in a trice recover its Light) and the sending in for the Candles to consult the Watch, did in all take up but *six* Minutes.

Experiment III.

THe forementioned Experiment, without taking notice how long it lasted, being reiterated twice in this new Receiver, we had a desire to see, whether this *luminousness* of our Wood would more resemble a *Coal*, or the Life of a *perfect Animal*, in being totally and finally extinguish'd, in case the Air were kept from it a few minutes, or else the Life of *Insects*, which in our exhausted *Receiver* I had observed to lose all appearance of its continuing, and that for a much longer time than a few minutes, and yet afterwards, upon the restitution of Air, to recover presently, and shew manifest signs of Life: Wherefore having exhausted the *Receiver*, 'till the Wood quite disappeared, we stayed somewhat above a quarter of an hour in the dark, without perceiving that the Wood had regained any thing of Light, though about the end of this time we made the place about it as dark as we could; and then it being too late at night to protract the Experiment, we let in the Air, upon whose admission the Wood presently recovered Light enough to be conspicuous at a distance, though it seemed to me somewhat less vivid than before, which yet may be either a weakness in my sight, or an effect of the steams of the Cement; unfriendly perhaps to the Luminousness of the Wood.

Thus far we proceeded yester-night, to which we this Night added these Observations.

We put in a piece of Wood bigger than the former (this being above an inch long) and that shone very vigorously. And having by a few sucks quite deprived it of Light, we left it in the exhausted *Receiver* for full half an hour, and then coming into the dark Room again, we found all had not continued so stanch, but that some small portion of Air had insinuated it self into the *Receiver*. This we concluded to be but a small portion of Air, because the Wood was but visible to an attentive Eye. And yet, that it was really some Air, which was got in, that caused the little glimmering light, which we perceived, may appear by this, that it did presently (as we expected) vanish at the first or second suck; and then the Air being let into the dark *Receiver*, the included Wood presently shone again as before, though I suspected, I discerned some little diminution of its brightness; which yet, 'till further Trials of the like kind, and for a longer time, have been made, I dare not affirm. Before the *Receiver* was sufficiently emptied at the beginning of the Experiment made with this greater piece of Wood, a small Leak accidentally sprung, which, letting in a little Air, did sooner than we intended, recall the almost disappearing Light.

Experiment IV.

THere is an Experiment of affinity with the former, which we thought it not altogether impertinent to try: For having observed on another occasion, That sometimes the Operation, which the withdrawing the Air hath upon a Body included in the *Receiver*, proves more considerable some *minutes* after we have ceased pumping, than *immediately* after the exercise is left off, I imagined, that even in such cases, where the Light is not made wholly to disappear (though it be made almost quite to do so) by the emptying of the *Pneumatical* Glass, the suffering the Body to remain a while there, though without any pumping (unless now and then a very little to remove the Air, that might have stollen in in the mean time) the remaining Light of the Body might probably be further impaired, if not reduced quite to vanish. To examine this conjecture, we put in a Body that was not Wood, which had some parts much more luminous than the rest;

rest ; and having drawn out the Air, all the others disappeared, and even the formerly brighter ones shone but faintly, when the *Pneumatical Glass* seemed to be exhausted. But keeping the included Body a while in that unfriendly place, we perceived the parts, that had retained light, to grow more and more dim, some of them disappearing, and that, which was formerly the most conspicuous, being now but just visible to an attentive Eye, and that scarce without dispute ; for if we had not known beforehand, that a shining matter had been included in the *Receiver*, perhaps we should not have found it out. And he that had the youngest Eyes in the company could not at all discern it, (the Air being let in, the Body began to shine again.) But this being a single Trial, which the lateness of the night hinder'd us from reiterating, is to be further prosecuted, and in differing substances, before much be built upon it.

Experiment V.

THe *Rarefaction* or Expansion of the Air having so notable an operation upon our shining Wood, I thought it would not be amiss to try, what the *Compression* of the Air would do to it. For which purpose we included a piece of it in such a little Instrument to compress, which you may remember to have been devised and proposed by Mr. *Hook*. But though we impell'd the Air forcibly enough into the Glass, yet by reason of the thickness requisite in such Glasses, and the opacity thence arising, we were not able then to determine, whether or no any change was made in the luminousness of the Wood.

Which I thought the less strange, because by some Experiments purposely devised (at one of which I remember you were present) I had long since observed, That even a great pressure from a fluid Body, which presseth more uniformly against all the parts, it toucheth of the consistent Body, does work a far less manifest change even on soft or tender substances, than one would expect from the force wherewith it compresseth.

And were it not, that one contrary oftentimes minds us of another, I might have forgot, that I had divers thoughts about finding some good ways of Trying, whether any such change of Texture might be discover'd to be made in the shining Wood by
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the absence and return of the ambient Air, as might with any probability have the loss or recovery of the Woods splendour attributed to it. For I had formerly (if I were not mistaken) found by several circumstances, which I shall not now stay to name, That a slight (so it be an appropriated) variation of the Texture of this Wood, and which may seem mainly to respect the Pores (which perhaps ought to be of a determinate shape and size, and filled with a determinate matter) will have a great operation upon its splendour. And I formerly found by other Trials, that even consistent Bodies, if soft ones, may have their Pores enlarged and vitiated, and their bulk, and consequently their texture (at least as to their Pores) manifestly enough alter'd, by having the Air withdrawn from about them (whereby the Aerial Particles within them were enabled to expand themselves) and let in again, whereby, as to sense, they seem'd pretty well restored to their former state. But the success of my endeavours either with *Microscopes* (through which a vivid piece of Wood will shine by its own light) or otherwise, was not considerable enough to deserve a particular account, especially in this Paper, where I am not to venture at matter of *Theory*.

Experiment V I.

THinking fit to try, Whether a small quantity of Air, without being ventilated or renewed, might not suffice to maintain this cold Fire, though it will not that of a Live Coal, or a piece of Match, we caus'd a piece of shining Wood to be Hermetically sealed up in a pipe of clear and thin Glass; but though carrying it into the dark, we found it had quite lost its light, yet imagining that that might proceed from its having been overheated (being sealed up in a Pipe not long enough to afford it a due distance from the flame of the Lamp we employ'd to seal it) we caus'd two or three pieces of fresh Wood, amounting all of them to the length of about two inches, to be seal'd up in a slender pipe between four or five inches in length, which being warily done, the Wood retained its light very well, when the Operation was over; and afterwards laying it by my bed-side, when the Candles were carried away out of the Room, I considered

dered it a while before I went to sleep, and found it to shine vividly.

The next morning when I awoke, though the Sun was risen, yet forbearing to draw open the Curtains of my Bed 'till I had looked upon the sealed Glass, which I had fenced with a piece of Cloth held between it and the Window, my Eyes having not yet been exposed to the day-light since the darkness they had been accustomed to during the night, made me think the Wood shined brighter than ever. And this night, after ten of the Clock, looking on it in a dark place, it appeared luminous all its length, though not so much so as in the morning.

The morning after, and the night after that, the same Wood did likewise manifestly, though not vigorously shine, especially one piece, whose light was much more vivid than the rest. And, for ought I know, I might have observed them to shine longer, if one of the sealed ends of the Glass had not been accidentally broken.

Experiment VII.

WHilst the former Trials were making, I was wishing for a good *Bolonian Stone*, to try what effect the withdrawing of the Air would have upon it. For though I knew it might be objected, that the Experiments of Light performable in our *Engine*, must be made in the night, whereas the *Bolonian Stone* gains its light by being exposed to the Sun-beams, yet that Objection did not hinder my wish, since the better sort of *Bolonian Stones* may be indued with a luminousness by the flame of Fire, or of large Candles.

I also wished for such a *shining Diamond*, as is now in the hands that best deserve such a Rarity, our *Royal Founder's*. For you may remember, that in the Observations I made of that Stone, and annexed to the conclusion of the Book of *Colours*, I shew how it may several ways be brought to shine; so that by one or other of those ways, especially that of external Heat, I thought it very likely I should be able to make the light continue four or five minutes, which would be long enough to try in a very small *Receiver*, exhaustible at a Suck or two, whether the withdrawing and restoring the Air would have any visible Operation on it?

I also wish'd for some of the *Glow-worms*, with which I formerly made other Trials. For though I forgot not what operation the withdrawing of the Air by our *Engine* is wont to have upon living Creatures; yet that made me not forbear my wish, not only because of the different effect I have found the *Engine* to have on *Insects* in respect of other Animals, but because I am not of the opinion of those modern Writers, who will have the Light of *Glow-worms* depend altogether upon their Life, and end with it. But being not likely by my wishes to procure any new subject to make trials on, I thought fit at least to do what was in my power, and accordingly (to gratifie them, who, I presumed, would, if present, propose such a Trial) caused a piece of *Iron* to be forged, whose top was of the bigness of a *Nutmeg*; the rest being a stem, of an inch, or an inch and a half long, for which we provided a little Candlestick of Tobaccopipe-clay, which would not yield any smোক to fill and darken the *Receiver*. Then having heated the *Iron* red-hot, and placed it in this Clay, so that the round part was clearly *protuberant*, we convey'd it into the *Receiver* of white Glass, which was so placed, as to keep the sides at as good a distance as we could from the *Iron*, lest the excessive heat should (as we much feared it would) break the Glass. Then sending away the Candles, and making the Room dark, we hastily pumped out the Air, but could not perceive the withdrawing of it had any operation on the glowing *Iron*. And though it continued shining long enough to give us opportunity to pump out and let in the Air three several times, yet we could not observe, that the Air had any manifest operation one way or other. For though upon the withdrawing of the Air the *Iron* grew dimmer and dimmer, yet that I attributed to the *cooling* of it; and the rather, because having (to examine the conjecture) let in two or three times the Air, when the *Receiver* had been exhausted, there appeared no manifest increase of Light upon sudden admission of it.

Experiment VIII.

HAVING formerly in our *Physico-Mechanical* Experiments, about the *Spring* of the *Air*, observed, That the Air is thus far a Vehicle of *Sound*, that a Body but faintly sounding, being placed

placed in our *Receiver*, gave a yet weaker sound when the Air was withdrawn from about it, than when the *Receiver* was full of Air: I presumed, some curious persons would, if they had been present, desire to have a trial made, whether or no a small piece of *Shining Wood* being so included in the *Receiver*, as that the pumping out of the Air should have no injurious operation upon the body of it, its Light would upon the withdrawing of the Air be manifestly diminish'd. And this I was the less backward to try, because (not to mention the *Relation*, which the former Experiments shew there may be in some cases between *Light* and *Air*) it did not readily occur to my memory, that by any *manifest Experiment* (for I know, there are probable Reasons to prove it) it appeared, that a Body more thin than Air will or can transmit Light, as well as other *diaphanous mediums*. And those modern *Atomists*, that think, there is in our *exhausted Receiver* very many times more *Vacuum* than *Body*, would, I presumed, be glad to be supplied with an Argument against the *Peripateticks*, to shew, That the motion of Bodies, *viz.* the Corpuscles of Light, may be freely made in *Vacuo*, and proceed without the assistance of a Vehicle.

Wherefore having *Hermetically* sealed up a small piece of *Shining Wood* in a slender Pipe, and placed it in a small *Receiver* that was likewise made of clear Glass, we exhausted it of Air, and afterwards let in again that which we had excluded. But by neither of the Operations could we perceive any sensible decrement or encrease of the Light of the Wood, though by that very Observation it appeared, that the Glass had been well sealed, since otherwise the included Air would have got out of the Pipe into the *Receiver*, and have left the Wood without Light.

Experiment IX.

I Had also a mind to try, both what *degree* of *Rarefaction* of the *Air* would deprive the *Wood* of its splendour in such and such measures, and whether or no the self-same Air, which, when rarified, would not suffer the Wood to shine, would, when reduced to its former density, allow it to shine as much as before.

This I proposed to do, by putting some *Shining Wood* into a
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clear and conveniently shaped Glafs, that the long Stem or Pipe being so far filled with *Quicksilver*, as that there might be about half a spoonful of Air left at the enclosed end where the *Wood* was placed, it might be inverted into a little Glafs of *Stagnant Quicksilver*, and therewith conveyed into a slender *Receiver*, out of which, as the *Air* should come to be pumped, that included in the Glafs, which held the *Wood*, might be rarified, and afterwards upon the admission of the outward *Air* (which must impell up the *Quicksilver* to its former height) might be restored to its former state: But when we came to make trial of this, we had no *Receiver* conveniently shaped that was so clear and thin, as that we could see the *Wood* shine through both the Glasses. And though we would for an Expedient have substituted a fine thin Bladder wherein the *Wood* was to be put, and a convenient quantity of *Air* strongly tied up with it, yet for want of a Bladder fine enough for our turn, that Expedient also proved useles to us. But being desirous to make what trial we could by the least unfit means we had in our power, we got an old, but thin Glafs, sealed at one end, whose shape was pretty *Cylindrical*, and whose bore was about the bigness of a man's little finger, and whose length was about a foot or more. Into this Pipe, near the seal'd end, we put a piece of *Shining Wood*, wedged in with a piece of *Cork* to keep it from falling; and having inverted the nose of it into another slender Glafs, but not *Cylindrical*, wherein was pretty store of *Quicksilver*, we put them both into a long *Receiver*, shaped almost like a *Glass Churn*, and having pumped a while, that the *Air* included in the Pipe expanding it self, might depress the *Quicksilver*, and so make escapes into the *Receiver* as long as we thought fit; we then let in the outward *Air*, that the *stagnant Quicksilver* might be impelled into the cavity of the Pipe now freed from much of the *Air*, to the height requisite for our purpose.

This done, we plied the Pump again, and observed, That as the *Air* in the Pipe did by its own *Spring* expand it self more and more, and grow thinner and thinner, the *Shining Wood* grew dimmer and dimmer, till at length it ceased to shine, the internal *Air* being then got a good way lower, than the surface of the external *Quicksilver*; whereupon opening the commerce between the cavity of the *Receiver*, and the *Atmosphere*, the *Quick-*
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silver was driven up again, and consequently, the *Air* above it was restored to its former density; upon which, the *rotten Wood* also recover'd its light. What the greatest Expansion of this *Air* was, we could not certainly determine, because the Expansion rais'd the *external Quicksilver* so high, as to hinder us to see and measure it. But we guessed, that the *Air* reached to about a foot or more from the top of the Pipe to the surface of the *Quicksilver* near the bottom of it. But when that rarified *Air* was impell'd into its former dimensions, we measured it, and found, that the upper part of the Tube, unpossit by the *Quicksilver*, was about three inches; and the *Wood* being about an inch long, there remained two inches or somewhat better for the *Air*. But this Experiment is to be repeated, when exacter Instruments can be procured.

Experiment X.

THinking it fit to try, as well, Whether *sinking Fish* that shines be of the same nature, as to Luminousness, with *rotten Wood* that shines too; as, whether the withdrawing of the *Air* will extinguish or eclipse the Light of a considerable *bulk* of luminous matter, as in the Experiments hitherto made, we found it would do to a *small* one: We took a *Fish* that we had kept; and caused to be watched 'till 'twas almost all over Luminous, though much more in the *Belly*, and some parts of the *Head*, than elsewhere: And having suspended him in a conveniently shaped *Receiver*, we found him to give so great a light, that we suspected beforehand, that the withdrawing of the *Air* would hardly have its full operation upon a *Body*, whose *bulk* was considerable, as well as its *light* very vivid, and which had many luminous parts retired to a pretty distance from the *Air*. Accordingly having exhausted the *Receiver* as much as we were wont, it appeared indeed, especially towards the latter end of the operation, that the absence of the *Air* did considerably *lessen*, and in some places *eclipse* the light of those parts that shone less strongly. But the *Belly* appeared not much less luminous than before: Wherefore supposing, that upon the turning of the *Stop-cock*, the *Air* coming in much more hastily than it could be drawn out, we should have the best advantage to discern, what interest it had in the Lumi-

nousness of the Fish, we readmitted it, and upon its rushing in, perceived the Light to be as it were revived and encreased; those parts of the Fish that were scarce visible before, or shone but dimly, receiving presently their former splendour.

And not to leave unprofecuted the remaining part of the Experiment, which was to try, Whether it was the *Kind* of the Luminous Body, or only the *greatness* of the *Bulk*, and the *vividness* of *Light*, and, if I may so speak, the *Tenacity* of the substance it resided in, that made the difference between the *Fish* and the *wood*; we put part of the Fish of another kind, that shone much more faintly than *that* hitherto spoken of, and but in some places; and by the withdrawing the *Air*, we made some of the luminous parts disappear, and the others so dim, as scarce to be discerned, and yet both the one and the other regained their former light upon the return of the *Air*.

And to pursue the Experiment a little further, we put in such a piece of the first Fish as though it were bright, was yet but thin, and not considerably great, and upon pumping out the *Air*, we found it, according to our expectation, quite eclipsed, though it recovered its Light upon the *Air's* re-entry.

THese, Sir, are the Experiments I have lately made about Shining Bodies in our Engine. More I would have tried, notwithstanding the trouble we found in managing the Engine in the dark, if rotten Wood had not failed us, and if I were not in a place, where Glass-men's Shops are not near so well furnish'd as the Stationers.

I scarce doubt, but these Experiments will occasion among the Virtuosi several Queries and Conjectures, according to the differing Hypotheses and Inquiries, to which men are inclined. And particularly 'tis probable, that some will make use of this Discourse to countenance their Opinion, That notwithstanding the Coldness (at least as to sense) of Fishes and other Animals, there may be in the Heart and Blood a Vital kind of Fire, which needs Air, as well as those Fires that are sensibly hot: Which may lessen the wonder, that Animals should not be able to live when robbed of Air. And if I had now time, I could possibly furnish you with some other Trials, that seem much to favour the Comparison, though as to the opinion it self of a Vital Flame, I shall not now tell you my thoughts about it. And though not only the Cartesians will perhaps draw an Argument from the past Phænomena in favour of their Theory of Light, but divers others will discourse upon them, and propose further Questions, and perhaps Enquiries suitable to their several Hypotheses; yet I shall content my self at present to have faithfully delivered the Historical part of these Apparences, without
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making, at least at this time, any Reflections on them. And the rather indeed, because I enjoyed so little health when I was making the Experiments, that 'twas not fit for me to engage in Speculations, that would much exercise my thoughts, which, I doubt, have been more gratified, than my health hath been by the bare Trials, which are most seasonably made at hours unseasonable for one that is not well.

P O S T S C R I P T

*Sent by the same Noble Author from the same place,
December 6. 1667.*

M*T condition in point of health being not much improved since I writ to you in October last, when I shall have added, that I have not these five or six weeks been able to procure any Shining Wood (except one single piece, which, though large, was so ill-condition'd, that it afforded me but one Trial) you will not, I hope, expect, that I should add much to the Experiments I formerly sent you, about the Relation 'twixt Light and Air. But however, since the Subject is new and noble, and since your curiosity about other matters has been so welcome and useful to the Virtuosi, I shall not decline even on this occasion to comply with it, and the rather, because I half promised you some Additionals a good while since, and because too, that though, what I shall acquaint you with, may seem to be but a Confirmation of two or three of the former Experiments; yet, besides that 'tis of them which most needed a Confirmation, these Trials will also afford some Circumstances that will not, I think, be unwelcome.*

Experiment XI.

T*O examine then the Conjecture mentioned in the last Experiment, That the durableness of the Light in the Shining Fish, in spite of the withdrawing the Air, might proceed in great part from the vividness of it, and the beauty of the matter it resided in, rather than from the Extent of the Luminous Body, in comparison of the small pieces of Shining Wood, I hitherto had made my Trials with; I put in the above-mentioned piece of Wood, whose luminous Superficies might be perhaps ten or twelve times as great as that which the Eye saw at once of
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the surface of such fragments of *Shining Wood*, as I was wont to employ: And though some parts of this large *Superficies* shined vividly (for the light was usually enough for rotten Wood, inferior to that of our Fish) yet this great piece being put into a convenient *Receiver*, was, upon the withdrawing of the Air, deprived of Light, as the smaller ones had been formerly; the returning Air restoring its Light to the one, as it had done to the other.

Experiment XII.

BUT this is not the chief thing I intended to acquaint you with, *That* being the success of some Trials; which we made in prosecution of these two neighbouring Experiments.

In the *first* of these I told you, I had been able to try but for half an hour or a little more, that a *shining* piece of *Wood*, deprived in our *Engine* of Light, would yet retain a disposition to be as it were rekindled upon the fresh access of the Air. Wherefore, though I could have wished to have made a further Trial with the same kind of Bodies, yet being able to procure none, I substituted in their room small pieces of *rotten Fish*, that shone some of them more faintly, and some of them more vividly, in reference to one another, but none as strongly as some that I could have employed; and having in a very small and clear *Receiver* so far drawn off the Air, as to make the included Body disappear, we so ordered the matter, that we kept out the Air for about 24 hours; and then allowing the Air to re-enter in a dark place, and late at night, upon its first admittance the *Fish* regain'd its Light.

Experiment XIII.

THis, compar'd with some of my former Observations about *Putrefaction*, put me upon a Trial, which, though it miscarried, I shall here make mention of, that in case you, who are better furnish'd with Glasses, think it worth while, you may get reiterated by the *Society's* Operator; considering then, how great an interest *Putrefaction* hath in the *shining* of *Fishes*, and *Air* in the *Phænomena* of *Putrefaction*, I thought it might be somewhat to the purpose, to take a Fish that was, according to the common

mon course I had observed in Animals, not far from the state, at which it would begin to shine; and having cut out a piece of it, I caused the rest to be hung up again in a Cellar, and the expected piece to be put into a small and transparent *Receiver*, that we might observe, if a day or two, or more, after the Fish in the Cellar should begin to shine, that in the exhausted *Receiver* would either also shine, or (because that seemed not likely) would, notwithstanding the check, which the absence of the Air might be presumed to give the *Putrefaction*, be found to shine too, either immediately upon the admission of the Air, or not long after it.

But this Experiment, as I lately intimated, was *only* design'd and attempted, not compleated; the *Receiver* being so thin, that upon the exhaustion of the *internal* Air, the *weight* of the *external* broke it; and we could ill spare another of that kind from Trials, we were more concerned to make: Notwithstanding which, we made one Trial more, which succeeded no better than the *former*, but miscarried upon a quite differing account, *viz.* because neither the included piece of Fish, nor the remaining, though it were of the same sort with the Fishes I usually employed, would shine at all, though kept a pretty while beyond the usual time, at which such Fishes were wont to grow luminous.

If this Experiment had succeeded, I had some others to try in prosecution of it, which I shall not now trouble you with the mention of. But that this *Paragraff* may not be useless to you, I'll take this occasion to give you a couple of *Advertisements*, that may relate not only to this Experiment, but also more generally to those, whether precedent or subsequent, where *shining Fish* are employed.

Advertisement I.

IN the first place then, I will not undertake, that all the Experiments you shall make with rotten Fish, shall have just the same success with these I have related. For, as I elsewhere observed, (in a Discourse written purposely on that Subject) that the event of divers other Experiments is not always certain, so I have had occasion to observe the like about Shining of Fishes. And, besides what I lately took notice of at the close of the tenth Experiment, I remember, that having
 once

once designed to make Observations about the Light of rotten Fishes, and having in order thereunto caused a competent number of them to be bought, not one of them all would shine, though they were bought by the same person I was wont to employ, and hung up in the same place where I use to have them put, and kept not only 'till they began to putrifie, but beyond the time that others used to continue to shine; although a parcel of the same kind of Fishes, bought the week before, and another of the same kind, bought not many days after, shined according to expectation. What the reason of this disappointment was, I could not determine; only I remember, that at the time, it happen'd, the weather was variable, and not without some days of Frost and Snow. Nor is this the oddest Observation I could relate to you about the uncertain shining of Fishes, if I thought it necessary to add it in this place.

Advertisement II.

Notice must also be taken in making Experiments with shining Fish, that their luminousness is not wont to continue very many days. Which Advertisement may be therefore useful, because without it we may be apt sometimes to make Trials, that cannot be soon enough brought to an issue; and so we may mistake the loss of Light in the Fish to be a deprivation of it caused by the Experiment, which indeed is but a cessation according to the usual course of Nature.

Experiment XIV.

I Know not whether you will think it worth while to be told of a Trial that we made, to save those Criticks a labour, that else might perhaps demand, why 'twas not made. We put therefore a piece of *Shining Fish* into a wide-mouth'd Glass, about half filled with fair Water, and having placed this Glass in a *Receiver*, we exhausted the Air for a good while, to observe, Whether, when the pressure of the Air was removed, and yet (by reason of the Water that did before keep the Air from immediately touching the Fish) the Exhaustion of the *Receiver* did not deprive the Fish of that contact of Air, which it had lost before: Whether, I say, in this case the absence of the Air would have the same influence on the shining Body, as in the former Experiments? And here,

here, as far as the numerous bubbles excited in the Water would give us leave to discern it (for they did, though not unexpectedly somewhat disturb the Experiment, which inconvenience we might have prevented, if we had thought it worth while) we could not perceive, that either the absence or return of the Air had any great operation upon the Light of the immersed Body; which yet did not keep me from intending to make a somewhat-like Trial with *Shining Wood* (when I can get any) fastened to the lower part of a clear Glass, and covered over, but not very deep, with *Quicksilver*. Of which practice I shall not now stay to give you the Reasons, having elsewhere fully enough expressed them.

And that this *Section* may acquaint you with something besides the (seemingly) insignificant Experiment related in it, I shall here inform you (since I perceive, I did not in the first Papers I sent you) that though, when I formerly put together some Notes about Luminous Bodies, I confined not my Observations to one or two sorts of Fishes, yet the Experiments, sent you since *October* last, were all of them (except a *Collateral* one or two) made with *Whitings*, which, among the Fishes, I have had occasion to take notice of, is (except one sort that I cannot procure) the fittest for such Trials, and consequently fit to be named to you, to facilitate your future ones, in case you think it requisite to make any upon such subjects.

Experiment XV.

THe other of the two neighbouring Experiments I lately mention'd (*viz.* the ninth) I told you, when I sent it you, needed a reiteration to confirm it, since we had but once tried it (and that without all the conveniency we desired) that a shining Body, which upon the first withdrawing the Air loseth *much*, but not *all* its Light, may be deprived of the rest by continuing in that unfriendly place, though the Air be no further exhausted. To prosecute therefore both the Experiments in one Trial, we took somewhat late at night a piece of rotten Fish, which we judged to shine too strongly, to be quickly deprived of all its Light, and having put it into a small and clear *Receiver*, we found (as we had foreseen) that the Light was much impaired, but nothing near

ſuppreſſed by the withdrawing of the Air. Wherefore having removed the *Receiver* into a convenient place, I cauſed it to be brought to me about midnight (after I was in Bed) and having by cloſe drawing the Curtains, and other means, made the place pretty dark, I perceived the included Body to continue to ſhine more vividly than one would have expected, (and, if I miſtake not, I ſaw it ſhining in the morning, whilſt it was dark;) but the night after, coming to look upon it again, its light appeared no more: notwithſtanding which, I made a ſhift to keep out the Air about 24 hours longer, and ſo after 48 hours in all, we opened the *Receiver* in a dark place, and preſently upon the ingreſs of the Air were pleaſingly ſaluted with ſo vivid an Apparition of Light, that the included Body continued to ſhine, when carried into a Room, where there was both Fire and Candle, if it were but by a Hat ſcreen'd from the beams.

Being encouraged, as well as pleaſed with this ſucceſs, we forthwith exhausted the Air once more out of the ſame *Receiver*, and having kept it about 4 hours longer, we lookt upon it again in a dark place, and finding no appearance of Light, let the Air in upon it, whereby it was made to ſhine again, and that vigorously enough, ſo that I had cauſed the *Receiver* to be exhausted once more, but that it being *Sunday* night, I was unwilling to ſcandalize any, by putting my Servants upon a laborious, and not neceſſary work.

The ſuddenneſs, with which the included Body appeared to be, as 'twere, rekindled upon the firſt contact of the Air, revived in me ſome ſuſpicions I have had about the poſſible cauſes of theſe *ſhort-liv'd Apparitions* of Light (for I ſpeak not now of *real* Lamps found in Tombs, for a reaſon to be told you another time) which diſcloſing themſelves upon mens coming in, and conſequently letting in freſh Air into Vaults, that had been very long cloſe, did ſoon after vaniſh. Theſe thoughts, as I was ſaying, occurr'd to me upon what I had been relating, by reaſon of the ſudden operation of the freſh Air upon a Body, that but a minute before diſcloſed no light. For though the Lights reported to have been ſeen in Caves, quickly diſappeared, which that of our Fiſh did not; yet that difference might poſſibly proceed from the Tenacity, or ſome other diſpoſition of the matter, wherein

wherein the luminousness of the Fish resides: For I remembered that I had more than once observed a certain glimmering and small Light to be produced in a sort of Bodies upon putting them out of their former *Rest*, and taking them into the Air, which sparks would vanish themselves sometimes within one minute, sometimes within a few minutes. But as these thoughts were but transient conjectures, so I shall not *entertain* you any longer about them, but *rather contenting* my *self* with the hint *already given*, take notice of what may be more certainly deduced from our Experiment, which is, That the *Air* may have a much greater *interest* in divers odd *Phænomena* of Nature, than we are hitherto aware of.

And for confirmation of our Experiment, I shall add, that having in another *Receiver* eclipsed a piece of Fish, that shone when 'twas put in more languidly than divers others that we had tried, I kept it about three days and three nights in a *Receiver*, which (*Receiver*) being somewhat like another, at first suggested to me, when I came to take it, some scruple, but afterwards, upon further examination, concluded it to be the same; wherefore I opened it in the dark, and upon letting in the Air on this Body, that shined but faintly at first, it immediately recovered its so long suppressed Light; and having included another piece that was yet more faint than this, when it was put into the *Receiver*, I thought fit to try at once the Experiment hitherto confirmed, and the *Converse* of it. And therefore having kept this piece also three days and three nights in the *exhausted Glass*, I let in the Air upon it, and notwithstanding the darkness of the place, nothing of Life was thereupon revived. But this being little other than I expected from a Body, that shined so faintly when 'twas put into the *Receiver*, and had been kept there so long, I resolved to exercise my *patience* a while as well as my *curiosity*, and try, Whether the Appulse and Contact of the Air would have that *operation* after *some time*, that it had not at *first*; and accordingly, after having waited a while, I observed the Fish to disclose a Light, which though but dim, was manifest enough; but having considered it for some time, I had not leisure to watch, whether 'twould increase, or how long 'twould continue.

I know not, *Sir*, whether you are weary with reading, but I am sure I am quite tired with making so many Experiments upon *one*

Subject; and therefore I shall here conclude this Paper, as soon as I have added this Confirmation, as well of what I last related, as of something that I observed before, That having included in small *Receivers* two pieces of *rotten Whitings*, whereof the one, before it was put in, scarce shone so vividly, as did the other after the *Receiver* was exhausted; and having ordered the matter so, that we were able to keep out the Air for some days, at the end of about 48 hours, we found, that the more strongly shining Body retained yet a deal of Light; but afterwards looking upon them both in a dark place, we could not perceive in either any show of Light. Wherefore having let in the Air into that *Receiver*, whereinto the Body that at first shined the faintlier had been put, there did not ensue any glimmering of Light for a pretty while: nay, upon the rushing in of the Air into the other Glass (then also made accessible to the *Atmosphere*) the Body that at first shone so strongly, and that continued to shine so long, shewed no glimmering of Light. But being resolved to expect the issue a while longer, our patience was rewarded within less than a quarter of an hour with the sight of a manifest light in the Body last nam'd, and a while after the other also became visible, but by a Light very dim. The more luminous of these Bodies I observed to retain some Light 24 hours after; and the hitherto recited Experiment had this peculiar Circumstance in it, That the two *Receivers* were uninterruptedly kept exhausted no less than 4 days, and as many nights*.

* what method the noble Author of these Experiments used in keeping out the Air for so long a time will probably be made known ere long by himself.

An Account of two Books.

I. PARTHOLOGIÆ CEREBRI & NERVOSI GENERIS SPECIMEN: In quo agitur de MORBIS CONVULSIVIS & SCORBUTO, studio THOMÆ WILLIS, M. D.

WHAT this excellent Author formerly promised of the whole *Pathology of Brain and Nerves*, he gives in this Book a very considerable *Specimen* of. The knowledge of the Diseases which use to affect these parts, is esteemed very difficult and intricate, and particularly the true causes of *Convulsions* are of a very deep search. For the clearing them up, this Author Philosopheth