SURVEY

OF THE

Wiſdom of GOD *in the* CREATION:

OR A

COMPENDIUM

OF

Natural Philoſophy.

In THREE VOLUMES.

VOL. III.

Theſe are thy glorious Works, Parent of Good,
Almighty! Thine this univerſal Frame,
Thus wondrous fair! Thyſelf how wondrous then!

MILTON.

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APPENDIX.

PART. II.

READER.

1. A Few Years ago, when I ventured to publish a little Sketch of Natural Philoſophy, I had no Thought or Deſign of ever going any farther, or making any Additions to it. But the favourable Acceptance which it met with, ſo far beyond my Expectation, encouraged me, at my leiſure Hours, to look farther into the Subject, and to ſet down whatever, from Time to Time appeared moſt worthy of Obſervation.

2. My firſt Deſign was, in the next Edition of the Book, to inſert in their proper Places additional Notes, to correct, to explain, or to inlarge upon, what had been before delivered. But on Reflection, I feared this might give Diſguſt to the Purchaſers of the former Edition. It ſeemed therefore more adviſeable, to throw them all together, in the Form of an Appendix: By which Means theſe might have equal Advantage, with the Purchaſers of the latter Edition.

3. But as I went on, the Work grew upon my Hands, ſo that an Appendix ſoon ſwelled into a Volume. Yet ſtill it ſeemed beſt, to refer every Article in this to its proper Place in the preceding Volumes.

Volumes. Whoever therefore chuſes to take that Trouble, may read them together with this. And he will find many Things which occur there, here placed in a clearer or ſtronger Light. But if any prefer the Reading it all together, it may not be loſt Labour. Only let them remember, This Volume alone is not a Syſtem of Natural Philoſophy, but barely a Collection of Philoſophical Experiments and Obſervations.

4. One Uſe which a ſerious Reader may make of this as well as the preceding Volumes, is to fix in himſelf a fuller and deeper Conviction of the Wiſdom of GOD and the Ignorance of Man. For all the additional Light which we here receive, touching the wonderful Works of GOD, is an additional Proof, how ſmall a Part of his Ways we are able to underſtand. Let us praiſe him however for what Knowledge we have; which ſmall as it is, yet is an invaluable Treaſure: Eſpecially when it's directed to its proper End, the Knowledge of Him, whom to know is Life eternal!

Part the First.

CHAP. I.

Of the Structure of the Human Body.

1. *The Nature of a Cartilage:*
2. *The Nutriment pervades the Bones:*
3. *Use of the Lymphatic Vessels:*
4. *A Boy with a dappled Skin:*
5. *Structure of the Pores:*
6. *Queries concerning Perspiration:*
7. *Queries concerning the Eyes:*
8. *Peculiarities relative to them:*
9. *Help for decayed Sight:*
10. *Account of a Person couched:*
11. *The Structure of the Nose:*
12. *A Person speaking without a tongue:*
13. *Persons deaf and dumb taught to speak:*
14. *Dumbness suddenly removed:*
15. *The Hair turned white through Fear:*
16. *Through Grief.*
17. *White Hairs triangular:*
18. *Voice in common Discourse all Concords:*
19. *An Old Woman giving suck:*
20. *Account of a Man without arms.*

V. I. p. 18. A *Cartilage* is an elastic Substance, uniformly compact and somewhat transparent, harder and more brittle than a Ligament, softer than a Bone. It is covered with a fine Membrane, a

Continuation

Continuation of that which lines the Capſular Ligament, folded over the Bone, from where the Ligament is inſerted. Every Joint is inſerted with a Membrane, which forms a complete Bag, and covers every Thing within the Articulation. The Blood-veſſels are ſo ſmall, that they do not admit the red Globules, and are demonſtrable only in very young Subjects. All round the Neck of the Bone, there are numerous Arteries and Veins which ramify into ſmaller Branches, and communicate with each other. Theſe divide into ſtill ſmaller Branches, on the adjoining Surface, as they run toward the Center of the Cartilage. We can ſeldom trace them into its Subſtance, becauſe they end abruptly, at the Edge of the Cartilage. The larger Veſſels, plunge in by numberleſs ſmall Holes, and diſperſe themſelves into Branches between the Cartilage and Bone. From theſe again there ariſe many ſhort, ſmall Twigs, which ſhoot toward the outward Surface. This Diſtribution of the Blood Veſſels is very peculiar, and calculated for obviating great Inconveniencies. Had they run on the outward Surface, the Preſſure and Motion of the two Cartilages muſt have occaſioned frequent Obſtructions and Inflammations. But by creeping round the cartilagenous Brim, where there is little Friction, or under the Cartilage, where there is none, they are perfectly well defended from all ſuch Accidents.

Cartilages are admirably contrived for all the Purpoſes of Motion. By their uniform Surface they move upon one another with Eaſe: By their ſoft, ſmooth and ſlippery Surface, mutual Abraſion is prevented. By their Flexibility the contiguous Surfaces are conſtantly adapted to each other. By their Elaſticity the Violence of any Shock, which might happen in running, jumping, or the like, is broken, which muſt have been extremely pernicious, if the hard Surfaces of Bones had been immediately contiguous. The cartilaginous Fibres appear calculated chiefly for this laſt Advantage. To conclude, the Inſenſibility of theſe Cartilages is no leſs wiſely deſigned, that by this Means

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the neceſſary Motions of the Body may be performed without Pain.

V. I. ibid. That the Nouriſhment taken in, is continually conveyed through *the Bones*, as well as the Fleſh, appears from an eaſy Experiment. Mix any red Liquor with the Food of any Animals, and in a ſhort Time, their Bones are died red. When Madder Root was mixt with the Food of a Cock, which died after ſixteen Days, all his Bones were red, the internal Parts as well as the external. And the moſt ſolid Parts were the moſt deeply tinctured: In Swine, the Teeth above all the reſt.

V. I. p. 21. It has been lately diſcovered, that the *Lymphatic Veſſels* have two Coats, betwixt which there are innumerable fine Filaments without any Valves, containing a nutritious Juice, which is conveyed into all Parts of the Body, by a Motion from the Centre to the Circumference, and returns through the inner Pipes, (furniſhed with Valves) of the ſame watry Veſſels. But this Juice when returning is no more Water or Dew, but Ferment, and the Veſſels may be termed Ferment-Veſſels. This Ferment is conveyed into the Blood, by a Motion from the Circumference to the Center.

The Lymphatics carry their dewy Particles through the Glandules, which lie betwcen the two Coats. In the lowermoſt End of theſe Glandules, the Ferment-Veſſels take their riſe. Moſt of the Juice of the Lymphatic-Veſſels is diſcharged between the Coats of the Veins, Arteries, and Veſſels, in the Meſentory, to be conveyed into all the Parts of the Body, both internal and external. Even in bearing Females the Fruit is not nouriſhed by Blood, but by this nutritious Juice: The remaining Part of which, is tranſmitted into the Blood through the thoracic Duct and jugular Veins.

P. 23. Who can account for the following Caſe? Sir *Charles Wager* had a Boy about eleven Years old, who

was

was born in *Virginia*, of Negro Parents. Till he was three Years old, he was like other black Children. He then, without any Diſtemper began to have little white Specks, upon his Neck and Breaſt. Theſe increaſed with his Years, both in Number and Bigneſs, ſo that from the upper Part of his Neck, quite down to his Knees, he was dappled with white Spots, ſome of them broader than the Palms of a Man's Hand. They were wonderfully white, equal to the Skin of the faireſt Lady, only ſomewhat paler. His Face, Arms and Legs, were perfectly black. He was exceeding active, ſprightly, and more ingenious, than is common among that Generation.

The Pores in our Hands and Feet are very remarkable. Survey with a Glaſs the Palm of your Hand well-waſhed, and you may perceive innumerable little Ridges, of equal Bigneſs and Diſtance, every where running parallel with each other: Theſe are very obſervable on the Ends and firſt Joints of the Fingers and Thumb, and near its Root, a little above the Wriſt.

On theſe Ridges ſtand the Pores, all in even Rows. Through a good Glaſs every Pore looks like a Fountain. The Sweat may be ſeen to ſtand therein, as clear as Rock Water. The Ridges are ſo placed, that they may better ſuit with the Uſe and Motion of the Hand: Thoſe on the lower Side of each Triangle, to the Bending-in of the Fingers: Thoſe on the other two Sides, and on the Elliptic Ridges, to the Preſſure of the Hand or Fingers Ends, againſt any Body, requiring them to yield to the Right and Left.

The Pores are placed on theſe Ridges, not in the Furrows between them, that their Structure may be leſs liable to be injured by Compreſſion, whereby the Furrows only are dilated or contracted: The Ridges conſtantly maintaining themſelves; and ſo the Pores are unaltered. For the ſame Reaſon the Pores are very large, that they may be the better preſerved; though the Skin be never ſo much compreſſed and condenſed, by the conſtant Labour of the Hand: And ſo thoſe on the Feet, that they may be preſerved, notwithſtanding the Compreſſion of the Skin, by the Weight of the whole Body.

Perhaps

Perhaps the following Fact is no leſs difficult to be accounted for. A Negro Woman, Cook to Colonel *Barnes*, in *Maryland*, about forty Years of Age, remarkably healthy, had her Skin as dark as that of the moſt ſwarthy *African*. But that Part of it next her Finger Nails, about fifteen Years ago. became white. Her Mouth ſoon underwent the ſame change, which has ſince gradually extended over the whole Body. At preſent four Parts in five of her Skin, are white, ſmooth, and tranſparent, as in a fair European, elegantly ſhewing the Ramifications of the ſubjacent Blood-veſſels. The other Parts daily loſe their Blackneſs, and partake of the prevailing Colour. The Neck and Back retain moſt of their preſtine Hue; the Head, Face, Breaſt, Legs and Arms are all white. Her Face and Breaſt, when Anger or Shame has been excited in her, have been immediately obſerved to glow with Bluſhes. This is the naked Fact; but upon what Principles of Philoſophy can we account for it?

V. I. p. 24. Some Queries propoſed concerning Perſpiration by an ingenious Writer, ſeem to deſerve a ſerious Conſideration. 1. "Why do carnivorous Animals ſweat ſo little? A fox hunted almoſt to Death never ſweats. 2. Why do thoſe which feed on Vegetables perſpire ſo much? Horſes and Cows, for Example. We may often ſee them involved in a Cloud of their own Vapours, yea, almoſt covered with Froth. 3. How can Animals, whoſe natural Food is Vegetables, be kept alive and in Health in very cold Climates, by purely animal Food? Cows in *Iceland* and in *Norway*, are fed in Winter upon Fiſh bones." I would beg leave to aſk, 4. Do the *Sweat-pores* only, *imbibe?* Or thoſe alſo which ſerve for *inſenſible Perſpiration*?

P. 28. The *Rein-deer* has over his Eye-lids a Kind of Skin, through which he ſees a little; otherwiſe in the hard Snows, he would be obliged to ſhut his Eyes intirely.

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This therefore is a ſingular Inſtance, of the Wiſdom and Goodneſs of God.

V. I. p. 32. I would beg leave to propoſe a few Queries here, to which I have not found a ſatisfactory Anſwer.

1. Why do we ſee Things *falſe* with one Eye? Particularly, with regard to their Situation.

2. How do the two Eyes *compound* the Rays of Light, ſo as to ſee right?

3. Why do we not ſee all Things *double?*

4. Since all Things are painted *upſide down* on the Bottom of the Eye, why do we not ſee them ſo?

Vol. 1. 32. Some odd Circumſtances relative to the Eyes, are related by a Phyſician in the *Philoſophical Tranſactions.*

" A Perſon had no viſible Diſeaſe in his Eyes; yet could not ſee, unleſs he ſqueezed his Noſe with his Fingers, or ſaddled it with narrow Spectacles, and then he ſaw very well.

" A Maid, 23 Years old could ſee very well, but no Colour, beſide white or black. She could ſometimes, in the greateſt Darkneſs, ſee to read almoſt a Quarter of an Hour.

" A Saddler's Daughter had an Impoſthume, which broke in the Corner of her Eyes. And out of it there came about thirty Stones, as big as ſmall Pearls".

" A young Man in *Suffolk*, about 20 Years of Age, has all the Day a clear and ſtrong Sight. But when Twilight comes, he is quite blind; nor can he ſee any Thing at all, either by Fire-light or Candle-light. No Glaſſes give him any Help. He has been thus, ever ſince he can remember. This Cloudineſs comes gradually upon him, like a Miſt, as Day-light declines. It is juſt the ſame, both in Summer and Winter, and at all Times of the Moon."

" When I was about Sixty, my Sight was ſo decayed, that I could not diſtinguiſh Men from Women. I received no help from any Glaſſes, till I took Spectacles

cles with the largeſt Circles. Cloſe to the upper Semicircle on both Sides, I cut the Bone, and taking out the Glaſſes, put black Spaniſh Leather taper-wiſe into the emptied Circles. Theſe took in my whole Eye at the wider End, and through the narrow End I can read the ſmalleſt Print. Into this End I can only put my little Finger, not quite to the firſt Joint. But they may be made wider or narrower, and longer or ſhorter, as beſt fits every Eye.

" At firſt I could not bear them above two Hours at a Time: Now I can uſe them above twelve Hours in four and twenty. And they prove a great Help, to thoſe who are purblind, who have weak Eyes, or decayed with Age. But for the Purblind they muſt be made ſhorter; longer, for Eyes decayed with Age.

" Inſtead of Leather, they may be made of Paper, coloured black and paſted on; and with inner Folds to be drawn out, from one Inch to three."

V. I. p. 33. An Extract from Dr. *Cheſſelden*'s Account of a Perſon couched, will not be unacceptable to the curious.

" This young Gentleman could in a ſtrong Light diſtinguiſh black, white, and ſcarlet. Yet the faint Ideas he had of them before he was couched, did not ſuffice to make him know them after. He now thought Scarlet the moſt beautiful of all Colours. Of others, the moſt gay were the moſt pleaſing. But the firſt Time he ſaw black, he was very uneaſy; yet after a while he was reconciled to it. When he firſt ſaw no Objects were ſo agreeable to him, as thoſe that were ſmooth and regular: Although he knew not the Shape of any Thing, nor could diſtinguiſh one from another, either by its Shape or Size. Being told, what thoſe Things were, whoſe Forms he knew by feeling, he would carefully obſerve, that he might know them again. Thus having often forgot, which was the Cat, and which the Dog, he was aſhamed to aſk: But catching the Cat, (which he knew by feeling) he looked at her ſtedfaſtly, and ſaid, " So, Puſs, I ſhall know you another Time." He was ſurprized, that

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the Things or Perſons he liked beſt, did not appear moſt agreeable to his Sight, expecting that what was moſt pleaſing to his other Senſes, would be ſo to his Sight alſo.

We thought he ſoon knew the Nature of Pictures, but found afterward we were miſtaken: For it was two Months after the Operation, before he diſcovered, that they repreſented ſolid Bodies. Even then he was no leſs ſurprized, expecting they would feel like the Things they repreſented. He was amazed, that thoſe Parts, which by their Light and Shade appeared round and uneven, ſhould feel like the reſt, and aſked, Which was the *Lying Senſe*, feeling or ſeeing? Being ſhewn his Father's Picture drawn in Minature, and told, what it was, he acknowledged the Likeneſs; but aſked, how it could be, that ſo large a Face ſhould be contained in ſo little Room? Saying, it would have ſeemed as impoſſible to him, as to put a Buſhel of any Thing into a Pint. But even Blindneſs he obſerved, had this Advantage, that he could go any where in the Dark, better than thoſe that could ſee. And after he was couched, he did not loſe it, but could go all about the Houſe without a Light. Every new Object gave him new Delight, ſuch as he wanted Words to expreſs. He was particularly delighted when he firſt ſaw a large Proſpect, and called it, a new Kind of ſeeing. Being afterwards couched in his other Eye, he ſaid, that Objects appeared larger to this Eye; though not ſo large as they did to the other, when it was newly couched. But looking on them with both Eyes, they ſeemed twice as large, as if he looked with that only."

P. 36. Each of the *cartilaginous Laminæ* is divided into many others, folded into a ſpiral Line. The *Os cribroſum* is made up of the Extremities of theſe; the Holes therein being the Intervals between them. They are deſigned to uphold the inner Tunic of *the Noſe*, which is folded round about together with theſe Laminæ, that by its great Expanſion it may receive

a greater Number of the odorant Particles. For the ſame Reaſon, it is furniſhed with many ſmall Glands, which open into it, and moiſten it with a ſlimy Exudation, fitted to intangle and detain the ſubtle Effluvia that touch it. And not only the Number, but alſo the Length of theſe Laminæ, is of great Uſe for the Strength of ſmelling. For this Purpoſe moſt Beaſts which either hunt, or diſtinguiſh their Food by Smell, have not their Noſe in the Middle of their Face, like Man, but prolonged to the very End.

V. I. p. 39. It has been generally ſuppoſed, that the Tongue is eſſentially neceſſary to the Formation of Speech. But as ſure as we have been of this, it is an entire Miſtake. A Child in *Eſſex* ſome Years ago, had her Tongue entirely cut out, by Reaſon of an incurable Canker. She was then three Years old. Twenty Years after, it was reported, that ſhe was able to ſpeak: To be ſatisfied hereof, Mr. *Benjamin Boddington*, Turkey-Merchant of *Ipſwich*, with two other Gentlemen went to *Wicham-Market*, where the young Woman then lived, whoſe Caſe they thus deſcribe.

"We have this Day been at *Wicham Market*, to ſatisfy ourſelves concerning *Margaret Cutting*. We examined her Mouth with the greateſt Exactneſs, but found no Part of the Tongue remaining; nor was there any Uvula. The Paſſage down the Throat is a circular, open Hole, large enough to admit a ſmall Nutmeg.

"Notwithſtanding this, ſhe ſwallowed both Solids and Fluids as well as we could do, and in the ſame Manner. Yea, and ſhe talked as fluently as other Perſons do. She pronounced Letters and Syllables very articulately, even thoſe which ſeem neceſſarily to require the Help of the Tongue, as d, l, t, w. She read to us in a Book diſtinctly, ſhe ſings very prettily; nay, and ſhe diſtinguiſhes Taſtes, and can tell the leaſt Difference either in Taſte or Smell."

But is it poſſible to teach any one to ſpeak, who has been *deaf and dumb* from his Birth? It is. Dr. *Wallis* taught ſuch an one to ſpeak, Mr. *Daniel Whaley* of *Northampton*. He was preſent before the Royal Society, May 21, 1662, and did there pronounce diſtinctly enough ſuch Words as the Company propoſed to him: Indeed not altogether with the uſual Tone, yet ſo as eaſily to be underſtood. In a Year, which was the Time he ſtayed with Dr. *Wallis*, he read over great Part of the Engliſh Bible, and learned to expreſs himſelf intelligibly in common Affairs, to underſtand Letters written to him, and to anſwer them. And in the Preſence of many Foreigners, he has not only read *Engliſh* and *Latin* to them, but has pronounced the moſt difficult Words in their Languages, which they could propoſe to him.

The Doctor has ſince done the ſame for Mr. *Alexander Popham*, a Gentleman of a fair Eſtate.

But we have an Inſtance of *Dumbneſs* cured in a ſhorter Time. *Henry Axford*, Son of *Henry Axford*, in the *Devizes*, at 28 Years of Age, perceived an Hoarſeneſs, and in about ſix Days became quite Speechleſs, not only unable to ſpeak articulately, but to utter the leaſt Sound with his Tongue. His Cold went off, but he remained abſolutely Speechleſs; and the Advice of all the neighbouring Phyſicians did not help him.

He continued totally dumb for four Years, till in July 1741, being at *Stoke*, in returning homeward at Night, he fell from his Horſe, and was taken up and put to Bed in an Houſe upon the Road. He ſoon fell aſleep, and dreamed, he was fallen into a Veſſel of boiling Wort. Struggling with all his Might, to call for Help, he actually did call aloud, and recovered the Uſe of his Tongue from that Moment, as perfectly as ever he had it in his Life.

Perhaps therefore there is Truth in that antient Story, concerning the Son of King *Cræſus*, namely, having been dumb from his Birth, he had never ſpoke at all, till in the Battle, ſeeing a Man ready to

kill

kill his Father, his Tongue was loosed, and he cried out aloud, "Soldier, spare the King."

V. I. p. 40. Extreme Fear may *turn the Hair grey* or even white in a short Space. So it was in that famous Instance some Years ago: A Nobleman in *Germany* was condemned to die, and ordered for Execution in the Morning. During the Night, in ten or twelve Hours Time, all his Hair turned white as Flax. The Emperor being informed of this, said, "He has suffered enough," and pardoned him.

Since that Time there has been an Instance of one of our own Country-men, who being ship-wrecked, saved himself on a small Rock, surrounded by the Sea. A Boat took him off, after he had stayed there four Hours. But in that Space, his Hair was turn'd quite white.

Perhaps a still stranger Instance of this Kind, is related in the Duke of *Sully*'s Memoirs, "*Henry* IV. told the Marquis *de la Force*, That the Moment he was informed, *Henry* the III. had published an Edict, (in July, 1585) ordering all the Huguenots either to go to Mass, or to abandon the Kingdom in six Months, his Mustaches turned suddenly white on that Side of his Face, which he supported with his Hand."

V. I. p. 41. Many *white Hairs* appear *triangular*, even to the naked Eye. Are *all* grey and white Hairs so? How do they appear thro' a good Microscope?

Are Hairs *minute Horns?* Are they a Medium between Horn and Flesh? Or do they rather belong to the Vegetable Kingdom?

P. 45. With regard to the *Human Voice*, an ingenious Man observes. "Sitting in Company I chanced to take Notice, that in ordinary Discourse, all that is spoke, is spoken in *perfect Notes*; and that some of the Company used Eights, some Fifths, and others

Thirds. I obſerved likewiſe of him whoſe Speech was the moſt pleaſing, that all the Tones he uſed conſiſted either of Concords, or of ſuch Diſcords as made up Harmony.

P. 47. "One informing me of an *old Woman that gave ſuck*, I went to the Houſe in *Tottenham-court Road*. Her Name is *Elizabeth Bryan*. She is in the 68th Year of her Age, and has not borne a child for many Years; her Face is withered, her Cheeks and Mouth ſunk in; but her Breaſts are full, fair and void of Wrinkles. About four Years ago, her Daughter was obliged to leave an Infant ſhe gave ſuck to, in the Care of her Mother. The old Woman finding the Child froward for want of the Breaſt, applied it to her own. Having done this ſeveral Times, her Son thought the Child ſeemed to ſwallow, and begged his Mother, he might try, if ſhe had not Milk? It ſoon appeared ſhe had; and ſhe then continued to ſuckle the Child in Earneſt. Two Years after her Daughter had another Child; on which the Grand-mother weaned the Firſt, and ſuckled the Second. Both the Children are healthy, plump and firm in Fleſh, and as briſk and lively as can be deſired.

P. 51. Is there any poſſibility, that the want of ſo neceſſary an Inſtrument as the Arm ſhould be ſupplied? One would think, it impoſſible. But it is not: Such is the amazing Power of God! *James Walker* was born in 1718, in *Ireland*, in the Pariſh of *Hilſborough*. His Mother could not be delivered, till the Surgeon totally ſeparated the Arms of the Child from the Body. Nevertheleſs he lived, and in the room of his Arms, had little Protuberances that appeared as Stumps. He grew to be ſix Feet high, ſlender, and active. "He ſits a Saddle, ſays an Eye-witneſs, upright and firm, will ride 40 Miles a Day to a Fair, and deals in buying and ſelling Horſes, which he dreſſes and curries as well as any Groom can do, holding the Curry-comb between his Chin and Shoulders. The ſame Way he holds the Goad

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in driving the Plow, and the Spade when he digs. He throws a Stone from the Top of his Foot with greater Force than moſt Men can with their Hand, and ſeldom fails to hit his Mark. He mounts a Horſe without any Aſſiſtance, and ſhuffling the Bridle over his Head, till he gets it on his Shoulders, guides his Horſe with as little fear, and as much Skill as any Man."

CHAP. II.

Of the Natural State of the Human Body.

1. *Cauſe of the Natural Heat,*
2. *The Blood contains much Air,*
3. *Men taller in the Morning than at Night,*
4. *Account of Giants,*
5. *Account of a remarkable Dwarf,*
6. *Account of Thomas Parre and Henry Jenkins,*
7. *Men living without Food.*

P. 53. WHENCE ariſes the *Natural Heat* in us? This deſerves a particular Enquiry.

Fermentation is that ſpontaneous, inteſtine Motion, which by the Heat of ſubterraneous Caverns, will in a few Hours ſo change Vegetable Juices (for Fermentation is confined to the vegetable Kingdom) as from a vapid Wart quenching Fire, to nouriſh Fire, and to afford that inflammable Liquor, commonly called Spirits.

Effervescence ariſes from an inteſtine Motion excited in various Fluids, by the Mixture of other Fluids, or of Salts or Powders of a different Nature. Acids and Alcali's when mixt, cauſe a great Ebullition, but no great Heat: Whereas the Solution of ſome metals in Aqua-fortis, cauſe intenſe Heat, and emit Flame. Aramatic Oils mixt with acid mineral Spirits, kindle

kindle and burn with violent Explosions. And many Vegetables, putrefying with Moisture, will heat so as to kindle.

In these Cases, as there is no adventitious Fire, there must be Fire lying hid in one or other of the Bodies. And it is known much Air lies dormant in all Bodies. It is known likewise, that Fire cannot exert itself, without the Help of Air. It being granted then, that Fire and Air lie dormant in all Bodies, there is only required such an Action as may set at Liberty the Particles of Air and of Fire. By this Action the Particles of Air recover their Elasticity, and putting those of Fire in Motion, cause Heat, but not Incension, unless this Fire meet a proper Pabulem, which Pabulem is Sulphur only; tho' differently modified, whether in the Appearance of Brimstone, Oil, Spirits, Metalline Sulphur, or the most inflammable of all, Animal Sulphur, commonly called *Phosphorus*.

In *Fermentation* the Fire and Air being let loose, produce Warmth, but seldom kindle, because of the Water predominating. But in the *Effervescence* produced by the Solution of Metalline Sulphur, they kindle and sometimes cause Explosions. Aromatic Oils, containing little but the sulphureous Parts of the Vegetables, immediately kindle and break out into Flame. And Phosphorus is so highly inflammable, that if it be only exposed to the Air a few Minutes, it kindles and flames.

Now all Animals contain more or less Phosphorus. Some Insects constantly shine in the open Air. Many Sorts of Fish are luminous: Some Quadrupeds emit Light, on a very slight Friction. These are Proofs of Phosphorus lying dormant in Animal Fluids: and as they all contain Air likewise, let only the phosphoreal and aereal Particles be brought into Contact, and Heat necessarily ensues.

This clearly explains the Cause of Animal Heat: Of which the Heart and Arteries are the Occasion, not by Friction, but by the intestine Motion which the Circulation gives to the several Particles that constitute

ſtitute the Maſs of Animal Fluids. As the Velocity of theſe Fluids is increaſed, the Particles of which they conſiſt, come oftner into Contact, and the oftner the phoſphoreal and aereal meet, the more Heat they produce. And this may explain what happened to the Lady *Bandi*, and *Grace Pett*; who having drank plenty of Gin, that Circumſtance would naturally promote the kindling of the Phoſphoreal Fire. And this Pabulum being largely conveyed into the moſt minute capillary Veſſels, might produce an almoſt inſtantaneous Deflagration and Diſſolution of all the ſolid, containing Parts.

P. 54. That much Air is wrought into the Animal Frame, appears by the following Experiments. The Blood of a Sheep freſh drawn, was in a wide mouthed Glaſs put into a Receiver, and the Air drawn out. After a while the ſubtle Parts of the Blood forced their Way thro' the clammy ones, and ſeemed to boil in large cluſters, ſome as big as Nutmegs. And ſometimes the Expanſion was ſo vehement, that it boiled over the Glaſs. Some Milk being put into a Veſſel four or five Inches high, when the Air was drawn out, it boiled ſo impetuouſly, as to throw up ſeveral Parts out of the Glaſs that contained it.

And to ſhew, that not only the Blood, but the other Parts of Animals include Air, the Liver of an Eel was put into a Receiver: And even this apparently ſwelled every Way, as ſoon as the Air was withdrawn.

P. 58. What a Paradox is it, that all Men are *taller* in the Morning than in the Evening? In a young Man the Difference is near an Inch, try the Experiment as often as you pleaſe. Does not the Difference proceed from hence, that as long as the Trunk of the Body is in an erect Poſture, there is a conſtant Preſſure on the large Cartilages connecting the Vertebræ of the Spine? So long they gradually contract, and conſequently a Man grows ſhorter. But they

again

again gradually expand themſelves, while we are in a reclining Poſture.

There is a manifeſt Congruity between the Stature of Man, and his Age during the Time of his Growth. And as five Feet and an Half may be thought the ordinary Height of Man, ſo may ſeventy Years, the ordinary Period of his Years. Yet ſome vaſtly exceed in both Reſpects. And as we know *Thomas Parre* and *Henry Jenkins*, compleated double that uſual Term of life, ſo we have no Reaſon to queſtion, that ſome have doubled the common Stature of Man. *Walter Parſons*, King *James* the Firſt's Porter, was full ſeven Feet, ſeven Inches high. Mr. *Ray* ſaw a Man at *Bruges*, who was eight Feet and a Half; all his Limbs well ſhaped, and his Strength proportionable. *Becanus* ſays, he ſaw a Youth almoſt Nine feet high, a Man near ten, and a Woman quite ten Feet. *Pliny* mentions ſeveral Men of the ſame Height in his Age. Yea *Thevet* tells us, that he met a *Spaniſh* Merchant on the Coaſt of *Afric*, who had in a Coffer the Scull and Bones of an *American* Giant, which he brought with him from that Country, who was 11 Feet, five Inches in Height, and died in the Year 1559.

From theſe warrantable Accounts we learn, that there have been Men 11 or 12 Feet high, which equals if not exceeds the Stature of the talleſt Giant mentioned in Scripture. The Height of *Goliah* was but ſix Cubits and a Span, which is only nine Feet, nine Inches. Indeed the Bedſtead of *Og*, the King of *Baſan*, is ſaid to have been nine Cubits in Length. But his Bed muſt have been longer than his Body: We may fairly allow, nine Inches above his Head, and as much below his Feet. And making this Deduction, he was not above twelve Feet high: Much of the ſame Stature with the Giant whoſe Forehead Bone is ſtill kept, in the Medicine-ſchool at *Leyden*.

Is this Deviation from the common Stature of Man by Largeneſs, more remarkable than its oppoſite

poſite? The Deviation from it by Littleneſs, which has been obſerved in ſome Inſtances? Such was the Dwarf who lived for ſeveral Years in the Palace of the King of *Poland*. His Parents were healthy, ſtrong Peaſants, who affirmed, that at his Birth he weighed ſcarce a Pound and a Quarter, that he was preſented on a Plate to be baptized, and for a long Time had a wooden Shoe for his Bed. When 18 Months old, he could ſpeak ſome Words; when two Years old, he could walk almoſt without Help. His Shoes were then juſt an Inch and a Half long. When he was ſix Years of Age, the King of *Poland* gave him the Name of *Bebe*, and kept him in his Palace. His Height was then fifteen Inches, and he weighed thirteen Pounds. He was in perfect Health, his Perſon was agreeable and well-proportioned, but there was little Appearance of Underſtanding. He had no Senſe of Religion, was incapable of reaſoning, and could learn neither Muſic nor Dancing. Yet he was ſuſceptible of Paſſions in an high Degree, Anger and Jealouſy in particular. When 16 Years old, he was 29 Inches high, being ſtill healthy and well-proportioned; but from that Time his Health declined; yet he grew four Inches in the four ſucceeding Years. At 21 he was ſhrunk and decrepit, and at Twenty-two it was with Difficulty he could walk an 100 Steps. In his 23d Year he fell into a Kind of Lethargy, and in a few Days died, as it were of old Age.

The two moſt eminent Inſtances of Longevity in *England* were *Thomas Parre* and *Henry Jenkins*. *Thomas Parre* was a poor Countryman of *Shropſhire*, whence he was brought up to *London* by *Thomas* Earl of *Arundel*. At the Age of 120 he married a Widow: At 130 he could do any huſbandry Work, even threſhing of Corn, although ſoon after his Sight began to fail; nor had he the Uſe of his Memory, or but in a ſmall Degree for ſeveral Years before he died. But he retained his Hearing and Apprehen-

ſion

ſion to the laſt. He uſed to eat often by Day and by Night, of Milk, old Cheeſe with coarſe Bread, Whey and ſmall Beer. He died at the Age of an Hundred Fifty-two Years and nine Months. He might have lived much longer, but coming out of a clear thin and free Air to *London*, and from a plain country Diet, to that of a ſplendid Family, where he fed high, and drank the beſt Wines, the natural Functions were overcharged, and Death could not but ſoon enſue.

"*Henry Jenkins*, calling at my Houſe, I aſked, how old he was? He pauſed and ſaid, "About 162, or 163." I aſked, "What was the firſt public Tranſaction he remember'd?" He ſaid, the Battle of *Flowden-Field*, being then 11 or 12 Years old."

For many Years he was a Fiſherman, and uſed to wade in the Streams. After he was an hundred Years old, he frequently ſwam in the Rivers. The latter Part of his Life, he was obliged to beg. He died at *Ellerton upon Swale*, in *Yorkſhire*, Dec. 8. 1670. Having lived (ſuppoſing him to have been 12 Years old, at the Battle of *Flowden-field*, which was fought *Sept.* the 9th, 1513) an Hundred and Sixty-nine Years, that is, ſixteen longer than *Thomas Parre*.

P. 77. *John Ferguſon*, of *Killmelfoord* in *Argyle-ſhire*, about 18 Years ago, overheated himſelf, drank largely of cold Water, and fell aſleep. He ſlept for four and twenty Hours, and waked in an high Fever, ever ſince his Stomach loaths, and can retain no Kind of Aliment but Water. A neighbouring Gentleman to whom his Father is Tenant, locked him up for 20 Days, ſupplying him daily with Water, and taking Care that he ſhould have no other Food. But it made no Difference either in his Look or Strength. He is now ſix and thirty Years of Age, of a freſh Complexion, and as ſtrong as any common Man.

Gilbert Jackſon, about fifteen Years of Age, in February 1716, was ſeized with a violent Fever, it returned

returned in April for three Weeks, and again on the tenth of June; he then loſt his Speech, his Stomach, and the Uſe of his Limbs, and could not be perſuaded either to eat or drink any Thing. May the 17th 1717, his Fever left him, but ſtill deprived of Speech and of the Uſe of his Limbs, and taking no Food whatever. June 30th he was ſeized with a Fever again, and the next Day recovered his Speech, but without eating or drinking, or the Uſe of his Limbs. On the 11th of October he recovered his Health, with the Uſe of one of his Legs, but neither eat nor drank; only ſometimes waſhed his Mouth with Water.

On the 18th of June 1718, the Fever returned and laſted till September. He then recovered, and continued in pretty good Health and freſh coloured, but took no Kind of Meat or Drink. On the 9th of June, 1719, he was again ſeized with a ſevere Fever. On the tenth at Night, his Father prevailed on him to take a Spoonful of Milk boiled with Oatmeal. It ſtuck ſo long in his Throat, that his Parents feared he had been choaked; but ever ſince that Time he has taken Food, tho' ſo little, that an Half-penny Loaf ſerves him for eight Days. All the Time he faſted, he had no Evacuation, either by Stool, or Urine: And it was fourteen Days after he began to eat, before he had any. He is now in pretty good Health.

I ſuppoſe ſuch another Inſtance as this, has ſcarce been known in the Memory of Man.

C CHAP.

CHAP. III.

Of the preternatural State of the Human Body.

1. *Of the Plague:*
2. *An involuntary Mimic:*
3. *An Horny Girl:*
4. *Of Mr. Greatrix:*
5. *Way of recovering drowned Men.*

P. 84. THE Plague is not an *European* Diſeaſe. It is properly a Diſeaſe of *Aſia*, where it is Epidemical, and is never known elſewhere, but by Importation from thence. The Small-pox alſo is an exotic Diſeaſe, and was not known in *Europe*, or even *Aſia Minor*, till a Spice Trade was opened by the later Princes of *Egypt* to the remoteſt Part of the *Eaſt Indies*. Thence it originally came, and there it rages even at this Day.

I know not whether the Gentlemen of the Faculty would not term the following, "a Diſeaſe of the *Animal Spirits*." *Donald Monro*, at *Strathbogie*, in *Scotland*, imitates unawares all the Motions of thoſe he is with. He is a little, ſlender old Man, and was ſubject to this Infirmity from his Infancy. He is loath to have it obſerved, and therefore caſts down his Eyes in the Streets, and turns them aſide when in Company. We had made ſeveral Trials before he perceived it, and afterward had much ado to make him ſtay. He imitated not only our ſcratching our Head, but the wringing our Hands, and every other Motion. We needed not to perſuade him to be covered; for he ſtill covered or uncovered as we did: And all ſo exactly and yet with ſuch a natural and unaffected Air, that none could ſuſpect he did it deſignedly. When we held both his Hands, and

cauſed

cauſed another to make ſuch Motions, he ſtruggled to get free. But when we would have known more particularly, how he found himſelf affected, he would only give us this ſimple Anſwer, That "it vexed his Heart and his Brain."

But to what Claſs ſhall we refer the Diſeaſe of *Ann Jackſon?* She was born at *Waterford*, of *Engliſh* Parents, both ſaid to be found and healthy, and from three Years old, had Horns growing on various Parts of her Body. She is now thirteen or fourteen; the Horns grow chiefly about the Joints, they are faſtened to the Skin like Warts, and about the Roots reſemble them much in Subſtance, but toward the End are much harder. At the End of each Finger and Toe is one, as long as the Finger or Toe itſelf, riſing a little between the Nail and Fleſh, and bending again like a Turkey's Claw. On the Joints of each Finger and Toe are ſmaller ones, which ſometimes fall off, but others come in their Place. Round her Knees and Elbows are many; two in particular at each Elbow, which twiſt like Rams-horns. At each Ear grows one, yet ſhe eats and drinks heartily, ſleeps ſoundly, and performs all the Offices of Nature, like other healthy Perſons.

P. 86. A moſt unaccountable Method of removing Diſeaſes, was that of the famous Mr. *Greatrix*. "I give you nothing concerning him, ſays Mr. *Boyle*, but from Eye-witneſſes. My own Brother ſome Time ſince was ſeized with a violent Pain in his Head and Back. Mr. *Greatrix* coming by Accident to our Houſe, gave preſent Eaſe to his Head by ſtroking it. He then ſtroked his Back: The Pain immediately fled to his right Thigh. He purſued it with his Hand to the Knee, Ankle, Foot, Toe, then he ſtroked this, and it was gone.

My Uncle's Daughter was ſeized with a Pain in her Knees, which occaſioned a White Swelling, ſhe

tried many Remedies without Effect, for six or seven Years. Mr. *Greatrix* then coming to *Dublin*, my Aunt brought her to him. He stroaked her Knees, and the Pain fled downward from his Hands, till he drove it out of her Toes. And in a little Time the white swelling went away.

I had an Acquaintance, who after a Fever was very deaf, and had a violent Pain in her Ears. Mr. *Greatrix* put some Spittle into her Ears and rubbed them, which cured both the Pain and Deafness.

Another told me, that when a child, she was extremely troubled with the *King's-Evil*. She tried many Remedies, in vain; but Mr. *G.* stroaked and perfectly cured her. A Smith near us had two Daughters troubled with the same Distemper. One of these had a running Sore in the Thigh, the other in the Arm: He cured them both. He cured all Kinds of Hysteric Fits. He likewise cured the Falling Sickness, and without any Relapse, provided he could see the Patient in three or four Fits.

P. 86. A Person suffocated by the Steam of Coals, set on Fire in the Pit, fell down as dead, He lay between half an Hour and three Quarters, and was then drawn up, his Eyes, staring, his Mouth gaping, his Skin cold. Not the least Breathing being perceivable, nor the least Pulse either in his Heart or Arteries. A Surgeon applied his Mouth to that of the Patient, and by blowing strongly, holding the Nostrils at the same Time, raised the Chest by his Breath. Immediately he felt six or seven quick Beats of the Heart: The Lungs began to play, and soon after the Pulse was felt in the Arteries. He then opened a Vein, which at first bled Drop by Drop, but in a while bled freely. Mean Time he caused him to be pulled and rubbed. In an Hour he began to come to himself; in four Hours walked Home, and in four Days returned to his Work.

Wherever the Solids are whole, and their Tone unimpaired, where the Juices are not corrupted, where

where there is the leaſt Remains of Animal Heat, it would be wrong not to try this Experiment. This takes in a few Diſeaſes, and many Accidents. Among the firſt are many that cauſe ſudden Deaths, as Apoplexies and Fits of various Kinds. In many of theſe it might be of Uſe to apply this Method: And in various Caſualties: Such as Suffocations from the Damps of Mines and Coal-pits, the condenſed Air of long-unopen'd Wells, the noxious Vapours of fermenting Liquors, received from a narrow Vent, the Steam of burning Charcoal, Arſenical Effluvia, or ſulphureous mineral Acids. And perhaps thoſe who ſeem to be ſtruck dead by Lightning, or any violent Agitation of the Paſſions, as Joy, Fear, Anger, Surprize, might frequently be recovered by this ſimple Proceſs.

The animal Machine is like a Clock: The Wheels whereof may be in ever ſo good Order, the Mechaniſm compleat in every Part, and wound up to the full Pitch; yet without ſome Impulſe communicated to the Pendulum, the whole continues Motionleſs.

Thus in theſe Accidents, the Solids are whole and elaſtic, and the Juices no otherwiſe vitiated, than by a ſhort Stagnation, from the Quieſcence of that moving *Something*, which enables Matter in animated Bodies, to overcome the Reſiſtence of the Medium it acts in. Inflating the Lungs, and thus communicating Motion to the Heart, like giving the firſt Vibration to a Pendulum, enables this Something to reſume the Government of the Fabric, and actuate its Organs a freſh. It has been ſuggeſted, That a Pair of Bellows might be applied, better than a Man's Mouth. But 1. Bellows may not be at Hand: 2. The Lungs of one Man may ſafely bear as great a Force, as the Lungs of another can exert, which by the Bellows cannot always be determined: 3. The Warmth and Moiſture of the Breath may likewiſe be of Uſe.

CHAP. IV.

Of the Origin of Man.

Of the Generation of Bodies.

P. 97. THAT ſome Animals firſt exiſt. not in the Seed of the Male, but wholly *in the Egg* of the Female, undeniably appears from the Caſe of Frogs and Toads: (And why may it not be the ſame Thing with other Animals?) The Eggs of theſe are not impregnated by the Male, till they iſſue from the Womb. It is while they are ejected, that he fecundates them with his ſeminal Liquor. And there is no Circumſtance, by which the fecundated Egg can be known from the unfecundated. It appears therefore, that Tadpoles exiſt before Fecundation. For the unfecundated Eggs do not differ in the leaſt from thoſe that are fecundated. But theſe are only Tadpoles coiled up. Such therefore are the unfecundated. Tadpoles therefore exiſt before Fecundation; only they cannot unfold themſelves without the Liquid of the Male. Frogs then ſhould not be placed among oviparous Animals, but among viviparous: If they do not rather conſtitute a Claſs between both. Thus Nature ſeems to delight in diverſifying the Modes of Animal Generation.

This may be the Caſe, with regard to one, or perhaps a few Species of Animals. But in general, where to place the pre-exiſtent Animal or Embryo, in the *Animalcule Egg*, is ſtill the Queſtion. A Diviſion of vital, eſſential, and original Stamina, is impoſſible. Yet innumerable Inſtances in Monſters, Mules, and many natural Subjects, concur to prove,

that

that the Young partakes of the Nature and Qualities of both the Parents, even to their Defects and Diſeaſes, which are often hereditary. How then can we ſuppoſe unalterable Stamina? Can the viſible Species of any Production, be determined by them, if every ſenſible Quality may be influenced indiſcriminately by either Parent?

If they are placed in the Animalcule or the Egg, how are they tranſmitted? If in the Animalcule, why is the Proceſs attended, with ſo vaſt an Expence, ſo great a Waſte of Millions of Entities, each containing a Series of the moſt perfect and moſt wonderful Productions, when one only of thoſe Millions is to take Place? And how are theſe Animals generated? If in the common Way, not only the Proceſs will be boundleſs: Theſe in their Seed will have others, and ſo on in an endleſs Series; but they cannot then be unalterable, becauſe they are capable of being generated. Further, If they float in the Air, or lie hid in Food, how is it that the Stamina of one Species, do not ſometimes inſinuate themſelves into a Parent of another Species? Or if they are excluded by proper Strainers in diſtant Species, they cannot be ſo in thoſe that are near akin. For if the ſpermatic Animal, which in the Matrix of a Mare, produces an Horſe, is yet ſo fitted to that of an Aſs, that it can poſſeſs a Cellule there, excluſive of every other, which ſhews an exact Co-aptitude: Certainly the ſame Animal, if contained in Food or Air, common to both Horſe and Aſs, might paſs indiſcriminately the Strainers of either: And ſo we might have Mules without the promiſcuous Congreſs of the two Species.

In another View, if we conſider the extreme Tenuity of one of theſe Stamina, in its firſt Origin at the Diſtance of many Ages, compared to the ſmalleſt Fibre of the Animal it is ſaid to conſtitute: Can ſo Minute a Filament ſerve as a Subſtratum for a Cylinder, comparatively immenſe? Can the terraqueous Globe derive its preſent Dimenſions, from the Dilatation of an Atom? Such is a muſcular Fibre in

its preſent State, compared to what it was in its origin. Conſequently, what muſt have been the Increaſe of extraneous Matter, either by Appoſition or Incorporation, which is now as much a Part of the Fibre, as the original Stamen? And if thus much can be mechanically aſſimilated, why not the whole formed by mechanical Cauſes? Or why muſt ſo inſignificant a Part of it, be ſuppoſed to be concreated with the Univerſe?

The Difficulty ſtill increaſes immenſely, if we look into the Vegetation of Plants, and the wonderful Reproduction of the Parts of the Polypus, Lobſters, and many other Animals. The original Stamina, how minute ſoever, queſtionleſs are diffuſed through the whole Production: Since in this Syſtem all animal and vegetable Growth is made by Developement only. But if diffuſed, then ſome or all may be loſt by ſucceſſive Biſection. And if loſt, how can they be re-produced? If re-produced, how were they concreated with the Univerſe? Theſe and a Thouſand other Difficulties can in no wiſe be evaded, but by multiplying Suppoſition on Suppoſition, which render the Hypotheſis ſo complex, as utterly contradicts the ordinary Proceſs of Nature.

It is more reaſonable to ſay, that ſo many ſecretory Ducts, ſo many Strainers, ſo many preparatory Veſſels in Animals, and ſuch a curious Diſpoſition in Plants, for the Continuation of every Species, imply a Digeſtion, Secretion, and Preparation of Principles, invariably productive of every Individual, when they fall into their reſpective Matrixes, and find Aliment proper to aſſimilate? Are not theſe Principles contained in the Nouriſhment taken by the Parent Plant or Animal, the ſame that continually vegetate in it, and increaſe it till it is adult, then exuberate, while it is by new Preparations fitted, invariably to propagate its Kind? Elſe why this Digeſtion? Why this Secretion? Why ſo many Strainers, Receivers, Ducts and Valves? And why is ſome Food more productive of theſe Principles than others?

And

And if every mixt Body is made up by the Combination of certain Principles, we cannot doubt, but GOD may have eſtabliſhed Forces in Nature, by which ſuch Principles may in certain Circumſtances, be invariably united, without any Danger of deviating, ſo as to render Generation equivocal. And if every Production in Queſtion is a mixt Body, we know that how various ſo ever they are, a ſmall Number of Principles differently combined, will yield Variety enough to produce them all. Thus we reduce Nature to what it is ever found to be, ſimple in the Beginning of its Courſe, but afterwards, when it is diſtributed, magnificent beyond Expreſſion.

Modern Naturaliſts all agree, That every Plant proceeds from its ſpecific Seed, every Animal from an Egg, or ſomething analogous, pre-exiſting in its Parent. But what do we mean by Seeds and Eggs? *Theſe in the common Senſe of the Words, are cer-*tain mixt Bodies, that immediately furniſh thoſe Productions. They are ſaid to contain not only the preexiſtent Germ, but the fit Nidus alſo, and Aliment to be aſſimilated in proper Circumſtances. They are therefore heterogeneous Bodies, that coaleſce in a known Time. And their Principles are ſo far from being united at the Creation, that they ſenſibly come together from diſtant Places in all hermaphrodite Plants, and from different Individuals in all thoſe Species, where the Male and Female are diſtinct.

But it is vain for us to lay down any certain Rule, and to ſay to Nature, "This is thy Scheme; from this thou ſhalt not deviate." If ſhe makes it a Law in many Species, that every Individual requires the Co-operation of a Male and Female Parent: She has at the ſame Time her Hermaphrodites, both in Plants and Animals. And if in ſome Hermaphrodites, the Sexes are ſo diſtinct, that ſhe ſeems not to deviate far from her primitive Law: She will, in another Inſtance, that of the Pucerons, act either with or without the Co-operation of a Male. Again: In ſome Species the Female may be ſo impregnated, that the

Impreg-

Impregnation ſhall diffuſe itſelf to five or ſix Generations. Yet again: In many Kinds of Polype, Generation proceeds, without Male or Female, Egg or Seed. And farther ſtill; there are ſome Species of Polypes, where a whole Family, (after branching out by real Vegetation, as far as Nature deſigns) jointly concurs to furniſh one Egg, as the Source of a future Progeny. If at laſt you reſolve to ſtand by this, that at leaſt every individual proceeds from a Parent like itſelf: Even this is overthrown by late Experiments. For we have now a Cloud of Inſtances, of a Claſs of Beings hitherto unknown, wherein Animals grow upon, are produced by, and in the ſtrict Senſe of the Word, brought forth from Plants. Then by a ſtrange Viciſſitude they become Plants of another Kind. Theſe again become Animals of another, and thus on for a Series farther than the utmoſt Power of Glaſſes can carry the moſt inquiſitive Obſerver.

PART

Part the Second.

CHAP. I.

Of Beasts.

1. *Of the Rhinoceros,*
2. *Of the Lama,*
3. *Of the Beaver,*
4. *Of Sable-mice,*
5. *Variety in the Shape and Colour of Beasts.*

P. 108 THE outer Skin of the *Rhinoceros*, which consists of many Folds, is thick and impenetrable. In running ones Finger under one of the Folds, it feels like a Piece of Board half an Inch thick. But between the Folds the Skin is as smooth and soft as Silk, and easily penetrated. See here the Wisdom of the great Creator! If the outer Skin, which is quite inflexible, was continued all over him without any Fold. he could not perform any Action whatever. But the Suppleness of Skin in other Beasts, is compensated in this by these Folds. It was necessary his Skin should be hard for his Defence: Meantime it was a noble Contrivance, that it should be so soft and smooth underneath, that when he bends himself any Way, one Part of this board-like Skin, should slide over the other. And these Folds are placed in such Parts of his Body, as to facilitate the Performance of every voluntary Motion.

P. 109. The *Lama*'s in *Peru*, have ſmall Heads, reſembling in ſome Meaſure both an Horſe and a Sheep. The upper Lip is cleft, like that of an Hare, through which, when they are inraged, they ſpit, even to ten Paces Diſtance, a Sort of Juice, which when it falls upon the Skin, cauſes a red Spot and great itching. The Neck is long, like that of a Camel, the Body like that of a Sheep, but with much longer Legs. It yields ſtrong and fine Wool, and is alſo a Beaſt of Burden, and kept at an eaſy Expence. It carries its Burden a vaſt Way, without tiring, eats very little and never drinks. At Night he lies down, and no Blows can make him riſe, or move one Foot till Morning.

P. 111. The Feet of the Female *Beaver*, which a Gentleman kept in *England* ſome Years ſince, were webbed, like thoſe of a Gooſe. The Tail was ſcaly, and ſhaped like the Blade of an Oar. This ſhe uſed as a Rudder to ſteer herſelf, eſpecially when ſhe ſwam under Water, which ſhe would do for two or three Minutes, and then come up to take Breath, ſometimes raiſing only her Noſtrils above Water. She ſwam ſwifter than any Water-fowl; and under Water as ſwift as a Carp. The hind Legs being longer than the Fore, made her walk ſlow on dry Land, or rather waddle like a Duck. If drove along faſt, ſhe could not run, but went by Jumps, flapping her Tail againſt the Ground. She never made any Noiſe, except a little Sort of a Grunting, when angry, or driven faſt. As the Beaver frequents the Water like Water-fowls, may not the Caſtor be provided for him by Nature, to anoint his Fur with, and prevent the Water from ſoaking to his Skin. And as it is impregnated with penetrating, pungent Particles, it may likewiſe contribute to keep off the Chill, which the Water might otherwiſe ſtrike to his Body, when he remains long therein.

P. 112. *The Sable-mice*, (which were firſt obſerved in *Lapland*, in 1697,) are near as big as a ſmall Squirrel.

rel. Their Skin is ſtreaked and ſpotted black and light brown. They have two Teeth above and two under, very ſharp and pointed. Their Feet are like a Squirrel's. They are ſo fierce, that if a Stick be held out to them, they will bite it, and hold ſo faſt, that they may be ſwinged about in the Air. In their March they keep a direct Line, generally from North-Eaſt to South-Weſt. Innumerable Thouſands are in each Troop, which is uſually a Square. They lie ſtill by Day, and march by Night. The Diſtance of the Lines they go in, parallel to each other, is of ſome Ells. Whatever they meet in their Way, tho' it were a Fire, a deep Well, a Torrent, Lake, or Moraſs, they avoid it not, but ruſh forward. By this Means many Thouſands of them are deſtroyed. If they are met ſwimming over a Lake, and are forced out of their Courſe, they quickly return into it again. If they are met in Woods or Fields and ſtopt, they raiſe themſelves on their hinder Legs, like a Dog, and make a Kind of barking Noiſe, leaping up as high as a Man's Knees, and defending their Line as long as they can. If at laſt they are forced out of it, they creep into Holes, and ſet up a Cry, ſounding like *Biab, biab.* If a Houſe ſtand in their Way, they never come into it, but ſtop there till they die. But they will eat their Way through a Stack of Corn or Hay. When they march through a Meadow, they eat the Roots of the Graſs: And if they encamp there by Day, they utterly ſpoil it, and make it look juſt as if it had been burnt. They are exceeding fruitful: But their Breeding does not hinder their March. For ſome of them have been obſerved, to carry one young in their Mouth, and another upon their Back. In Winter they live under the Snow, having their Breathing-holes, as Hares and other Creatures have.

V. I. 120. The *Variety* of Shape and Colour obſervable in *Beaſts*, prevents any two from being exactly alike, as much as the human Features diſtinguiſh Mankind one from another. Wherefore then was

this Variety beſtowed upon Brutes? Are they at all ſenſible of ſuch Diverſity? Are they the more happy, or more uſeful to one another for it? No. This Variety then is doubtleſs intended for the Sake of Man, to prevent Confuſion, and decide and aſcertain his Property.

CHAP. II.

Of Birds.

1. *Of the Art of Flying,*
2. *Of the Virginian Martin,*
3. *Of Birds of Paſſage,*
4. *Of the Solan Gooſe,*
5. *Of the Eagles in Roma,*
6. *Of Barnacles.*

P. 125. THE *Art of Flying* has been ſeriouſly attempted by many, in various Ages, particularly in the Time of our famous Friar *Bacon*, who lived about 500 Years ſince, and whom his excellent Works ſhew to have been a rare Chymiſt, an excellent Mathematician, a knowing Mechanic, and a moſt accompliſhed experimental Philoſopher. Yet even he believed, the Art of Flying poſſible, and ſays, he himſelf knew how to make an Engine, in which a Man ſitting might be able to convey himſelf through the Air, like a Bird. Nay he affirms, That there was then another Perſon, who had actually tried it with Succeſs.

VI. p. 141. I know not how we can doubt of the Fact, that Swallows have been found in Winter, under Water, clung together, atteſted by Men of unqueſtionable Veracity. And yet others affirm, that they have ſeen Flights of Swallows croſſing the Sea in Autumn. The Truth ſeems to be this. There are ſom

ſome Species of Swallows, which ſeek a warmer Climate at the Approach of Winter, while others remain here in a temporary Death, like the Flies on which they feed.

They have in *Virginia*, a *Martin* like ours, only larger, which builds in the ſame Manner. Col. *Bacon* obſerved for ſeveral Years, that they conſtantly came thither upon the Tenth of March Two of them always appeared a Day or two before, hovering in the Air. Then they went away, and ſpeedily returned, with the whole Flock.

The following ſeems to be a very rational Account of thoſe which are really Birds of Paſſage.

V. I. p. 141. When by the Approach of our Winter their Food fails, *Birds of Paſſage* are taught by Inſtinct to ſeek it elſewhere. Want of Food ſeems to be the chief, if not the only Reaſon of their Migration. The Length of their Wings enables them to catch the Flying Inſects, with which the Air is ſtored during the warm Months. And moſt *Summer Birds* of Paſſage, feed on the Wing upon ſuch Inſects as are ſeen no more when Winter comes. If it be conſidered, how much of the Globe ſtill remains unknown, it is no Wonder, we are not yet acquainted with the Places to which they retire. Probably they lie in the ſame Latitude in the Southern Hemiſphere, as thoſe from whence they depart.

As *Swallows* cannot bear ſo much cold, as ſome other Birds of Paſſage, they are conſtrained to viſit us ſomewhat later, and to depart ſooner. Some ſtay a Month after them. Probably many of them perform their long Journeys chiefly in the Night. Lying on the Deck of a Sloop on the North Side of *Cuba*, I and the Company with me, heard three Nights ſucceſſively, Flights of *Rice-birds* (their Notes being plainly diſtinguiſhable) paſſing over our Heads Northerly, which is their direct Way from the Southern Continent of *America*, from whence they go yearly when

the Rice begins to ripen, and after growing fat, return back.

There are also *Winter Birds of Passage*, which arrive here in Autumn and go away in Spring, namely, the Fieldfare, Redwing, Woodcock and Snipe. But the two latter sometimes spend the whole Year here: Whereas the two former constantly at the Approach of Summer, retire to more Northern Climates, where they breed, and remain till at the Return of Winter, they return to us again.

The Winter Food of these Birds being Berries and Haws, which are far more plentiful here than in more Northern Regions, these are one Reason of their coming over: But the Principal is, the Severity of the Weather in those Climates, which Nature teaches them to exchange, for such as are more temperate. But why do they depart from us in Spring? This still remains among the Secrets of Nature.

Beside these Summer and Winter Birds, there are others which come periodically to certain Places, for the Sake of some Sort of Food, which their own Country is destitute of. These quickly depart, and are seen no more till that Time Twelvemonth. Such are the Rice-bird and Blue-wing of *Carolina*.

But above half a Century passed, from the Time of cultivating Rice and Wheat in *Carolina* and *Virginia*, before these foreign Birds made their Appearance there. The *Wheat* Birds now come annually to *Virginia*, when the Wheat ripens, and have come every Year, since their first appearance, in numerous Flights.

P. 144. After *same Nest.*

The *Solan-Goose*, somewhat less than a Land Goose, is white: Only the Tips of its wings are black, and the Top of the Head yellow. The Bill is long, and so sharp-pointed, that it pierces an Inch deep into a Board, when they stoop at fish which are laid there on. This is one Way of catching them. When they

they ſleep, they put their Head under their Wings: But one keeps Watch. If that be ſurprized by the Fowler, which frequently happens, all the reſt are eaſily caught by the Neck, one after another. But if the Centinel cries and gives them warning, the whole Flock eſcapes. When they fiſh for Herrings, which come in Shoals, they fly near ſixty Yards high, and ſtoop perpendicularly. But when they aim at a ſingle Fiſh, they deſcend aſlant.

There is always one Tribe among them which is barren: Theſe keep together, and never mix with them that build and hatch. (Is it not probable, that theſe are the Males, like the Drones among the Bees?) The Solan Geeſe come to the Weſtern Iſles in *Scotland*, in March taking the Advantage of a South-weſt Wind. They ſend a few before them, who make a Tour round the Iſles, and then return to their Company. In a few Days after, the whole Flock comes together, and ſtays till September. All this Time they are daily making up their Neſts, in the Shelves of high Rocks. They fiſh, hatch and make their Neſts by Turns. In order to this they amaſs together, not only Heaps of Graſs, but whatever elſe they find floating on the Water. In a Neſt on St. *Kilda*, was found a Soldier's red Coat, and ſome *Molucca* Beans in another.

They are thought the ſharpeſt ſighted of all Seafowls. They have a large Gorget, ſomewhat like a Pelican, in which one of them will preſerve five or ſix Herrings intire, and carry them to her Neſt, where they empty them out, for Food to their Young. Nay, they have been obſerved to go a Fiſhing, to ſome Iſles which are thirty Leagues diſtant, and bring the Fiſh in their Gorget all that Way.

P. 146. After *with others.*

In the Iſle of *Rona*, (one of the *Scotch* Weſtern Iſles) there are a Couple of Eagles, which the Natives ſay, not only drive away their Young as ſoon as they are able

able to fly, but keep Poſſeſſion of the Iſland, not ſuffering any of their Kind to live there but themſelves.

There are alſo a Couple of *Ravens* in this Iſland, which beat away all ravenous Fowls. And when their own Young are able to fly, they beat away them likewiſe.

But who can account for another Matter of Fact, which is continually obſerved on the *Weſtern Iſlands?* The Weſtern Ocean throws up on their Shores, great Quantities of weather-beaten Timber, on which hang Multitudes of little Shells, faſtened to one another, much as Muſcle-ſhells are. In every one of theſe Shells is a perfect Fowl: The little Bill is like that of a Gooſe; the Eye marked; the Head, Neck, Breaſt, Wings, Tail and Feet formed. The Feathers are perfectly ſhaped, and of a blackiſh Colour, and the Feet like thoſe of other Water-fowl. But we cannot hear of any Perſon, that ever ſaw any of them alive.

Now, as Bats are a Kind of Medium between Beaſts and Birds, are not *Barnacles* a Kind of Medium between Birds and Fiſhes?

CHAP. III.

Of Fiſhes.

P. 156. THERE is ſomething extremely odd, in the Experiments of an ingenious Man,

on

on ſome of our common *Fiſhes*. "I put a Banſtickle, ſays he, in a Glaſs Jar filled with Water: At firſt, it refuſed to eat any Thing, which is common with all Fiſhes, but afterwards it grew ſo tame, as to take ſmall Worms out of my Hand. Nay, it was ſo bold at laſt, that when its Belly was full, it would ſet up its Prickles, and with all its Strength, make a ſtroke at my Fingers, if I put them near it.

"This Fiſh was ſo unſociable, that it would ſuffer no other Fiſh to live in the Jar with it, and ſo audacious as to attack whatever I put in, tho' ten Times its own Size. One Day I put in a ſmall Ruff, the Banſtickle inſtantly aſſaulted it, tore off Part of its Tail, and I am perſuaded would have killed it, had I not ſeparated them.

"The Abilities they uſe to get from Place to Place, are likewiſe extraordinary. Tho' they are ſcarce two Inches long, I have ſeen them leap out of the Water a Foot high perpendicularly, and much farther obliquely, when they wanted to get over ſome Obſtacle in their Way.

"Nature has furniſhed them with a kind of Breaſt-plate, to be a Defence againſt outward Injury, and with Prickles upon their Sides and Back, which they erect on the leaſt Appearance of Danger.

"I have always obſerved among the Fiſh I keep in Jars, that ſuch as I keep awhile together, contract ſo great an Affection for each other, that if they are ſeparated, they grow melancholy and ſullen. About Chriſtmas I put two Ruffs into a Jar, where they lived together till April. I then gave one of them to a Friend, the other was ſo affected, that for three Weeks it would eat nothing. Fearing it would pine to Death, I ſent it to its Companion: being put to this, it ate immediately, and preſently recovered its former Briſkneſs.

In the Beginning of September, ſays the ſame Gentleman, I procured a ſmall *Dace*, which I kept in a Glaſs Jar, till the latter End of May following.

Alt

All this while it ate nothing except the ſmall Animalcule, which happened to be in the Water I gave it, once a Day in Winter, and twice or thrice in the Spring, as the Weather grew warmer. When the Water was freſh, it came up to the Top about once an Hour, to blow out ſome ſmall Bubbles of Air. Then putting its Noſe near the Surface, it took in freſh, and retired to the Bottom again. But as the Water became leſs pure by its Uſe, its returns to the Surface were more frequent, and at laſt it would remain there continually, till I gave it a freſh Quantity. I believe I might have kept it for Years, but Buſineſs one Day prevented me from giving it clean Water in due Time, which put a Period to the Life of my little Companion.

At firſt it would not ſuffer me to come nigh the Glaſs, without the utmoſt Confuſion and Surprize, but at laſt it grew ſo tame, that I if came but in Sight, it would be ſure to be at the ſame Side of the Glaſs, and lie gazing at me, until I was weary of obſerving it. I often took the Opportunity of looking at it by Candle-light, which it ſeemed to take great Pleaſure in.

In the above mentioned Month, I put into another Glaſs, a Ruff about three Inches long. At firſt he too appeared mighty reſerved, and would not eat, nor ſuffer me to come nigh him, but in a ſhort Time all-powerful Hunger tamed him, for he could not, like the Dace, live on the ſmall Inhabitants of the Water, and ſo was quickly forced to take whatever I provided for him. In a while it grew ſo tame, that it would not only eat ſmall Worms which I threw into the Glaſs, but would take them out of my Hands. Nay, it would even riſe out above the Water for them; which is contrary to the Way wherein this Kind of Fiſh uſes to take its Food. At laſt, it would come to my Hand, whenever I put it into the Glaſs, and ſuffer me to handle it. When I had

I had made all the Obſervations I thought proper after eight Months I gave him his Liberty.

Crabs-Eyes ſo called, are found in the Bodies of *Cray fiſh*. Each Fiſh produces two yearly, one on each ſide of the Stomach, between the Coats of it. Here it grows Coat upon Coat, and is ſupplied with petrifying Juices by Veſſels opening on the inner Surface of the outward Coat. The firſt Scale, whereon all the others are formed, may be perceived in the Center, the Brims or Circumferences of many of the reſt being likewiſe apparent. It is believed, that they caſt theſe Stones with their Shells yearly; but this is not the Caſe. For about the Time of caſting their Shell, the Stones break thro' the internal Coat of the Stomach, and being ground by the three ſerrated Teeth therein, become diſſolved in the Space of a few Days, which makes it difficult to find them juſt at this Time.

They eat the old Shells immediately after ſhedding them. Perhaps theſe Stones may be deſigned to furniſh new petreſcent Juices to its Fluids, for the Reproduction of their annual Dreſs.

It may be worth obſerving, that *Lobſters* uſe their Tails as Fins, wherewith they commonly ſwim backward, by Jirks or Springs, reaching ſometimes ten Yards at a Spring. For this Purpoſe, as the *Gill fins* of other Fiſhes, which are their Oars, are a little concave backward, theſe have the Plates of their Tails, when they bend them down as they uſe to do, a little concave forward.

Oyſters ſpawn on the *Iriſh* Coaſts in the Summer months. Their Spawn ſticks to Stones, Oyſter-ſhells, or any ſuch Subſtance at the Bottom of the Sea. They are near two Years before they come to full Growth, they move very little from the Place where they firſt lie.

Among

Among the *Shell-fish* on the *Waterford* Coaſt, is the *Murex*, which gave the *Tyrian* Purple. It is in great Plenty there, and is by the *Engliſh* called an Horſe-winkle. The Shell is about an Inch long, and half an Inch broad, and turns ſpirally like a Snail-ſhell. Each Fiſh has a peculiar Reſervoir, which contains a large Drop of Liquor, if this is preſt out on Linen, the Linen firſt appears of a dirty Yellow, inclining to Green, afterward it changes to a Lemon Colour, then to a deep Green; then it turns to a deep Blue, and at laſt to a charming Purple.

The Shells of the antient *Purple-fiſh*, are ſtill common upon the *Tyrian*-ſhore. The Fiſh itſelf is found in great Abundance in the Seas of the *Spaniſh Weſt-Indies*, near *Panama* and *Nicoya*, exactly agreeing with *Pliny*'s Account of the antient *Murex*-Cloth of *Segovia* died with this Purple, which is ſold for 20 Crowns an Ell, and is very rarely worn by any, but the greateſt Noblemen in *Spain*. The *Caribbee* Iſlands have alſo the ſame Sort of Fiſh, which we may likewiſe find nearer home, namely on the Coaſts of *Somerſetſhire*, as well as of *South Wales*.

The *Pearl Muſcles* lie partly open: The inſide of the Shell is of a pearly Colour. The Pearl lies in the ſmaller End of it, at the Extremity of the Gut, and out of the Body of the Fiſh, between the two Films that line the Shell. This anſwers to the *Stone* in other Animals, increaſing by Cruſts growing over one another. Accordingly if a Pearl be pinched in a Vice, the upper Coat will crack and leap away. And as it is now known, that the Shells of Fiſhes are formed of ſtony Matter oozing out of their Body, it is no Wonder if that Matter when it chances to overflow, burſts forth in any Cavity of the Body, and forms a little Maſs, which hardening becomes a Pearl of the ſame Colour with the Shell.

Whereas all other Animals take in Nutriment by the Mouth, the *Muſcle* takes it in by the Anus. The Part called the Head, tho' without Eyes, Ears or Tongue,

Tongue, is immovably faſtened to one of the Shells; ſo that it cannot receive any Thing. The Food of a Muſcle is Water, which as the Shell opens, enters in at the Anus, and paſſing on by certain Canals running between the Shell and the Animal, is thence conveyed into the Mouth.

What is farther ſurprizing is, that it is an Hermaphrodite; but one of a peculiar Kind, for it propagates (not as Worms and Snails, reciprocally) but independent of any other Animal. So that itſelf is both the Father and the Mother of its own Offſpring.

We have lately diſcovered a progreſſive Motion in theſe Shell-fiſh, which were ſuppoſed to be quite fixt. Even Oyſters, which one would think wholly immovable, if they are thrown irregularly into a Veſſel of Water, will in a while turn themſelves, till the ſmooth Shell becomes uppermoſt: Otherwiſe they could hold no Water in the concave Shell for their Suſtenance.

Muſcles can walk on the Ground, which they do on this Manner. Lying on the flat Side of their Shell, they thruſt out a Part, in Form of a Tongue, wherewith they make little Motions to the Right and Left, and thereby dig a Paſſage in the Sand. In this digging they drop gradually on one Side, and ſo get the Shell mounted on its Edge, then they ſtretch out the Tongue as far as they can, and reſt for a Minute or two on its Extremity, to draw the Shell after them as Water-ſnails do. This Motion is repeated as long as they pleaſe; thus they form a Sort of Groove in the Sand, which ſuſtains the Shell on either Side, and leaves behind them a Sort of irregular Tract, three or four Yards long. In Rivers abounding with Muſcles one may ſee many of them, with a Muſcle at the End of each.

That called the *Arm* or *Leg* in a *Sea-Muſcle*, which in its natural State is not above two Lines long, may reach out of the Shell two Inches: And the Muſcle having laid hold on a fixt Point therewith, bends and

and ſhortens it, and ſo drags itſelf on. The *Beard* ſerves for an Anchor to faſten it to ſome heavy Body, that it may not be carried away with the Motion of the Waves.

When a *Pond-Muſcle* walks, it thruſts out its whole Belly, in form of the Keil of a Ship, and creeps on its Belly as the Serpent does. So true it is, that Nature is not confined in her Manner of Operation, but is ever varying, tho' never confuſed.

P. 157. In *Port-Mahon* Harbour, there are Stones from Half an Hundred to five Hundred Weight each, lying at all Depths, full of Shells, each containing a ſingle Fiſh, of the Muſcle Kind. The Holes in the Surface are far narrower than the Hole in which is the Fiſh, which it ſeems is capable of enlarging its Room, as it grows bigger by abrading the Sides of its Cells. And this is apparent, from the ſandy Matter found in the Bottom of thoſe Cells, whenever the Orifice is higher than the Bottom; for then the Fiſh cannot throw it out.

The *Bollani* likewiſe in the *Adriatic* Sea, live in large Stones. Their Shell is rough and oblong, not unlike a Date. They are found in ſeveral Kinds of porous Stones. In the Pores of theſe the Spawn is depoſited. Frequently the Aperture thro' which it was injected, is no longer perceivable; but the Fiſh thrives notwithſtanding. On breaking ſome of theſe Stones, one finds near thirty live Fiſh, tho' no Opening can be perceived on the Outſide. Each has juſt Room to open its Shell, the Inſide of which is white, the Outſide Aſh-colour; the largeſt is four or five Inches long. Both the Fiſh itſelf and its Juices are ſo luminous, one may ſee to read by it, and even Water in which it has been ſqueezed, put into a Glaſs, will ſhine ten or twelve Hours.

Likewiſe in *Toulon* Harbour are found ſolid Stones containing in ſeparate Cells, ſecluded from all Communication with the Air, ſeveral living Shell-fiſh. The ſame are found along the Coaſt of *Ancona*, in

Stones

Stones weighing 50 Pounds and upwards. The Outside of which is ſoft, but the Inſide ſo hard, as to require an Iron Mall, and a ſtrong Arm to break them:

It is plain therefore that Life may ſubſiſt even without *Air*: As appears likewiſe undeniably from two Memoirs given by the Academy of Sciences at *Paris*. "In the Center of a large Elm, four Feet above the Root, was found a Toad, filling up the whole vacant Space. No ſooner was the Wood ſplit, than it crept away in haſte. No Tree could be more ſound. Then how came it there? Probably the Egg whence it was formed, was lodged in the Tree at its firſt Growth, by ſome ſingular Accident. There it lived, tho' without Air, feeding on the Juices of the Tree, and growing as the Tree grew. Since then we have been certainly informed of one found in an Oak larger than that Elm. By the Time requiſite for the Growth of the Tree, it muſt have ſubſiſted there, without any Commerce with the external Air, for eighty or an hundred Years."

A like Fact is related by *Ambroſe Pare*, chief Surgeon to *Henry* IIId of France. "Overlooking my Labourers, whom I had ſet to break ſome hard and large Stones, in the Middle of one, we found an huge Toad, full of Life, tho' there was no Aperture in the Stone: And the Labourer told me, it was not the firſt Time he had found ſuch, in huge Blocks of Stone, which had no viſible Opening.

Other Authors of undoubted Credit, give us Accounts of Frogs, Snakes, Crabs and Lobſters, found alive within large Stones and Blocks of Marble. Without attempting to account for theſe Facts, we may infer from them,

1. That the Eggs from which theſe Creatures proceeded, were lodged in the Tree at its firſt Growth, or in the ſoft Mud, out of which the Stones were formed:

2. That they have ſubſiſted there 50, an 100, an 150 Years, or more:

3. That conſequently they have lived far longer than Animals of the ſame Kind do, when at Liberty:

4. That all the Time they had no Aliment but the Sap of the Tree, or Moiſture penetrating the Stone:

5. That they lived without any more Air, than was contained in thoſe ſcanty Cells:

6. That to this Excluſion of the external Air, their Longevity was chiefly owing: And

7. That either they were provided at firſt with Cells proportioned to their utmoſt Size, or as they grew, they had the Sagacity to inlarge their Cells, by repelling or gradually abrading the Sides that formed them.

But what a Life was this! Here was *gentle inactivity* for a Century together!

P. 161. The Fiſhers on the Weſtern Iſles of *Scotland* obſerve, That there is a large *Herring*, double the Size of a common one, which leads all that are in a Bay, the Shoal following him wherever he goes. This Leader they term, *The King of Herrings*: And when they chance to ketch it alive, they drop it carefully into the Sea, judging it petty Treaſon to deſtroy a Fiſh of that Name.

P. 163. At *Leixlip*, ſeven Miles from *Dublin*, there is a fine Water-fall, or *Salmon-leap* ſo called, from the numberleſs Salmon which leap up it, at the Seaſon of the Year for ſpawning. When they come to the Foot of the Fall, you may obſerve them frequently to leap up juſt above the Water, as if to make an Obſervation of the Diſtance. Soon after they leap up again, with an Attempt to gain the Top, and perhaps riſe near it; but the falling Water drives them down again. The ſame Fiſh ſoon ſprings up again, and riſes above the Fall; yet this is equally unſucceſsful, for dropping with their Broadſides on

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the rapid Curvature of the Waters, they are thrown back again headlong. The only Method of ſucceeding in their Attempt, is to dart their Heads into the Water, in its firſt Curvature over the Rocks. By this Means they firſt make a Lodgment on the Top of the Rock for a few Moments, and then ſcud up the Stream. There ſeems to be a peculiar Inſtinct in them, to aim at this very Point; for the Force of the Stream on the Top of the Precipice, is leſs at the Bottom, cloſe to the Rock than on the Surface. 'Tis almoſt incredible, the Height to which they will leap, they frequently leap near twenty Feet. The Manner of their doing it is, by bending their Tails round, almoſt to their Heads; it is then by the ſtrong re-action of their Tails againſt the Water, that they ſpring ſo much above it.

P. 163. The *Shark*, as vaſt as his Strength is, has no Bones, except in his Head. His Jaws are only Griſtles, and he has three, four, five, or perhaps more Rows of Teeth, as he grows in Years. Theſe are juſt like Lancets, and are moveable, erected or lying flat, as he pleaſes. His Ribs are all Griſtles; ſo is his Spine, yet divided into Vertebræ. The Shark, the Dolphin, and the Spaniſh Mackrel ſwim faſter than any Ship ſails.

P. 164. The *Whalebone Whale* is about 70 Feet long, and very bulky, having Scales, and no Fins, but only one on each Side, from five to eight Feet long.

The *Spermaceti Whale* is much of the ſame Dimenſions. The Spermaceti Oil lies in a great Trunk, four or five Feet deep, and ten or 12 Feet long, near the whole Length, Breadth and Depth of the Head. It ſeems to be no other than the Brain. Not but ſome other Parts of the Fiſh yield an Oil; but not ſo good as that in the Trunk.

The Care of their Young is remarkable: While they carry them under Water, they often riſe for the Benefit of the Air. However they are chaſed or

wounded, as long as they have Senſe, and perceive Life in their Young, they will not leave them, and if in their flying, the young one drops off, the Dam, comes about, and paſſing underneath takes it again.

Whales are gregarious, being ſometimes found an Hundred in a ſwell, and are great Travellers. In Autumn the Whalebone Whales go Weſtward; in Spring Eaſtward again. The ſeveral Kinds of Whales do not mix with each other, but each keep by themſelves.

Their wonderful Strength lies chiefly in the Tail. A Boat has been cut down from the Top to the Bottom by the Tail of a Whale, and the Clap-boards hardly ſplintered, tho' the Gunnel on the Top was of tough Wood. Another has had the Stern-poſt, three Inches thick, cut off ſmooth without ſo much as ſhattering the Boat, or drawing the Nails of the Boards.

P. 168. There is ſomething highly remarkable in the Change of Tadpoles into Frogs: But there is ſomething ſtill more remarkable in the *Frog-fiſh*. Theſe are found in great Numbers in the River of *Surinam*. At firſt they are perfect Frogs, they are ſpotted with brown, yellow and green; but are paler on the Belly, their hinder Feet are webbed, like thoſe of a Gooſe, the Fore-feet without Webs. The firſt Change the Animal undergoes, is by the growing of a Tail. After this the Fore-feet decreaſe, and periſh by Degrees. The Decreaſe of the hinder Legs follows, and at laſt the Frog is changed into a perfect Fiſh.

P. 169. The *Blood of Tortoiſes* is colder than any common Spring Water: Yet is the beating of the Heart as vigorous as that of any Animal, and the Arteries as firm as thoſe of any Creature.

It has been commonly ſuppoſed, that all Fiſhes are mute, as well as void of Hearing. But a late Author ſays, There is one Kind of Whale, that when they

are

are ſtruck roar ſo loud as to be heard two Miles. He likewiſe aſſerts, that ſome of them have Hearing, as have Frogs, Snakes and all the Lizard Kind, tho' they have not the uſual outward Apparatus of Hearing. But they have the Auditory Paſſages, by which Sound is conveyed, and internal Organs, to which the Meatus Auditories reaches. This is obſervable in all the Whale-kind, and in all Fiſhes that have Lungs. And whereas ſome have ſuppoſed, that Water cannot tranſmit Sound, the contrary of this is now well known. Many Experiments have ſhewn, that even a Man under Water may hear what is ſpoken in the open Air.

CHAP IV.

Of Reptiles.

P. 172. SERPENTS will ſwim a long Time, but they cannot ſtay long under Water, without being ſuffocated. In Winter they retire under Stones, Roots of Trees, old Walls, or any warm, dry Shelter. Here they ſleep half dead, tho' with their Eyes open, till the returning Sun recalls them to Life.

P. 173. The Venom of a Viper is not mortal to a ſound and robuſt Body, though attended with painful Swellings, violent Vomitings, Phrenſies and Convulſions. In eight or ten Days, the Poiſon having run thro' divers Parts of the Body, throws itſelf into the Scrotum, and ſwelling it extremely, cauſes great Heat, and much Urine very hot and ſharp, by which it is diſcharged, this being the certain Criſis of the Diſeaſe.

But a ſickly or fearful Perſon, bit by a Viper ſurely dies, if there be not ſpeedy Help. Any one bit, in two or three Days weighs almoſt as much more as he did before. Who can account for this?

It is remarkable, that the youngeſt Vipers are provided with poiſonous Teeth grown to Perfection, commenſurate to their Bulk; that ſo they may be able to kill their Prey and feed themſelves, as ſoon as they are born.

P. 174. A common Snake will avoid a Man; but a *Rattle-ſnake* never turns out of the Way. His Eye has ſomething ſo terrible in it, that there is no looking ſtedfaſtly at him. But he creeps very ſlow, with his Head cloſe to the Ground, ſo that one may eaſily get out of his Way. His leaping is no more than uncoiling himſelf, ſo that a Man is in no Danger, if he is not within the Length of the Snake. Neither can he do any Harm, unleſs he firſt coil, and then uncoil himſelf; but both theſe are done in a Moment.

The Noiſe they make is not owing (as ſome imagine) to little Bones lodged in their Tails. But their Tail is compoſed of Joints that lap over one another, like a Lobſters, and they make that Noiſe by ſtriking them one upon another. This is loudeſt in fair Weather; in rainy Weather they make no Noiſe at all. It is remarkable, that whenever a ſingle Snake rattles, all that are within hearing rattle in like Manner.

Of how extremely penetrating a Nature is their Poiſon? A Man provoking one of them to bite the Edge

Edge of his Broad-axe, the Colour of the ſteeled Part preſently changed: And at the firſt Stroke he made with it in his Work, the diſcoloured Part broke out, leaving a Gap in the Axe.

A Gentleman has lately given a particular Account, of what he felt after being bit by one of them.

"Hearing, ſays he, a Bell upon the Top of a ſteep Hill, which I knew to be on one of the Cows of the People where I then quartered, I went right up the Hill; but near the Top my Foot ſlipped and brought me down upon my Knees. I laid my Hand on a broad Stone to ſtay myſelf; I ſuppoſe the Snake lay on the other Side, who bit my Hand in an Inſtant, then ſlid under the Stone, and ſounded his Rattles. But I ſoon found him, cruſhed his Head to Pieces with a Stone, took him up in my left Hand, and ran Home, ſucking the Wound on my Right hand, and ſpitting out the Poiſon. This kept it eaſy; but my Tongue and my Lips grew ſtiff and numb, as if they were froze. When I came Home, one preſently ripped a Fowl open, and bound it upon my Hand. This eaſed me a little. I kept my Elbow bent and my Fingers up, which kept the Poiſon from my Arm. Another bruiſed ſome Turmerick, and bound it round my Arm, to keep the Poiſon in my Hand. This kept my Arm eaſy for ſome Hours, and my Hand tho' numb, was not much ſwelled, nor even painful; but about Midnight it puffed up on a ſudden and grew furious, till I ſlit my Fingers with a Razor. I alſo ſlit the Back of my Hand and cupped it, and drew out a Quart of ſlimy Stuff, yet my Arm ſwelled. Then I got it tied ſo faſt, that it was almoſt void of Feeling. Yet would it work, writhe, jump, and twine like a Snake, change Colours and be ſpotted. And the Spots moved to and fro upon the Arm, which grew painful at the Bone. All Things were applied for two Days which could be thought on; but without Effect, till the Aſhes of White Aſh-bark

made

made into a Plaiſter with Vinegar, drew out the Poiſon. We then untied my Arm; but within two Hours all my Right-ſide turned black. Yet it did not ſwell, nor pain me. I bled at the Mouth ſoon after, and continued bleeding and feveriſh four Days. The Pain raged ſtill in my Arm, and I was by Times, delirious for an Hour or two. After nine Days the Fever went; but my Hand and Arm were ſpotted like a Snake all the Summer. In Autumn my Arm ſwelled, gathered and burſt, ſo away went Poiſon, Spots and all.

But the moſt ſurprizing Circumſtance was my Dreams. In all Sickneſſes before, theſe were always pleaſant. But now all were horrid. Often I was rolling among old Logs; ſometimes I was a white Oak cut in Pieces. Frequently my Feet would be growing into two Hickary Trees: So that it was a Terror to me, to think of going to ſleep.

P. 177. The Eyes of a *Chameleon* are of the Size of a Pea, which it moves in a wonderful Manner, the one backward, the other forward, the one upward, the other downward, or if it fixes one Eye on an Object, while the other moves according to the Motion of another Object; ſo that its Eyes are quite independent on each other, and capable of all the different Motions that can be imagined. The Structure of its Eyes is alſo ſurprizing; for they are covered with a Skin almoſt like that of the Body, the Grain of which is in Circles, diminiſhing gradually to the Center, where is a Hole no bigger than the Head of a Pin, which receives the Light.

The common Colour of the Chameleons in *Smyrna* is green, toward the Belly inclining to a yellow. But thoſe in the Ruins of the Caſtle are greyiſh, like the Stones among which they breed. One of them, having been kept in a Napkin, appeared whitiſh; but it never changed to red or blue, tho' wrapt in Cloth of thoſe Colours for ſeveral Hours together. On being handled or diſturbed, it became ſtained with

with dark Spots, bordering on green. Sometimes from a green all over, it became full of black Spots; ſometimes when it appeared black, green Spots ſuddenly appeared. So far is it from being true, that it changed its Colour, according to every Object near it. Nor could we perceive this Change to be any fixt Law, it rather ſeemed ſpontaneous. This only was conſtant; being placed on green, it became green; being on the Earth, it changed to the Colour of Earth.

P. 178. In moſt Parts of *Italy* there are Swarms of *Lizards*, eſpecially of the green Kind. In the Spring, Hundreds of them are ſeen, baſking on the Roofs, and crawling up and down the Walls of Houſes. They are very nimble, and have a bright, ſleek Skin, and beautiful Eyes, but are entirely harmleſs. The *Scorpions* are not ſo; they harbour not only in old Walls and under Stones, but in every Part of the Houſe, eſpecially the Beds; and if touched, immediately ſting. The Sting of an *Apulian* Scorpion, has the ſame Effect with the Bite of a Tarantula. And it requires the ſame Method of Cure; only by different Inſtruments, the Flute and Bagpipe in particular, with the briſk Beat of a Drum. But the common Remedy againſt the Sting of a Scorpion is, to bruiſe the Animal, and bind it on the Wound.

With Regard to *Water-lizards*, commonly called *Newts*, which moſt people ſuppoſe to be venomous, they are harmleſs as Land-lizards, and are found in Summer, in moſt ſhallow ſtanding Waters. One who kept ſeveral of them in Glaſs Jars for many Months obſerves, in Reſpect of that odd Circumſtance, caſting their Skins, they do this every Fortnight or three Weeks. A Day or two before the Change, the Animal appears more ſluggiſh than uſual, and takes no Notice of its Food, which at other Times it devours greedily. The Skin in ſome Parts appears looſe, and of not ſo lively a Colour as before. It

begins

begins this Work, by looſening with its Fore-feet, the Skin about its Jaws, puſhing it forward gently and gradually both above and below the Head, till it can ſlip out firſt one Leg and then the other. Then it thruſts the Skin backward as far as thoſe Legs can reach. Next it rubs itſelf againſt Pebbles, Gravel or whatever elſe it can meet with, till more than half the Body is freed from the Skin; which then appears doubled back, covering the hinder Part of the Body and Tail. Then turning its Head round to meet its Tail, it takes hold of the Skin with its Mouth, and ſetting its Feet thereon, by Degrees pulls it off, drawing the Hind-legs out, as it did the Fore-legs. If you then examine the Skin, it will be found Inſide outward, but without the leaſt Hole or Breach, the Part which covered the hind Legs ſeeming like Gloves turned Inſide out, tho' intirely perfect and unbroken. They do not however put off the Coverings of their Eyes, as moſt Kinds of Snakes do; for the Skin of the Newt has always two Holes, at the Places where the Eyes have been. When the Skin is off, if it be not ſoon taken away, the Creature ſwallows it whole.

Many Creatures of very different Kinds, put off their Skins or Shells at certain Periods, and if we may gueſs at other Shell-fiſh by the *freſh Water Shrimps*, their Shells are put off without any Breach but one, lengthways, in the Middle of the Belly part, thro' which the Body, Tail and Claws are pulled out, and the Shell left in a Manner whole. In the Inſect Tribe, the Changes of Caterpillars are well known. The *Spider* throws off its Skin as frequently, getting out of it by a Rupture underneath, and leaving every Claw intire, and even the horny Covering of his Forceps. Even the Mite caſts its Skin at ſeveral ſhort Periods, and nearly in the ſame Manner.

A particular Species of Water-Lizard, Abbe *Spallanzani* terms an *Aquatic Salamander*. Yet he obſerves, this cannot bear any great Degree, either of Heat or Cold.

Cold. But the moſt remarkable Circumſtance relating to it is, that let its Tail, Legs, or even Jaws be cut away, and in a ſhort Time they are re-produced. The Tail, beſide a compleat Apparatus of Nerves, Muſcles, Glands, Arteries and Veins, has Vertebræ of real Bone. And their Legs do not differ from thoſe of the moſt perfect Animals, in the Number of Bones, whereof they are compoſed. Now when the Legs and Tail of this Animal are taken away, new Vertebræ, new Bones are produced: A Phænomenon as wonderful, as any hitherto known. This takes Place in every known Species of Salamander, at any Period of their Life, on the Earth or in the Water; and let the Length of the divided Part be greater or leſs. Nor do the conſtituent Parts of the new Tail differ from thoſe of the Part that was cut, either in Number, Structure, or Connection. But a whole Year is ſcarce ſufficient to render the new Part equal to that which was cut off. Indeed the regenerating Power ceaſes during the Winter half Year.

When the Part re-produced is cut off, it is ſucceeded by another, which proceeds in the ſame Manner as the former, and this a ſecond, a third, or a fourth Time: The Salamander ſtill forming new Parts, by the ſame unalterable Laws.

There are in the Legs of a Salamander ninety and nine Bones. In the four regenerated Legs there is the ſame Number. The Form and internal Structure of the re-produced. Bones of the Natural, are the ſame. But the Colour of the new Bones is ſomewhat different, and their Subſtance more tender. And all theſe Parts are re-produced in the ſame Manner and the ſame Time, whether the Creature is fed, or kept faſting.

When their Jaws are cut off, the ſame Thing happens. New Bones are re-produced, new Teeth, new Cartil ges, Veins and Arteries. From the wonderful Reproduction of ſo many Parts in this, may we not extend our Enquiry to other Animals of equally complicated Structure? Let us inquire firſt concerning

Tad-poles.

Tad-poles. If the whole of their Tails be cut off, they ſink to the Bottom of the Water and periſh. But if Part only, they ſoon recover it. In one Summer's Day, the Reproduction makes a rapid Progreſs in young Tad-poles. And in a ſhort Time, the new Part of the Tail and the old together, equal the Tail of others born at theſame Time. A ſecond, third, and fourth Reproduction conſtantly follows, upon a ſecond, third, or fourth Section. Nay ſucceſſive Regenerations never fail, as long as the Tad-pole keeps its Tail.

If no Nouriſhment is given Tad-poles, they do not grow, nor are the Membranes of the Infant-ſtate caſt off. Yet the Tails cut off, will be reproduced, in nearly the ſame Time.

If the Head of an *Earth-worm* be cut off, a new Head it reproduced. Nay, if both the Head and the Tail are cut off from the middle Part, both of them are reproduced. Nor is this regenerating Power ſoon exhauſted: A ſecond Reproduction being cut off, is ſucceeded by a Third, this by a Fourth, that by a Fifth, and ſo on.

The ſame Thing takes Place in another Kind of Worm, little known, which he calls an *aquatic Boat-worm.* It is compoſed of Rings, like the Earth-worm, which it ſhortens or lengthens at Pleaſure, and ſo moves from Place to Place. Toward the Head it is as large as the largeſt Gooſe-quill, and its Length is about a Span. It lives in ſhallow, clear Water, either ſtagnating or flowing gently, fixing its fore Part in the Mud, whence it is nouriſhed. The back Part reaches the Top of the Water, and being ſtretched and hollowed, form a Kind of Boat on the Surface. Its Sides riſe above the Water, ſo that none gets in. But on the leaſt Agitation of the Water, the Inſect immediately ſhuts up his Boat, and retires into the Mud. When the Motion is over, he again thruſts his Tail out of the Water, and makes his Boat afreſh, which remains entire till he is diſturbed again. And this he does not fail to make, though the

Mud

Mud is removed, and he left with little Water. It ſeems the Organs of Reſpiration are placed in this Part, as they are in various Sorts of aquatic Animals.

Theſe Worms are quicker in their Reproduction than Earth-worms. They more eaſily recover their Heads. as well as Tails, and this Power exerts itſelf throughout the whole Year.

The Caſe of *the Snail* may ſeem ſtill more ſtrange. It can firſt, reproduce its Horns. After they have been cut off, the Trunk becomes like a ſmall Knob, whence ſprings a black Point, which is the Eye. The Trunk then increaſes in Length and Size, till it equals the former Horn.

If the Head be cut off, a new one ſucceeds; but in a ſingular Manner. If a Worms Head be cut off, the Reproduction is an intire organic Body, that is, a Part in Miniature exactly ſimilar to that which was cut off. But what appears on the Trunk of a Snail, is not an intire organic Body, containing in Miniature all the Parts of the Head which were cut off: But theſe Parts grow Piece by Piece at different Intervals, and require Time to unite and conſolidate into one Maſs, reſembling the original Pattern. For Inſtance. Sometimes the Reproduction is like a round, ſmall Body, containing the primary Parts of the two Lips, and of the ſmall Horns, which are united to the Mouth, and to the new formed Teeth. This round Body is placed on the Center of the Trunk. The large Horns and the fore Part of the Snail, which in the entire Animal are contiguous to the Head, are wanting. Another Trunk ſhews the larger Horn on the right Side, more than a Tenth of an Inch long, already provided with its Eye. Under this, at ſome Diſtance, the firſt Lineaments of the Lips appear. In a third Snail ariſe three Horns, two of which are of their natural Length, while the Third is but juſt above the Skin. Some ſhew nothing but the Trunk, without any Sign of Reproduction, although the Head was taken off at the ſame Time with that of

others, from which are come forth such a Number and Variety of Organs: On the contrary in some Snails, there is no Difference between the old and the new Head; Only there is an ash coloured Line, painting out exactly where the Head was cut off.

V. I. p. 178. Both the whole *Tape worm*, and every Part of it seems to be a compleat Animal. In every Joint there is a Mouth for receiving Food, and doubtless Organs for digesting it. Single Joints, as well as larger Pieces, are frequently voided alive. All those Pieces are almost equally turgid with Chyle. Now it is not probable, that a single Worm, should in voiding, be broke into so many Pieces; And had it been done some Time before, they would be emaciated. There seems then to be an Analogy, between this jointed Worm and knotted Grass; each Joint of which is a compleat Plant, and propagates itself. It is indeed a Zoophyton. a Plant-Animal. bred in Animal-Bodies. Since so large and frequent Detruncations, do not destroy the Life of it.

Not only Vegetables and Animals have their respective Insects, to which they afford Food as well as Habitation, but *Stones* themselves. Those Kind of Worms, called *Lithophagi*, are a Proof of this. One might think it incredible, that these little Creatures should subsist by gnawing Stones. And yet nothing is more certain, these worm-eaten Stones being found almost every where. These are generally Lime stones. Grit or Free-stone is seldom eaten in this Manner. Yet there is an antient Wall of Free-stone in the *Benedictine* Abby at *Caen* in *Normandy*, so eaten with Worms, that one may put one's Hands into many of the Cavities. The Worms are covered with a greenish Shell, having flat Heads, a wide Mouth and four black Jaws. And they lay their Eggs in those Cavities, which they gnaw in the Stone.

CHAP.

CHAP. V.

Of Inſects.

1. *Of the Coya,*
2. *Of the Death-watch,*
3. *Of the Clorneb Caterpillar,*
5. *Of Ants,*
6. *A Pennſylvanian Waſp-neſt.*

P. 187. THERE is found in *America*, a Kind of Spider more miſchievous than even the Tarantula, chiefly in the Valleys of *Neyba*, and others within the Juriſdiction of *Popayan*. It is called a *Coya*. It is much leſs than a Bug, and is of a fiery red Colour. It is found in the Corners of Walls and among the Herbage. On ſqueezing it, if any Moiſture from it falls on the Skin of either Man or Beaſt, it immediately penetrates the Fleſh, and cauſes large Tumours, which are ſoon followed by Death.

The only Remedy is, on the firſt Appearance of a Swelling, to ſinge the Perſon all over the Body with a Flame of Straw, or of the long Graſs, growing on thoſe Plains. This the *Indians* perform with great Dexterity, ſome holding him by the Feet, others by the Hands.

Travellers here are warned by their *Indian* Guides, if they feel any Thing crawl on their Neck or Face, not even to liſt their Hand, the *Coya* being ſo delicate a Texture, that it would immediately burſt. But, let them tell the *Indian* what they feel, and he comes, and blows it away.

The Beaſts which feed there, are taught by Inſtinct, before they touch the Herbage with their Lips, to blow on it with all their Force, in order to clear it of theſe pernicious Vermin. And when their ſmell informs them, that a Coya's Neſt is near, they im-

mediately leap and run to ſome other Part. Yet ſometimes a Mule, after all his Care, has taken in a Coya with his Paſture. In this Caſe after ſwelling to a frightful Degree, it expires upon the Spot. Thus does even the irrational Creation *groan and travail in Pain together*,--until it ſhall be *delivered into the glorious Liberty of the Children of GOD!*

V. I. p. 188. Examining one Day, ſays Mr. —— a Number of the *Eels in ſour Paſte*. I placed the largeſt that I could find under the Microſcope. In doing this I wounded it in the Belly. A long, ſlender Tube came out, which I then took for an Inteſtine. I imparted this to a Friend, who the next Day, cut one in two near the Midole. A great Number of ſeeming Ova came out: But to our Surprize, we ſoon found they were live Eels, though in different Degrees of Maturity. Some moved ſlowly: Others coiled and uncoiled themſelves briſkly. The moſt Mature ſtrove to diſengage themſelves from their inveloping Membranes, frequently varying their Poſition, till at laſt they were at Liberty, and ſwam about like the Parent Eel. So what I firſt took for an Inteſtine was the Uterus. Hence it is plain, that theſe Eels are viviparous. Conſequently, it is not true, that all Kinds of Animalcula are produced from Eggs floating in the Air.

P. 192. That Death-Watches do woo one another, but not always, we may learn from the Account of an accurate Obſerver. "As I was in my Study, I happened to hear what is called a *Death-watch*. Inclining my Head toward a Chair, I found it was beating there. The Manner of its beating was this. It lifted up itſelf on its hinder Legs, and extending its Neck, ſtruck its Face upon the Sedge, which was bared upon its outward Coat, about the Length of Half an Inch. The Impreſſion of its Strokes was viſible: The outward Coat of the Sedge being depreſt, where it had juſt been beating, for about the Compaſs of a

Silver-

Silver-penny. I am inclined to think, it beats for Food. There were ſeveral Places on the Sedge, where it had been at work, and where it had probably been ſojourning for ſome Days.

Poſſibly the Inſect may ſometimes woo its Mate by beating thus: But it was not the Caſe now. It had not any other of its own Kind near it: It ſeemed therefore to be preparing its Food. It was about a a Quarter of an Inch long, of a dark dirty Colour, having a broad Helmet over its Head, which he can draw up under it, ſo that it is a notable Defence, againſt the Falls, to which he is continually expoſed, creeping over-rotten and decayed Places.

The ſecond Day after I took it, I opened the Box and ſet it in the Sun. It was ſoon very briſk, and crept nimbly to and fro, till ſuddenly it ſtruck out its Wings, and was going to take its Leave; but on my ſhading it over, it drew in its Wings and was quiet.

This ſeems to be the ſmalleſt of the *Beetle* Kind. A Gentleman deſcribes one of a very different Sort, in the Philoſophical Tranſactions. "On the Removal of a large Leaden Ciſtern, I obſerved at the Bottom of it ſeveral black *Beetles*. One of the largeſt I threw into a Cup of Spirits, (it being the Way of killing and preparing Inſects for my Purpoſe.) In a few Minutes it appeared to be quite dead. I then ſhut it up in a Box about an Inch and half Diameter, and throwing it into a Drawer, thought no more of it for two Months, when opening the Box I found it alive and vigorous, though it had had no Food all the Time, nor any more Air than it could find in ſo ſmall a Box, whoſe Cover ſhut very cloſe. A few Days before, a Friend had ſent me three or four Cock-roaches. Theſe I had put under a large Glaſs: I put my Beetle among them, and fed them with green Ginger, which they ate greedily; but he would never taſte it, for the five Weeks they lived there. The Cock-roaches would avoid the Beetle, and ſeem frighted at his Approach: But he uſually ſtalked along, not at all regarding whether they came in his Way or

not. During the two Years and an Half that I have kept him, he has neither eat nor drank.

How then has he been kept alive? Is it by the Air? There are Particles in this, which ſupply a Growth to ſome Species of Plants, as Sempervive, Orpine and Houſe-leek: May not the ſame or the like Particles ſupply Nouriſhment to ſome Species of Animals? In the amazing Plan of Nature, the Animal, Vegetable and Mineral Kingdoms, are not ſeparated from each other by wide Diſtances, but near their Boundaries, differ from each other, by ſuch minute and inſenſible Degrees that we cannot find out certainly, where the one begins, or the other Ends. As the Air therefore nouriſhes ſome Plants, ſo it may nouriſh ſome Animals: Otherwiſe a Link would ſeem to be wanting, in the mighty Chain of Beings. It is certain Cameleons and Snakes can live many Months without any viſible Suſtenance: And probably, not merely by their ſlow Digeſtion, but rather by Means of Particles contained in the Air, as this Beetle did; yet doubtleſs in its natural State, it uſed more ſubſtantial Food. So the Plants above-named thrive beſt with a little Earth, although they flouriſh a long Time, and ſend forth Branches and Flowers, when they are ſuſpended in the Air.

Even in the exhauſted Receiver, after it had been there half an Hour, it ſeemed perfectly unconcerned, walking about as briſkly as ever. But on the Admiſſion of the Air, it ſeemed to be in a Surprize for a Minute.

After I had kept him half a Year longer, he got away, through the Careleſſneſs of a Servant who took down the Glaſs.

V. I. p. 204. In the Beginning of May 1737, the Cornel-trees, near *Monaghan* in *Ireland*, appeared covered with ſmall *Caterpillars*, employed partly in feeding on the Leaves, partly in crawling over the Bark of the Tree. Each as it crawled left a fine Thread ſticking to the Bark. By the End of May, there was

not

not a Leaf on any of the Trees, except a few reserved for a curious Purpose. But instead of the Green, a white Cloathing covered the whole Bark, from the Ground to the Point of the smallest Twigs, and that so glossy, that it shewed in the Sun, as if it was cased in burnished Silver. Then they covered with the same all the Ash, Beech, Lime, yea the very Weeds which grew near them.

But how did they travel from Tree to Tree? Many crawled along the Ground. But many had a quicker Way. They hung by their own Threads from the utmost Branches of the Tree, so that a small Breeze wafted them to the next Tree, as Spiders pass from one Bush to another.

As they made no Use of the Threads left behind them, probably they wrought for no other Purpose, than to rid themselves of that glutinous Matter, out of which it was spun.

In the Beginning of June, they retired to rest. Their Manner of executing this, was very ingenious. Some chose the under Side of the Branches, just where they spring from the Trunk, that they might be defended from the Water, which in a Shower, running down the Bark of the Tree, is parted by the Branches, and sent off on each Side. Here they draw their Threads across the Angle made by the Trunk and Branch, and crossing those with other Threads, make a strong Covering. Within this they place themselves Lengthways among the Threads, and rolling their Bodies round, spin themselves into little Hammocks, in the mean time shrinking into half their Length. These Hammocks being suspended by the transverse Threads, do not press each other. That they may take up the less room, they lie parallel to each other, in the most convenient Order possible. Others, still more ingenious, fasten their Threads to the Edge of the Leaves which they had saved for that Purpose: And with that slender Cordage pulling in the Extremities of the Leaves, draw themselves into a Kind of Purse, within which they form

ſorm the ſame Sort of Work, and lay themſelves up as above. They lay themſelves up in great Numbers together, both becauſe many were neceſſary to the Work of providing a common Covering, and alſo to keep one another warm, while preparing for the great Change.

Between the Worm thus laid up, and the Hammock incloſing it, there is a tough brown Shell, probably formed of ſome glutinous Matter, tranſuding through its Pores. In the End of June, they gnaw through the Shells and Hammocks, and come forth a moſt beautiful Fly. After its Reſurrection, it needs no Food. Thoſe that came out in a Room, lived long there, as the reſt did abroad. After a while ſeveral of them diſcharged a Drop of brown Liquor, probably containing the Egg. But as it was not lodged in a proper Receptable, it produced no Worm the next Year.

As the Cornel only ſupplies this Worm with Food, ſo it is the only Nurſe of its Egg. There is not an Animal or a Vegetable, but yields Habitation and Food to its peculiar Inſect. The Scheme of Life begins in Vegetation: And whenever Nature produces Vegetables, ſhe obliges them to pay for their Nouriſhment, to certain Animals which ſhe billets upon them. Each of theſe again, is to diet and lodge another Set of living Creatures. This juſt Community in Nature, which ſuffers nothing to ſubſiſt merely for itſelf, is found not only every where on the Earth, but likewiſe every where in the Waters. By Microſcopes we diſcover an Infinity of little Creatures, feeding on the floating Vegetables, or on one another. Indeed as to the Sea, we know only what happens near the Shores, where we find Vegetables of various Kinds, which breed and nouriſh a like Variety of Inſects. Theſe, with a Multitude of others bred in the Mud, are the Prey of the ſmaller Kinds of Fiſh, and they again of the greater. That this Scheme of Nature, found every where elſe, dives into the Depths of the Ocean, we may gather from the wonderful Kinds of

Fiſhes,

Fiſhes, waſhed up by the Storms now and then from the deep Waters.

Now it is on the Cornel alone, that the Worms we have ſpoken of can be propagated and fed. The ſpecific Qualities with which its Juices are impregnated, are peculiarly ſuitable to this Inſect. If theſe reſide in the eſſential Oil of the Plant, this, as well as other Inſects, ſubſiſting on Vegetables, have the Skill to extract, nicer than any Chymiſt can do, the eſſential Oil of each Plant, nothing elſe therein. being a Nature ſufficiently peculiar, either to aſſiſt the Propagation, or ſupply the Nouriſhment of the Inſect.

P. 208. Though *Ants* unite in Colonies, in ſuch Places as are agreeable to their different Natures, yet they often vary their Reſidence. But the ſeveral Species never intermix, though they will be good Neighbours one to another.

Their Architecture is adjuſted with remarkable Art. The whole Structure is divided into numerous Cells, communicating with each other by ſmall ſubterraneous Channels, which are circular and ſmooth. They carry on all their Works by Means of their double Saws, and the Hooks at the Extremity of them.

A Colony from the latter End of Auguſt, to the Beginning of June, conſiſts of a Female, and various Companies of Workers: And beſide theſe in the latter End of June, all July and Part of Auguſt, of a Number of winged Ants.

The labouring Ants, being of no Sex, are wholly employed in providing for the Young, which the Queen depoſits in the Cells. In whatever Apartment ſhe is preſent, univerſal Joy is ſhewn. They have a particular Way of ſkipping, leaping, prancing, and ſtanding on their hind Legs. Some walk gently over her, others dance round her, all expreſs their Loyalty and Affection: Of all which you may be convinced in a few Moments, by placing the Queen and her Retinue under a Glaſs.

The

The Queen lays three different Sorts of Eggs, Male and Female in Spring, Neutral, in July and Part of Auguſt. The common Ants then brood over them in little Cluſters, and remove them to and fro, for a juſt Degree of Heat. The Young diſengage themſelves from them Membranes that encloſe the Eggs, juſt as the Silk-worms do. The Female Eggs put on the Form of Worms. ſome Time in February; the Male, by the latter End of March, the Neutral, by September. The firſt Summer they grow little, and leſs in Winter. In the Beginning of April the ſecond Year, they viſibly increaſe every Day. By the End of May the Male and Female attain their full Growth, and are ready for another Change. This long Continuance of Ants in the vermicular State, has nothing like it in any other Claſs of Inſects. The Vermicles in a few Days infold themſelves in a ſoft, ſilken Covering, and ſo commence Aurelias, which are commonly miſtaken for Ants Eggs. As ſoon as they tend to life, the Workers give them Air, by an Aperture in the End of the Covering. This they gradually enlarge for a Day or Two, and then take out their Young.

There is a larger and a ſmaller Sort of winged Ants, the latter Male, the former Female. Thoſe Females, which eſcape being devoured by other Creatures, become Queens. and give Birth to new Colonies.

In all other Inſects the Loſs of their Wings leſſens their Beauty, and ſhortens their Lives. But Ants gain by that Loſs; this being the Prelude of their aſcending the Throne.

The Young are fed by the Juices of moſt Sorts of Fruits, which the Labourers extract, and receive into their own Stomach; where they are prepared, and afterwards transfuſed into the tender Vermicles.

Perhaps in warm Climates, Ants do not paſs the Winter in ſleep, as they do with us. If ſo, they need a Store of Food, which in our Climate is quite needleſs. Accordingly thoſe who have accurately examined their moſt numerous Settlements, could never

never find out any Reſervoir of Corn or other Aliments. And they that have carefully obſerved their Excurſions from and Return to their Colonies, could never obſerve that they returned with any Wheat, Corn, or any other vegetable Seed: Though they would eagerly attack a Pot of Honey, or a Jar of Sweet-meats.

"But is it not ſaid, *Prov.* 6. viii. *She provideth her Meat in the Summer, and gathereth her Food in the Harveſt?*" It is: But this does not neceſſarily mean any more, than that ſhe collects her Food in the proper Seaſon. Nor is any Thing more declared, ch. 30. 35. than that Ants carry Food into their Repoſitories. That they do this againſt Winter, is not ſaid: Neither is it true in Fact.

P. 208. After *Foot deep.*

If a Frog be put into a Box with Holes bored therein, and the Box laid near a Neſt of Ants, they will entirely diſſect him, and make the fineſt Skeleton poſſible, leaving even the Ligaments unhurt.

P. 215. There is a purpliſh *Waſp* in *Pennſylvania*, whoſe artful Contrivance is wonderful. And as if it were given to chear them in their Labour, they make a particular muſical Noiſe. Their Manner of Working is, to moiſten Clay, and temper it up into a little Lump, of the Size of a Swan-ſhot. This they carry to build with. They begin at the upper End of the Cell, and work downward, till it is long enough to contain the Nymph When they have ſpread out the Lump in a proper Manner, they ſet up their muſical Note, and go and work up more Clay for the next Courſe. Thus they ſing and work by Turns, till a Cell is finiſhed, which is made delicately ſmooth within. At the farther End of each Cell, they lay an Egg: Then by a ſurprizing Inſtinct, they go and catch Spiders and cram the Cell full of them. But it is farther wonderful, they do not kill, but only diſable

diſable the Spiders, which is to anſwer two Purpoſes; firſt, that they ſhould not get away; and next, that they may be preſerved alive and freſh for the Food of the Young.

Of one Sort of *Ephemeron*, Mr. *Collinſon* writes thus, May 26, 1744, I was firſt ſhewn this, by the Name of *May-fly*. It lies all the Year, but a few Days, at the Bottom of the River; then riſes to the Surface of the Water, and ſplitting open its Caſe, up ſprings the new Animal, with a ſlender Body, four ſhining Wings, and three long Hairs in its Tail. It next flies about to find a proper Place, where it may wait for its approaching Change. This comes in two or three Days. I held one on my Finger, while it performed this great Work. It was ſurprizing to ſee, how eaſily its Back ſplit, and produced the new Birth, which leaves Head, Body, Wings, Legs, and even its three-haired Tail behind, or the Caſes of them. After it has reſted a little, it flies nimbly to ſeek its Mate. The Males kept under the Trees, remote from the River. Hither the Females reſorted, and when impregnated, ſoon left the Males, ſought the Rivers, and kept continually playing up and down on the Water. Every Time they darted down they ejected a Cluſter of Eggs. Then they ſprang up again. Thus they went up and down, till they had exhauſted their Stock of Eggs and ſpent their Strength, being ſo weak that they can riſe no more, but fall a prey to the Fiſh. This is the End of the Females. The Males never reſort to the River, but having done their Office, drop down and die.

In a Life of three or four Days, they eat nothing. They have no Apparatus for that Purpoſe, yet they have Strength to ſhed their Skin, and to perform the Ends of their Life with great Vivacity.

But how poor an End, to our Apprehenſion, is anſwered, by the Life of this, and innumerable other Animals?

CHAP.

CHAP VI.

General Obſervations.

1. *Of the cloathing of ſome Animals:* || 2. *Of the Transformation of Animals.*

P. 216. AS Barnacles ſeem to be a Medium between Birds and Fiſhes, altho' they more properly belong to the former, ſo is a *Polypus*, (altho' it is doubtleſs an Animal) between Animals and Plants.

In a Polypus, Life is preſerved, after it is cut into ſeveral Pieces, ſo that one Animal is by Section immediately divided into two, three or more compleat Animals, each enjoying Life and continuing to perform the proper Offices of its Species.

The common Operations both of the animal and vegetable World, are all in themſelves aſtoniſhing. Nothing but daily Experience makes us ſee without Amazement, an Animal bring forth Young, or a Tree bear Leaves and Fruit. The ſame Experience makes it familiar to us, that Vegetables are propagated not only from the Seed, but from Cuttings. So the Willow-twig cut off and only ſtuck in the Ground, preſently takes Root, and is as perfect a Tree as that whence it was taken. This is common in the vegetable Kingdom, and we have a rare Example of it in the Animal.

The Polypus is an aquatic Animal, to be found in Ditch-water. It is very ſlender, and has on the fore part ſeveral Horns, which ſerve it for Legs and Arms. Between theſe is the Mouth; it opens into the Stomach, which takes up the whole Length of the Body.

Indeed the whole Body is but one Pipe, a Sort of Gut which opens at both Ends.

The common Polypus is about three Quarters of an Inch long: But there are many Species of them. Some of which can extend themſelves to the Length of ſix or ſeven Inches. Even in the ſame Species, the Number of Legs and Arms is not always the ſame; but they have ſeldom fewer than ſix. Both the Body and Arms may be inflated all Manner of Ways, and hence it is, that they put themſelves into ſo great Variety of Figures.

They do not ſwim, but crawl on the Ground, or on any Body they meet with in the Waters. They uſually fix their poſterior End to ſome Thing, and ſtretch their Bodies and Arms into the Water. With theſe Arms they catch numberleſs Inſects, which are ſwiming up and down. A Polypus, having ſeized its Prey, uſes one or more Arms to bring it to his Mouth. He can maſter a Worm thrice as long as himſelf, which he ſwallows whole; and having drawn all that is nutritive from it, he then throws out the Skin.

"I have cut a Polypus in two, between ſeven and eight in the Morning, and before three in the Afternoon, each Part was a compleat Animal, able to eat a Worm as long as itſelf. If a Polypus be cut Lengthways, beginning at the Head, but not quite to the Tail, there is a Polypus with two Heads, two Bodies, and one Tail. Some of theſe Heads and Bodies may ſoon be cut Lengthways again. Thus I have produced a Polypus with ſeven Heads, ſeven Bodies, and one Tail. I cut off the Heads of this new Hydra, ſeven others grew up, and each of theſe cut off, became a Polypus.

"I cut a Polypus croſs-ways into two Parts; put them together again and they re-united. I put the poſterior Part of one, to the anterior of another, they ſoon united into one Polypus, which ate the next Day, and ſoon put forth young ones, from each Part.

"As

"As the Body of a Polypus is but one Gut, I have turned [illegible] out. The Inside soon after became the Out[illegible] [illegible] and multiplied as before. They [illegible] [illegible] at all; but each Polypus has the Faculty [illegible] [illegible]ying itself: Yea, before it is severed from [illegible] [illegible]ent. I have seen a Polypus while growing [illegible] of the Side of its Parent, bring forth young ones: Nay, and those young ones themselves have also brought forth others.

Cut a Polypus across, and the same Day the anterior End Lengthens itself, creeps and eats. The [l]ower Part which has no Head, gets one, forms itself [a] Mouth and puts forth Arms. It is all one, in whatever Part the Body is cut; cut it into three or [f]our Parts, and each becomes a compleat Polypus.

Cut one Lengthways. slitting it quite in two so as [t]o form two half Pipes. It is not long before the [t]wo Eyes of them close, they begin at the posterior [P]art, and close upward, till each half Pipe becomes [a] whole one. All this is done in less than an Hour, [a]nd the Polypus produced from each of those Halves, [d]iffers nothing from the First, only it has fewer Arms. [B]ut these too are soon supplied!

But as strange Animals as all Polypi are, the *clustering Polypi* are more strange than the Rest. One [S]pecies of these are of a Bell-like form. Their an[te]rior Part, in which is their Mouth, is hollowed in[w]ard, and resembles the open End of a Bell. Their [ot]her Extremity ends in a Point, to which is fixt a [St]alk or Pedicle. The Polypus when it is ready to [di]vide, first draws in its Lips into the Cavity, it then [by] Degrees grows round, and presently after divides [its]elf, into two other round Bodies. These in a few [M]oments open, loose ther spherical Form, and put [on] that of a Bell, or compleat Polypus. This is the [ma]nner in which clustering Polypi are multiplied, [Th]e whole Operation is performed in three Quarters [of] an Hour. The Cluster which they form, rests [up]on a Stem, which is fixt to some other Body at its [low]er Extremity, and from its other arise Branches:

Other Branches again ſhoot out from theſe in different Places; from theſe laſt other new ones, and ſo on. At the Extremity of each Branch is a Polypus. The Aſſemblage of all theſe Branches with the Polypi at their Extremities, form a Cluſter much reſembling a Tuft of Flowers. The Stem which carries all the Cluſtre, is capable of a remarkable Motion; each Branch contracts when it is touched: Each can contract itſelf alone, tho' this ſeldom happens, for in contracting it commonly touches another, which then immediately contracts with it. When the main Stem which bears the whole Cluſter contracts, all the Branches contract together, and the whole becomes intirely cloſed. A Moment after, the Branches and the Stem again extend themſelves, and the whole Cluſter recovers it ordinary Figure. A Cluſter is formed thus: A ſingle Polypus detaching from the Cluſter, ſwims about in the Water, till it meets with ſome proper Body, to fix itſelf upon. It then has a Pedicle, but which is no longer than the Polypus itſelf; but it becomes eight or nine Times as long in four and twenty Hours, and is to be the main Stem of the new Cluſtre. In a Day after it is fixt it divides itſelf into two, each of which in a few Hours divides into two more. Theſe ſoon after put out Branches, and all this is re-iterated ſeveral Times. Thus a principal Branch is formed, provided with ſeveral lateral ones, which afterwards become principal ones, with Regard to others that ſpring from them.

When a Cluſter is nearly ſtript of its Polypi, the Branches are no longer able to contract. When but a few Polypi remain, none can contract but thoſe to which they are fixt. Hence it appears, that the Motion in the Stem and Branches of a Cluſter is entirely derived from the Polypi. Indeed at firſt Sight one would imagine, that the Polypi fixt to the Branches of the Cluſter, ſpring from them, in the ſame Manner as the Leaves, the Flowers, and the Fruit of a Vegetable ſpring from it. On the contrary

the Branches compoſing the Cluſters of Polypi, ſpring from the Polypi, which are at their Extremities, and theſe Polypi, which at firſt appear to be Fruits, may rather be termed the Roots of them.

The Nature of Corallines, and the Mechaniſm of their *Polypi*, (ſays Dr. *Peyſſonel*) made me conjecture, that it was the ſame with Reſpect to *Sponges*; that Animals neſted in the Inteſtices of their Fibres, gave them their Origin and Growth: But I had not yet ſeen the Inſects. Sponges appeared to me only as Skeletons, and I at length diſcovered the Worms which form them. They are of four Species, 1. The Tube-like Sponge. 2. The Cord-like Sponge. 3. The fingered Sponge. 4. The Honey-comb Sponge.

Theſe four Kinds only differ in Form, they have the ſame Qualities, and are made by the ſame Kinds of Worm; they are all compoſed of hard, firm, dirty Fibres, ſometime brittle, ſeparated one from another, having large hollow Tubes diſperſed thro' their Subſtance, theſe Tubes are ſmooth within. Theſe Fibres, which conſiſt of the twiſted Doubles of the Sponge, form as it were a Labyrinth filled with Worms, which are eaſily cruſhed; but having carefully torn the Sponges, and their groſs Fibres, I diſcovered the living Worms.

Theſe Species of Sponge commonly grow upon ſandy Bottoms. At their Origins we perceive, a Nodule of Sand, or other Matter, almoſt petrified, round which the Worms begin to work, and round which they retire, as to their laſt Refuge, where I had the Pleaſure of ſeeing them play, exerciſe themſelves, and retire, by examining them with the Microſcope.

The Worms are about one third of a Line thick, and two or three Lines in Length. They are ſo tranſparent that one may diſcern their Viſcera through their Subſtance, and the Blood may be ſeen to circulate. They have a ſmall black Head, furniſhed with two Pincers; the other Extremity is almoſt

Square, and much larger than the Head. Upon the Back may be ſeen two white Streaks, as if they contained the Chyle: Theſe two Canals are parallel to each other from the Head to the other Extremity, where they come together. In the Middle where the Belly and Viſcera ought to be placed, a blackiſh Matter is perceivable, which has a Kind of Circulation; ſometimes it fills all the Body of the Worm, ſometimes it gathers towards the Head, or at the other End, and ſometimes it follows the Motion of the Animal. This vermicular Motion begins at the poſterior Extremity, and ends at the Head. They have no particular Lodge, they walk indifferently into the tubular Labyrinth. Theſe Sponges are attached to ſome ſolid Body in the Sea. Some Kinds are fixed to Rocks, others to Heaps of Sand, or to Pieces of petrified Matter; and the Sea putting in Motion the Sand, and the little Parcels of broken Shells, forces them into the Holes of the Sponge.

So far the Doctor But ſtill I doubt, whether the Worms form the Sponge, or only lodge therein.

The ſame Doubt I have with Regard to what follows. "The *Belemnites* is a Foſſile, a Kind of ſtony Shell, which has hitherto perplext the Naturaliſts of all Countries. Strait ones are common in *Sweden*, *Livonia* and *Germany*, thoſe that are curved are more common in *France* and *England*. The Nucleus of it ſeems to be a ſtrait concamerated Shell, which is ſurrounded by a huge, ſolid Subſtance. Now how was this formed? And how is it that ſome have a Nucleus, others not? Again, how is it that in ſome the Cavities containing it, is very ſmall, in others not viſible?

In order to underſtand this, we may conſider, that many Bodies which we always took for Vegetable, are really Animal. So the ſeveral Coralline Subſtances, hitherto reputed Marine Plants, are now generally believed, to be the Shells of Polypi. Is it not then highly probable, that the teſtaceous Tribe in general are generated like Flies, the latter from a Maggot,

Maggot, the former from a Polypis? It muſt be ſo with many: And as Corals in general ſeem to be conſtructed by Polypis, are they not the primary State of all, or moſt of the teſtaceous Tribe? If ſo, it is almoſt beyond a Conjecture, that the Body called a Belemnites (which on being put into Acids is found to ferment in like Manner as Corals) is formed likewiſe by a Polypis, from which the Nucleus ſeems to be the laſt State. And does not this concamerated Body of which the Belemnites is only the Habitation, lead us into the Connexion and Manner of Generation (perhaps particular to the teſtaceous Tribe) by remaining within its Nidies all its Life, whereas the Generality quit their Nidi as ſoon as they are able to ſhift for themſelves.

The Polypis is an Animal of the Vermicular Kind; the Bodies of ſome are long and ſlender, like a fine Fibre, extremely tender, and from the Head proceed a Variety of Claws or Arms, with which it catches its Food, and prepares its Habitation. They are of various Shapes and Textures according to the Species of the Animal that is to proceed from them; and very wonderful it is, how ſo ſmall an Animal ſhould form ſo large a Body as the Belemnites! ſome Animals in the terreſtrial Part of the Creation, naturally aſſociate together, others ſeek Solitude. The ſame Diſpoſitions we find in the aquatic, then why not among the Polypis? Is not this evidently ſeen from the Variety of Coral Bodies? it ſeems in ſome as if Thouſands acted in Concert together; in others each acts for itſelf; of which latter is the Belemnites. The Shape of the Belemnites is generally Conic, terminating in a Point, and of various Colours, according to the Juices of the Stratum in which it lay; it has uſually a Seam running down the whole Length of it. Its interior Conſtitution ſeems compoſed of ſeveral Cruſts, which when broken tranſverſly proceed on Rays from the Seam to the Centre. This Seam I take to have been the Habitation of the Animal in its Polypi State, and in which the Body was affixed. The Animals of the teſtaceous Tribe in general,

general, as they increaſe in Age, increaſe their Shells in thickneſs, until they have lived their ſtated Time, and that is done by adding a new Cruſt to, as ſeveral, if not all the Tubuli, the Oyſters, and the Nutili witneſs. By Length of Time they grow inactive and dead, the Effect of extreme old Age, ſuffering other Marine Bodies, as Worms, Oyſters, to affix themſelves to their outer Coat. The like Appearance we frequently meet with on Belemnitæ when the Animal within was either waxed old, or dead.

One might enlarge upon the Analogies which may be found, between the Origin of theſe minute Animals, the Origin of Plants, and that of thoſe other Animals which we are more acquainted with. But we ſhall be better able to judge of thoſe Analogies, when we come to know more both of Plants and Animals.

The ſurprizing Facts which the Study of Natural Hiſtory lays before us Day by Day, may convince us, that the Nature of Plants and Animals, is as yet but very imperfectly known: Indeed much more imperfectly, than many have been apt to imagine. All we know is very little, in Compariſon of what remains unknown. And this Conſideration, as it ſhould prompt us, ſtill more diligently to enquire after Truth, ſo it ſhould make us exceeding cautious, how we judge of the Nature of Things, from ſo few Principles as we are at preſent Maſters of.

P. 222. All the Animals near *Hudſons-Bay*, are cloathed with a cloſe, ſoft, warm Fur. But what is ſtill more ſurprizing, and what draws all attentive Minds to admire the Wiſdom and Goodneſs of Providence, is that the very Dogs and Cats which are brought thither from *England*, on the Approach of Winter change their Appearance, and acquire a much longer, ſofter and thicker Coat of Hair than they originally had.

One Circumſtance more is worthy our fartheſt Obſervation, with Regard not only to Inſects, but in

ſome

ſome Meaſure to the whole Animal Creation, namely the various *Tranſformations* they undergo. Thoſe kinds of Animals which are viviparous, which produce their Young alive, undergo the ſlighteſt Alteration; yet even theſe have ſome. Growth itſelf is the loweſt Step of this Ladder: And this is common to all Animals. Man himſelf, lordly as he is, at his perfect Growth, is not only the moſt helpleſs at his Birth, but continues ſo longer than any other Member of the Animal World. However, except that of Growth, he undergoes no conſiderable Alteration in this Life.

Quadrupeds undergo a greater Change yearly, by the loſs and renovation of their Outward Covering. This Change however is gradual and almoſt inſenſible, the latter being of the ſame Subſtance, and even Colour as the Former. But there is an Exception to this, in thoſe which undergo this Change twice in the Year, as do the Bares, Hares and Foxes in *Greenland* and other extremely cold Countries: And the *Ermins*, which are frequent in *Yorkſhire*, and ſeveral other Parts of *England*, their Hair changes white at the Approach of Winter, and in Spring reſumes its former Colour.

One Claſs however of Viviparous Animals undergo a more ſudden Alteration, namely, the Serpent Kind. Theſe having no Hair or Fur to loſe gradually, caſt their whole Covering at once, and are ſo dextrous therein, tho' they have neither Feet nor Claws, yet their whole Skins are frequently found entire, without even the Cornea or outward Caſe of the Eyes which accompanies the other Exuviæ, being broken.

Next to theſe are the Oviparous Animals, theſe make their firſt Appearance in a State of intire Inaction, but being gradually ripened by natural or artificial Heat, burſt out, ſome in their compleat State, as Lizards, Spiders and Fiſh in general; and others, as Birds, requiring like viviparous Animals, the addition of the extrementious Parts. Almoſt all the

Species

Species of these which we know, need the same farther Change with the Viviparous. All Birds moult their Feathers, and many in cold Countries change the Colour of them in the Winter. Lizards drop their Skins, like Snakes; one Kind of them, Water Newts, every two or three Weeks Spiders, Crabs and all whose outward Covering is crustaceous, and therefore incapable of distension, cast their Shells once a Year, at which Time Nature provides them with such supplementary Juices, by a Kind of Exudation from their Pores, as form a new Shell beneath.

Proceed we to those Animals, whose Transformations are more compleat, which being fully possest of Life in one Figure, afterwards assumes another, or being first in One, afterwards inhabits a quite different Element.

To give an Instance of each. The Egg of a Frog being laid in the Water, produces a lively Animal which we call a Tadpole. He has a thin slimy Tail, which steers him in the Water, in which he wholly resides. But after a while, Legs and Feet burst thro' the Skin; the Tail drops off, he is a perfect Quadruped. He leaps upon the Earth and ranges over that Ground, on which some Time since it would have been Death to him to be cast.

The Beetle Class is an Instance of the other Change, and particularly the Cock-chaffer. The Female deposits her Egg below the Surface of the Earth, which hatches into a Grub, with two or three Pair of strong Forcipes, whereby it is enabled to force its Way through the Mould where it was lodged, and to cut and tear in Pieces for its Nourishment any small Roots which come in its Way. After staying here two whole Years, a shelly Covering forms over its soft Body, a Pair of fine Wings grow on its Back, to secure which from Danger when not used, a Pair of strong Cases are provided. And now forcing his Way out of the Ground, he becomes a lively Inhabitant of the Air.

Part the Third.

Of Plants and Foſſils.

CHAP I.

Of Plants.

V. I. p. 298. PERHAPS *the Bark* in Fruit Trees is principally deſigned for the Augmentation of the Tree itſelf, while the finer Veſſels of the *Woody* Part, ſtrain and prepare the Juices for the Fruit. A Gentleman near *Cork*, obſerving that his Peach-tree grew exceedingly but bore no Fruit, cut off the Bark almoſt quite round, for the Breadth

of

of two Fingers. The next Year the Tree hardly grew at all, but bore Abundance of Fruit.

P. 239. If no Moisture come to the *Roots* of Trees, they cannot grow; but if it comes only to the Points of the Root, though all the rest remain dry, they grow well. For the Root shoots out yearly a sharp-pointed tender Part, somewhat like the sharp Bud on the End of a Sprig, by which it not only inlarges itself in Breadth, as the Branches do above, but also receives its Nourishment. And that tender Part moves toward the soft and moist Earth. So that to loosen the Earth at the Points of their Roots, much helps the Growth of all Plants.

P. 240. It is remarkable, the Trees of the most different Kinds, draw their whole Sustenance from the Moisture they find in the same Piece of Ground, and from the ambient Air and Dews. Hence we may infer, that the very Contextures of their Bodies from the first Seed, are the natural Limbes, where the common Water and Air, are digested into so many different Leaves and Fruits.

We see also, that an handful of Mos, sometimes above a Span long, grows out of a small Oyster-shell, without any Earth, as do Trees out of bare Rocks. Hence we easily learn, that the Seeds first, and then the Roots, Stems and Leaves of Trees, are the Strainers which secrete and generate their peculiar Saps and Juices. These are at first little else than pure Air and Water, till they are concreted into peculiar Salts, by more curious Strainers and more subtle Boilers than Art has ever devised.

The Antients generally supposed the Earth to produce Vegetables; but this many of the Moderns ascribe to Water alone, just as well, as if planted in Earth. But it is a Doubt, wither that Experiment ever was made with the Nicety that is requisite. However it proves nothing, unless that Water be quite pure from any terrestrial Mixture. For if it be

not

not, the Plant may owe its whole Growth to that terreſtrial Matter.

Who can find any Water, newly taken out of the Spring, which does not exhibit even to the naked Eye, great Numbers of ſmall terreſtrial Particles, diſperſed through every Part of it? Theſe are of two general Kinds. Some are of a mineral Nature, others of a Vegetable. Of the latter ſome are fit to nouriſh one Plant, or one Part of it, and ſome another. All Water is much charged with vegetable Matter, which is fine, light and eaſily moveable. Spring-Water contains more of Mineral than River Water, River Water more than Rain Water.

To which of theſe Waters, or the Matter ſuſtained therein, do Vegetables owe their Growth? In order to decide this, the following Experiments were made. Several Phials of the ſame Shape and Size were filled with equal Quantities of Water. Over each was tied a Piece of Parchment, with an Hole in it juſt large enough for the Stem of a Plant, to prevent the Water from evaporating, or aſcending any Way but through the Plant. Several Plants being exactly weighed, were then placed in theſe Phials, and as they imbibed the Water, more was added from Time to Time. Each Glaſs was marked with a different Letter, and all ſet in the ſame Window, from July 20, till October 1. Then they were taken out, the Water in each Phial weighed, and the Plant with the Leaves that had fallen off. It then appeared how much each Plant had gained, and how much Water had been expended upon it.

Letters on the Glaſſes.	Weight of the Plant put in. gr.	Weight when taken out. gr.	Weight gained in 77 Days.	Expence of Water.	Proportion of the Increaſe to the Expence of Water.
A. Spear-mint ſet in Spring-water,	27	42	15	2558	1 to 170
B. Spear-mint in Rain-water.	28	45	17	3004	1 to 171
C. Spear-mint in Thames-water.	28	54	26	2493	1 to 95
D. Night-ſhade in Spring-water.	49	106	57	3708	1 to 65

The Water aſcends through the Veſſels of Plants, through a Filtre. And a larger Filtre draws more Water than a ſmaller. Therefore Plants that have more or larger Veſſels, draw more than thoſe that have fewer and ſmaller.

But the greateſt Part of the Water imbibed by Plants, paſſes through their Pores into the Atmoſphere. Hence the leaſt Proportion of Water expended to the Increaſe of the Plant, is as 46 or 50 to one. In ſome it is 100, 200, nay in one, 700 Times as much as the Increaſe of the Plant.

Nor does this Water paſs off alone, but bears with it many Particles of the Plant. The Groſſer indeed are not ſo eaſily borne up into the Atmoſphere, but are uſually depoſited on the Surface of the Flowers, Leaves, or other Parts of the Plant. Hence our Honey-dews, and other gummous Exudations. But the finer eaſily aſcend into the Atmoſphere, and are conveyed to our Organs of Smell.

Great Part of the terreſtrial Matter mixt with the Water, aſcends into the Plants. After the Experiment, there was much more of it in the Glaſſes which had

had no Plants in them, than in thoſe that had. Indeed this Matter, being ſo fine and light, attends Water in all its Motions: So that filtre it ever ſo often, ſome will remain.

The Plant increaſes more or leſs as the Water it ſtands in, contains more or leſs of this Matter. So the Mint in the Glaſs C, was of much the ſame Bulk and Weight with thoſe in A and B. But ſtanding in River-water, which contained more terreſtrial Matter, than the Spring or Rain-water wherein they ſtood, it increaſed almoſt double to either of them, yea and with leſs Expence of Water.

But all vegetable Matter is not proper for the Nouriſhment of every Plant. Although ſome Parts in all may owe their Supply to the ſame common Matter, yet others require a peculiar Sort of Matter, and cannot be formed without it. Yea different Ingredients go to the Compoſition of one and the ſame Plant. If therefore the Soil wherein a Plant is ſet, contains all, or moſt of thoſe Ingredients, it will grow there, otherwiſe not. If there be not as many Sorts of Particles, as are requiſite for the eſſential Parts it will not grow at all. If they be there, but not enough of them, it will not grow to its natural Stature. If the leſs eſſential Particles be wanting, it will be defective in Smell, Taſte, or ſome other Way. But though ſome Land may contain Matter proper for ſome Plants, yet it may for others. All this ſhews, that Plants owe their Increaſe, not to Water only, but to a particular terreſtrial Matter: Elſe there would be no Need of Manure, or of tranſplanting them from Place to Place. The Rain falls on all Place alike: On this Field and that, this Garden or Orchard and another. Vegetables therefore are not formed of Water. One Plant drew up 2501 Grains of this; yet increaſed only three Grains and a Half. The Mint in B. took thirty-nine Grains of Water a Day, which was much more than the whole Weight of the original Plant. And yet it gained not one-fourth of a Grain, in a Day and Night.

Water then is only a Vehicle to the terreſtrial Matter, which forms Vegetables. Where this is wanting, the Plant does not increaſe, tho' ever ſo much Water aſcend into it. This is only the Agent which conveys that Matter to them, and diſtributes it to their ſeveral Parts for their Nouriſhment. It is fitted for this Office, by the Figure of its Parts, which are exactly ſpherical; therefore eaſily ſuſceptible of of Motion, and conſequently capable of conveying other Matter that is not ſo voluble. Then the Intervals of Bodies conſiſting of ſpherical Particles, are the largeſt of all others, and ſo more fitted to receive foreign Matter. Beſides the conſtituent Particles of Water are abſolutely ſolid, and do not yield to the greateſt external Force: Therefore their Intervals are always alike. By this quality Water is diſpoſed to receive Matter into it: By the former, to bear it along with it.

It is farther qualified to be a Vehicle of this Matter, by the Fineneſs of its Particles. We ſcarce know a Fluid in Nature, except Fire whoſe conſtituent Parts are ſo exceeding ſmall. They paſs Pores which Air itſelf cannot paſs. This enables them to enter the fineſt Veſſels of Plants, and to introduce the terreſtrial Matter to all Parts of them; each of which, by Means of peculiar Organs, aſſumes the Particles ſuitable to its own Nature, letting the reſt paſs on through the common Ducts.

P. 241. Earth is certainly, &c.

That the Sap *deſcends* in Winter, appears from hence, that the Graft will either corrupt or heal the Stock. Nay, it changes the very Way of the Growing of the Root, which it could not do, but by ſending down its Sap thither. Crab-ſtocks grafted with Fruit, which the Soil does not like, will canker, not only in the Graft, but the Stock alſo. But graft them again with Fruit it does like, and it will quickly heal. Farther: Graft twenty young Pear-ſtocks with

with one Sort of Pear, and twenty with another. The Roots of one Sort will grow all alike, and ſo will thoſe of the other.

Evergreens grafted on Trees which drop their Leaves, as the ever-green Oak of *Virginia* upon the common *Engliſh* Oak, hold their Leaves all the Winter. Does not this ſhew, that the Juices aſcend in Winter, as well as Summer, even in the Plants which drop their Leaves? Otherwiſe thoſe grafted on them muſt ſoon die.

It ſeems that the Sap does not riſe by the Pith: becauſe ſome large Trees are without that Part, and yet continue to put forth Branches. Indeed no Pith is found in thoſe Branches of a Tree, which exceed two or three Years Growth. And the Pith which is in a Branch of this Year, is diſtributed into thoſe Boughs which are formed the next Seaſon.

Many believe, the Tree does not receive its Nouriſhment by the Bark; becauſe Trees that have loſt that Part, continue to grow. But they ſuppoſe a Tree has but one Bark; whereas every Branch has four diſtinct Coverings. The two outermoſt of theſe may be taken from a Tree without much Damage. But if the two others be taken off, it will infallibly kill the Tree.

Some affirm, that the Sap neither riſes nor falls in the woody Part of the Tree, becauſe when a Branch is cut, they cannot diſcern any Sap iſſue out of it. Certainly they cannot; becauſe thoſe Tubes are not large enough, to receive any Thing more groſs than Vapour. The Root receives, chiefly in Autumn its proper Juices, which the Warmth in Spring raiſes into a Vapour, that gradually aſcends through thoſe fine Tubes, and by that Means cauſes Vegetation.

Some have objected to our Lord's ſpeaking of Corn increaſing *an hundred Fold*, that this is impoſſible. So far from it, that a Grain of Barley, has been known to produce 249 Stalks, containing above 18000 Grains.

A ſtill more curious Experiment was made with *Turnip* Seed, at *Sutton-Coldfield*, in *Warwickſhire*. In leſs than three Days after it was ſown, the Turnips were above Ground. In three Weeks the Roots were as big as Walnuts: In leſs than five Weeks, as large as Apples. Auguſt 19th, one of them weighed 2 lb. 14 Oz. At the ſame Time was weighed an Ounce of the Seed, which had been ſown, and it was found to contain 14600 ſingle Grains. This being multiplied by 46 (the Ounces that the Turnip weighed) produces 671600, viz. the Number of ſingle Grains required to equal the Weight of the Turnip. Hence it follows, that (ſuppoſing the Increaſe was uniform) the Grain, when it was ſown, weighing but $\frac{1}{671600}$th Part of an Oz, increaſed in the following Proportion:

In Six Weeks -	671600	Times its own Weight.
A Week - -	111933	
A Day - -	15990	
An Hour - -	660	
A Minute - -	11	

Mr. Miller ſeparated the Male Plants of *Spinach* from the Female. The Seed ſwelled as uſual, but did not grow when he ſowed it. Yet it might have been impregnated another Way, as appeared from another Experiment. He ſet twelve Tulips about ſix Yards from any other, and as ſoon as they flowered, carefully took out the Stamina. Two Days after he ſaw Bees working on other Tulips, and coming out loaded with the Duſt. They flew into the firſt Tulips, and left therein Duſt enough to impregnate them, which accordingly bore good Seed. Thus we ſee the Farina may be carried by Inſects, and lodged on Flowers, which it is fit to impregnate.

Afterwards he bought and ſowed ſome *Savory* Seed, and planted out the Plants, but was ſurprized at the Production. For he had ſome red Cabbage, ſome white, ſome Savoys with red ribs, and ſome a Mixture of all together in one Plant. The Gardener aſſured him, he had carefully ſaved the Seed. Being

aſked,

aſked, where he had ſet the Plants for Seed, he ſhewed him, and ſaid, He planted firſt a Dozen white Cabbages, next a Dozen Savoys, and then a Dozen red Cabbages. Is it not plain, that here the Effluvia of one Sort, impregnated the other? For did each Grain of the Farina impregnate only its own Kind, this mongrel ſort could never be produced.

An Inſtance of the ſame Kind has been obſerved, with Regard to *Indian Corn*: This is of ſeveral Colours, as white, red and yellow. If each of theſe be planted by themſelves, they produce their own Colour. But if you plant the blue Corn in one Row, and the white or yellow in the next, they will interchange Colours: Some of the Ears in the blue Corn-rows, are white or yellow, and ſome in the white or yellow Rows are blue. That this is cauſed by the Effluvia of one impregnating the other, is manifeſt from hence. Place a Cloſe, high Fence, between the Corn of different Colours, and there is no Change of Colour in any of them.

P. 105. The *Holly* is deſcribed by all Naturaliſts, as bearing hermaphrodite Flowers. But by late Obſervations it has appeared, that ſome Trees bear Male, ſome Female Flowers. Yet there is a vaſt Variety. In Chelſea-Garden, ſome Hollies bear Female, ſome hermaphrodite Flowers. But ſome Trees bear only Male flowers; ſome only Female, ſome only Hermaphrodite. Others bear both Male and Female, both Male and Hermaphrodite or Female and Hermaprodite. And others bear Male, Female, and Hermaphrodite, all at the ſame Time.

P. 105. *Acoſta* and *Proſper Alpinus*, who both wrote near the Concluſion of the ſixteenth Century, are, the firſt, who recorded that Nocturnal Change in the Leaves of Plants, which has ſince been called *Sleep*. It is now many Years ſince *Linnæus* firſt attended to this Quality in Plants. In his *Flora Lapponica*, he remarks, that the Leaves of many, were ſubject to this

Change

Change in the Night Time: And he had then found, that heat and cold were not the Cauſe of this Quality; ſince they were alike influenced by it when placed in Stoves, where the Temperature of the Air was always the ſame. The Subject of the Sleep of Plants cannot but be entertaining to the Lovers of natural Knowledge: And ſuch, cannot be leſs entertained with that Faculty, which *Linnæus* calls the *awaking of Flowers*. Previous to our Explanation of this, we may obſerve, that the Flowers of moſt Plants, after they are once opened, continue ſo Night and Day, until they drop off, or die away. Others, which ſhut in the Night-time, open in the Morning ſooner, or later, according to their Situation in the Sun or Shade, or as they are influenced by the manifeſt Changes of the Atmoſphere. There are another Claſs of Flowers, which make the Subject of theſe Obſervations, which obſerve a more uniform Law in this Particular.

Theſe open and ſhut conſtantly at certain Hours, excluſive of any manifeſt Changes in the Atmoſphere; and this with ſo little Variation in Point of Time, as to render the Phænomenon worth Obſervation. *Linnæus*'s Obſervation extends to near fifty Species which are ſubject to this Law. We will enumerate ſome of theſe, and mention the Time when the Flowers open and ſhut. The Flowers of the *Male Pimpernell* open about eight o'Clock in the Morning, and never cloſe till paſt Noon. This Plant is common in Kitchen Gardens and in Corn-fields, and flowers in June, and continues in Flower three Months. *The little blue Convolvulus, or Bindweed*, opens its Flowers between five and ſix in the Morning, and ſhuts them in the Afternoon. The Flowers of the *Day-lily*, open about five in the Morning, and ſhut at ſeven or eight in the Evening. *The leſſer Water-Plantain*, during its flowering Time, only opens its Flowers each Day about Noon. *The* Flowers of *Proliferous Pink*, expand about eight in the Morning, and cloſe again about one in the Afternoon. *Purple Spurrey*, expands between nine and ten

in

in the Morning, and closes between two and three in the Afternoon. This little Plant is common among the Corn in sandy Soils, and flowers in June. *Common Purslain*, opens its Flowers about nine or ten in the Morning, and closes them again in about an Hour's Time. *The white Water-Lilly* grows in Rivers, Ponds, and Ditches, and the Flowers lie upon the Surface of the Water. At their Time of Expansion, which is about seven in the Morning, the Stalk is erected, and the Flower more elevated above the Surface. In this Situation it continues till about four in the Afternoon, when the Flower sinks to the Surface of the Water, and closes again. *Yellow Goats Beard*, or *Go-to-bed-at-noon*. The latter of these Names was given to this Plant long since, on account of this remarkable Property. The Flowers open in general about three or four o'Clock, and close again about nine or ten in the Morning. These Flowers will perform their Vigiliæ, if set in a Phial of Water, within Doors for several Mornings successively. Sometimes they are quite closed, from their utmost State of Expansion, in less than a Quarter of an Hour. It flowers in June. *Tree Sowthistle*, expands its Flowers about six or seven, and closes them between eleven and twelve in the Forenoon.

This is common in Corn-fields, and flowers in June, July, and August. *Garden Lettuce*, opens its Flowers about seven, and closes them about ten, in the Forenoon. *Dandelion* expands at five or six, and closes at eight or nine, in the Forenoon. This Flowers early in the Spring, and again in Autumn. *Rough Dandelion*, opens its Flowers about four in the Morning, and keeps them expanded till three in the Afternoon. *Yellow Devil's-bit* opens about seven, and keeps in an expanded State till about three in the Afternoon. It flowers in July and August. *Common creeping Mouseer* opens about eight in the Morning, and closes about two in the Afternoon. It is very common on dry Pastures, flowering in June and July. *Wild Succory* grows on the Borders of Fields, flowering in August

and

and September. The Flowers open about eight in the Forenoon, and keep expanded till about four in the Afternoon. *Wild Marigold* expands from nine in the Morning till three in the Afternoon.

P. 254. If the Top of a *Viburtrum* is planted in the Ground, it becomes Roots, and the Roots turned up become Branches; and the Plant grows exactly as well as it did in its natural Poſition: Whether the Veſſels which fed the Branches have changed their Courſe, or whether the Juices go up and down in the ſame Veſſels.

P. 256. The Berries of *Miſſelto* have within their viſcid Pulp, a Kernel covered with a thin, whitiſh Skin. One placed theſe Berries within the Bark of Oak, Aſh, Beech, Pear and Apple-trees, by making ſeveral Cuts in the Sides of the Trees, but the whole Berries would not ſtay in any of them. And when he broke them, the Seed always ſlipt out to the Edge of the Cut, and there ſtuck to the Bark by its viſcous Covering. He ſtuck one Seed to the Bark without any cutting at all, which ſucceeded beſt, and yielded two Plants. The viſcous Matter drying away, drew the Seeds cloſe to the Bark, and on theſe with two more on an Apple tree and one on a Pear-tree, there began in Spring to ſhoot out at the End of the Seed next the Eye of the Berry, a ſmall deep-green Shoot, like a little Claſper of a Vine. At firſt it roſe upward, then turning again, ſwelled out ſomewhat bigger round the End; yet leaving the Tip quite flat, forming as it were, a Foot to ſtand upon. This Foot in June came to the Bark, and fixt itſelf thereon. Being thus faſtened at both Ends, it formed a little Arch, whoſe Diameter was as long as the Seed. Thus it remained till March following. Then the other End let go its Hold, and raiſing itſelf upward became the Head of the Plant, while the End which ſprung out firſt, became the Root. Tis not uncommon, for the Seeds of Evergreens to be two Years before they

ſpring

ſpring out of the Ground. But this was ſurprizing, the Change of the Ends, firſt one ſhooting out, and then the other. Yet we find Nature is uniform, and even in this ſtrange Plant, acts as in other Vegetables, firſt carrying the Sap to form the Root, then turning the Courſe of it back again, to ſend out the upper Parts of the Plant. The ſtrangeſt Circumſtance is, that the rooting End ſhould firſt ſhoot into the Air, and then turn down, to find a Place to fix on. This it is, which has kept the World ſo long in Ignorance about the growing of this Seed. For by requiring a new, ſmooth Part of the Bark whereon to fix the rooting Part, it has fruſtrated all Attemps of ſowing it as we do other Seeds.

V. I. P. 256. In Strawberries and Raſberries the Hairs which grow on the ripe Fruit, are ſo many Tubes leading to the ſeveral Seeds. And therefore we may obſerve, that in the firſt Opening of the Flower, the whole inward Area is like a little Wood of theſe Hairs; and when they have received and conveyed their Globules, the Seeds ſwell and riſe in a fleſhy Pulp.

The Manner wherein *Moſſes* in general *Seed*, is exceeding little underſtood. But in one Species at leaſt, it may be clearly explained, from a Number of Obſervations. The Head of this Moſs appears to the naked Eye, ſmooth and of a pale-brown Colour. The Top of this is bounded by an Orange-coloured Ring, which is a *Calix*, containing ſixteen pyramidal *Stamina*, loaded with a white *Farina*. Theſe bend toward each other, and when the Head is nearly ripe, almoſt meet in a Point at their Tops. Immediately under the Arch formed by theſe Stamina, is placed a ſlender, hollow *Piſtil*, through which the Farina makes its Way; and is diſperſed among the Seeds in the Head. The external Membrane of the Head, is a Continuation of the outward Covering of the Stalk.

A Section of the Head ſhews, that this Membrane includes a Seed-veſſel ſo large as to fill it every Way. This is filled with perfect and beautiful Seeds. They are round and tranſparent when unripe, but afterwards they are opake, and of a beautiful Green. The Number of Seeds in one of theſe Heads, is not leſs than 13,800.

The *Seed Veſſels* of *Mahogany* Trees are of a curious Form. They conſiſt of a large Cone, which ſpliting into five Parts, diſcloſes its winged Seeds. None would think, that ſo tall and ſo large Trees, could grow on ſolid Rocks. They are four Feet and upward in Diameter. The Manner of their Growth is as follows. The Seeds fly along the Surface of the Ground, and ſome falling into the Chinks of the Rocks, ſtrike Root, then creep out upon the Surface, and ſeek another Chink. In this they ſwell to ſuch a Size and Strength, that the Rock ſplits and makes Way for the Root to ſink deeper. And with this little Nouriſhment the Tree in a few Years grows to that ſtupendous Size.

Other Trees have been propagated by a ſtill more ſurprizing Way. One having cauſed ſome Aſhen Pipes, that had brought Water to his Fountain twelve Years to be taken up, they were left in the Yard, where they rotted almoſt intirely. But in their Room there ſhot up a young Forreſt of Aſhes, which are now about four Feet high. There is no Aſhe-tree within a great Diſtance of the Yard. Where then were the Seeds from which they ſprung?

Mr. *Bonnet* of *Geneva* was inclined to try, whether Plants would grow, when planted in *Moſs* inſtead of Earth. So he filled ſeveral Garden-pots with Moſs, and compreſt it more or leſs, as he judged the ſeveral Plants might require, a cloſer or a looſer Soil.

He

He then ſowed therein Wheat, Barley, Oats and Peas. And he found firſt, that all the Grains thus ſown, came to Maturity later, than thoſe of the ſame Sorts, which had been ſown in Mould. 2. That the Stems from the Seeds ſown in Moſs, were generally taller than thoſe ſown in Earth: 3. That there came more Blades from the Grains ſown in Moſs, than from thoſe ſown in the Ground: 4. The Grains ſown in Moſs produced more plentifully than the others. 5. The Grains gathered from the Corn which grew in the Moſs, having been ſown again, partly in Moſs and partly in Earth, ſucceeded well in both.

He alſo planted in Moſs, Pinks, Daiſies, Tulips, Jonquils, and ſeveral other Sorts of Flowers. And all theſe ſucceeded full as well, as thoſe of the ſame Sort which he planted in Mould. He alſo placed in Moſs, Cuttings and Layers of Vines, all which grew up into Vines. And theſe in a while were larger than thoſe which came from Cuttings and Layers planted at the ſame Time in the Ground.

The Huſbandry of *Figs*, as it is ſtill practiſed in many Parts, is one of the greateſt Curioſities in Nature. There are two Sorts of Fig-trees, the Wild, and the Garden Fig-tree. The Wild bear three Kinds of Fruit, *Fornites*, *Cratitires* and *Orni*: And all theſe are neceſſary to ripen the Garden-fig. The *Fornites* appear in Auguſt, and hold to November without ripening. Herein breed ſmall Worms, which turn to a Kind of Gnats, no where to be ſeen but about theſe Trees. In November theſe Gnats make a Puncture in the *Cratitires*, which do not appear till toward the End of September, and the *Fornites* gradually fall off, after the Gnats have left them. The *Cratitires* remain on the Tree till May, and incloſe the Eggs depoſited in them. In May the *Orni* appear, which after they grow to a certain Size, are pricked by the Gnat iſſuing from the *Cratitires*.

None of these are good to eat, but only to ripen the Fruit of the Garden Fig-Tree in the following Manner. In June and July, the Peasants take the *Orni*, when their Gnats are just ready to break out, and carry them to the Garden Fig-tree. If they do not mind the Time exactly, the *Orni* drop, and the Garden-fruit not ripening, for want of its proper Puncture, will likewise fall soon after. Therefore they carefully inspect the *Orni* every Morning, and transfer such of them as are proper. By this Means the Garden-figs become ripe, in about six Weeks after they have received the Puncture of the Insect. When they have dried them in the Sun, they put them into Ovens, to destroy the Eggs of the Gnats laid in them, from whence otherwise Worms would be produced, which would consume the Fruit.

What an Expence of Time and Pains is here! Who can but admire the Patience of the *Greeks*, busied above two Months in carrying these Prickers from one Tree to another! But how do these contribute to the ripening of the Garden-figs? Perhaps by causing the nutritious Juice to extravasate, whose Vessels they tear asunder, in depositing their Eggs. Perhaps too they leave with their Eggs some Kind of Liquor, proper to ferment with the Milk of the Fig and make it tender. Figs in *Paris* ripen sooner for having their Buds pricked with a Straw dipt in Oil.

CHAP.

CHAP. II.

Of ſome particular Plants.

1. *Graſs of the Submarine Meadows:*
2. *Submarine ſenſitive Plant:*
3. *Odd Motion of Hop-vines:*
4. *Jamaica Pepper:*
5. *Peruvian Bark:*
6. *The Balſam-tree:*
7. *Manna:*
8. *Palm-trees:*
9. *Manchineel-tree:*
10. *Indian Poiſon:*
11. *Sugar not unwholeſome:*
12. *Maple-Sugar:*
13. *Moloſſes extracted from Apples:*
14. *The Fountain-tree:*
15. *The Quickſilver Plant.*
16. *Ambergris.*

P. 261. THE Graſs of the *Submarine Meadows* is not a Span long, and is of a green approaching to a Yellow. The Tortoiſes ſeem to live wholly on this; but they bite much more of it than they ſwallow. Hence the Sea is covered with this Graſs wherever they feed at the Bottom. About once in Half an Hour they come up, fetch one Breath like a Sigh, and ſink again. They breathe ſomewhat oftner, when on Shore; if you hurt them, the Tears will trickle from their Eyes. They will live out of Water 20 Days and be fat, if they have twice a Day Half a Pint of Salt-water.

A *ſubmarine Senſitive Plant* has been obſerved on the *Iriſh* Coaſt. It conſiſts of a long ſlender Tube about as thick as the Barrel of a Gooſe-quill, growing about ſix or eight Inches, out of the Crevices of the Rocks, eſpecially in ſuch Hollows as the Salt-water remains in, after the Tide ebbs away. In the Middle of the Tube ſprings up a ſlender Stalk. The Top of which is a reddiſh, round veſicle. If you

point a Finger to this, as ſoon as you are near touching it, the Stalk withdraws to the very Bottom of the Tube, and the Tube itſelf bends and becomes flaccid. The Plant has no Branches, nor can the Root be ſeparated from the Rock without breaking it. On the *Corniſh* Shores, there grows a Kind of *Senſitive Fucus*. Bring this ſo near the Fire as juſt to warm, and its Edges ſhrink up. In this State move a Finger toward them, and they ſhrink from, but if the Finger is removed, recover their former Situation. Placed on a warm Hand, it moves perpetually to and from the Hand, like an Animal ſtruggling for Life. This odd Effect is entirely owing to the Structure of theſe Plants. They are ſo extremely thin, that they yield to the Perſpiration of the Hand; the Effluvia being of Force ſufficient to repell the Leaves when they are near.

P. 262 after *Vegetable Kind.*

The *Vines* of *Hops* wind about the Poles with the Sun, thoſe of *Kidney Beans* againſt the Sun, and that ſo obſtinately, that although the one or the other be over-night wound the oppoſite Way, yet in the Morning it will be found to be got back again to its natural Bent.

The Tree that bears *Jamaica Pepper* is about thirty Feet high, and covered with a grey, ſmooth, ſhining Bark. It ſhoots out Abundance of Branches which bears large Leaves, like thoſe of the Bay-Tree. At the very End of the Twigs grow Bunches of Flowers, each ſtalk bearing a Flower which bends back. To theſe ſucceeds a Bunch of Berries, larger when ripe than Juniper Berries. They are then black, ſmooth and ſhinning; but they are taken from the Tree when unripe, and dried in the Sun. They have a mixt Flavour of many Kinds of Spice, and hence they are called *All-ſpice.*

P. 263

P. 263. *Peruvian-Bark* comes from a Tree, about the Bigneſs of a Plumb-tree. Its Leaves are like Ivy, and are always green. It is gathered in Autumn, the Rind is taken off all round, both from the Boughs and the Tree, and grows again in four Months. It bears a Fruit not unlike a Cheſnut, except its outward Shell. This Shell is properly called *China-China*, and is eſteemed by the Natives, far above the Bark, which is taken from the Trunk or Boughs. And it ſeems this only was in Uſe, till the Demand for it ſo increaſed.

The *Balſam Tree* grows on Rocks, and frequently on the Limbs or Trunks of other Trees. This is occaſioned by Birds, ſcattering or voiding the Seeds, which being glutinous like thoſe of Miſſelto, take Root and grow; but not finding ſufficient Nouriſhment, the Roots ſpread on the Bark till they find a decayed Hole wherein is ſome Soil. Into this they enter and become a Tree. But the Nouriſhment of this ſecond Spot being exhauſted, one or two of the Roots paſs out of the Hole, and fall directly to the Ground, though at forty Feet Diſtance. Here again they take Root, and become a much larger Tree than before. They flouriſh on the *Bahama* Iſlands, and many other of the hot Parts of *America*.

In Italy are many Coppice Woods, of what our Gardeners call the *flowering Aſh*. *Manna* is procured by piercing the Bark, and catching the Sap, as we do that of Birch Trees, to make Birch Wine. It begins to run in the beginning of Auguſt, and in a dry Seaſon, runs for five or ſix Weeks. But we have no need to be beholden to the King of *Naples*. For the Tree grows as well in *England* as in *Italy*. What Stupidity is it then, to import at a large Expence, what we may have at our own Doors?

Palm Trees are Male and Female. In March or April, when the Sheaths that incloſe the young

Cluſters of the Flowers and Fruit begin to open, (at which Time the *Dates* are formed) they take a Sprig of the male Cluſter, and inſert it into the Sheath of the Female; or elſe take a whole Cluſter of the male Tree, and ſprinkle the Farina of it over ſeveral Cluſters of the Female. Where they uſe the former Method, one Male ſuffices to impregnate 4 or 500 Females.

The Palm Tree is in its greateſt Vigour about 30 Years after Tranſplantation, and for 70 Years longer bears yearly, 15 or 20 Cluſters of Dates, each of 15 or 20 Pounds Weight. Afterward they gradually pine away, and uſually fall about the latter End of their 2d Century.

To procure the Honey of the Palm Tree, they cut off its Head, and ſcoop the Top of the Trunk into the Shape of a Baſon. The Sap aſcending lodges in this Cavity, for the firſt ten or 12 Days, three Quarts or a Gallon a Day. Then it gradually diminiſhes, till in ſix or eight Weeks, the Juices are conſumed and the Tree is fit only for Firewood. This Liquor is a thin Syrup, of a more lucious Sweetneſs than Honey. Hence our Poet mentions

"Fruit of Palm Tree pleaſant to Thirſt
And Hunger both:" Though one would imagine, a Liquor of that Kind, would not be very proper to quench Thirſt.

The *Manchineel* Apple is moſt beautiful to the Eye, agreeable to the Smell, and pleaſant to the Taſte, but if eaten it is certain Death. Yea, the whole Tree is ſo poiſonous, that the Wood of it while Green, if rubbed againſt the Hand will raiſe Bliſters. And if Rain falling from the Leaves light on the naked Skin it will have the ſame Effect.

The Wood is good for Tables, Cabinets, and all other curious Work. But the virulent Nature of the Sap, calls for great Caution in felling the Tree. I was cutting down one of them, ſays Mr. *Cateſby*, when ſome of the milky Juice ſpurting in my Eyes,

I was

I was two Days totally blind, my Eyes and Face being much ſwelled. For four and twenty Hours, I felt a violent, pricking Pain, which then gradually abated. Indeed not only Rain or Dew falling from the Leaves, raiſe Bliſters on the Skin, but even the Effluvia will affect the Senſes of them that ſtand any Time under the Shade of it.

V. I. P. 264 after *Man's Head.*

Many Phyſicians affirm, That *Sugar* is unwholeſome, and moſt, that it deſtroys the Teeth. But how will this agree with the following Account? "My Grandfather, ſays Dr. *Slare*, took as much Sugar as his Butter ſpread upon Bread would receive, for his daily Breakfaſt. He put Sugar into all his Ale and Beer, and into all the Sauces he uſed to his Meat. At eighty Years old he had all his Teeth ſtrong and firm, (having never had the Tooth-ach) and never refuſed the hardeſt Cruſt. In his 82d Year one of his Teeth came out, and in two or three Years all the Reſt. But others filled up their Room, and in a ſhort Time, he had a new Set quite round. His Hair alſo from very white became dark. He continued in Health and Strength, and died without any Diſeaſe, in his Ninety-ninth or hundred Year.

It is not only from the Canes that *Sugar* is extracted: In *New England* much of it is made from the Juice of the Upland *Maple.* They firſt make a Hole in the Tree, within a Foot of the Ground, ſhelving inward, ſo as to hold about a Pint. Then they tap this Hole, and by a Reed draw off the Liquor into a Veſſel. A large Tree will yield between the Beginning of February and the End of April twenty Gallons of Juice. A Gallon in boiling 16 Hours is reduced to three Pints, and yields more than two Pounds of Sugar, which our Phyſicians prefer to all other, for Medicinal Uſes.

Moloſſes likewiſe may be procured without Sugar-canes. This was diſcovered a few Years ago, by Mr. *Chandler*

Chandler of *Woodſtock*, in *New-England*, an inland Town, where the common Moloſſes is ſcarce and dear. Ever ſince both he and his Neighbours ſupply themſelves with it, out of their own Orchards. The Apple that produce it, is a Summer Sweeting, of a middling Size and full of Juice. They grind and preſs the Apple, and then gently boil the Juice for about ſix Hours. In that Time it comes to the Sweetneſs and Conſiſtency, and anſwers all the Purpoſes of other Moloſſes.

P. 265. An admirable Inſtance of Divine Providence we have in the *Fountain Tree*, which grows on *Hierro*, one of the *Canary* Iſlands. In the rocky Cliff which ſurrounds the Iſland, is a narrow Gutter, which begins at the Sea, and continues to the Summit of the Cliff, where it falls into a Valley, which is bounded by the ſteep Front of a Rock. On the Top of this grows a Tree, which has continued many Years. Its Leaves conſtantly diſtill as much Water, as is ſufficient for the drink of every living Creature on the Iſland. It ſtands by itſelf, a League and a Half from the Sea, and no one knows of what Species it is. Its Trunk is about nine Feet round, in Diameter about Three. It is thirty Feet high; the Circumference of all the Branches together is about Ninety. The Branches are thick, the loweſt of them is about an Ell from the Ground. Its Fruit reſembles an Acorn, its Leaves reſemble thoſe of the Laurel, but are longer and broader. They come forth in perpetual Succeſſion, ſo that the Tree is always green. On the Northſide of it are two Ciſterns of rough Stone, each fifteen Feet ſquare, and twelve deep: One of which contains Water for the Drink of the Inhabitants; the other, for their Cattle and all other Purpoſes.

Every Morning, near this Part of the Iſland, a Miſt riſes from the Sea, which the South and Eaſterly Winds drive againſt the fore-mentioned Cliff, which it gradually aſcends, and thence advances to the

the End of the Valley. Being ſtopt there by the Front of the Rock, it reſts upon the Leaves and Branches of the Tree, whence it diſtills the Remainder of the Day.

But Trees yielding Water are not peculiar to the Iſland of *Hierro*. One of the ſame Kind grows on the Iſland of St. *Thomas*, in the Gulph of *Guinea*. And of the ſame Nature is that near the Mountains of *Vera Pogz*, whereof we have the following Account in *Cockburn's Voyages*.

"In the Morning of the fourth Day, we came out on a large Plain, in the midſt of which ſtood a Tree of an unuſual Size. Its Trunk was above five Fathoms round; the Soil it grew on was very ſtony. And on the niceſt Enquiry we could afterwards make, both of the *Spaniards* and the Natives, we could not learn, that any other ſuch Tree had been known in all *New Spain*.

"Perceiving the Ground under it wet, we were ſurprized, knowing that according to the certain Courſe of the Seaſon in that Latitude, there had no Rain fallen for ſix Months, and that it could not be owing to the Dew, for this the Sun entirely dried up, in a few Minutes after his riſing. At laſt, to our great Amazement, as well as Joy, we perceived Water dropping from the End of every Leaf; after we had been labouring four Days through extreme Heat, and were almoſt expiring for Thirſt, we could not but look on this, as Liquor ſent from Heaven, to relieve us in our Extremity. We catched it in our Hands, and drank ſo plentifully, that we could ſcarce tell when to give over."

P. 266. In the Valley of *Lancy*, which runs between the Mountains of *Jurin*, grows a Plant like the *Doronicum*, near the Roots whereof is found pure Quickſilver, running in ſmall Grains like Pearls. One would not imagine the Plant had any Influence on this, but for the following Experiment. Expreſs the

the Juice: Expoſé it to the Air in a clear Night, and there will be found as much Mercury as there is loſt of Juice.

P. 268. Some have maintained, that *Ambergris* was a Subſtance naturally bred in one Species of Whales, in a Bag three or four Feet long. But this Bag is in Truth, only the Bladder of the Whale and the ſuppoſed Ambergris is only a Calculus of the Bladder. The largeſt of theſe ever found in a Whale, weighed twenty-one Pounds. But Pieces of Ambergris have been found, which were ſix Feet long and weighed above an hundred and eighty Pounds.

It ſeems, 1. That Ambergris, like yellow Amber, comes out of the Earth into the Sea: 2. That it comes, not like Napththa, but in a thicker, viſcid and tenacious Conſiſtence. 3. That in the firſt Formation thereof, a liquid Bitumen or Napththa is mixt with it. 4. That large Pieces may be generated at the ſame Time; but uſually a ſmall one riſes firſt, to which another ſoon adheres, and ſo more and more, forming irregular Figures, under which it is ſoft, ſo that various Subſtances ſtick to it; but it gradually hardens to the Conſiſtence of Wax.

And as Ambergris, ſo divers other foſſil Bodies are found in Strata: However one would not be poſitive, as to the Manner of its Generation. For who can explain in what Manner Amber is produced? Or how Metals, Semi-metals, precious Stones, and innumerable other Mineral Subſtances are generated? We know what they are, but how they are formed, we know not with any Degree of Certainty.

CHAP.

CHAP. III.

Of Metals, Minerals, and other Foſſils.

V. II. P. 6. GOLD is either found in ſmall Grains in the Sand of Rivers, (formerly in ſeveral of the Rivers of *Europe*) or is dug out of the Earth, in ſmall Pieces of a tolerable Purity. Sometimes it is alſo found, like the Ore of other Metals, in a Maſs of Earth, Stone or Sulphur. In this State it is of all Colours, red, white, blackiſh, making no Oſtentation of its real Value.

P. 7. *Silver*, like the Ore of all other Metals, is found in the Earth, under different Forms and Colours. But it uſually affects ſomewhat of a pointed, regular Form like Chryſtals. It is never found in Sand

Sand or Grains, as native Gold is. It is ſometimes Aſh-coloured, ſometimes ſpotted with red and blue, ſometimes of changeable Colours, many Times almoſt black.

Altho' the Hiſtory of Foſſils has been diligently cultivated, eſpecially by the Moderns, yet it muſt be owned, that amidſt the vaſt Variety of them, there is ſtill Room for new Enquiries. No wonder therefore, that among the great Variety of Salts, Ores and other Concretes, new Mixtures ſhould daily be diſcovered. But that among Bodies ſo ſimple as Metals, any ſhould ſtill remain unknown, will doubtleſs appear extraordinary.

Yet ſo it is: There has been diſcovered in *New Spain*, an original Metal between Gold and Silver. The *Spaniards* call it *Platina*, from the Reſemblance in Colour which it bears to Silver. It is of an uniform Texture, bright and ſhining. It takes a fine poliſh, and does not tarniſh or ruſt. It is very hard and compact, but extremely brittle, and quite unmalleable.

It is found, not in Ore, but in ſmall Grains, yet not pure, but mixt with a ſhining black Sand. There are likewiſe uſually mixt with it, a few ſhining Particles of a golden Colour.

When expoſed by itſelf to the Fire, it is extremely hard to melt. It has been kept for two Hours in an Air-furnace, in a Heat that would melt caſt Iron in fifteen Minutes, without being either melted or waſted. But when expoſed to a proper Heat with Gold, Silver, Copper, Lead or Tin, it readily melts and incorporates with them. Having been kept in an Aſſay-furnace with Lead for three Hours, till all the Lead was wrought off, it was found remaining at the Bottom, without having ſuffered any Alteration or Diminution. A Piece of it was put into ſtrong Aqua-fortis, and kept in a Sand-heat for twelve Hours, yet when taken out, it was no way corroded, and was of the ſame Weight as when put in. It

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has been ſaid to be heavier than Gold: But that is a Miſtake. Its Specific Gravity is to that of Water, as 15 to 1. Yet an equal Mixture of Gold and Platina, was near as heavy as Gold itſelf, being to Water as 19 to 1. It appears then, that no known Body comes ſo near Gold in Fixedneſs and Solidity. If it could be made as ductile as Gold, it would not eaſily be diſtinguiſhed from it.

It farther appears, from many Experiments, that Platina is likewiſe found in large hard Maſſes; that theſe Maſſes are with great Labour, reduced into ſmall Grains, which are afterwards ground with Mercury to extract the Gold, and that it is not to be brought into Fuſion by the greateſt Degree of Fire procurable in the ordinary Furnaces, whether expoſed to its Action in cloſe Veſſels, or in Contact with the Fuel. It entirely reſiſts the vitriolic Acid, which diſſolves or corrodes every other known metallic Body except Gold. Nay it reſiſts the marine Fumes; and the Regal Cement, ſo called, from its being ſuppoſed to purify Gold from all heterogeneous metallic Matters. It alſo reſiſts the Force of the vitriolic and nitrous Acids, though applyed in ſuch a Manner, as to be capable of perfectly diſſolving all other known metallic Bodies. It follows from other Experiments, that Platina contains no Gold; for it cannot any more than the common metallic or other ſoluble Subſtances, prevent a ſmall Portion of Gold mixt with it from being diſcoverable. It farther appears, that Platina, like Gold is not acted on by the ſimple Acids which is known to diſſolve every metallic Body beſides: That Aquæ Regiæ, the ſolvents of Gold, prove menſtrua for Platina: And that conſequently the common Methods for aſſaying or purifying Gold by Aqua Fortis, Aqua Regis, or the regal Cement, can no longer be depended on: That it differs from Gold, in giving no Stain to the ſolid Parts of Animals, not ſtriking a purple Colour with Tin, not being revived from its Solutions by inflammable Spirits, not being totally preciptable by alca-

line Salts; that in certain Circumſtances it throws out Gold from its Solutions; that theſe Properties afford Means of diſtinguiſhing a ſmall Portion of Gold mixt with a large one of Platina, or a ſmall Portion of Platina with a large one of Gold; and that Platina contains no Gold excepting the few Particles diſtinguiſhed by the Eye. That Platina is precipitated from its Solutions by the vitriolic Accid, and by the metallic Subſtances, which precipitate Gold, though ſcarce totally by any: And that its Precipitates reſiſt Vitrification, and this perhaps in a more perfect Manner than precipitates of Gold itſelf. It is therefore a ſimple Metal, of a particular Kind, eſſentially diſtinct from all thoſe hitherto known, though poſſeſſed of ſome Properties generally ſuppoſed peculiar to Gold. Many of its Characters have been already pointed out; others reſult from combining it with the ſeveral Metals, with each of which notwithſtanding its reſiſtance to the moſt intenſe Fires by itſelf, or with unmetallic Additions, it melts perfectly; occaſioning remarkable Alterations in their Colours, Texture, and Hardneſs. It melts with equal its Weight of each of the Metals, with one more readily than with another. With ſome it becomes Fluid, in a moderate Fire; but a ſtrong one is requiſite for its perfect Solution. Compoſitions of Silver, Copper, Lead, with about one third their Weight of Platina, which had flowed thin enough to run freely in the Mould, and appeared to the Eye perfectly mixed, on being digeſted in Aqua-fortis till the Menſtrum ceaſed to act, left ſeveral Grains of Platina in their original Form. Upon viewing theſe with a Microſcope ſome appeared to ſuffer no Alteration; others exhibited an infinite Number of minute bright globular Protuberances, as if they had juſt begun to melt. Platina hardens and ſtiffens all Metals; one more than another, Lead the moſt. In a moderate Quantity it diminiſhes, and in a large one deſtroys, the toughneſs of all the malleable Metals, but communicates ſome Degree of this Quality to Caſt Iron. Tin bears much the leaſt,

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and Gold and Silver the greateſt Quantity without the loſs of their Malleability. A very ſmall Portion of Platina ſcarce injures the Colour of Copper and Gold: A larger renders both pale. A far leſs Quantity has this Effect on Copper than on Gold. It debaſes and darkens in Proportion to its Quantity, the Colour of the white Metals; that of Silver much the leaſt, and of Lead the moſt. It in good Meaſure preſerves Iron and Copper from tarniſhing; ſcarce alters Gold or Silver in this Reſpect; makes Tin tarniſh ſoon, and lead exceeding quickly.

P. 7. Of all the Subſtances concurring to form the terreſtrial Globe, *Iron* ſeems to have the greateſt Share; as it not only abounds in moſt Kinds of Stone, but enters greatly into the Compoſition of Clay: This may be judged from the Similitude of Colour between Clay and dry Iron-Ore, from the eaſy Vitrification of Clay, from the Reſemblance of vitrified Clay to Clinkers of Iron, from its deep red Colour after Calcination, and laſtly, from its yielding pure Iron, by being burnt with Oil.

A Friend of mine ſhewed me an odd Experiment. In a Glaſs placed over a moderate Fire, there was a continual budding of *Silver*, in the Form of a Branch. When this was clipped off with Sciſſars, and a little crude Mercury added, in a ſmall Time there aroſe another Branch of true Silver, which had ſucked in and converted into Metallic Sprigs, a conſiderable Portion of the Quickſilver. The increment of new Silver Branches ceaſed not, as long as the Fire was continued and freſh Mercury ſupplied, for the due Nutriment of this mineral Vegetation. The Ingredients were only Aqua-fortis, Quickſilver, and a ſmall Quantity of Silver, far leſs than you may reap in a ſmall Time from theſe Silver Springs. Yet far more Expence is blown away in Smoke, than can be recovered from this ſilver Harveſt.

Not much unlike this was an Experiment made by a Gentleman, who kept in a Cabinet ſome Pieces of *Fire-ſtone* from a Coal-pit, and ſome large Pieces of crude *Allum-ſtone*, ſuch as it was taken out of the Rock. After a Time both theſe had ſhot out Tufts of long and ſlender Fibres; ſome of which were Half an Inch long, bended and curled like Hairs. And as often as theſe Tufts were wiped off, they ſprouted out again.

But both of theſe fall ſhort of what is related by a curious Naturaliſt. "Having extracted the Salts out of a Quantity of *Fern aſhes* after the common Method, moſt of the Water being evaporated, I had ſeveral Pounds of Salt, moſt of which being dried, I expoſed the Reſt to the Air. Having put it into a large Glaſs, I forgot it for five or ſix Weeks: Looking after it then, I was ſaluted with a pleaſing Spectacle. The Lixivium had depoſited a large Portion of Salt, out of which ſprung at a ſmall Diſtance from each other, about forty Branches, which exactly reſembled Fern, putting out many Leaves on each Side from one Stem. They were of different Sizes, but the Figures of all were preciſely the ſame. And theſe artificial Vegetables, taking care not to ſhake them, I preſerved for many Weeks."

And yet the following Account is ſtranger ſtill. "I mixt equal Parts of *Sal Ammoniac* and *Pot aſhes*, which were put into a tall Glaſs Body, till plenty of volatile Salts ſublimed. I expected no unuſual Appearance from this, having often repeated the Operation. Being called out juſt as the Salt began to appear, how was I amazed at my return, to ſee in the Glaſs-head a Foreſt in perſpective, ſo delineated, as ſcarce to be equalled by the greateſt Maſters. They were a Repreſentation of Firs, Pines, and another Sort of Tree which I had never ſeen. But of this delightful Spectacle I was ſoon deprived, by the Sublimation of more Salts.

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" The next Day I related this to Sir *Robert Murray*. He told me, one *Davison*, an experienced Chymist at *Paris*, had frequently shewed him in a Glass a great Company of Firs and Pines, full as lively as any can be painted. But in a little Time they disappeared. He produced them again at Pleasure. But herein his Operation differed from mine: The Substance out of which he raised those Shapes, was of a more fixt Nature; that which afforded mine, was volatile to the highest Degree. Again, He could constantly and regularly produce those beautiful Representations: Whereas mine unexpectedly appeared; nor have I any Hope of seeing them again.

Sal Ammoniac is made of the Soot arising from the Dung of four-footed Animals, as Sheep, Oxen and Camels, so long as they feed only on green Vegetables. This Dung is collected in the four first Months of the Year, when all these feed on fresh Spring Grass. This in *Egypt* is a Kind of Trefoil or Clover. But when the Cattle are fed on Hay, and the Camels on bruised Date-Kernels, their Excrements are not fit for this Purpose.

Vol. II. P. 10. *Soowar* is a large Village in *Hungary*, peopled with Miners, Wood-cutters and Officers of Excise. Near this are large Salt-Works. In the Borders of *Transylvania*, there are Mountains of Salt, sufficient to furnish the whole World. When cut, it grows again in a short Time. It is black at first, but when pounded, extremely white. In most Stables they keep large Pieces of it, which the Cattle lick at Pleasure. There is in this Mine a Chappel, with an Altar, a Pulpit, a Sacristy, Chairs and Forms, all cut out of the solid Rock. In this they have Service once a Year, the Week after Epiphany. But what is most curious is, the Flowers of Salt. They grow out of the Rock like the Beard of a Goat, but much finer and whiter. They are extremely beautiful, and are the purest, the whitest, and the keenest Salt in the World.

Mines in General are Cavities, within the Earth, containing Subſtances of various Kinds. Theſe the Miners term *Loads*: If *Metallic*, they are ſaid to be *alive*; if not, to be *dead Loads*. In *Cornwall* and *Devonſhire* the Loads always run from Eaſt to Weſt. Mines ſeem to be, or to have been the Channels of Waters within the Earth, and have Branches opening into them in all Directions. Moſt Mines have Streams running through them; where they have not, probably the Water has changed its Courſe. The Springs in theſe Parts are always hard, abounding either with ſtony or ſulphureo-ſaline Particles. Theſe Particles are either of a vitriolic or an arſenical Nature. The firſt concretes into white Cubes, reſembling Silver, the ſecond into yellow ones reſembling Gold. Both theſe are by the Miners termed *Mundic*.

Mundic is variouſly coloured on the outſide with blue, green, purple, Gold, Silver, Braſs, and Copper-colours. But within it is either of the Colour of Silver: of Braſs or Gold Colour or brown. The other Colours are no more than a thin Film or Sediment, which Water variouſly impregnated, depoſites upon the Surface.

There are few Copper Loads, if any, but have this Semi-metal (which is a Kind of wild Mock-copper) attending upon them. Therefore, in ſearching for Copper, it is reckoned a great Encouragement to meet with Mundic. The Mundic does not intimately incorporate itſelf, with the Ore of Copper; for Copper in its mineral State being uſually of a cloſe Conſiſtence, repels the Mundic, which is therefore eaſily ſeparated from the Ore.

Corniſh Waters are infected by Mundic, more or leſs, according to the Quantity which they paſs through, and the Diſpoſition of the Mundic, either to retain or to communicate the noxious Particles of which it conſiſts. Arſenick, Sulphur, Vitriol, and Mercury are the Conſtituents of Mundic, yet,

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theſe ſo pernicious Ingredients are ſo bridled and detained by their mutual Action and Re-action, and by mixing with other Minerals, that the Water is not poiſonous, (generally ſpeaking) even in the Mine where it proceeds directly from the Mundic.

Mundic reſembles Plants, Animals, Moldings, Carvings, and ſundry more Varieties, too numerous to inſert. Shall we attribute this to a plaſtic Power ſuperintending the Congreſs of Foſſils, and ſporting itſelf with natural or preter-natural Repreſentations? Or ſhall we rather ſay, that the great Power which contrived and made all Things, needing no Delegate, artfully throws the flexile liquid Materials of the Foſſil Kingdom into various Figures, to draw the Attention of Mankind to his Works, and thence lead them, to the acknowledgment, and Adoration of an intelligent Being, inexhauſtibly wiſe, good, and glorious? Doubtleſs theſe are the Works of that ſame Lover of Shape, Colour, and Uniformity that paints the Peacock's Train, that veins the Onyx, that ſtreaks the Zebra: It is the ſame Hand whoſe Traces we may diſcover even among the meaneſt and moſt obſcure Foſſils. God loves Symmetry, Graceſulneſs, Elegance, and Variety, and diſtributes them for his Complacency as well as Glory, limits them not to Plants, and Animals, and open Day-light, but like a great Maſter, habitually imparts them to all his Works, tho' in the deepeſt Ocean, and in the moſt ſecret Parts of the Earth.

Although *Fiſſures* are the natural Reſult of a moiſtened and mixed Congeries of Matter, paſſing by Approximation of Parts into a State of Solidity, we are by no Means to conclude them uſeleſs, or the Works of Chance. No, the great Architect, who contrived the whole, determined the ſeveral Parts of his Scheme ſo to operate, as that one uſeful Effect ſhould become the beneficial Cauſe of another. Hence it happens that Matter could not contract itſelf into ſolid large Maſſes, without leaving Fiſſures between them; and yet the Fiſſures are as neceſſary

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and useful as the Strata through which they pass.—These are the Drains which carry off the redundant Moisture from the Earth, which but for them, would be too full of Fens and Bogs for Animals to live, or Plants to thrive on.——Through these Fissures the Rain which sinks beneath the Channels of Rivers, not having the Advantage of that Conveyance above Ground, returns into the Sea, bringing the Salts and mineral Juices of the Earth into the Ocean, enabling it to supply the Firmament with proper and sufficient Moisture, and preserving that vast Body the Sea, wholesome, fit for Fish to live in, and Sailors to navigate.

In these Fissures the several Ingredients which form the richest Loads, by the continual Passing of Waters, and the Menstrua of Metals, are educed out of the adjacent Strata, collected, and conveniently lodged in a narrow Channel, much to the Advantage of those who search for and pursue them, for if Minerals were more dispersed, and scattered thinly in the Body of the Strata, the trouble of finding and getting at Metals (those necessary Instruments of Art and Commerce, and the Ornaments of Life) would be endless, and the Expence of procuring, would exceed the Value of the Acquisition:—Without these, neither Metals, Marbles, Salts, Earths, nor Stones, could be so easily, or in such Plenty, provided as is necessary for the Use of Man.

Earth is certainly the general Food and *Stamen* of all Bodies, yet we know of itself it can do nothing; it must be connected by a Cement, or it cannot form Stone; it must be softened and attenuated by Moisture and Warmth, or it cannot enter into the alimentary Vessels of Plants and Animals. The Parts of Earth which constitute the Solids of any Plants are exceeding fine, and the common Mass in which we plant Trees, is for the most Part Gravel, Clay, and Sand, which promote Vegetation, but are too gross to enter into, and become the constituent Parts of them. Water must therefore be considered as the Vehicle

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of more ſolid Nouriſhment, and the Parent of the Fluids: The Earths, Salts, and Oils, are the great Inſtruments of the Increaſe of Solids. To trace Fertility a little farther: When the Earth is ſoftened and diluted, heat rarefies and evaporates the Mixture, the Salts contained and diſſolved, are always active and promote Motion; the Elaſticity of the Air quickens and continues it; the Oils ſupple the Paſſages, of which ſome are fitted to ſecrete, arreſt, and depoſit the nutritious Particles as they paſs; ſome adapted (by the ſame ſecret Hand, which conducts every Part of the Operation) to throw off the redundant Moiſture by Perſpiration: the earthly Mixture compoſes the hard and ſolid Parts, and the genial, little Atmoſphere of every Plant gives Spirit, Colour, Odour, and Taſte. Herbs and Fruits being thus fed and matured, make the Earth they contain better prepared to paſs into the ſtill more curious and highly organized Parts of Animals. It is eaſy to ſee that this is rather a Detail of the ſeveral Materials and well-known Inſtruments, conducing to Fertility, than the Cauſe. Fertility is owing to the Concert, Fitneſs and Agreement of all theſe, with ſome volatile active Principle, of which we know nothing at all. But whence that Agreement reſults, how the Materials ferment, replace, connect, and invigorate one another, how the Veſſels chuſe and refuſe, (if I may ſo ſay) in order to produce the Fertility deſired, is known only to the infinitely wiſe Diſpoſer of all Things, ever attentive to the Nurture and Support of what he has created. But to whatever Cauſe the Fertility of Earth is to be aſſigned, Earth it muſt be owned is a moſt fruitful, univerſal Element. Animals, Plants, Metals, and Stones, ariſe out of it, and return to it again; there, as it were, to receive a new Exiſtence, and form new Combinations, the Ruins and Diſſolutions of one Sort affording more and more Materials for the Production of others.

In Stones and Metals, we admire the Continuity, Hardneſs and Luſtre of Earth; in Plants the Rari-

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ty, Softneſs, Colours, and Odour; in Animals the Fleſh, the Bone, and infinite Number of Fluids, in which this ſupple Element can take Place: But the greateſt Wonder is, that Earth is capable of being ſubtilized to ſuch an exquiſite Degree, as by uniting and communicating with Spirit, to perform all animal Functions given it in change by the Soul. This is the higheſt and utmoſt Refinement; which in this State of Being, Earth is capable of; but that it may be ſtill farther refined, in order to be qualified for a future, incorruptible, and more glorious State, is one of the greateſt Truths which we owe to Revelation.

Wherever the Miners meet with Water, they do not want Air. When they find no Water, they are deſtitute of Air, ſufficient to breathe in: But when they drive up an Adit, to draw away a great Quantity of Water, from a deep Mine; as ſoon as it is brought ſo near that the ſtanding Water begins to run away, they muſt ſecure themſelves as well as they can. For the Air included in the Water, breaks forth with ſuch Violence as to carry all before it, looſening the very Rocks.

V. II. P. 11. The vegetable Mould or Surface of the Earth, is made up of Sands, Clays, Marls, Loams, rotten Stalks and Leaves of Herbs, ſerving both as a proper Bed and Covering, and as a Receptacle and Conductor of Moiſture to the Roots of Trees and Plants. Sands and Pebbles may be conſidered as Drains, for carrying off the redundant Moiſture, to Places where it may be ready to ſupply the Place of what is continually riſing in Exhalations. But leſt the Strata of Sand ſhould be too thick, ſmall ones of Clay are often placed between, to prevent the Moiſture from departing too far, from where it may be of Uſe. And leſt theſe thin Partitions of Clay, ſhould let the Particles of Sand inſinuate into them, and thereby let the Moiſture paſs through

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thin Cruſts of a ferrugineous Subſtance, are placed above and beneath each of theſe clayey Strata; by which Means the Clay and Sand are effectually kept aſunder.

Suppoſing ſome *Stones* are organized Vegetables, and are produced from Seed, yet moſt Sorts of Stones, ſeem to be *unorganized Vegetables*. Other Vegetables grow by a *Solution* of Salts, *attracted* into their Veſſels. Moſt Stones grow by an *Accretion* of Salts, which often ſhoot into regular Figures. This appears by the Formation of Chryſtals upon the Alps. And that Stones are formed by the ſimple Accretion of Salts, appears from the Tartar on the Inſide of a Claret Veſſel, and ſtill more clearly, from the Formation of a Stone in the Human Body. The Air is in many Places impregnated with ſuch Salts or ſtony Particles. And theſe aſcending from the Cavities of the Earth, may petrify Wood. In this Caſe the petrifying Quality is not originally, either in the Earth or the Water. But in the riſing Sreams impregnated with with ſaline or ſtony Particles.

P. 12. With regard to *Lough Neagh*, the petrifying Quality, ſeems to be not only in the Water, but in the adjacent Soil. Many Pieces of petrified Wood are thrown up daily, in breaking up new Ground, which that Water never touched. They are often found two Miles from the Lough, in great Numbers, and deep in the Ground, altogether like the *Lough Neagh* Stones. That theſe were once Wood is certain. They burn clear, and may be cut with a Knife, tho' not ſo eaſily as other Wood.

P. 12. *Petrifying Springs* are impregnated, ſome with Particles of Stone, others with ferrugineous and vitriolic Particles. When the ſtony ones drop on Wood or other Vegetables, they act moſtly by Incruſtation. They coagulate upon it, and by Degrees cover it with a ſtony Coat. If this be broke before the Wood is rotted away, you find it in the Heart of the Stone.

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If the Wood is rotted, you will find a Cavity in the Stone; but this alſo in Time will be filled up with ſtony Particles. Sometimes indeed theſe Waters permeate the Pores of the Wood, fill them up with their ſtony Particles, and by their burning Quality proceeding from Lime-ſtone, deſtroy the Wood, and aſſume the Shape of the Plant.

Metallic Particles moſtly act, by inſinuating into the Pores of Wood or other Vegetables, without increaſing their Bulk, or altering their Texture, tho' it greatly increaſe their Weight. Such is the petrified Wood in and near *Lough Neagh*. It does not ſhew any outward Addition of Matter, and preſerves the Grain of Wood. All the Alteration is in the Weight and Cloſeneſs, by the mineral Particles pervading and filling the Pores.

That there are Mines near the Lough, we may gather from the great Quantity of Iron-ſtones found on its Shores, and from the yellowiſh Ochre and Clay in many Places near it. Now whatever Springs run through theſe, will be impregnated with metallic Particles. And if they riſe in the Middle of a River or Lake, and in their Courſe meet with Wood or other Vegetables, theſe Particles will inſinuate and lodge themſelves in their Pores, and by Degrees turn them into Stone.

That ſuch Springs are under this Lake, appears from hence, that in the great Froſt, 1740. though the Lake was froze over, ſo as to bear Men on Horſeback, yet ſeveral circular Spots remained unfrozen. Hence it appears, that this petrific Quality is not in all Parts of the Lake, but here and there only. As to the Trees which are found petrified and buried at a ſmall Diſtance from the Lake, probably it was broader once than it is now, ſo that what was then under Water, is now dry Land. If ſo, theſe Trees might have been petrified, in the Part which was then overflowed, though it is now dry.

But what ſhall we judge of thoſe *petrified Shells*, which have been dug up in many Places? Some indeed

deed are not petrified. Near *Reading*, in *Berkshire*, for ſucceeding Generations, a continued Body of Oyſter-ſhells has been found through the Circumference of five or ſix Acres of Ground. Beneath is a hard, rocky Chalk, on which the Shells lie in a Bed of green Sand, about two Feet thick. Above are various Strata for at leaſt eighteen Feet. The Shells are ſo brittle, that in digging, one of the Valves will frequently drop from its Fellow. But ſeveral are dug out entire; nay ſome double Oyſters, with all their Valves united.

In a Quarry at the Eaſt End of *Broughton* in *Lincolnſhire*, there is a Clay under the Stone, in which are numberleſs Fragments of the Shells of Shell-fiſh of various Kinds. And there are ſometimes found whole Shell-fiſh, with their Shells on, in their natural Colours, only bruiſed and broken, and ſome ſqueezed flat, by the Weight of Earth, which was caſt upon them at the Deluge.

There is another Quarry, South of the Town, of a blue, hard Stone, (probably a pure Clay in ſome antediluvian Lake) in which are numberleſs Shell-fiſh of various Sorts, but ſo united to the Stone, that it is hard to get them out whole. They are all in the Surface of the Quarry, within a Foot of the Top. On the Surface, there are many Shell-fiſh half in the Stone, half out. That Part which is within the Quarry is whole, but is a hard Stone. That which is without, is all conſumed, but a little of the Edges, which are plain Shell.

Some of the Shell-fiſh in this Quarry are half open, and filled with the Matter of the Bed on which they lie. Some of them are broken, others bruiſed: The Edges of one Fiſh is ſometimes thruſt into the Sides of another. One Shell of ſome is thruſt half Way over the other, and ſo they are petrified together.

Among theſe there are ſeveral great Horſe-muſcles, ſuch as breed in Rivers and Ponds. And in the Fields and Stones near *Bromby* and *Frodingham* is found a Sort of Fiſh bending like a Ram's Horn, and creaſed

like one on the outside. The Bed wherein, it seems this Fish bred, is about a Foot thick: In which are Millions of the Fish, sticking half within the Stone, half without. And this Shell being extremely durable, even the Part sticking out, is not consumed, as it usually is in others, but remains whole and entire.

It is certain, that Water impregnated with metallic Particles, when falling on Wood or other Vegetables, will coagulate upon it, as was observed above, and cover it with a metallic Coat. It is also certain, that the Vegetables included therein, are gradually destroyed, till the same Matter which first formed the Crust, takes up the whole Space which they occupied before. But it is not only Wood and other Vegetables, which are capable of being thus acted upon, first crusted over and then destroyed. A Shovel of *Iron* some Years since lying in the Water, in the County of *Wicklow* in *Ireland*, was observed to be incrusted with Copper, which gave Occasion to an important Discovery: A Gentleman, who visited the Place on Purpose, to examine the Truth of what was commonly reported, observes, "I saw the Iron Bars impregnating with Copper. I was an Eye-witness to the Change in all its Progress; and so were thousands besides. I saw the Masons laying a Chain of new Stone Troughs, for the Copper Water to run through I saw the Men also laying the Iron Bars, on Wooden Rrafters in those Troughs. I saw the Iron Bars lifted up out of some Troughs, where they had laid from one to eight Months: And saw them incrusted over with Copper, and corroded more or less, (some of them to very thin Plates) according to the Time they had lain in the Water. I saw some of the Troughs emptied, wherein the Bars were wholly dissolved: And the Labourers were throwing up with shovels the Copper, which lay on the Stones in the Bottom of them. It was like Mud, as it lay wet in the Heap, but became Dust as it dried. I also saw

ſaw ſeveral Pieces of Copper, which had been made out of their Copper-Mud.

" This Water is ſuppoſed to flow over a Vein of Copper, in the neighbouring Mountain. It is of a ſharp, acid Taſte, and of a blue Colour. It is received and collected in thoſe Troughs, wherein the Iron Bars are placed; which after lying in the Water, often not above three Months, are entirely conſumed: Then at the Bottom of the Troughs, a Quantity of Copper is found, in the Form of coarſe Sand. And it is remarkable, that there is a greater Quantity of this Copper, than there was of Iron.

" But by what Principle is this Effect produced?" In order to diſcover this, I made the following Experiments.

1. Some ſmall Iron Nails put into the Water, were in four Minutes covered with a Subſtance of a Copper Colour. And during that Time the Nails gained four Grains in Weight. The Water had the very ſame Effect on Silver and Tin; but not on Gold. Hence we obſerve, the Colour and Increaſe of Weight were owing to the Adheſion of the Particles of the Matter diſſolved in the Water by an Acid, which could not penetrate Gold.

2. " In order to determine the Quantity and Quality of this Matter, I put two Drams of ſmall Iron Nails into three Ounces of the Water. After they had lain therein four and twenty Hours, I found the Surface of the Water covered with a thick Scum, exactly like that which uſually covers a Chalybeate Spaw. I obſerved likewiſe, it had loſt the blue Colour, and ſharp, vitriolic Taſte. It was quite tranſparent, and at the Bottom lay a brown Powder, which when dried, weighed fourteen Grains. This Powder, melted without any Flux, produced twelve Grains of pure Copper. The Nails alſo (which had loſt eight Grains) were in ſeveral Places covered with a ſolid Lamina of pure Copper. The Water being

afterward filtrated and evaporated, afforded a pure green Vitriol.

3. "From the Spring Water treated in the same Manner, I obtained a blue Vitriol, the Basis of which is Copper. From all these Experiments it appears, That a Mineral Acid is the active Principle in the Water, which being diffused through the Copper Ore, unites itself with that Metal, and forms a Vitriol. This is dissolved by the Water and remains suspended therein, till it meets with the Iron in the Trough, and by which it is more strongly attracted, than by the Copper. Therefore it quits the Copper, corrodes the Iron and changes it into a Vitriol, which is again dissolved and carried off in the Stream. Meantime the Copper, deserted by its Acid, falls by its specific Gravity to the Bottom of the Trough.

It appears then upon the whole, That this admirable Process of Nature, whereby one Metal seems to be turned into another, is no more than a simple Precipitation of the Copper, by Means of Iron.

V. II. P. 13. Dr. *Boerhaave* supposes Chrystal to be the Basis of all precious Stones. But Dr. *Barlase* ranges Chrystal itself and all Gems, under the Head of *Spar*, which says he, are only finer and purer Substances of the Spar-kind.

All Spar has been in a state of Fluidity. In some are found Straws and other light Bodies. Yet Time adds nothing to their Firmness; but they are as hard when first consolidated, as ever they will be. But why do we find no Spars in their fluid State? Because while the Matter of them remains incorporated with the Water, it is not to be distinguished from it, and as soon as it is deserted by the Water wherein it swims, it commences Stone. It is by Water that the sparry Atoms are washed out of their Repositories, and collected into a transparent or opake Juice. As soon as the redundant Water is drained off or evaporated, the stony Parts accede to a closer Union. They are assisted therein, either by Cold, compressing the Parts,

or

or by ſudden evaporating Heat. Thus the Stone is formed, ſo much Water reſting in the Pores, as is neceſſary to fix it into a Conſiſtency. Hence may ariſe ſome Queries.

1. Whether Spar is not the univerſal Gluten of Stones, diſtinguiſhed from each other, by various Mixtures of earthy, mineral, or metallic Particles, but all united by the ſparry Liquor? Perhaps there is ſcarce any Sand, Stone, or Ore, which either by the naked Eye or Glaſſes, may not be diſcerned to have a Portion of Spar, clearer or opake, in its Compoſition.

2. Whether theſe and all other Sort of Stones are not continually forming in the Earth?

3. Whether there are not Quarries of Stone, which when left unwrought for a conſiderable Time, yield a freſh Supply of Stone, in thoſe Channels, which had been before thoroughly cleared?

One Sort of precious Stones, as it has been long accounted, the *blue Turquois*, is indeed no other than foſſil Bone, or Ivory ſaturated with Copper diſſolved in an alkaine Menſtrum; the *green Turquois* is the ſame Subſtance, intimately penetrated by a cupreous Matter diſſolved in an Acid Menſtrum.

P. 16. I cut a Piece, ſays Dr. *Knight*, of a *Loadſtone*, into an oblong Square. In this I placed the magnetic Virtue in ſuch a Manner, that the two oppoſite Ends were both South Poles, and the Middle, quite round, was a North Pole. I made the two oppoſite Ends of another Stone, North Poles, the oppoſite Sides South Poles. An irregular Stone had two broad, flat Surfaces oppoſite to each other. I made half of each of theſe Surfaces a North Pole, and the other half a South Pole. So that the North Pole of one Surface was oppoſite to the South Pole of the other. I took a Stone that had a Grain very apparent, running the Lengthways of it. At one End of it I placed a North Pole ſurrounded by a South: At the other a South ſurrounded by a North Pole:

So that the Edges of each Surface had a different Pole from that which occupied the Middle.

Many Varieties of this Kind might eaſily be deviſed. But theſe Examples are ſufficient to ſhew, how manageable the magnetic Virtue is, with Reſpect to its Direction; and how defective all the Hypotheſes are, which are brought to account for the Phænomena of the Loadſtone.

An odd Diſcovery has been lately made, that not only Iron, as has been generally thought, but *Braſs* too, by being hammered and properly touched, will conſtruct a true magnetic Virtue. And perhaps it will be hereafter diſcovered, that other Metals may receive the ſame.

P. 16. Mr. *Howard* ſailed to *Barbadoes* in Company with another Ship, commanded by one *Groſton*. Suddenly a terrible Clap of Thunder broke *Groſton's* Fore-maſt, and did ſome Damage to his Rigging. When the Noiſe was paſt, he was ſurprized to ſee Mr. *Groſton's* Ship ſteering directly homeward. He tacked and ſtood after him, and found that Mr. *Groſton* did indeed ſteer by the Right Point of his Compaſs, but that the Card was turned round, the North and South Point having changed Places. If he ſet it right with his Finger, as ſoon as it was at Liberty, it returned to its former Poſture. And on Examination, he found every Compaſs in the Ship had undergone the ſame Change.

Amber is a Kind of foſſil Pitch, the Veins of which run chiefly at the Bottom of the Sea. It is hardened in tract of Time, and caſt on Shore by the Motion of the Sea. It was long thought, that none could be found but in *Pruſſia*: But it has ſince been found in *Sweden*, on the Shores of the Iſle of *Ecorkoo*, though ſituate in a Lake, whoſe Water is ſweet. Nay it is digged out of the Earth, at a conſiderable Diſtance from the Sea, and not only in ſandy, but in firm Ground.

P. 18. Signior *Marco Antonio Caſtagna*, Superintendant on ſome Mines in *Italy*, has found in one of them a great Quantity of *Linum Aſbeſtum*. He can prepare it, ſo as to make it like either a very white Skin, or a very white Paper. Both of theſe reſiſt the moſt violent Fire. The Skin was covered with kindled Coals for ſome Time: Being taken out it was ſoon as white as before: Neither had it loſt any Thing of its Weight. The Paper alſo was tried in the Fire, and without any Detriment. Neither could any Change be perceived, either with Regard to its Whiteneſs, Fineneſs, or Softneſs.

PART

Part the Fourth.

Of Earth, Water, Fire, Air and Meteors.

CHAP. I.

Of Earth and Water.

P. 22. IT is probable, *Sand* was once the exterior Cover of the whole Earth. All our Northern

Northern Mountains are, more or leſs, covered with it at this Day. And the higher the Mountain, the coarſes the Sand. The Rivers riſing in the Mountains, ſtill daily bring it down in large Quantities. And that it has been ſo in all Ages, ſince the firſt Rains fell on the Earth, ſeems highly probable, in that the Mouths of Rivers, and Entrances of Harbours are uſually barred with it. And if you pierce deep into the low Ground near Rivers, you find this Mountain-Sand in great Quantities: It was the more fit to be the general Cover of the Earth, becauſe of its great Hardneſs, and conſequently durableneſs. Mountain Sand above all other, not being made (as much Sand is) by Attrition, ſteddily keeps its original Figures and Magnitude.

All *Sands* are either natural or fictitious. Natural Sands are thoſe which have been in the ſame, or nearly the ſame State from the Creation, diffuſed through all Parts of the Earth. Sand viewed in a Microſcope is no more than a Parcel of little Stones; doubtleſs therefore they muſt have begun to exiſt, and been formed by the ſame Laws that Stones were formed by. Now, Stones were formed firſt into hard and ſolid Maſſes, in Proportion to the Quantity of ſimilar Materials, and proper Cement. Where there was a great Quantity of lapideous Particles, and few heterogeneous Mixtures, there Strata, Rocks, and large Stones were formed. But where the lapideous Particles were ſcattered and diſunited by the Intervention of other Bodies, there ſmall Rubble, Stones, Gravel, Grits, and the ſmalleſt and moſt numerous of all Stones, Sand, coaleſced into minute Glebes. This probably was the Proceſs in every Part of the Earth; ſo that Sand is one of the primæval Bodies, concreted at the ſame Time with Stones, upon the higheſt Mountains, as well as in the Valleys; and at the Bottom of the Sea, as well as upon dry Land.

Beſides this natural Sand, there is alſo a Fictitious one, which owes its Origin to the fretting of River or Sea-water. For Water always in Motion, prays upon

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the Stones, and grinds them by Degrees into that ſtony Powder which we call Sand: Hence it is that the Sand of a particular Stone, Cove or Bay, has generally the ſame Colour, and in a Microſcope the ſame Structure, as the Rocks, and Stones of the adjacent Cliff, and the Strata under the Sea, upon which the Waves are perpetually working, and driving into the Shore what they daſh off from thoſe Strata.

We have heard of large *Bodies of Sand* moving together in the Deſarts of *Arabia*. But has any Thing of the Kind been known in *England*? There has, and that very lately. It is not a Century, ſays Mr. *Wright*, ſince our Sands, near *Dewnham* in *Suffolk*, firſt broke Priſon. In a Warren near *Lakenheath*, an impetuous South Weſt Wind having broken the Sand of ſome Sand-hills, the Sand blew upon the adjacent Grounds, which being much of the ſame Nature, the thin Cruſt of barren Earth was ſoon rotted and diſſolved by this Sand lying upon it, and thereby fitted to bear it Company in its ſtrange Progreſs. At its firſt Erruption, the whole Magazine of Sand could not cover above eight or ten Acres of Land. But it increaſed into a Thouſand Acres, before the Sand had travelled four Miles. Above thirty Years ſince it reached the Bounds of this Town, where for ten or twelve Years it did no inconſiderable Miſchief; becauſe its Courſe was then down the Hill, which ſheltered it from the Wind that gave it Motion. But the Valley once paſt, it went above a Mile (up hill) in two Months Time. It over-run two Hundred Acres of good Corn that-ſame Year. 'Tis now got into the Body of this little Town, where it has buried ſeveral Houſes. And the Remainder have been preſerved at more Expence than they were worth. At the other End of the Town divers Houſes are Lutied, and our Paſtures and Meadows deſtroyed. A Branch of the River *Ouſe*, upon which we border for three Miles together, is more than half filled up with Sand. And had not this interpoſed to ſtop its Paſſage

into

into *Norfolk*, doubtleſs a conſiderable Part of that County, had e'er now been left a deſolate Trophy of this conquering Enemy.

As Air is neceſſary every Minute to give Spring and Motion to the Solids, as well as Fluids of all Bodies, ſo is *Water* to renew the Liquids which are perpetually ſhifting their Place, and without conſtant Supplies, would leave the Solids they depart from mere Duſt. Water is therefore diſpers'd throughout the Univerſe, in order to maintain the Coherence of all Bodies, ſupply Waſte, and prevent the Aſcendency of Fire, which without Water to oppoſe and qualify it, would parch and reduce all Bodies to a Calx, to Aſhes or Cinders.

Particles of Water are generally allowed to be round. This Figure indeed is not to be demonſtrated, but is inferred from its Fluidity. Allowing then the Particles of it to be round, Fluidity muſt be an eſſential Property of all Quantities and Aſſemblages of it. For take any Maſs of round Bodies, (Bullets for Inſtance, Pebbles, or the like) they will not cohere or reſt by one another without Force, but will flow on every Side, till they meet with ſuch Reſiſtance from external Bodies, or their internal Gravitation, as ſhall prevent farther Motion.

The Particles of Water are unalterable, for paſſing into ſo many Bodies, and through ſuch alternate Extremes of Heat and Cold, if they had not preſerved their eſſential Properties conſtantly, Moiſture ſince the beginning of the World, muſt have very ſenſibly diminiſhed. But ſeeing that no ſuch Deficiency appears, and that Springs, Rains, and Rivers, are as abundant now as they anciently were; as by the riſing of the *Nile* for many Ages, among other Reaſons, may appear) we are to conclude, though Waters may be tranſplanted, they can neither be tranſmuted nor deſtroyed. And wherever removed, they will make their Appearance again when at Liberty, in the ſame liquid State as they were before.

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The Particles of Water are exceedingly ſmall, for they may be ſo divided from each other, that one ſquare Inch of common Water ſhall when rariſied, fill a Space of 14000 ſquare Inches. And it is computed that at leaſt 13000 Particles of Water may be held on the Point of a Needle. By this it appears, that what we call Water is an Aſſemblage of ſmall tranſparent Globules, which are compoſed again of an infinite Number of ſmaller Particles or Atoms of this elementary Liquor.

P. 24. The Rivers of *Indus* and *Ganges*, before they enter the Ocean, contain between them a large Peninſula, divided in the Middle by a Ridge of high Hills, which runs from Eaſt to Weſt, quite to Cape *Cormorin*. On the one Side is *Malabar*, on the other *Coromondel*. On the *Malabar* Side it is Summer from September till April; a clear Sky and ſcarce any Rain. This is Winter on the *Coromondel* Side, every Day and Night yielding Abundance of Rain. So that as you croſs the Hills to St. *Thomas*, in little more than twenty Leagues, you aſcend the Hill with fair Summer Weather, and deſcend with a ſtormy Winter. There is a like Ridge of Hills in *Jamaica* running from Eaſt to Weſt, thro' the Midſt of the Iſland. On the Southſide of theſe there is Summer from November to April, on the Northſide, Winter, and ſo vice verſa.

Hence it appears, that not the leſſening the Gravity of the Atmoſphere only, is needful to produce Rain, but likewiſe either a Change of Winds, or a Ridge of Hills, to drive the Particles of the Vapours together. And hence it is, that while the Wind blows from North Eaſt in *Coromondel* and on the North-ſide of the Mountains in *Jamaica*, there are continual Rains, and conſtant fair Weather on the South-ſide of the Mountains and in *Malabar*. Whereas while it blows from the South Weſt, there are conſtant Rains on the Southſide of the *Jamaica* Mountains and in *Malabar*; but conſtant fair Weather

ther on the North-ſide of thoſe Mountains and in *Coromandel*.

This alſo may account for the Singularity of Seaſons in *Peru*, which runs Southward from the Line above a Thouſand Leagues. It is divided into three Parts, long and narrow: The *Lano's* or Plains, which run along the Sea-coaſts, the *Sierra's*, which are Hills with Vallies intermixt, and the *Andes*, which are ſteep and craggy Mountains. The Lano's are, ſome ten Leagues in Breadth, ſome leſs, and ſome more. The Sierra is 20 Leagues in Breadth, and the Andes the ſame. It is remarkable, 1. that in the Lanos, the South and South Weſt Winds continually blow. 2. That they never have any Thunder, Hail, Snow or Rain, only ſometimes a ſmall Dew. 3. On the Andes it rains almoſt continually. 4. In the Sierra, which lies between, it rains from September to April, and is clear from April to September. The Reaſon is plain; the conſtant Wind blowing over the Lanos, finds nothing to ſtop it and drive the Vapours into Rain. But the Andes continually intercept theſe Vapours, and ſo occaſion continual Rain. The Sierras being lower, intercept the Vapours, only from September to April, becauſe then the Sun being nearer, the Atmoſphere is lighter, and conſequently the Vapours ſink lower.

P. 25. The Height of *Swowden* Hill, ſuppoſed the higheſt in *Great Britain*, is 1240 Yards. The Height of ſeveral Mountains in *France* is as follows:

	Feet
Bwgarach in *Languedoc*	3888
Le Puy de domme in *Auvergne*	4860
Le Courland	5088
Le Coote	5106
Le Cantal	5904
Le Mont d'or	6180
Le Mont Ventoux in *Avignon*	6216

The Height of the *Pyrenean* Mountains is,

St. Barthelemi	7110

La Montagne des Mauſſet 7548
Le Conigoc 8630

Probably theſe Mountains may vie in Height with moſt in the known World. Yet above all theſe is the *Stella Piz Hail*, a ſteep Mountain in the *Griſons*, which is 9585 *Paris* Feet above the Level of the Sea; an Height which the Wild-goats themſelves ſcarce venture to aſcend.

But Mr. *Martel* informs us, that the higheſt Point of *Mont-Blanc* is higher even than this: That it is 2076 Toiſes above the Level of the *Rhone*, which added to the Height of this above the Sea, makes 19115 *Paris* Feet, or above two Engliſh Miles, and two Thirds of a Mile. If ſo, this is the higheſt Mountain in *Europe*, and perhaps in all the World.

"But is not the celebrated Mount *Atlas* in *Afric*, the Wonder of all Ages, far higher than this?" One who ſaw it, and travelled all over it, is beſt able to anſwer this Queſtion. He writes thus,

"*Barbary* is bounded on the South by *Biledulgerid*, from which it is divided by *Atlas*, a Chain of Mountains, but not of that extraordinary Height or Bigneſs, which the Antients attributed to it. Thoſe Parts of them, ſays Dr. *Shaw*, which I have ſeen, are rarely, if ever equal to ſome of the Mountains of our own Iſland, and cannot any where ſtand in competition, with either the *Alps* or *Appennines*. *Atlas* is a Number of Hills, uſually 4, 5 or 600 Yards high, with an eaſy Aſcent, and Groves of Fruit and Foreſt-Trees, riſing up, one behind another. Only here and there is ſeen a rocky Precipice, of a ſuperior Eminence.

The Benefit of Mountains in general is not only, that Vapours driven againſt them are condenſed, ſo as to be precipitated through the Chinks of the Rocks, but that afterwards in their Bowels they are preſerv'd, till they form Rivulets and then Rivers. Vapours would fall in Rain or Dew, tho' there were no *Mountains*, but then they would fall equally, over conſiderable Places of the Globe at once, and ſo would

would be ſuck'd deep in the Ground, or make an univerſal Puddle; whereas by Means of Mountains, they are perpetually pouring down in particular Places, and treaſuring up for a conſtant ſupply to the Rivers. Another conſiderable Uſe of them, is the Determination of theſe Rivers: for if there could have been Rivers without Mountains, yet they could only have run in a ſtraight Line, if they had run at all; whereas by theſe Eminences, placed up and down, they make innumerable Turnings and Windings, whereby they enrich, fatten, and water the Soil of ſeveral different Countries in one Courſe, and at laſt diſembogue in ſeveral Mouths into the Sea.

Laſtly, moſt Hills are the Neſts of Metals or Minerals, either of Stone, Iron, Tin, Copper, or ſuch like lower Vegetables. Theſe Metals and Minerals by the Efficacy of ſubterranean Heat, converting the adjacent Earths into their Subſtance, encreaſe and grow as truly as Animals or Vegetables. I juſt mention their Uſe for the Production, Shelter, and Nouriſhment of ſome Sorts of Vegetables and Animals, which could not grow or live ſo well any where elſe. But from the whole, we may ſee of what Advantage theſe unſightly Moles (as ſome thought them) are to the Accommodations and even Neceſſities of Life.

P. 28. The *Nile*, which the Natives call *Abava*, that is the Father of Rivers, riſes firſt in *Sacala*, a Province of the Kingdom of *Goiama*, the moſt fruitful in all *Abyſſinia*. In the Eaſtern Part of this Province, on the Declivity of a Mountain, are two Springs, each about two Feet Diameter, a Stone's-Caſt diſtant from each other, which are the real Source of this celebrated River. Its Waters after the firſt Riſe, run Eaſt about a Muſket-Shot, then turning to the North, continue hid in the Graſs and Weeds, for about a Quarter of a League, and diſcover themſelves for the firſt Time among ſome Rocks, a pleaſ-

ing ſight to thoſe who have read the fabulous Accounts of the Antients. It flows thence with a very ſmall Stream, but ſoon receives ſuch an Increaſe from various Rivulets, that not above three Days Journey from its Source, it is near a Mile broad. After running nine or ten Leagues farther, it enters the Lake of *Dambia*. It croſſes this at one End, with ſuch Rapidity, that the Waters of the Nile may be diſtinguiſhed thro' the whole Paſſage, which is ſix Leagues. Fifteen Miles farther it ruſhes from the Top of an high Rock, and forms one of the moſt beautiful Caſcades in the World. The Fall of this mighty Stream from ſo vaſt a Height; makes a conſiderable Noiſe. Yet the neighbouring Inhabitants are not deaf, but hear juſt as well as others. After this Cataract, the Nile again collects its ſcattered Stream, and flows on thro' various Nations. Hence we may learn, that it is impoſſible to arrive at the Source of the Nile, by tracing its Channel from the Mouth, there being ſo many Cataracts in the Way, which no Veſſel can paſs.

In *Abyſſinia* from June to September, there is no Day without Rain. Now the Nile receives in its Courſe all the Brooks, Rivers and Torrents, which flow from the *Abyſſinian* Mountains. Theſe neceſſarily ſwell it above the Banks, and fill the Plain of *Egypt* with the Inundation. This comes regularly in the Month of July, that is, three Weeks after the Beginning of the Rains in *Ethiopia*.

There is very little Difference between the Bottom of the *Adriatic Sea*, and the Surface of the neighbouring Countries. There are at the Bottom of the Water, Mountains, Plains, Valleys, and Caverns, juſt as upon the Land. The Soil conſiſts of different Strata planted one upon another; and for the moſt Part, correſponds to thoſe of the Rock, Iſlands, and neighbouring Continents. They contain Stones of different Sorts, Minerals, Metals, various petrified

Bodies

Bodies, Pumice-ſtones and Lavas, formed by Vulcanos. *Iſtria*, *Dalmatia*, *Albania*, and other adjacent Countries, as well as the Rocks, the Iſlands, and the Bottom of the *Adriatic* Sea, conſiſt of a Maſs of white Marble, of an uniform Grain, and of almoſt of an equal Hardneſs. This vaſt Bed of Marble in many Places under both the Earth and the Sea, is interrupted by ſeveral other Kinds of Marble, and covered by a great Variety of Bodies. The Variety of theſe Soils under the Sea is remarkable: It is to this are owing the Varieties of Plants and Animals found at the Bottom of the Sea. Some Places are inhabited by a great Number of different Species of Plants and Animals, in others, only ſome particular Species are found, and in others neither Plants nor Animals. Theſe Obſervations not only point out to us the Reſemblance between the Surface of the Earth and the Bottom of the Sea, but likewiſe one Cauſe of the Varieties, which are obſerved in the Diſtribution of the Marine Foſſils found in the Earth.

In that vaſt Maſs of Marble, which is common to the Bottom of the *Adriatic*, and the neighbouring Provinces towards the Eaſt, are a Multitude of Marine Bodies petrified; ſome of which are ſo united to the ſtony Subſtance, that they are ſcarce to be diſtinguiſhed. Likewiſe a Cruſt is diſcovered under the Water in divers Places, and for a great Extent, which is a Compoſition of cruſtaceous and teſtaceous Bodies and Beds of Polypes of different Kinds, confuſedly blended with Earth, Sand, and Gravel.

Theſe different Bodies, which enter into the Compoſition of this Cruſt, are at the Depth of a Foot or more, entirely petrified and reduced into Marble. At leſs than the Depth of a Foot they approach nearer to their natural State. And at the Surface of this Cruſt, they are either dead, tho' extremely well preſerved, or ſtill living.

This demonſtrates that Stones may be formed, from Things petrified, and actually are formed, in

great Quantities under the Water. Cruſtaceous, and teſtaceous Bodies and Polypes, are every where mingled in the utmoſt Confuſion, which ſhews a ſtriking Reſemblance between the Cruſt diſcovered under the Sea, and the marine Bodies petrified in many Parts under the Earth.

The more theſe cruſtaceous and teſtaceous Bodies and Beds of Polypes multiply, the more their Exuviæ, and Skeletons contribute to inlarge this Cruſt. In ſeveral Parts it forms very conſiderable Banks, and of a very great Thickneſs.

It follows that the Bottom of the Sea is riſing conſtantly higher and higher. Divers other Cauſes contribute to this Snow and Rain. Waters bring down from the Mountains, into the Sea, a great Quantity of Earth and Stones. The Waves, beating againſt the Continent and Iſlands, detach many Maſſes, which are ſpread upon the Bottom of the Sea. The Rivers carry the Mud with their Waters into the Sea, at the Bottom of which that Mud depoſits itſelf.

From the riſing of the Bottom of the Sea, that of the Level of the Water naturally follows. So at *Venice*, in *Iſtria*, and in *Dalmatia*, the Level of the Waters is ſeveral Feet higher than it was formerly. This Elevation is obſerved only on the northern and eaſtern Coaſts of the *Adriatic*. The Sea ſeems on the contrary, to abandon the weſtern Coaſt, that of *Italy*.

Ocean-ſhells are frequently found very near the Surface, which proves that ſuch Places formerly have been the Sea-ſhore. Hence it is clear, that the Cauſe which tranſported them thither, acted ſuddenly; which perfectly agrees with the Account of the Deluge given by *Moſes*.

The greateſt Depths of the Sea, as yet ſounded, have been found to be about 3000 Fathoms. The ordinary Depths are about 150. Though theſe Shells are to be found in almoſt all the plainer Parts of the Surface of the Earth, yet there are certain very large

Tracts,

Tracts, where such Bodies are never found, viz. the Mountains, which seem to be the Remains of the original Strata of the Earth. It is true that there are many Eminences, which have been taken for Mountains, where Sea-shells of every Kind are found; but these are Hillocks, compared with the large Mountains, which may be traced in immense Chains, without almost any Discontinuity, from one Continent to another; and from Continents to neighbouring and opposite Islands, insomuch that all these Chains not only of the old, but likewise of the new World, seem connected one with another. In the *Alps*, *Appinean* and *Pyreneans*, no Shells nor marine Bodies of any Kind are to be found; neither in the large *Grampion* Mountains in *Scotland*.

The same is observed of all the large Mountains of *Africa*, and of *Asia*, and in the huge Chain of *Cordilleres* in *Peru*. This Kind of Mountains (which indeed alone deserve that Name) are chiefly composed of vitrifiable Matter; and if they are sometimes found to contain Sea-shells, it is never to great Depths, though such Bodies are found in great Abundance at the Foot of Mountains, and in the adjacent Valleys, in which there are many Eminences, though but of small Extent, which contain Marble, Sea-shells and Chalk, but never any Veins of Metal.

The Deluge must have produced very considerable Changes on the Surface of the Earth. Many Volcanos were formed at that Time by the Accumulation of animal, vegetable and mineral Substances, in huge Masses which afterwards fermented and putrified, and in Process of Time burst out into Flames. Earthquakes must have been frequent in the first Years after the Deluge, by the Fermentation of these heterogeneous Bodies, before the Remains of so prodigious an Inundation could be dissipated; for wherever there is any intestine Commotion in the Earth, its Violence must be greatly increased, if it

meets

meets with Water, and by its Heat reduces it into Vapour, which we know acts with an immenſe Force. There are many Obſervations, which prove that the Earth, or at leaſt many Parts of its Surface, have ſuffered by Fire, not to mention the Marks of it, which are to be obſerved on many mineral Subſtances. The artificial Production of Potters Earth or Clay, is a very ſtrong Argument in Support of this Opinion.

Potters Earth, as is well known, is found plentifully in moſt low Grounds and Valleys, between mountainous Tracts. By expoſing common flint Stones to the confined Vapour of boiling Water, a Clay of the very ſame Kind may be formed, and is no more than a Decompoſition of the Flints. Hence it would appear, that wherever this Clay is to be found, there the Earth has undergone ſome Violence by Fire; and that this has been effected by Earthquakes, ſoon after the Deluge, ſeems extremely probable. The Deluge has given Origin to many foſſil Subſtances, and given Combinations, which otherwiſe would not have happened. Chalk is no more than the Ruins of Sea-ſhells, and Lime-ſtones conſiſt of the ſame Bodies cemented together by a ſtony Juice.

Amber appears to be, the Reſin of antediluvian Trees (which are frequently found with it at this Day) united to the acid of Sea-ſalt, which abounds in the Earth. The Reaſon of Inſects, Straws, &c. being immerſed in Amber is now no more a Secret; for we know that nothing is more common than to find ſuch Bodies immerſed in the Reſin of Trees. Foſſil Sea-ſalt ſeems to have been depoſited in the Quarries, from whence it is dug, at the Time of the Deluge. All or moſt Part of Pit-coal, appears to be of diluvian Origin, for it gives a Caput Mortuum, the Texture of which exactly reſembles that of burnt Wood. We may reaſonably ſuppoſe large Foreſts to

have

have been buried at the Time of the Deluge, which have undergone a Fermentation and Putrefaction in the Earth, so that the Colour of the woody Part has been changed, though the Texture has remained intire. All Bitumens, Piſſaſphaltum, &c. ſeem to be no more than Productions of reſinous Subſtances united with mineral Acids, which have caught Fire in the Earth by fermenting with heterogeneous Matter, and have there undergone a Sort of natural Diſtillation and Exalation.

Theſe are even demonſtrated by Experiments; for Amber can be produced artifically, as likewiſe Bitumens by the Diſtillation of reſinous Subſtances with mineral Acids.

V. II. P. 28. The River *Oby*, in *Siberia*, after running a Courſe of near 800 Leagues, falls into the *Mare Glaciale*. The Lake *Baiatal* is the greateſt freſh Water Lake yet diſcovered. It extends in Length above five Hundred Leagues, and is from twenty-five to 80 Leagues in Breadth. It is every where deep and navigable. The Water is extremely clear, and abounds with fine Fiſh. It receives abundance of Rivers, but none runs out of it, beſides one, the *Angara*.

Salt Lakes are common in many Parts of *Siberia*. Some contain a pure, white Salt, fit for Uſe, which in Summer is chryſtalized by the Heat of the Sun, and forms a Cruſt on the Top of the Lake. Springs of Salt-water ſometimes riſe in the midſt of freſh Water. One of theſe riſes through a Rock, in the Bed of the River *Angara*. Thirty Leagues above this, there is a Hill 30 Fathom high and 210 long, conſiſting entirely of Rock-ſalt. There are ſome Lakes, which were freſh ſome Years ſince, but are now ſalt: Some have by Degrees dried up; others appear, where formerly it was dry Ground. And ſome of theſe, which at firſt had no Fiſh, are now plentifully ſtocked therewith. The Natives ſay, Ducks and other

Birds

Birds that live upon Fiſh, carry their Eggs from one Lake to another.

P. 29. It is a curious Remark, which Dr. *Cheyne* makes, concerning *Fluids* in general. "I take Notice, firſt of the *Fewneſs* of the original *Fluids*, in Reſpect of the vaſt Number of compound Ones. The primary Ones hitherto known are only four, Air, Water, Mercury, and Light, three of which are ſeldom much compounded with others; ſo that it is Water alone, that is the Baſis of all our Mixtures. It is the Parts of ſolid Bodies floating in this Fluid, that produce all our delightful and uſeful Varieties of Liquors: ſo frugal is Nature in Principles, and ſo fruitful in Effects and Compoſitions. Take Notice, 2dly. Of the great Difference between the *ſpecific Gravities* of our Fluids, Mercury being eight Thouſand Times heavier than Air. Now, not to mention the many Uſes of this laſt Fluid in Artificers Works, had Air been as heavy as Mercury it had been altogether uſeleſs in Reſpiration; it had choaked us immediately. And had there not been a Fluid of the ſame Weight with Mercury, i. e. a Collection of exceeding ſmall, heavy *Spherules* in the preſent Circumſtances of Mankind, I do not know what a great Part of the World would have done. For the Wickedneſs of Mankind, has brought many Diſeaſes to that Degree of Malignity, that a thorough Cure could ſcarce be made of them without this Fluid. But by the Gravity of this, a Remedy is provided for all theſe Malaſſies, which are more than two or three. But that which is moſt wonderful in theſe Fluids is, 3dly. That univerſal Property, the Direction of their Preſſure upon the Sides of the containing Veſſel. In all Fluids of whatſoever Kind or Nature, this Preſſure is communicated in Lines perpendicular to the Sides of the containing Veſſel. And indeed this Property of Fluids, which is ſo uniform, is the neceſſary Conſequence of the Sphericity of their conſtituent Particles.

Now

Now, could any Thing but the Almighty Power of God, have rounded thoſe infinite Numbers of ſmall Particles? Or could any Thing but his Wiſdom have aſſigned them their true Dimenſions, their exact Weights and required Solidities? We ſhall allow him to continue in his Infidelity, who can demonſtrate by what Laws of Mechaniſm, all the Particles of Water were turned of the ſame Diameter, Solidity and Weight; and thoſe of Air, Mercury and Light, turned all of different Diameters, Solidities, and Weights from one another; but all of the ſame Diameters, Solidities and Weighs among themſelves. And what a beautiful Idea of this Fluid does Sir *Iſaac Newton*'s later Diſcoveries preſent us with; every Ray is endowed with its own Colour, and its different Degree of Refrangibility and Reflexibility. One Ray is Violet, another Indigo, a third blue, a fourth green, a fifth yellow, a ſixth orange, and the laſt red. And theſe are the primary and original Colours from the Mixture whereof, all the intermediate ones proceed, and white from an equal Mixture of the whole; black on the contrary, from the ſmall Quantity of any of them being reflected; or all of them in a great Meaſure ſuffocated. So that it is not properly Bodies that are coloured, but the Light that falls upon them; and their Colours ariſe from their Aptitude, to reflect Rays of one Colour, and tranſmit all thoſe of another. The prominent little Parts, upon their Surfaces, according to their different Degree of Denſity and Thinneſs, are apt to reflect back upon our Organs Rays of one Colour, and of one Degree of Refrangibility and Reflexibility, and to let others paſs through their Pores, and this one Colour too is leſs or more intenſe, according as their prominent Parts are of different Denſities. For the firſt Degrees of Intenſeneſs, in all the Primary Colours, ſeem to ariſe from the Degrees of Denſity and Thinneſs, and the ſubſequent Degrees, from the other different Degrees of Thickneſs, or Thinneſs of the Prominent little Parts of the Surfaces of Bodies. Light

acts

acts upon Bodies by heating, diſſolving, and putting their Parts in a vibrating Motion. Bodies act upon Light, in drawing its Parts to them, and that in Lines perpendicular to their Surfaces. And as there may be different Degrees of Attraction in Bodies, which produce their different Degrees of Elaſticity and Cohesion, ſo there muſt be different Degrees of Attraction in Mediums ſuppoſed, to account for their different Powers, in bringing the refracted Rays nearer to, or farther from the Perpendicular. For it is well known all Mediums have not the ſame refractive Virtue. Now, what a beautiful uniform, and ſimple Theory of Light is here! This is ſo very like the frugal Simplicity, and yet the manifold Variety of Nature, that one would be almoſt tempted to believe it true, were there no Experiment to confirm it. We may obſerve one more Inſtance of the wonderful Wiſdom of Nature, in the Propagation of Light, viz. That a Ray of Light in paſſing from a luminous Point, through two differently refracting Mediums, to illuminate a given Point, ſpends the leaſt Time (the refracting Powers of the ſeveral Mediums conſidered) poſſible; and conſequently when a Ray paſſes through one Medium, from a luminous Point to reflect upon a given Point, it takes the ſhorteſt Way poſſible. This the Geometers have demonſtrated. Now, is not this an Inſtance of Counſel and Deſign? Is not this like the Methods of Wiſdom which will not ſpend more Time on a Thing than juſt what is neceſſary to do the Buſineſs; which will not go about, but take the ſhorteſt Courſe poſſible that will bring it to the Place deſigned?

P. 30. It ſeems peculiar to the Water of the *Thames*, that in eight Months Time it acquires a ſpirituous Quality, ſo as to burn like Spirits of Wine. Even when it ſtinks, it is not unwholeſome: Men who were obliged to hold their Noſes, yet drank it all the Way to the Eaſt-Indies, and found no Inconvenience. If you take out the Bung from any Caſk that ſtinks, and

and let the Air come in, it will be ſweet in 24 Hours. If you take a Broom-ſtick, and ſtir it well, it will be ſweet in four or five Hours. It caſts a black Lee to the Bottom, which remixing with it, cauſes a third or fourth Fermentation, after which it ſtinks no more. But though *Thames* Water does not putrify when it ſtinks, moſt other Water does, and is at that Time very dangerous to drink.

P. 93. On the fourteenth of December, 1759, there was at *Peterſburgh*, the moſt exceſſive cold Weather that ever was known, even to 205 Degrees of *De Liſle*'s Thermometer. At that Time Profeſſor *Braun* repeated *Fahrenhait's* Experiments, in order to produce exceſſive Cold by Means of Spirit of Nitre combined with Snow. He ſaw with Surpriſe, the Quickſilver in the other Thermometer deſcend even to 470 Degrees: There the Quickſilver remained fixed in the open Air, for the Space of a Quarter of an Hour, and did not begin to riſe till it was carried into a warm Room. He repeated the ſame Experiment, firſt with the ſame, and then with another Thermometer, with the ſame Succeſs. But as Mr. *Braun* had not broken the Glaſſes, he could only at that Time form a Conjecture. On the 17th he produced, again, cold equal to that of the 14th, and communicated his Diſcovery at a Meeting of the Academy. On the 25th of December, in the Morning, between nine and ten, *De Liſle*'s Thermometer was at the 199th Degree of Cold, and Mr. *Braun*, as well as Profeſſor *Æpinus*, repeated this Experiment. As ſoon as the former obſerved the Quickſilver immoveable in the Thermometer, he broke the Glaſs, and found the Quickſilver frozen but not entirely; Mr. *Æpinus*'s Thermometer fell with extreme Rapidity, almoſt to the 500th Degree, and in breaking the Glaſs from below, he found the Quickſilver contained in it abſolutely frozen. Both the Gentlemen found, that the Quickſilver, thus rendered ſolid, bore hammering and Extenſion, like other Metals;

but being expoſed to the open Air, it recovered its former Fluidity in a little Time.

Mr. *Æpinus* went farther, to examine the Quickſilver when it was made ſolid. He poured Quickſilver into a Glaſs Tube, as thick as one's Finger, cloſed at the Bottom, but open at Top.

The Quickſilver in this Cylinder, which was about one Inch and half Long, froze in three Quarters of a Minute; and became ſolid, perfectly reſembling other Metals. Mean Time it continually contracted, and its Surface, which was at firſt pretty high, ſoon ſunk very low, and the Cylinder of frozen Quickſilver ſunk to the Bottom of the fluid Quickſilver. We know the Contrary happens to water frozen and other Fluids, which extend as they become ſolid, and their Ice ſwims in the fluid Matter, of which they were produced. On the 26th of December, in the Morning, between nine and ten, the Cold became extremely ſharp at 24 Degrees, and ſuch as exceeded the greateſt Degree of artificial Cold fixed by *Fahrenheit*. Mr. *Braun* repeated this Experiment with the ſame Succeſs as the Day before. Counſellor Lomonoſſow made the ſame Experiment; and by Means of Aqua-fortis, the Cold came to 495 Degrees. He then poured in Spirit of common Salt, and the Quickſilver fell in the Thermometer to 554 Degrees; and in taking the Thermometer from the Mixture, the Quickſilver continued to fall in the open Air to the 552d Degree: He threw yet into the Glaſs a little more Snow, pouring on it ſome Oil of Vitriol, and ſuddenly the Quickſilver fell to 1260 Degrees. Then he broke the Ball, and found the Mercury changed to a ſolid Body.

The Quickſilver which remained in the Tube, was alſo become ſolid, and appeared like a looſe Silver Wire, attached to the Ball, which was flexible every Way. He gave the Ball of Quickſilver ſeveral Blows with a turned Ax, and it became flat like an Engliſh Half-Crown: but receiving thereby ſome Cracks, it diſſolved in about 20 Minutes.

P. 42. In cutting a Channel for the Canal of *New-*
in Ireland, a great Multitude of fallen Trees was
ſcovered, lying near two Miles in Length, and in
any Places, ſix or eight Feet deep. Many of theſe
e very large, and are tumbled down one over ano-
ier, ſome lying in ſtrait Lines, and others in an ob-
que or tranſverſe Poſition. If Trees thus found had
een felled by the Deluge, (as undoubtedly others
ere) they would all lie in one Poſition. But this is
ot the Caſe. We muſt therefore ſeek for other
auſes. And one Cauſe ſeems to have been this. If
Vater flowing either from Springs or Streams be
ept, it naturally ſoftens and looſens the Earth; and
n a Courſe of Time, even to the Roots of Trees,
hich are then ſubject to be overturned by any vio-
ent Storm. This doubtleſs was the Caſe with moſt
f thoſe Trees, that are found in Bogs with the Roots
dhering to them. Trees thus falling ſink into the
ielding Soil, and cauſe a farther Stoppage in the
Courſe of the Waters. Hence the looſe Earth is in-
reaſed, by a yearly Acceſſion of Scurf, Moſs, Graſs
nd Weeds. Add to this, that the higher Lands be-
ng gradually diſſolved by repeated Rains, and waſh-
d down by Floods, in a long Courſe of Years cover
he lower Grounds with freſh Layers of Earth. This
eing ſo, it is not ſtrange to find Trees buried eight
r ten Feet under the Earth.

Another Cauſe may be this. Various Colonies from Time to Time arriving in the then uncultivated Country of *Ireland*, would naturally make Room for Tillage and Paſture, by clearing the Ground of its Foreſts. This was certainly the Caſe, where we find in Bogs, Trees partly burned, and others bearing the Mark of the Axe. But ſometimes theſe Colonies were driven by the Natives from their intended Settlements, leaving the Trees they had felled ſtrewed over the Plain, which ſtopping the Waters of Courſe created Bogs, that in Proceſs of Time covered thoſe Trees to a conſiderable Depth. Nay, as late as 1761, *Tyrone* and *O'Donnel*, marching toward *Kinſale*, through

Conaught, and laying the Country Waſte, there is a great Tract of Ground, now a Bog, which was then ploughed Land.

That Bogs in general grow but ſlowly may be gathered from a Lump of Coins of *Edward* IV. (probably loſt in a Purſe which rotted away) taken up in a Bog in *Yorkſhire*, eighteen Feet deep. This was about 200 Years before. So the Bog had grown about a Foot in eleven Years, that is, ſomewhat above an Inch in a Year: Although ſome ſeem to grow much faſter.

Much more antient is the *Great Level*, or ſenny Ground, which contains about 300,000 Acres, lying in the Counties of *Norfolk*, *Suffolk*, *Cambridge*, the iſle of *Ely*, *Huntingdon*, *Northampton*, and *Lincoln*. This was once firm Land. There have been found therein, Stones, Bricks, and other Materials for building. In ſetting down a Sluice, there was found ſixteen Feet deep, a Smith's Forge, and all the Tools thereto belonging. *William* of *Malmſbury*, who lived 1200 Years ago, ſays, that in his Time, "The Trees which grew there, ſmooth and ſtreight, were ſo tall, that they ſeemed to touch the Stars. A Plain there is, as even as the Sea, which with the green Graſs allures the Eye; and there is not the leaſt Parcel of Ground, that lies waſte and void. Here you ſee Plantations of Fruit trees; there a Field ſet with Vines, Part creeping on the Ground, Part mounting on high Poles." But how came it to be reduced to ſo very different a State? It ſeems the Ocean broke in upon it, with ſuch reſiſtleſs Violence, that the Buildings throughout the whole Space were overturned, and the Trees torn up by the Roots. The amazing Quantities of Silt thrown up at the ſame Time, covered the whole Country, even to the Verge of the Highlands, ſeven, eight, or even ten Feet deep. Hence a few Years ſince in digging a Pool, there was found at the upper Skirts of the Level, the Skeleton of a large Fiſh, near twenty Feet long, lodged in Silt above ſix Feet below the Surface of the Grownd. Yet how or when this Inundation was,

was, we are not able to determine. Whenever it was, it was probably occaſioned by a violent Earthquake.

P. 42. A late Writer gives the following Account of the natural Origin of Bogs in *Ireland*. Some of theſe have vaſt Quantities of Timber under them: Others have very little. But the Surface of all is covered with a ſhort, thick, and matted Kind of Heath. This as it grows and thickens at the Top, vegetates at the Bottom into a cloſe and radacious Texture, which being replete with Moiſture, throws out annual Growths of this ramified Heath, Part of which dies every Winter, and moulders at the Bottom, where it forms another Stratum, from which at Spring comes a new Crop of Heath. And thus, as theſe Strata of mouldered Heath are annually repeated, the Roots increaſe, and at once extend higher, and are more conſolidated at the Bottom. Hence the Turf is ever found of a cloſer Texture, as we deſcend deeper in the Bog.

The Turf itſelf is only a cloſely concreted Combination of the Roots of this Heath, which univerſally grows on the Surface of theſe Bogs; not the Produce of the Trees, which are at the Bottom. Wherever theſe were thrown down, ſome Earth would be waſhed down upon them from the adjacent Grounds, the Surface of which every-where produces this Heath. And this being now ſupplied with conſtant Moiſture, would throw out a more plentiful Growth.

The ſame Cauſe produces theſe Bogs on the Sides, or even Tops of Mountains. But it is ever in wet Grounds, or in Flats on the Side of Hills, where the Water ſettles and ſupplies them with Moiſture.

There ſeems indeed to be a ſpungy Quality in this Heath, which prevents the Moiſtures ſinking away from it, by an Attraction of the Fluids, by an infinite Number of capillary Fibres, which are the very Subſtance of it. At the Bottom of theſe Mountain-Bogs,

no Trees are found. And very few in the largeſt Bogs, unleſs on the Skirts of them.

The Turf then from Top to Bottom is entirely the Produce of a Vegetation from itſelf. And the Reaſon why *Ireland* produces ſo many Turf-Bogs, is becauſe it ſo abounds with the Seeds of this Heath, which is every where found where the Land is uncultivated, and forms Bogs, wherever it has proper Moiſture.

Our Marle is found only in the Bottom of low Bogs, at the Depth of ſeven, eight, or nine Feet. For three Feet is a ſpungy Sort of Earth, then Gravel for about half a Foot. For about three Feet more is a ſpungy Earth, mixt with Timber, but ſo rotten that it cuts like Earth. Next this for the Depth of three Inches we find Leaves, that are fair to the Eye, but will not bear a Touch. With theſe are ſometimes mixt Heaps of Seed, which ſeem to be Broom or Furz Seed: Nay in one Place what ſeemed to be Gooſeberries and Currants was found, and Sea-weed in others. Under this was blue Clay half a Foot thick, throughly mix with Shells, as was alſo the Marle, which lay next, three or four Feet deep. They are Shells of Periwinkles: And among theſe are large Horns and Bones anſwerable thereto. But it is not only in Bogs that ſubterraneous Trees are found; nor in *Ireland* only, but in many Parts of *England*. At *Youle*, about twelve Miles from *York*, near the Place where the *Don* empties itſelf into the *Humber*, Abundance of them have been dug up from Time to Time; all of which are a Species of Fir. In the Iſle of *Axholme* in *Lincolnſhire*, not Firs only but Abundance of Oaks are found in the Moor, whereof ſome are five Yards in Compaſs, with Quantities of Acorns near them. The Firs lie ſomewhat deeper than the Oaks; one of them was thirty-ſix Yards long. The adjoining Levels (about 180000 Acres) were half of them yearly covered with Water, 'till King *Charles* I. ſold them to Sir *Cornelius Vermuyden*, who drained them at the Charge of above 400-0000 l.

400,000l. In the Soil of all this Land, through all *Marthland*, and on the Skirts of all the *Lincolnſhire* and *Yorkſhire* Wolds, are found Millions of Roots and Bodies of Trees, Firs, Oaks, Birch, Beech, Yew, Willow, Aſh. The Roots ſtand in their Natural Poſtures, as thick as ever they could grow. The Bodies of moſt of the great Trees, lie all their Length about a Yard from their Roots, with their Tops North Eaſt. The ſmaller lie acroſs in every Direction, ſome under, ſome above them. Some of the Oaks are thirty, ſome thirty-five Yards long, yet wanting ſome Yards at the ſmall Ends. They are firm, lasting and as black as Ebony. Many of them have been burnt, ſome quite through, ſome on one Side. Some have been found chopped and ſquared, ſome bored through; ſome half Cleft with great woodden Wedges in them, and broken Axe heads, ſhaped not unlike the ſacrificing Axes. And all theſe were in ſuch Places, and at ſuch Depths, as could not have been opened, from the Time the Foreſt was deſtroyed until the Ground was drained. Near a great Root in the Parish of *Hatfield* were found eight or nine *Roman* Coins: And at the Bottom of a new Drain, were found Trees ſquared and cut, Rails, Bars, a Kind of Battle-axe, and two or three Coins, of the Emperor *Veſpaſian*. Nay, the Ground at the Bottom of the River was found to lie in Ridge and Furrow, manifeſting that it had been ploughed. In an old Drain, an Oak was found forty Yards long, four Yards in Diameter at the great End. Three Yards and a Foot in the Middle, two Yards at the ſmall End, ſo that by a moderate Computation, it ſeems to have been as long again. Yea, about fifty Years ago there was found ſeveral Feet deep, a Man lying at his full Length, with his Head upon his Arm, as aſleep. His Skin, tanned as it were, by the Moor-Water, preſerved his Shape intire; but his Fleſh and moſt of his Bones were conſumed.

Theſe ſtately Trees formerly compoſed one of the moſt beautiful Foreſts in the World. But how came it to be deſtroyed? When the *Romans* purſued the *Britons*,

Britons, they always fled into the Woods. On this the *Roman* Generals ordered them to be cut down; this vaſt Foreſt in particular. The Trees falling croſs the Rivers which ran thro' the Country, ſoon dammed them up, turned the Ground into a Lake, and gave riſe to the Moors that increaſed continually, by earthly Matter waſhed down, the Conſumption of rotting Branches and Leaves, and the Growth of Water-moſs, which wonderfully flouriſhes on rotten Grounds. Hence it is, that ſo many *Roman* Coins have been found at the Bottom of theſe Levels; that ſo many Trees are found burnt or chopped; and that the Soil of the Country in general is two, three or more Yards higher than formerly.

Some ſimilar Alteration ſeems to have happened many Centuries ago, to that whole Tract of Land, near *Newbury* in *Oxfordſhire*, out of which they dig their *Peat*. There is a Stratum of this ſeveral Miles, which lies many Feet under the Surface.

The beſt Peat has very little (if any) Earth in it, but is a Compoſition of Wood, Branches, Twigs, Leaves, and Roots of Trees, with Graſs, Straw, Plants, and Weeds. The Colour is of a blackiſh Brown; and if it be chewed between the Teeth it is ſoft, and has no gritty Matter in it. It is indeed of a different Conſiſtence in different Places, ſome being ſofter and ſome harder; which may ariſe perhaps from the different Sorts of Trees it is compoſed of. Great Numbers of Trees are viſible in the true Peat, lying irregularly one upon another, and ſometimes even Cart-loads of them have been taken out: But the nearer theſe Trees lie to the Surface, the leſs ſound is the Wood; and ſometimes the ſmall Twigs, which lie at the Bottom, are ſo firm, as not to be eaſily cut through: Theſe Trees are generally Oaks, Alders, Willows, and Firs, beſides ſome others not eaſily known. The ſmall Roots are generally periſhed, but yet have ſufficient Signs to ſhew that the Trees were torn up by the Roots, and were not cut down

down; there being no Sign of the Ax or Saw, which had they been felled, would have been plainly visible. A great many Horns, Heads, and Bones of several Kinds of Deer, Horns of the Antelope, Heads and Tusks of Boars, and Heads of Bevers, are also found in it, and some human Bones.

The Islands of *Sylley* have been so noted among the Antients, one might expect to find among the Inhabitants some Consciousness of their own Antiquity, and of their Appearance in History before the other Parts of Britain were at all known. But there is nothing of this Kind, the Inhabitants are all new comers, not an old Habitation worth Notice, nor any Remains of Phœnician, Grecian, or Roman Arts, either in Town, Castle, Port, Temple, or Sculpture.

We are not to think however but Sylley was inhabited, and was as frequently resorted to antiently, as the old Historians relate. All the Islands (several of which are now without Inhabitant) by the Remains of Walls, Foundations of many contiguous Houses, and a great Number of Sepulchral Burrows, shew, that they have been fully cultivated and inhabited.

That they were inhabited by *Britons*, is past all Doubt, not only from their neighbourhood to *England*, but from the Druid Monuments. Several rude Stone Pillars, Circles of Stones erect, Rock-basons: All Monuments common in *Cornwall* and *Wales*, are equal Evidences of the Antiquity, Religion, and Original of the old Inhabitants.

How came these antient Inhabitants then (it may be ask'd) to vanish, so as that the present have no Pretensions to any Affinity of any Kind with them, either in Blood, Language, or Customs? How came they to disappear, &c. leave so few Traces of Plenty, or Arts, and no Posterity behind them? From two Causes, the manifest Incroachments of the Sea, and as manifest a Subsidence of some Parts of the Land.

The

The Sea is the inſatiable Monſter, which devours Iſlands, gorges itſelf with the Earth, Sand, Clay, and all the yielding Parts, and leaves nothing where it can reach, but the Skeleton, the bared Rock. The continual Advances, which the Sea makes upon the low Lands, are plain to all People of Obſervation. What we ſee happening every Day may aſſure us of what has happened in former Times, and from the Banks of Sand and Earth giving way to the Sea, and the Breaches becoming ſtill more open, and irrecoverable: it appears, that repeated Tempeſts have occaſioned a gradual Diſſolution of the Solids for many Ages.

Again, the Flats which ſtretch from one Iſland to the other, are plain Evidences of a former Union between many now diſtinct Iſlands. The Flats between ſome of them are quite dry at a Spring-tide, and Men eaſily paſs dry ſhod from one Iſland to the other, over Sand-banks (where, upon the ſhifting the Sands, Walls and Ruins are diſcovered frequently) upon which at full Sea, there are ten and twelve Feet of Water.

All ſtrong Arguments that theſe Iſlands were once one continued Tract of Land, though now, as to their Low-lands, over-run with the Sea and Sand. Hiſtory confirms their former Union. "The Iſles *Caſſiterides* (ſays *Strabo*) are ten in Number, cloſe to one another; one of them is deſert and unpeopled, the reſt are inhabited." But ſee how the Sea has multiplied theſe Iſlands, there are now reckoned 140. Into ſo many Fragments are they divided, and yet there are but ſix inhabited. But no Circumſtance can ſhew the great Alterations, which have happened in the Number and Extent of theſe Iſlands, more than this, viz. that the Iſle of *Sylley*, from which the little Cluſter takes its Name, is no more at preſent than a high Rock, of about a Furlong over, whoſe Cliffs hardly any Thing but Birds can mount, and whoſe Barrenneſs could never ſuffer any Thing but Sea-birds to inhabit it. How then came all theſe

Iſlands

Iſlands to have their general Name from ſuch a ſmall and uſeleſs Plot?

Doubtleſs *Sylley*, which is now a bare Rock, and ſeparate from the Lands of *Guel* and *Brehar* by a narrow Frith, was formerly joined to them by low Necks of Lands, being the rocky Promontory of one large Iſland now broke into ſeven. This Promontory (at preſent called *Sylley* Iſland) lying Weſtermoſt of all the high Lands, was the firſt Land of all the Iſlands diſcerned by the Traders from the *Mediterranean* and *Spaniſh* Coaſts, and, as ſoon as diſcovered was ſaid to be *Sylley*, nothing being more uſual with Sailors, upon their firſt ſeeing Land, than to call the Part by the Name of the whole. But when this conſiderable Iſland called *Sylley* was broken to Pieces, the greateſt Portions became inhabited, and had firſt *Britiſh* Names, as *Brehar*, *Treſcaw*, *Enmor*; but afterwards were called according to the Religion of the Times, after the Names of particular Saints. The chief Diviſion was intitled St. *Mary*'s, the others dedicated to St. *Nicholas*, St. *Martin*, St. *Theon*, and ſo on; but this remarkable Promontory being in nowiſe fit for Habitation or Devotion, was dedicated to no Saint, but left to enjoy its antient Name; and, notwithſtanding the modern Chriſtian Dedications, Sailors went on in their old Way. This high Land is ſtill called *Sylley*, and the Iſlands in general are ſtill denominated *Sylley* Iſles.

It muſt have been a diſpiriting Circumſtance to the old Inhabitants, to ſee the Ocean ſo continually eating away their Low-lands, in which they had their Treaſures of Tin, their houſes and Ports: But this gradual Decay was not the only Misfortune, which attended them. From the Iſland of *Sampſon*, one may ſee the Foundations of Stone-fences running on in a ſtrait Line croſs the Firth, towards *Treſcaw* Iſle, till they are hid in the Sand, which Sand, when it is full Tide, has from ten to twelve Feet Water on it. Now we cannot ſuppoſe that the Foundation of theſe Fences was laid as low as high

Water

Water Mark, (for who would build Fences upon ſo dangerous a Level?) at a Medium we may ſuppoſe them to have been laid ſix Feet above the full Tide.

Here then we have the Foundations, which were ſix Feet above the High-water Mark, now ten Feet under, which together make a Difference as to the Level of ſixteen Feet.

Here then was a great Subſidence, which muſt have been follow'd by a ſudden Inundation, and this Inundation is likely not only to have deſtroyed a great Part of the Inhabitants, but to have terrified others who ſurvived into a total Deſertion of their ſhattered Iſlands. By this Means that conſiderable People, who were the Aborigines, and carried on the Tin Trade which the *Phenicians*, *Greeks*, and *Romans*, were reduced to the laſt Gaſp. The few poor Remains of this Deſolation by their neceſſary Attention to Food and Raiment, muſt ſoon have loſt Sight of their ancient Proſperity, and the faint Remembrance, that was left of what the Iſlands had been before, expired of itſelf in an Age or two, thro' the Indigence of the Inhabitants.

That ſuch an Inundation has happen'd here, is ſtill more plain, becauſe theſe Iſlands are no longer what they were antiently, fertile in Tin; nor are there any Remains of ſo many antient Workings as could maintain a Trade, ſo greedily coveted by the Antients. But what is become of thoſe Mines? how ſhall this Queſtion be anſwered, but by confeſſing that the Land, in which they were, is now ſunk, and buried under the Sea?

I am not fond of introducing Earthquakes; but where there has been evidently a great Subſidence of the Earth's Surface, can it be accounted for at all without a previous Concuſſion of the Earth? And what Nature declares in this Caſe, Tradition ſeems to confirm; there being a ſtrong Perſuaſion in the Weſtern Parts of *Cornwall*, that formerly there exiſted a large Country between the *Land's-End* and *Sylley*,

now

now laid many Fathoms under Water. Indeed there are no Evidences of any ancient Connexion of the *Land's-End* and *Sylley*. Yet that the Cauſe of that Inundation, which deſtroyed much of theſe Iſlands, might reach alſo to the *Corniſh* Shores, is extremely probable; there being ſeveral Evidences of a like Subſidence of the Land in *Mount's-Bay*. The principal Anchoring-place, called a Lake, is now a Haven or open Harbour. The Mount from its *Corniſh* Name, we muſt conclude to have ſtood formerly in a Wood; but now at full Tide, it is half a Mile in the Sea, and not a Tree near it; and in the ſandy Beach betwixt the Mount and *Penzance*, when the Sands have been diſperſed by violent high Tides, there have been ſeen the Trunks of ſeveral large Trees in their natural Poſition, the Surface of their Section worn ſmooth by the Agitation of the Water, Sand, and Gravel, as if cut with an Axe, upon which at every full Tide, there muſt be twelve Feet Water; ſo that the Shores in *Sylley*, and the neighbouring Shores of *Cornwall*, are concurrent Evidences of ſuch a Subſidence, and the Memory of the Inundations, which were the neceſſary Conſequences of it, is preſerved in Tradition; the like other Traditions, in Proportion to their Age, obſcured by Fable.

That there has been ſuch a Subſidence, of the Lands belonging to theſe Iſlands, the preſent Ruins of the Iſlands teſtify. And this Subſidence reached even to Mount's-bay, and laid under Water a great Part of the Low-lands, then Woody, there being now ten Feet Water, ſo that the Shores in *Sylley* and the Shores in *Cornwall*, are equal Proofs of ſuch Inundation. When this Inundation happened, we know not; but two Pieces of Hiſtory, poſſibly may lead us near the Time. In the Time of *Strabo* and *Diodorus Siculus*, their Commerce was in full Vigour, "Abundance of Tin was carried in Carts," ſay *Diodorus Siculus*.—"But ten Iſlands in all (ſays *Strabo*) and nine of thoſe inhabited." The Deſtruction therefore

of *Sylley* must be placed after the Time of these Authors, that is, after the *Auguſtan* Age.

Now *Plutarch* hints, that the Iſlands round *Britain* were generally unpeopled in his Time. If he includes *Sylley* among them, then this Diſſolation muſt have happened between the Reign of *Trajan*, and that of *Auguſtus*.

Before we diſmiſs the Article of Bogs, it may not be improper to ſubjoin as ſtrange an Account as hardly any Age can parallel. June 7, 1697, near *Charleville* in *Ireland*, a great rumbling was heard in the Earth. Soon after, in the Bog of *Kapamhane*, ſtretching North and South, ſome Meadow and Paſture-Land, that lay on the Side of the Bog, ſeparated by a large Ditch, and other Land on the further Side adjoining to it, began to move: And a little Hill in the Middle of the Bog, ſunk down.

This was at Seven in the Evening, the Ground fluctuating in its Motion, like the Waves of the Sea. The Paſture-land then roſe up, over ran the Ground beneath, and moved upon its Surface, rolling on with great Violence, till it had covered the Meadow ſixteen Feet deep. It drew after it the Body of the Bog, Part of it lying on the Place, where the Paſture-land was before, leaving great Breaches behind it, and Currents of Water, which caſt up noiſome Vapours. There are ſtill Cracks and Chaſms through the whole Surface of the Bog, which contains forty Acres.

But we have a later Incident of the ſame Kind. On Saturday, January 26, 1745, a Part of *Pilling-moſs*, lying near *Heſcomb*-houſes, was obſerved to riſe to a ſurprizing Height. After a ſhort Time, it ſunk as much below the Level, and moved ſlowly toward the South-ſide. In half an Hour it covered 20 Acres of Land. The improved Land, adjoining to that Part of the Bog, is a concave Circle, containing near an hundred Acres, which is well nigh filled up with

with Bog and Water. In ſome Parts, it is thought to be five Yards deep.

An intenſe Froſt retards its Progreſs for the preſent, but it is likely to ſpoil a great deal more Land. That Part of the Moſs, which is ſunk like the Bed of a River, runs North and South It is above a Mile in Length, and near half a Mile in Breadth.

The Diſcovery of the *Bones* of *Elephants* at the Bottom of ſome of our *Engliſh* Bogs, ſeems a convincing Proof, that the Earth has undergone ſome very extraordinary Alterations. For the Remains of Animals of quite different Climates, which in the preſent Situation of the World, could never poſſibly come over hither, muſt imply, either their having been originally here, or that *England* was once joined to the Continent. But ſince we find theſe Creatures only in very hot Countries, it is highly probable, they were not originally here, unleſs we ſuppoſe the Temperature of our Climate to have been greatly altered. And without ſuch a Suppoſition, we cannot ſuppoſe they would have wandered hither, though all Parts of the Globe had been contigious. But what Changes have happened to our Earth, no human Wiſdom can find out. Suppoſe only the Axis thereof to have been ſhifted at any Time but a few Degrees, what Convulſions in Nature, what an univerſal Change in the Face of Things muſt have enſued? What Inundations of Water, bearing every Thing before them? What Breaches in the Earth, what Hurricanes and Tempeſts, muſt have attended ſuch an Event? For the Waters muſt have rolled along, till an Equipoiſe was produced. And all Parts of the World muſt acquire different Degrees of Heat and Cold from what they had before. Seas would be formed, where Continents had been; Continents torn in Pieces, or ſplit into Iſlands. Such would have been the Fate of inanimate Things. And as to living Creatures, they muſt have been

deſtroyed and buried in the Ruins of the World, as perhaps theſe Elephants were.

There is ſomething remarkable in the Manner, wherein the Tides riſe, in ſeveral of our Rivers. In the River *Severn*, in particular, near *Newnham*, and 160 Miles from *Lundy*, the Head of the Flood at Spring-tides riſes in Height like a Wall, near nine Foot high. Thus it pours on for many Miles, uſually overſetting any Veſſels that lie in its Way. This Head-tide they call the *Boar*: It flows here only Two, and ebbs ten Hours.

But how ſhall we account for the ebbing and flowing of *Lay-well*, near *Torbay*? This ebbs and flows many Times in an Hour. It uſually performs its Flux and Reflux in a Minute's Time. But it ſtands two or three Minutes after the Ebb: So that in the whole it ebbs and flows about ſixteen Times in an Hour.

Will it be improper to mention here, a cheap and eaſy Way, of making *Sea water freſh*? "I took, ſays a Gentleman, a long Glaſs Body, and having filled it with Sea-water, put therein *Sea-weed* with its Roots, freſh and new-gathered. Then I put on a Head and a Beak, and adapted a Receiver thereto, without any Lute or cloſing the Joints. From the Plants diſtilled daily a ſmall Quantity of very ſweet and potable Water, which had no unpleaſant Taſte, as that diſtilled by Fire always has. And probably there may be found other Plants near the Sea, which would yield freſh Water in larger Quantities.

P. 45. Does not the following Inſtance ſhew, that there is an *under Current* at the Mouth of the *Mediterranean* Sea? In the Year 1712, Monſ. *l'Aigle*, Commander of a Privateer, chaſing a Dutch Ship near *Ceuta* Point, came up with her in the Straits between *Tariffa* and *Tangier*, and giving her one Broad-ſide, ſunk

A few Days after this Ship with her Cargo of Brandy and Oil, aroſe near *Tangier*, four Leagues West of that Place where ſhe ſunk, and directly againſt the Strength of the Current. Certainly then the deep Water in the Middle of the Strait, ſets outward to the Grand Ocean. And poſſibly great Part of the Water, which runs in at the Straits, may run out again that Way.

One of the moſt *violent Currents* in the Northern Seas, runs between two of the *Weſtern Iſles*. The Sea begins to boil with the Tide of Flood, and increaſes gradually, till there are many Whirlpools, which form themſelves in a Sort of Pyramids, and immediately ſpout up as high as the Maſt of a little Veſſel. At the ſame Time they make a loud Report. Theſe white Waves run two Leagues before they break. The Sea continues theſe Motions, till it is more than half Flood, and then decreaſes gradually, till it has ebbed half an Hour. From that Time it boils again, till it is within an Hour of Low-water. This boiling of the Sea is about a Piſtol-ſhot diſtant from the Iſle of *Scarba*. But the ſmalleſt Boat may ſafely croſs the Gulp, at the laſt Hour of the Flood or of the Ebb.

V. II. P. 46. In like Manner, the Colliſion of the oppoſite and oblique Streams, near the End of the *Orkney* Iſlands, excites a circular Motion in the Water, and when the Swiftneſs of the Tide is inconſiderable, occaſions *Whirlpools* or Cavities in the Sea, in the Form of an inverted Bell, wide at the Mouth, and growing gradually narrower toward the Bottom. Their Width and Depth are in Proportion to the Rapidity of the Streams that cauſe them. Thoſe in *Pentland* Firth, near the Iſlands *Stroma* and *Swona*, will with a Spring-tide, turn any Veſſel quite round. There have been Inſtances of Boats being ſwallowed up in them. The Cavity is largeſt, when it is firſt formed, and is carried along with the Stream, di-

miniſhing gradually as it goes, until it [illegible] pears. The Suction communicated to the Water, does not extend farther than the Cavity. When Fiſhermen are aware of their Approach to one of theſe *Wells*, as they call them; and have Time to throw an Ore or any other bulky Body into it, before they are too near, the ſpiral Motion is interrupted, and the Continuity of the Water broke, which ruſhing in on all Sides, fills up the Cavity, and enables them to go over it ſafe.

P. 50. Is it not remarkable, that *Sand* is a more effectual Barrier againſt the Sea than *Rock?* Accordingly the Sea is continually gaining upon a rocky Shore: But it is continually loſing on a ſandy Shore, unleſs where it ſets in with an Eddie. Thus it has been gaining from Age to Age, upon the Iſle of *Portland* and the *Land's-End* in *Cornwall*, under-mining, throwing down and ſwallowing up one huge Rock after another. Meantime the ſandy Shores both on our Southern and Weſtern Coaſts, gain continually upon the Sea.

CHAP II.

Of Fire and Air.

1. *The Effect of Fire in Vacuo:*
2. *Fire increaſes the Weight of Bodies:*
3. *Nearneſs to the Sun, not the ſole Cauſe of Heat:*
4. *Of Mount Veſuvius:*
5. *Of Herculaneum:*
6. *Of Monte Secco:*
7. *Of Monte Nuovo:*
8. *New Iſlands:*
9. *An Iſland burnt up:*
10. *A burning Mountain in Ternata:*
11. *A Journey to Mount Hecla:*

12. *De-*

V. II. P. 59. FIRE has ſome Effect on moſt Bodies, even in an exhauſted Receiver. One placed a black Ribbon therein, and then applied a Burning-glaſs. Abundance of Smoke iſſued out of it, which fell by little and little, and the Ribbon appeared not at all changed. But when it was touched, after the re-admiſſion of the Air, it preſently fell into Aſhes.

The Glaſs being applied to Gun-powder ſo incloſed, it burnt Grain by Grain, but none of the Grains kindled. Another Time, when the Sun had leſs Force, they would not burn, but only boiled and emitted Smoke. This Smoke falling on the Board on which the Powder lay, was of the Colour of Brimſtone. The Powder that remained, being put on Coals, burned like Salt-petre, inaſmuch as the Brimſtone had exhaled.

Tin and Copper melted together weigh more than both Bodies did before. Yea, Oripin being mixt with Salt of Tartar, is heavier by a fifth Part.

To reſolve this, it has been commonly ſuppoſed, that Fire adds to the Weight of Bodies. But Fire has itſelf no Weight at all: Therefore it can give none. Pure Fire as Dr. *Hillary* obſerves, is a Body without Gravity, and has no more Tendency to any one Part of Space, than to any other.

Is not then this Alteration of Weight rather owing to an Alteration of the inward Texture of the Particles, in the Body calcined? The lighter Particles being removed by Exhalation, do not thoſe remaining approach nearer each other? And muſt not then the Weight, which is always as the Solidity, increaſe accordingly?

Very *different Degrees of Heat* obtain in the ſame Latitude, on the different Sides of the *South American Continent*: Which ſhews that the Temperature of a Place depends much more upon other Circumſtances, than upon its Diſtance from the Pole, or Nearneſs to the Equinoctial. Thus though the Coaſt of *Braſil* is extremely ſultry, yet the Coaſt of the South Seas in the ſame Latitude, is quite Temperate, and in ranging along it, one does not meet with ſo warm Weather, as is frequent in a Summer's Day in *England*: which is the more Extraordinary, as there never falls any Rain to refreſh and cool the Air. On the Coaſt of *Peru*, even under the Line, every Thing contributes to make the Day agreeable. In other Countries, the ſcorching Sun in Summer, makes the Day unfit either for Labour or Amuſement: And the Rains are no leſs troubleſome, in the cooler Parts of the Year. But in this delightful Climate, the Sun rarely appears; for there is conſtantly a grey, chearful Sky, juſt ſufficient to ſcreen the Sun, without obſcuring the Air. Thus all Parts of the Day are proper for Labour, while the Coolneſs produced elſewhere by Rains, is here brought about by freſh Breezes, from the cooler Regions.

This is chiefly owing to the *Andes*, which running not far from, and nearly Parallel with the Shore, and riſing immenſely higher, than any other Moun-

tains

tains in *America*, or perhaps on the Globe, form on their Sides a prodigious Tract of Land, where according to their different Heights, all Kinds of Climates may be found, at all Seasons of the Year. These Mountains intercept great Part of the Eastern Winds, which generally blow on the Continent of *America*, cool that Part of the Air which comes over their Tops, and keep it cool by the Snows, with which they are always covered. Thus by spreading the Influence of their frozen Crests, to the Neighbouring Coasts and Seas, they cause the Temperature and Equability, which constantly prevail there. But when they leave these Mountains, they experience in a short Time an entire Change of Climate, and in two or three Days, pass from the temperate Air of *Peru*, to the sultry Atmosphere of the *West-Indies*.

P. 63. The fiery Erruptions of Mount *Vesuvius* strike the Neighbourhood with Horror. But as even noxious Things bring some Advantage with them, so this Mountain by the sulphureous and nitrous Particles with which it manures the Ground, and the Heat of its subterraneous Passages, much contributes to its uncommon Fertility. And wherever these inflammable Substances abound, 'tis better they should have a Vent than not. So Experience shews, that this Country has had fewer Earthquakes, and those less fatal in their Effects, since the Eruption of the subterraneous Matter, through the Mouth of *Vesuvius*. And the Inhabitants are not much alarmed, at seeing the usual vernal Explosions. They began in the Year 1730, in the End of February. The Smoke rose directly up in the Air, like a large black Pillar, and then expanded itself in long Streaks, resembling thick Clouds. In the Night, almost after every Explosion, a short fiery Pillar was seen to shoot up, consisting chiefly of red-hot Stones, thrown up in a perpendicular Direction.

The Distance from *Naples* to the Foot of *Vesuvius*, is five *Italian* Miles, from whence to the Top is near three

three Miles further. It properly conſiſts of two Hills, though one of them only, emits Fire and Smoke. The Valley between them is about a Mile long, and extremely Fertile. The burning Summit, which is the loweſt of the Two, is Eleven hundred Fathoms above the Surface of the Sea. From *Reſina*, the Aſcent grows ſteeper, and many Stones are ſcattered about, as Memorials of its former Devaſtations. It is aſtoniſhing to think of the Force, by which ſuch huge Bulks of 4 or 500 Hundred Weight have been thrown ſeveral Miles from the Hill.

This being ſteep, and covered with black Aſhes, the Aſcent is very Difficult. From the Mouth frequently iſſues a Flood of *Lava*, or Compoſition of Sulphur, Metals and Minerals. This ejected Matter lies ſtill one Layer above another, with large Stones projecting above the Surface, which in their Courſe along the fiery River, were ſtopped by their Inequalities, and fixing in the melted Matter, gradually hardened. Theſe Streams are not thrown up from the Mountain, like the Stones, but pour down, as from an inclined Veſſel, proceeding, it ſeems, from the whole Cavity, which is then full of melted Subſtances.

About half Way up the Mountain (ſays Mr. *Kyſler*) we met with Stones of above an hundred Weight glowing hot, which when broken had exactly the Appearance of red-hot Iron. As we went on, we heard a moſt horrid Noiſe, reſembling the Diſcharge of a whole Battery of Cannon, and under our Feet we perceived a rumbling, like the Boiling of a large Caldron. At laſt we reached the Place where the largeſt Volcano was formerly ſituated. But it is now not only choaked up, but covered with a round Pile of Aſhes and Lava. Thirty Years ſince, there was a Plain of about 3000 Yards to croſs, before you came to the Skirts of this new Mountain. But it is now ſo inlarged, that in moſt Places, the Plain is but about thirty Yards broad. Probably in a few Years it will be quite filled up, and the two Mountains joined in

one

ace. Here the Increaſe of Heat was very ſenſible, eſpecially at every Exploſion, when the Aſhes flew ſo ſtrongly in our Faces, that we were obliged to cover our Eyes. The Ground alſo was ſo hot under our Feet, that it burnt the Soles of our Shoes. Every Eruption was attended with a whizzing Noiſe, like that of many Rockets thrown up at once. The Clouds of Smoke, and Multitude of Stones thrown into the Air, totally obſcured the Sky. Moſt of the Stones, eſpecially if large, fell again into the Abyſs from which they are projected. Great Quantities, however fell on the Sides of the Mountain, and rolled down with an hideous Noiſe.

Even when all is ſtill, the Bottom of the Cavity is ſeldom ſeen, by Reaſon of the Smoke. When it is, it is ſubject to great Variation. Sometimes it is of a prodigious Depth; at other Times hardly more than an Hundred Feet, according to the riſing or falling of the melted Matter, ſince the laſt Erruption, by the hardening of which, this Bottom is formed.

Since the Birth of Chriſt, there are recorded upwards of twenty memorable Eruptions of *Veſuvius*. One of the moſt Violent was, that which happened in the Reign of *Titus Veſpaſian*, and deſtroyed the Cities *Herculanum*, *Stabice* and *Pompei*, which then ſtood near *Naples*. During that Eruption the Aſhes were driven as far as *Afric*, *Syria*, and *Egypt*, and even at *Rome*, the Sun was darkened by them. Theſe Cities were partly ſwallowed up, partly buried in the burning Lava, ſo that not the leaſt Remains of them were to be ſeen. But within a few Years many Things have been dug up out of *Herculaneum*, near *Portici*, the King of *Naples'* Palace. Among theſe are many Paintings, done in Stucco, in Water Colours in Freſco. They have been taken from the Walls of an Amphitheatre, a Temple, and ſeveral Houſes, and are in great Variety, ſome perfectly well preſerved.

Four capital Pieces are ſo extremely well executed that Don *Franceſco de la Vega*, a Painter, whom the King

King of *Naples* ſent for from *Rome*, to take Draughts of theſe Paintings, ſaid, " If Raphael were alive, he would be glad to ſtudy theſe Drawings, and perhaps take Leſſons from them." Nothing can be more juſt and correct The Muſcles are exactly and loſtly drawn, every one in its own Place, without any of that preternatural Swelling ſeen in the Works of ſome of the beſt *Italian* Maſters. And it is ſurprizing to ſee how freſh the Colours are, conſidering they have been under the Ground above ſixteen hundred and fifty Years.

The Matter thrown out of *Veſuvius*, ſhews whence its fiery Eruptions ariſe. For, pour Water on Sulphur, mixt with Filings of Iron, and it ſoon breaks out into a Flame. That Abundance of Sulphur and Iron is contained in *Veſuvius*, appears not only from what is ejected, but alſo from the Water, iſſuing from the Foot of the Mountain. The neighbouring Sea both ſupplies Moiſture to theſe inflammable Subſtances, and alſo Salt and Bitumen. That *Veſuvius* has a Communication with the Sea, Experience ſhews, the Waters being ſurpriſingly abſorbed, in 1681, before the Eruption, ſo that the ſeveral Veſſels before afloat were left dry. Likewiſe in 1698, the Sea ſuddenly ebbed twelve Paces, and the Mountain diſcharged a Torrent of bituminous Matter. When the Diſcharge ceaſed. and the Sea returned to its former Height, great Quantities of Shells, half burnt, and emitting a ſulphurous Smell, were found along the Shore. In another violent Eruption, not only Shells, but Sea-weeds, and hot Sea-water were ejected. This Volcano, however, affords ſeveral freſh Springs, ſome of which are conveyed to *Naples*, by a beautiful Aqueduct. Theſe Waters have not the leaſt Heat in them: Nay, a cold Wind is felt to blow, from ſeveral Fiſſures and Chaſms of the Mountain.

P. 65. Near *Puzzuolo* lies *Monte Secco*, which is *Veſuvius* in Minature. Its Summit, formerly a Cone, is now ſunk into a concave Oval, whoſe ſherteſt Diameter

meter is about 1000 Feet, the longeſt 1246. It is generally known by the Name of *Solfatara*. Tho' *Veſuvius* is twelve Miles diſtant, yet they have a Communication with each other. Hence the ſubterraneous Fire is quiet at *Solfatara*, when it has a Vent at *Veſuvius*: Whereas the Heat at the former increaſes, when the latter is at reſt.

On this Mountain are many Cracks emitting Smoaks; the Heat iſſuing from them is ſometimes inſupportable. Hold a Piece of Iron over one of theſe Cracks, and a ſweetiſh Fluid will drop from it: But a Piece of Paper, inſtead of being moiſtened, grows quite dry and ſtiff. The Stones near theſe Cracks are in continual Motion; and ſmall Stones dropt into them, are ejected to the Height of twelve Feet, like the ponderous Maſſes from *Veſuvius*. In ſome Places, the Sand by the Force of the Vapours, Springs up and down, like the Sparkling of Cyder.

Out of *Solfatara* they extract belide Sulphur, blue Vitriol, and the beſt Kind of Alum. The large leaden Kettles uſed herein, are not heated by a culinary Fire, but by the natural Heat iſſuing through Holes in the Ground, over which the Veſſels are placed.

Not far from *Puzzuolo* is the *Monte-Nuovo*, which roſe ſuddenly in the Night, between the 19th and 20th of September, 1636. During a dreadful Earthquake that laid the whole Neighbourhood in Ruins, the ſubterraneous Fire, opening a large Chaſm in the Ground, threw out ſuch Quantities of Stones, Aſhes, Bitumen and Sand, as in twenty-four Hours formed this Mountain. Its perpendicular Height is 400 Rods, its Circuit three Miles. The Edge of the firſt Aperture is ſtill viſible, a Mile in Circuit, though it is now intirely filled up.

An Event ſimilar to this occurr'd more lately. After a Shock of the Earth, there was ſeen from *Santorini* (an Iſland in the *Archipelago*, on the Coaſt of *Natolia*) on the 23d of May 1707, as it were a floating Rock. Some were ſo bold, as to go down upon it, even

while it was growing under their Feet. The Earth of it was very light, and contained a ſmall Quantity of Potters Clay. It increaſed daily, till it was half a Mile in Circumference, and twenty or twenty-five Feet high. At this Time a great Ridge of Rocks, dark and black, roſe out of the Sea, and joined to the new Iſland. Then there iſſued out of it a thick Smoke, with a Noiſe like conſtant Thundring, or a Diſcharge of many Cannon at once. The Sea-Water continually bubbled up; and in a ſhort Time the new Land preſented nothing to view for whole Nights, but a great Number of Stoves, which caſt forth Flames, with Showers of Aſhes, and innumerable ſmall Stones, red-hot. Rocks were alſo darted out of theſe burning Furnaces, which mounted up like Bombs. This continued till November.

There is likewiſe an Iſland among the *Azores*, which had the ſame Original. On the Night between the 7th and 8th of December, 1720, there was felt a Shock of an Earthquake at *Tercera*; and preſently after, an Iſland roſe, from the Midſt of boiling hot-water. It was nearly round, and high enough to be ſeen ſeven or eight Leagues off. But after a little while it ſunk, till it became level with the Water.

On June 4th, 1693, the Mountain on the Iſland *Torca* in the *Eaſt-Indies*, began about Day-break, to caſt out more Fire than uſual, which continued five or ſix Days, till at laſt it poured forth, not only a prodigious Flame, but likewiſe ſuch a black and ſulphurous Vapour, that the Inhabitants of *Hiſlo* (a Village in the Weſtern Part of the Iſland, and neareſt to the Opening) were wholly covered by it. Quickly followed a Stream of burning Brimſtone, which conſumed many that could not eſcape. Afterwards the Inhabitants perceived, a great Part of the Mountain was ſunk down. Another Part ſunk three or four Days after, and ſo from Time to Time, till the burning Lake covered near half the Iſland. Wherefore

they

they went on board their Boats; from whence they perceived huge Pieces of the Mountain fall into the fiery Lake, with a prodigious Noiſe, as if a whole Battery of Cannon was diſcharged. The Inhabitants of another Town on the Eaſt Side of the Iſland, not thinking themſelves in ſo great Danger, remained a Month longer. But the fiery Lake approaching nearer and nearer, ſo that there was no doubt but it would ſwallow up the whole Iſland, they too fled for their Lives and arrived at *Amboina*, July the 18th, 1693.

In the Mountains of *Ternata*, a terrible Noiſe is continually heard. The Fire frequently caſts out Stones, and lies exceeding deep. Probably the burning Mountains in the *Molucca* Iſlands are conſumed beneath by the ſame Fire.

Manilla is one of the largeſt of the *Philippine* Iſlands. The City is much larger than *Oxford*, is an Univerſity, and is inhabited only by *Spaniards*. The Houſes are large and built very ſtrong. The lower Walls are Stone, and of a prodigious Thickneſs. All above is Wood, and every Piece of Timber has a Connection with the others, and all are jointed together that the Earthquakes, which are very frequent, may not throw them down. In 1750, they had an Earthquake with almoſt continual Tremblings for three Months. Then followed an Eruption in a ſmall Iſland, ſurrounded by a large Lake which is unfathomable. The third Day after the Eruption began, there aroſe in the Lake four more ſmall Iſlands, all burning. About a Mile from one of theſe, there is a Fire riſing continually out of the Water, in a Part where there is no Ground for above an hundred Fathom.

A particular Account of a Journey to Mount *Hala*, is given by a late Author. We travelled, ſays he, two Days in rugged and unfrequented Roads. Then we came within ſix Miles of the Mountain, and perceived the Ground ſtrewed with Aſhes and Pumice Stones, over which we paſſed to the Foot of it. The

Weather being ſerene and calm, and no Flames iſſuing out of the Volcano, we reſolved to go to the Top; till being informed by our Guides, that if we went any further, we ſhould be in Danger of falling into Pits, where we might be ſuffocated by the Fumes riſing out of the Earth, all my Company declined it. I told them, if they would ſtay for me, I would go alone. They promiſed they would. So I alighted and prepared to go up, when one of them offered, to go up with me.

Having given our Horſes to our Guides, who ſtayed with the reſt of our Company, we ventured forward, reſolving to reach the Top, and in a ſhort Time ſaw a large Flight of Crows and Vultures, that had their Neſt in the Top of the Mountain. Having aſcended about half a League, we felt the Ground ſhake under us, and heard a terrible Noiſe, in the Bowels of the Earth, juſt as if it was going to burſt open. At the ſame Time there appeared on all Sides Chinks, out of which iſſued bluiſh Flames, with a ſtrong ſuffocating Smell. This made us turn back, for fear of being burnt to Aſhes. But we had ſcarce proceeded thirty Yards back, before a black Cloud of Smoke aſcended out of the Mountain, obſcured the Light of the Sun, and covered us ſo thick, that we could not ſee each other. Our Fears increaſed every Step we took; for behind us came Flames of Fire, with Showers of Aſhes and Pumice Stones, which fell as thick as Hail. This dreadful Storm was attended with horrible Noiſes, and we expected every Moment, the Earth would open and ſwallow us up. This added Wings to our Flight, ſo that in a Quarter of an Hour we got to the Bottom of the Mountain.

P. 63. Of the great Earthquake at *Port-Royal*, in *Jamaica*, an Eye-witneſs writes thus. It happened on January 7, juſt before Noon, and in the Space of two Minutes, ſhook down and drowned nine Tenths of the Town. The Houſes ſunk outright thirty or forty Fathom. The Earth opened and ſwallowed up

the

the People, in one Street and threw them up in another: Some roſe in the Middle of the Harbour. While the Houſes on one Side of a Street were ſwallowed up, thoſe on the other were thrown on Heaps. The Sand in the Street, riſing like Waves in the Sea, lifted up every one that ſtood upon it. Then ſuddenly ſinking into Pits, the Water broke out and rolled them over and over. Sloops and Ships in the Harbour were overſet and loſt: The Swan Frigate was driven over the Tops of many Houſes. All this was attended with a hollow, rumbling Noiſe. In leſs than a Minute, three Quarters of the Houſes, with their Inhabitants, were all ſunk under Water: And the little Part which remained was no better than an Heap of Rubbiſh. The Shock threw People down on their Knees or their Faces, as they ran about to look for Shelter. Several Houſes which were left ſtanding, were removed ſome Yards out of their Places. One whole Street was made twice as broad as before. In many Places the Earth cracked, opened and ſhut, with a Motion quick and faſt. And two or three Hundred of theſe Openings, might be ſeen at a Time. In ſome of theſe People were ſwallowed up, in others caught by the Middle and preſt to death. In others, the Heads of Men only appeared, in which Condition Dogs came and ate them. Out of ſome of theſe Openings, whole Rivers of Water ſpouted up a prodigious Height: And out of all the Wells the Water flew, with a ſurprizing Violence. The whole was attended with a noiſome Stench, and the Noiſe of falling Mountains at a Diſtance, while the Sky in a Minute's Time turned dull and reddiſh, like a glowing Oven. And yet more Houſes were left ſtanding at *Port-Royal*, than in all the Iſland beſide. Scarce a Planter's Houſe or Sugar-work was left throughout all *Jamaica*. A great Part of them was ſwallowed up, frequently Houſes, People and Trees at one Gap, in the Room of which there afterwards appeared, a large Pool of Water. This when dried up, diſcovered nothing but Sand, without any Mark that Houſe or Tree had

had been there. Two Thouſand People loſt their Lives: had it been in the Night, few would have eſcaped. A Thouſand Acres of Land were ſunk: One Plantation was removed half a Mile from its Place. Yet the Shocks were moſt violent among the Mountains. Not far from *Yall-houſe*, Part of a Mountain, after it had made ſeveral Leaps, overwhelm'd a whole Family and great Part of a Plantation, though a Mile diſtant. A large Mountain, near *Port Royal*, about a Day's Journey over, was quite ſwallowed up, and in the Place where it ſtood, remained a Lake, four or five Leagues over. Vaſt Pieces of Mountains with all the Trees thereon, falling together in a confuſed Manner, ſtopped up moſt of the Rivers, till ſwelling abroad, they made themſelves new Channels, tearing up every Thing that oppoſed their Paſſage, and carrying with them into the Sea, ſuch prodigious Quantities of Timber, that they ſeemed like moving Iſlands. In *Liguania* the Sea retiring from the Land, left the Ground dry for two or three Hundred Yards. But it returned in a Minute or two and overflowed a great Part of the Shore. Thoſe who eſcaped from the Town got on board the Ships in the Harbour, where many continued two Months: The Shakes all the Time being ſo Violent, that they durſt not come on Shore. The noiſome Vapours occaſioned a general Sickneſs ſwept away three Thouſand of thoſe that were left.

The following Account of this memorable Event is given by the Rector of *Port-Royal*.

On Wedneſday, June 7, I had been reading Prayers, (which I have read every Day ſince I came to *Port-Royal*, to keep up ſome Shew of Religion among a moſt ungodly People) and was gone to the Preſident of the Counſel. We had ſcarce dined, when I felt the Ground heave and roll under me. I ſaid, "Sir, what is this?" He replied compoſedly, "It is an Earthquake. Be not afraid; it will ſoon be over." But it increaſed more and more: And preſently we heard the Church and the Tower fall. Upon this we

ran

ran to ſave ourſelves: I quickly loſt him; and ran toward *Morgan's-Fort*; as that was a wide, open Place, and ſecure from the falling Houſes. As I ran, I ſaw the Earth open, and ſwallow up Multitudes of People, and the Sea mounting over the Fortifications. I then laid aſide all Thought of eſcape, and went homeward, to meet Death in as good a Poſture as I could. I was forced to go through two or three narrow Streets, the Houſes fell on each Side of me. Some Bricks came rolling over my Shoes, but none hurt me. When I came to my Lodging, I found all Things in the ſame Order that I left them. I went to the Balcony, and ſaw that no Houſes in our Street was fallen. The People ſeeing me, cried to me, to come and pray with them. When I came into the Street, every one laid hold on my Cloaths and embraced me. I deſired them to kneel down in a Ring, and prayed with them near an Hour, till I was almoſt ſpent between the Exerciſe, and the Heat of the Sun. They then brought me a Chair, the Earth working all the Time, like the rolling of the Sea, inſomuch that ſometimes while I was at Prayers, I could hardly keep on my Knees. By the Time I had been half an Hour longer with them, in ſetting their Sins before them, and exhorting them to Repentance, ſome Merchants came, and deſired me to go on Board one of the Ships in the Harbour from the Top of ſome Houſes which lay Level with the Water. I got into a Boat and went on Board the *Six-Merchant*. The Day when this happened was exceeding clear, and afforded no Suſpicion of Evil. But about half an Hour paſt Eleven, in leſs than three Minutes, *Port Royal*, one of the faireſt Towns in the *Engliſh* Plantations, was ſhattered in Pieces, and left a dreadful Monument of the Juſtice of God.

About ten Years after the Town was rebuilt a terrible Fire laid it in Aſhes. Yet they rebuilt it once more. But in the Year 1722, an Hurricane reduced it a third Time to an Heap of Rubbiſh. Warned by

theſe

these extraordinary Calamities, which seemed to mark it out as a devoted Spot, they removed the public Offices from thence, and forbad any Market to be held there for the future.

Perhaps we have not in History many more remarkable Deliverances than that of this good Man. But more remarkable, if possible, is the following Deliverance, from a Danger of a very different Kind.

In the Neighbourhood of *Demonte*, as one descends through the upper Valley of *Stura* towards the Middle of the Mountain, there were some Houses in a Place called *Bergemolletto*, which on the 19th of March, in the Morning (there being then a great Deal of *Snow*) were entirely overwhelmed by two vast Bodies of Snow, that tumbled down from the upper *Alps*. All the Inhabitants were then in their Houses, except one *Joseph Rochia*, a Man of about 50. Two and twenty Persons were buried under this Mass of Snow, which was 60 *English* Feet in Height. Many Men, were ordered to give them Assistance; but were not able to do them the least Service. After five Days, *Joseph Rochia*, got upon the Snow, (with his Son, and two Brothers of his wife) to try if they could find the Place under which his House and Stable were buried; but they could not. However the Month of April proving very hot, and the Snow beginning to melt, this unfortunate Man was again encouraged to use his best Endeavour. On the 24th, the Snow was greatly diminished, and he conceived Hopes of finding out his House by breaking the Ice. He thrust down a long Pole, but the Evening coming on, he proceeded no farther. His Wife's Brother dreamed the same Night, that his Sister was still alive, and beg'd him to help her. He rose early in the Morning, told his Dream to *Joseph* and his Neighbours, and went with them to work upon the Snow, where they made another opening, which led them to the House, they search-

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ed for: but finding no dead Bodies in its Ruins, they ſought for the Stable which was about 240 *Engliſh* Feet diſtant, and having found it, they heard a Cry of "Help my dear Brother." Being greatly ſurprized as well as encouraged by theſe Words, they laboured till they had made a large opening, thro' which the Brother went down, where the Siſter with a feeble Voice told him "I have truſted always in God and you, that you would not forſake me." The other Brother and the Huſband then went down, and found ſtill alive the Wife about 45, the Siſter about 35, and a Daughter about 13 Years of Age. Theſe they raiſed on their Shoulders to Men above, who pulled them up, and carried them to a neighbouring Houſe; they were unable to walk, and ſo waſted, that they appeared like mere Shadows.

Some Days after the Intendant came to ſee them, and they gave him the Account that follows. In the Morning of the 19th of March, we were in the Stable, with a Boy ſix Years old, and a Girl about 13. In the ſame Stable were ſix Goats, one of which had brought forth two dead Kids the Evening before; there were alſo an Aſs and five or ſix Fowls. We were ſheltering ourſelves in a Corner of the Stable, till the Church-bell ſhould ring, intending to attend the Service. The Wife wanting to go out of the Stable to kindle a Fire for her Huſband, then clearing away from the Top of the Houſe, ſhe perceived a Maſs of Snow breaking down towards the Eaſt, on which ſhe went back into the Stable, ſhut the Door and told her Siſter of it. In leſs than three Minutes they heard the Roof break over their Heads, and alſo Part of the Ceiling of the Stable. The Siſter adviſed her to get into the Rack and Manger, which ſhe did very carefully. The Aſs was tied to the Manger, but got looſe by ſtruggling, and though it did not break the Manger it threw down the little Veſſel which the Siſter took up, and uſed afterwards to hold the melted Snow, which ſerved them for Drink. Very fortunately the Manger was under the

main

main Prop of the Stable, and thereby reſiſted the Weight of the Snow. Their firſt Care was to know what they had to eat; the Siſter had in her Pockets fifteen Cheſnuts: The Children ſaid they had breakfaſted, and ſhould want no more that Day. They remembered there were 30 or 40 Loaves in a Place near the Stable, and endeavoured to get at them but were not able, by Reaſon of the Snow. On this they called out for Help as loudly as they could, but were heard by nobody. The Siſter came again to the Manger after ſhe had tried in vain to come at the Loaves, gave two Cheſnuts to the Wife, and eat two herſelf, and they drank ſome Snow-water. All this While the Aſs continued kicking, and the Goats bleated very much, but ſoon after they heard no more of them. Two of the Goats however were left alive, and were near the Manger, they felt them carefully, and knew by ſo doing that one of them was big, and would kid about the Middle of April; the other gave Milk, wherewith they preſerved their Lives.

The Women affirmed, that during all the Time they were buried, they ſaw not one Ray of Light; nevertheleſs, for about twenty Days, they had ſome Notion of Night and Day; for when the Fowls crowed, they imagined it was break of Day, but at laſt the Fowls died. The ſecond Day, being very hungry, they eat all the remaining Cheſnuts, and drank what Milk the Milk-goat yielded, which for the firſt Days was near two Pounds a Day, but the Quantity decreaſed gradually. The third Day, being very hungry, they again endeavoured to get to the Place where the Loaves were, but they could not penetrate to it. They then reſolved to take all poſſible Care to feed the Goats, as very fortunately over the ceiling of the Stable, and juſt above the Manger, there was an Hay-loft with a Hole, through which the Hay was put down into the Rack. This Opening was near the Siſter, who pulled down the Hay and gave it to the Goats, as long as ſhe could reach it, which when ſhe could no longer do, the Goats climbed

climbed upon her Shoulders, and reached it themſelves. On the ſixth Day the Boy ſickened, complaining of violent Pains in the Stomach for ſix Days, on the laſt of which he deſired his Mother, who all this Time had held him in her Lap, to lay him at his Length in the Manger. She did ſo, and taking him by the Hand felt it was very cold: She then put her Hand to his Mouth, and finding it likewiſe very cold ſhe gave him a little Milk; the Boy then cried, "O my Father in the Snow! Oh! Father! Father!" and then expired.

The Mother told the Siſter, the Boy was dead, and then laid him in the Manger, where the Siſter was. In the mean while the Milk given by the Goat diminiſhed daily, and the Fowls being dead, they could no more diſtinguiſh Night and Day; but according to their Calculation the Time was near when the other Goat ſhould kid, which as they computed would happen about the Middle of April; at Length they found the Goat was kidding by its Cries, the Siſter helped it; they killed the Kid to ſave the Milk for their own Subſiſtance. And now they knew it was the Middle of April. Whenever they called this Goat it would come and lick their Faces and Hands, and gave them every Day two Pounds of Milk, for which they ſtill bear a great Affection to it.

During all this Time, Hunger gave them but very little Uneaſineſs, except on the firſt five or ſix Days, their greateſt Pain was from the extreme Coldneſs, of the melted Snow-water, which fell on them; from the Stench of the dead Aſs, dead Goat, and Fowls; but more than all, from the uneaſy Poſture they were obliged to continue in; for though the Place in which they were buried was twelve *Engliſh* Feet long, eight wide, and five high, the Manger in which they ſat ſquatting, againſt the Wall, was no more than three Feet four Inches broad.

Lima

Lima in *Peru* contains about 60000 Perſons. In 1747 an Earthquake laid three Fourths of the City Level with the Ground. *Callao*, the Port of *Lima*, containing three or 4000 Inhabitants, was totally deſtroyed. Only one Man eſcaped, and that by a very ſingular Providence. He was going to ſtrike the Flag on the Fort, that overlooked the Harbour, when he ſaw the Sea retire to a conſiderable Diſtance, and then return, ſwelling Mountain high. The Inhabitants ran from their Houſes, in the utmoſt Degree of Terror and Confuſion. A cry for Mercy aroſe from all Parts: And immediately all was ſilent, the Sea had quite overwhelmed the City, and buried it for ever in its Boſom. But at the ſame Time it drove a little Boat to the Side of the Fort, into which the Man leaped and was ſaved.

May we not impute to Earthquakes, thoſe huge Cavities in the Earth, which are found in ſeveral Parts of *England?* Such is *Pooles-hole*, about half a Mile from *Buxton*, in *Derbyſhire*, ſaid to have been the Refuge of one *Poole*, a noted Robber. It is at the Foot of a Mountain: Its Entrance is low and narrow; but it preſently opens, into a broad and lofty Concavity, of above a Mile in Length. The Water dropping from the Roof, congeals into a Kind of Chryſtal, and forms a thouſand ſurprizing Figures. Here is alſo a large, clear Stone, reſembling Alabaſter, which the Queen of *Scots* when here, called *her Pillar*, and it ſtill goes by that Name. Along the Middle a Stream of Water falls among the Rocks, which loudly echoes through the Vault. The moſt ſurprizing Thing is, the Height of the Arch, and the ſpangled Roof reſembling Fret-work. And indeed the Drops of Water which petrifying as they fall, form Icicles reſembling Chryſtal above, and Pyramids hardened into Stone below, have a ſurprizing Effect from the Light of the Candles: The hanging Drops dazzling the Eyes, as if this mighty Arch was covered with Diamonds.

Elden-

Elden-hole is a frightful Chaſm in the Middle of a Field, fifty or ſixty Feet long, and about Twenty broad. But how deep it is, could never be diſcovered, notwithſtanding all the Attempts that have been made. Mr. *Cotton* endeavoured to fathom it with a Line of ſixteen hundred Yards; but in vain. Some ſuppoſe theſe to have been Paſſages, whereby the Waters of the Deluge, returned from the Surface of the Earth to the Great Abyſs.

A late ingenious Writer aſcribes all Earthquakes to the ſame Cauſe, *Electricity*. The Impreſſion, ſays he, they make on Land and Water, to the greateſt Diſtances is inſtantaneous. This can only be effected by *Electricity*. In the late Earthquake the Concuſſion was felt through the Space of an hundred Miles in Length, and forty in Breadth at the ſame Inſtant. Now what could throw a Tract of Land, of four thouſand ſquare Miles in Surface, into ſuch an Agitation in a Moment? No natural Power is equal to this; but that of Electricity, which alone acknowledges no Bounds, neither any ſenſible Tranſition of Time. The little Damage done by moſt Earthquakes, is another Argument, for their being occaſioned, by a ſimple Vibration of the Earth through an electric Shock. This Vibration on the Water, meeting with the ſolid Bottoms of Ships, occaſions that Thump which is felt by them. That this ſhakes Millions of ordinary Houſes, and yet not one of them falls, is a farther Proof, that it is not a Convulſion in the Bowels of the Earth, but an uniform Vibration along its Surface, like what we occaſion in a Glaſs, by rubbing our Finger on the Edge: Which yet may be brought to ſuch a Pitch, as to break the Glaſs in Pieces, by an electric Repulſion of its Parts.

There can be little Doubt, but ſome Earthquakes are owing to Electricity; but many more are owing to other Cauſes: Thoſe of *Callao*, *Lima*, *Port-royal*, for Inſtance, were unqueſtionablyowing to Water: Thoſe in the Neighbourhood of *Ætna* and *Veſuvius*,

with thoſe in the *Eaſt-Indies*, to Lakes of Fire. The grand Fault is therefore, the aſcribing them either to Electricity, or any one Cauſe, excluſive of the Reſt: Whereas ſome are owing to each of theſe Cauſes: Some to ſeveral of them acting conjointly.

V. II. P. 73. One who accurately obſerved it, gives the following particular Account of a *burning Well.*

"In the latter End of February, I went to ſee a Spring in the Road, which leads from *Wigan* to *Warrington*. When we came to it, and applied a lighted Candle to the Surface of the Water, there was ſuddenly a large and vigorous Flame produced. But having filled a Cup with Water at the flaming Place, and held a lighted Candle to it, it went out. Yet the Water at that Place boiled like Water over a Fire; though when I put my Hand into it, it did not feel ſo much as warm. This boiling ſeems to proceed from ſome ſulphureous Fumes, the Spring being not above 40 Yards from a Coal pit, and all the Country for many Miles round being underlaid with Coal.

When the Water was drained away, I applied the Candle to the Surface of the Earth where the Water burned before. The Fumes took Fire and burnt very bright and vigorous, the Flame aſcending a Foot and an half from the Ground: And the Baſis of it was as broad as a Man's Hat at the Brims. It was not diſcoloured like that of Sulphur, nor had any Scent. I ordered a Bucket of Water to be poured on the Fire, and it was immediately quenched."

There is a Spring of the ſame Kind at *Broſely*, near *Wenlock* in the County of *Salop*. It was diſcovered in June 1711, by a terrible Noiſe in the Night, which awaked ſeveral People in their Beds, who deſiring to know what it was, roſe up, and coming to a boggy Place under a little Hill about 200 Yards from the *Severn*, perceived a mighty rumbling and ſhaking of

the

the Earth, and a little Water boiling up through the Graſs. When they dug up ſome of the Earth, the Water flew up to a great Height, and a Candle that was in their Hand ſet on Fire. There is now (viz. in 1711) an Iron Ciſtern round the Spring, with a Cover, having a Hole in the Middle of it. If you put a lighted Candle to the Hole, the Water takes Fire, and burns like Spirits of Wine. It burns as long as you keep the Air from it; but if you take up the Cover it goes out. The Heat of this Fire exceeds that of common Fire. Some People after they have ſet the Water on Fire, have put a Kettle of Water over the Ciſtern, with a Joint of Meat in it. It was boiled much ſooner than it could be, by any artificial Fire. If you put Wood, or even green Boughs upon it, it preſently conſumes them to Aſhes. The Water of itſelf feels as cold as any common Water. Nay, if you put your Hand into it as ſoon as the Fire is out, it feels as cold as if there had been no Fire near it. But it ſtill continues boiling up, with a conſiderable Noiſe.

But this Well was loſt for many Years. The poor Man in whoſe Land it was, miſſing the Profit he uſed to have by ſhewing it, uſed all his Endeavours to find it again, and in May 1744, hearing a rumbling Noiſe under the Ground, a little nearer the River than the former Well was, he lighted upon it again. For five or ſix Feet deep, it is above ſix Feet wide. Within this is a ſmaller Hole, of like Depth dug in the Clay, in the Bottom of which is a cylindric earthen Veſſel, four or five Inches Diameter, having the Bottom taken off, and the Sides fixt in the Clay. Within the Pot is brown Water, thick as Puddle, continually forced up with a violent Motion and a hollow Noiſe, raiſing and falling by turns, five or ſix Inches. Upon putting a Candle at the End of a Stick, within a Quarter of a Yard, it took Fire, darting and flaſhing in a violent Manner, about half a Yard high, much like Spirits

in a Lamp, but with a greater Agitation. The Man ſaid, that it had made a Tea Kettle boil in nine Minutes, and that it would burn 48 Hours without any ſenſible Diminution. It was extinguiſht by putting a wet Mop upon it. And ſtill the Water felt very cold. The Well lies about thirty Yards from the *Severn*, which in that Place, and for ſome Miles above and below, runs in a Vale full an hundred Yards perpendicular below the Level of the Country on either Side.

There is a Fire of the ſame Kind at *Pietra Mala*, a Village on the *Apennines*. The Flame is extremely bright, covers a Surface of three Yards by two, and uſually riſes about four Feet. After great Rains or Snows, the whole bare Patch, about nine Yards diameter, flames. The Gravel, out of which it riſes, at a very little Depth, is quite cold. There are four of theſe Fires in the Neighbourhood: The Middle of the Ground whence one of them riſes, is a little hollowed, and has in it a Puddle of Water, thro' which there are ſtrong Ebullitions of Air. This Air will not take Fire; but that which riſes through the wet and cold Gravel, flames briſkly.

A Fire of a ſtill ſtranger Nature appeared in *Wales*, about Chriſtmas, 1693. A fiery Vapour came from the Sea, and moved up and down for many Weeks. It ſet on Fire ſixteen Ricks of Hay at *Harlech*, in *Merionethſhire*, and two Barns, and annoyed the Country, as well by poiſoning the Graſs, as firing the Hay. It was a blue, weak Flame, and did no Harm to the Men who tried to ſave the Hay, though they ventured even to touch it. An intelligent Perſon who lived near *Harlech*, informed his Friend ſome Time after, "The Fire ſtill continues there. It comes over a Part of the Sea, from a maſhy Place in *Carnarvonſhire*, eight or nine Miles off. The Graſs over which it moves, kills all Manner of Cattle that feed upon it, Sheep, Goats, Swine, Cows and Horſes.

But

But what is very remarkable is, that any great Noiſe, as beating a Drum or ſounding an Horn, effectually repells it from any Houſe, or Barn, or Stack of Hay."

P. 76. Perhaps a larger Account of ſo remarkable an Incident will not be unacceptable to the curious Reader.

The Counteſs, *Cornelia Bandi*, in the 62d Year of her Age, was all Day, as well as uſual. When ſhe was in Bed, ſhe paſſed two or three Hours in talking with her Maid; then ſhe fell aſleep. The Maid going into her Chamber in the Morning, ſaw four Feet diſtant from the Bed, an Heap of Aſhes, and two Legs with the Stockings on. Between them was Part of the Head; but the Brains, half the Scull, and the whole Chin were burnt to Aſhes. The Aſhes when taken up, left in the Hand a greaſy and ſtinking Moiſture. The Bed received no Damage; the Cloaths were raiſed on one Side, as by a Perſon riſing from it.

Doubtleſs the Fire was kindled within her by the Juices and Fermentations in the Stomach, by the many combuſtible Matters which abound in living Bodies, for the Uſes of Life. Theſe in Sleep, by a full Reſpiration, are put into a ſtronger Motion, and conſequently are more apt to take Fire.

Borelli obſerves, That ſuch Accidents often happened, to great Drinkers of Wine and Brandy. Such Flames would frequently riſe in us, if the natural Moiſture did not prevent.

Undoubtedly ſhe was burnt ſtanding; hence her Skull was fallen between her Legs, and the back Part of her Head was damaged more than the Forepart, partly becauſe of her Hair, partly becauſe in the Face, there were many Places, out of which the Flames might paſs.

An Inſtance of the ſame Kind occured at Chriſt Church in *Hampſhire*, on June 26, 1613. One *John*

Hitchell, a Carpenter of that Pariſh, having ended his Day's work, came Home and went to Reſt with his Wife. Her Mother being frightened in her Sleep, called to them for Help. None anſwering, ſhe ſtarted up and waked her Daughter, who found her Huſband dead by her Side. She dragged him out of the Bed into the Street; but the Fire then forced her to let him go. He lay burning there for three Days. Not that there was any Appearance of Fire outwardly, but only a Smoke aſcending from his Carcaſe, till it was burnt to Aſhes: Except only a ſmall Part of his Bones, which were caſt into a Pit.

Grace Pett, was a Fiſherman's Wife, of the Pariſh of St. *Clement's*, in *Ipſwich*, about Sixty. She had a Cuſtom for ſeveral Years of going down Stairs every Night, after ſhe was undreſt, to ſmoke a Pipe. Her Daughter, who lay with her, did not miſs her till the Morning, April 10, 1744, when going down Stairs, ſhe found her Mother's Body, extended over the Hearth, with her Legs on the Deal Floor, and appearing like a Block of Wood, burning with a glowing Fire without Flame. The Neighbours coming in at her Cries, found the Trunk of the Body in a Manner burnt to Aſhes. It then appeared like an Heap of Charcoal, covered with white Aſhes, the Head, Arms, Legs and Thighs were alſo much burnt. A Child's Cloaths on one Side of her, and a Paper-ſcreen on the other, were untouched. The Deal Floor alſo, on which her Legs lay, was neither ſinged, nor diſcoloured.

Almoſt as ſtrange, tho' not attended with any ill Conſequence, was the following Incident. In November, Mrs. *Suſanna Sewall*, Wife to Major *Sewall*, in *New England*, obſerved a ſtrange Flaſhing of Sparks in all the Apparel ſhe put off, which continued till Candlemas. In the Company of many Perſons, ſhe ſent for ſeveral Parts of her Wearing Apparel, and when they were ſhaken, Sparks flew out, making a

Noiſe,

Noiſe, much like Bay-leaves thrown into the Fire. One Spark light on Major Sewall's Thumb-nail, without any Heat, and continued at leaſt a Minute before it went out. They cauſed Mrs. *Sewall* one Day to put on her Siſter *Digge*'s Petticoat; and when ſhe put it off at Night, it ſparkled as her own uſed to do.

P. 76. There are few Phænomena relative to *Glaſs* more hard to be accounted, than that of the *Bologna* Bottle, ſo called becauſe it was firſt diſcovered at *Bologna*. If you let theſe Bottles fall from ſome Height on a Brick-floor, they will not be broken; but drop into them ſome little hard Body, and they will burſt in Pieces. I took one of theſe, ſays Dr. *I.* which held near a Pint, and let it fall five Feet and an half on a Brick-floor, and it was not broken. I dropt into it a Bit of Flint, weighing eleven Grains, and immediately it burſt in Pieces.

I dropt into another Bottle a Ball of Lead, weighing 140 Grains, into a Third a Piece of *Braſs*, weighing 300 Grains, when neither of them was broken.

Theſe Glaſſes only differ from common Phials in this, they have not cooled gradually in what is called, the *nealing Furnace*, but are expoſed to the open Air as ſoon as formed. They reſiſt hard Blows from without. I have given to ſome violent Strokes with a Mallet, and they have not broke. They likewiſe do not break, though ſeveral heavy Bodies be dropt into them. I have dropt into them from the Height of three Feet, Muſket-balls, and Pieces of Iron, Braſs, Gold, without any Effect; but when I dropt into it from the Height of three Inches, a Shiver of Flint no bigger than a ſmall Pea, in about two Seconds the Glaſs flew. Having tried the Experiment on ſeveral others with the ſame Piece of Flint, moſt of them broke in the Moment of the Stroke, the reſt one or two Seconds after it.

I let fall into ſeveral Glaſſes a Flint of half the Size, and they flew in like Manner. I let fall into one, a Flint no larger than a Grain of Sand; ſhook the Glaſs, and ſet it down. I did the ſame with four others. In about half an Hour, one of them flew, and the other four ſoon after.

I let fall into one a Sapphire ſet in a Ring: And though the Bottom of the Glaſs was near an Inch thick, the Sapphire paſſed through it as through a Spider's Webb. The Glaſs flew all Ways, and the Ring remained on the Table juſt where it fell.

A Bit of China, half a Line thick and two Lines broad, broke ſeveral Glaſſes; ſo did a Bit of Glaſs of the ſame Size, ſo did Diamonds alſo. And a very ſmall Piece of tempered Steel, broke all the Glaſſes into which I dropped it.

Some large, hollow Cups made at *Worceſter* of common Green Glaſs, much larger than the others, and ſome of them above three Inches thick at the Bottom, though they were not affected by a Muſket-ball dropt from the Height of near three Feet, were inſtantly broken with a Shiver of Flint, weighing but two Grains.

Equally ſtrange are the Phænomena of the *Glaſs-drop*. The Make of this Drop is as ſimple, as its Explanation is difficult. They take up a ſmall Quantity of melted Glaſs on the Top of an Iron Rod, and let it drop into a Pail of Water. When it does not break in the Operation, it forms the *Glaſs-drop*. This is of ſuch Firmneſs, that it bears ſmart Blows of an Hammer without breaking. But if you break but the Tip of the ſmall End, the Whole ſhatters into Powder. This ſhattering is attended with a loud Report, and the Powder ſcatters all around. If the Experiment be made in the Air-pump, the Drop burſts more impetuouſly, and the Duſt is finer than when it burſts in the open Air. This is the plain Matter of Fact. I do not undertake to account for it.

Near the Bay of *Acre* in *Paleſtine* runs a little River, now called *Kardanah*, ſuppoſed to be the antient *Belus*, famous for its Sand, much uſed in making *Glaſs*, and ſaid to have given Riſe to the Invention of it. The *Sidonians* are reported to have made this Diſcovery, from the following Accident. Some travelling having reared an Hearth on the Sand of this River with large Pieces of Nitre, and ſet ſome Fern on Fire under a Kettle, in order to boil their Victuals, perceived the Sand and Nitre to melt and incorporate with the Fern-aſhes, and preſently after, to run in a tranſparent Stream, which hardened as it cooled. From hence the Hint of making Glaſs was taken, which was gradually improved to its perfect Uſe and Beauty.

P. 84. Many have imagined, that the animal Fluids are furniſhed with *Air* by the Lungs only. But undoubtedly they are alſo ſupplied therewith, by Way of the chyliferous Canals: And that in no ſmall Quantity. For the Air, like all other animal Fluids, requires to be perpetuallyrenewed accordingly old Particles fly off every Moment, and new ones ſucceed in their Place.

It may be demonſtrated, that Urine contains much Air. Doubtleſs ſo does the perſpirable Matter: Which being the lighteſt of all animal Fluids, is the chief Vehicle of the effete and uſeleſs Air.

That *fixt Air* is a *cemmenting* Principle appears (to omit others) from that well known Experiment. Quicklime diſſolves fleſh, by extracting and imbibing the fixt Air, which it contained. But while the Fleſh falls in Pieces from the Loſs of the Principle, the Lime grows ſolid by having it reſtored.

That it contributes alſo to the *Diſſolution* of Bodies appears hence. Duriug the Progreſs of *Putrefaction*, a volatile Matter flies continually from the putrifying Subſtance. And this is no other than Air, which is now extricated and thrown off from a fixt and unelaſtic State, but immediately returns to it again, on meeting with a proper Recipient.

The preſerving Bodies from Putrefaction, depends almoſt

moſt in every Inſtance, on reſtraining the Flight of the fixt Air. For as this cements their conſtituent Parts, ſo Putrefaction which is the Diſunion of them, cannot take Place while this Remains.

And this Air both corrects and prevents putrid Acrimony in the animal Fluid. Hence any Food which does not contain a due Proportion of it, is found to promote Putrefaction: As do all damaged Vegetables, which being incapable of Fermentation, are incapable of producing the due Quantity of Air.

But there is an amazing Difference between the *fixt*, and the *common* Air, with Regard to their Effects upon animal Bodies. The fixt Air even when ſet free, and in a State of perfect Elaſticity, whether it be during the firſt Stage of Fermentation by Fire, by Effervescence, or by Putrefaction; if it be received into the Lungs of any Animal, cauſes inſtant Death. But the ſame Air, when received into the Stomach, whether thrown off by effervescent Mixtures in Medicine or extricated from the Food by natural Fermentation; in the firſt Inſtance often operates like a Charm, in reſtraining Vomitings; and in the ſecond is abſolutely needful, for the Support of Life and Health.

With regard to the *common* Air, on the contrary, no Animal can live long without taking large Quantities of it into the Lungs. Yet if a ſmall Portion of it be forced into the Blood-veſſels of any Animal, Death preſently enſues.

So that theſe two Species of Air have quite different Provinces, with Reſpect to animal Life. The firſt common Air, muſt mix wholly with the Blood; The ſecond only communicates ſome ſubtle Matter to it. Perhaps electric Fire, which we know is connected with every Particle of common Air.

Oil of Vitriol when expoſed to the *Air*, continually increaſes in Weight. Let a Phial of this ſtand unſtopped, and it will be conſtantly running over. Perhaps the Cauſe of this odd Phenomenon is, the Moiſture contained in the Air, which this Liquor, a potential

tential Fire, imbibes as greedily, as actual Fire does Nitre.

P. 87. After *Pieces.*

At the Height of forty-one Miles, the Air is so rarified, as to take up three thousand Times the Space it does here. At fifty three Miles high, it would be expanded thirty thousand Times as much as it is here. But it is probable, the utmost Power of its Spring, cannot produce so great an Expansion: And that no Part of the Atmolphere extends above forty five Miles from the Surface of the Earth.

At that Distance, (as was observed) it is expanded into three thousand Times the Space it occupies here. And we have seen it condensed into the sixteenth Part of the same Space. It seems then, that the Air is capable of being condensed into the hundred and eighty thousandth Part of the Space it would take up when free from Pressure. But what Texture must it be of, to make it capable of this immense Expansion and Contraction? How imperfectly is this accounted for, by comparing it to Wool, Cotton, and the like elastic Bodies?

CHAP III.

Of Meteors.

1. *How Vapours ascend.*
2. *Experiments on Dew.*
3. *What causes the Drops of Rain to be round?*
4. *Salt Rain.*
5. *Of Snow.*
6. *An uncommon Meteor.*
7. *Another.*
8. *A fatal Damp.*
9. *An unusual Murrain.*
10. *Ignis faturi.*
11. *Luminous Fish and Flesh.*
12. *Observations on Phosphorus.*
13. *All Diamonds emit Light.*
14. *Parallel between luminous Wood and live Coal.*
15. *—— between Electricity, Light and Magnetism.*
16. *Ether of Plants.*
17. *Of West-Indian Hurricanes.*
18. *Of Water-spouts.*
19. *Of Storms on the Fetter.*

P. 89. TO explain the Aſcent of *Watery Vapours*, it may be obſerved, that the Parts of Water being ſo ſmall and moveable, are eaſily ſeparated from one another. And when they are ſo divided into ſmall Parcels, as to become about eight hundred Times lighter than common Water, they are as light as the Air, and will by every ſucceſſive Degree of Separation, riſe in the Air in Proportion to their Lightneſs, the heavier Air forcing the rarified Fluid to aſcend into the Atmoſphere, till it finds a Place where it reſts in Equilibrium among bodies of equal Lightneſs to itſelf. This Separation or Comminution (if I may ſo call it) of Water into ſmall Parcels, may be performed either by Colliſion againſt harder and more compact Bodies, or by heat. The firſt we often ſee performed at the Bottom of Caſcades, where the Water that falls but a few Fathoms, ſhall riſe in a Miſt *from* the Bottom where it is broke; and there are Inſtances of Clouds riſing from the Fall of Waters, which may be ſeen five Miles off. Colliſion will therefore excite Vapours; but what is more conſtantly producing this Effect in every Part of the Univerſe, is Heat; whether from the Sun, which is always buſy this Way, or from artificial Ignition, or that generally inviſible elemental Fire which is diſtributed through all Matter. It has been by many Naturaliſts imagined, that heat, raiſes Vapours by extending the Air in the Pores of Water, and forming gradually a thin Film or Bubble of Water, of ſuch Dimenſions that it becomes greatly lighter than the ſame Space of common Air, and therefore riſes above it: but this Suppoſition is not tenable; for it is obſerved, that Steam will riſe in the Receiver of an Air Pump, where, tho' there remains ſome Air, there is not enough to conſtitute ſuch a Proceſs. It may here alſo be added that Earth, Stones, and Metals may be raiſed into the Atmoſphere, altho' their Parts will not form bubbles as thoſe of Water will. As this generally allow'd Suppoſition cannot be ſupported, ſo neither is it neceſſary for us to conſider

conſider in this Caſe, any other than the Diviſibility of Water, and the inſinuating and diſperſive Qualities of Fire. Fire, we ſee, ſeparates more or leſs the Parts of all Bodies, whether fluid or ſolid, and makes them riſe in the Air; and it does no more to Water: It ſeparates it, into ſuch ſmall Portions, that the Air is more ponderous than the Steam, and of Conſequence remains nearer the Earth, by its ſuperior Gravitation.

P. 90. A *Pewter* Plate placed all Night in the open Air, receives no Dew on its *upper-ſide*, but the *under-ſide* is covered with it. On the contrary, place a China Plate near it, and the upper-ſide of it is quite wet, but the under-ſide is quite dry. So one receives the Dew only on the upper, the other only on the under Surface!

Mr. *Kerſhaw* has obſerved, that Dew newly gathered and ſtrained, is not very clear, but of a yellowiſh Colour:

That when he endeavoured to putrify it, by various Degrees of Heat, he quite failed of his Intention: For Heat rather clariſied and preſerved it ſweet, than cauſed any Putrefaction;

That after it had been expoſed to the Sun, corked up for a whole Summer, there was no other Change than that much green Stuff (ſuch as we ſee in ſtanding Water) floated on the Top.

That after it had been expoſed to the Sun many Weeks in an open Glaſs, it was full of little Inſects, like Tadpoles, which in a while dropt their Skins, and became Gnats:

That vapouring away, great Quantities of this Dew, he procured two Pounds of greyiſh Earth, which lay in Leaves, one above another, like brown Paper, but very friable.

Laſtly, that by often calcining and filtring this Earth, he extracted two Ounces of a fine, ſmall, white *Salt*, which much reſembled Rock Salt, when it was viewed thro' a Microſcope.

By what Power are the *Drops of Rain* ſo equally diſperſed? This may be ſhewn by an eaſy Experiment. Put a Quantity of Braſs-duſt into an electric Phial. When this is charged, invert it, and throw ſome of the Duſt out. This will be ſpread over a flat Surface, with exact Uniformity, and will fall juſt like Rain or Snow. 'Tis highly probable, this is the Caſe with the Clouds. Being highly electrified, they of Courſe ſpread their Contents equally, over the Surface of the Earth.

P. 91. A few Years, during a violent *Storm* of Wind, much Rain fell in the weſtern Part of *Cornwall*, which was mere Sea-water, as ſalt as that which was juſt taken out of the Sea. It ſeemed to have been drawn out of the Sea, and thrown upon the Land in the ſame Hour: So that there was no Time for that wonderful Operation of Nature, whereby the Water that aſcends in Clouds, is freed from its ſalt and bituminous Particles, before it falls to the Earth.

Why is Snow, tho' it ſeems to be ſoft, truly hard? Becauſe it is true Ice. It ſeems ſoft, becauſe at the firſt Touch of the Finger on its ſharp Edges or Points, they melt. Otherwiſe they would pierce the Finger, juſt as ſo many Lancets.

But why, tho' it be true Ice, which is an hard and denſe Body, is it ſo very light? Becauſe of the extreme Thinneſs of each Icicle, in Compariſon of its Breadth. So Gold, the moſt ponderous of all Bodies, when beaten into Leaves, rides upon the Air.

Why is it white? Becauſe its Parts, tho' ſingly tranſparent, yet muſt appear white when mixt together: As do the Parts of Froth, of powdered Glaſs, and other tranſparent Bodies, whether ſoft or hard.

P. 95. Of what Kind was that *Meteor* which appeared March 21, 1676? Two Hours after Sun-ſet, it came over the *Adriatic* Sea, from E. N. E. to W. S. W. and croſſed over all *Italy*, being nearly vertical to

to *Rimini* on the one Side, and *Leghorn* on the other. It was at leaſt thirty-eight Miles high. In all Places near its Courſe, it made a hiſſing Noiſe, like a Sky-rocket. Having paſt *Leghorn*, it gave a Sound like that of a large Cannon, and quickly after like a Cart running over Stones. It was computed to move 160 Miles in a Minute, which is above ten Times as ſwift as the diurnal Motion of the Earth. Its ſmaller Diameter was judged to be above half a Mile. No wonder then that ſo large a Body, moving with ſuch incredible Swiftneſs thro' the Air, tho' ſo much rarefied, ſhould cauſe that hiſſing Noiſe. 'Tis much harder to conceive, how ſuch an Impetus could be impreſſed upon it? How this Impetus ſhould be determined, in a Direction ſo nearly parallel to the Horizon? And what Sort of Subſtance it muſt be, that cou'd be ſo impelled and ignited at the ſame Time? Whatever it was, it ſunk, and was extinguiſhed in the *Tyrrhene* Sea, to the W. S. W. of *Leghorn*. The great Noiſe was heard, on its Immerſion into the Water; the Rattlings ſound upon its quenching.

On Thurſday, March 19, 1719, there appeared at *London*, about eight at Night, a ſudden great Light, moving after the Manner, but more ſlowly than a falling Star, in a direct Line, a little beyond, and withall below *Orien's-Belt*, then in the South Weſt. In its Way it turned tapering upward, and at laſt ſpherical, near as big as the Full Moon. It was whitiſh, with an Eye of blue, as bright as the Sun in a clear Day. It ſeemed in half a Minute to move twenty Degrees, and to go out, as much above the Horizon. There remained after it for more than a Minute, a Track of a reddiſh Colour, ſuch as that of red-hot Iron; and Sparks ſeemed to iſſue from it, ſuch as come from red-hot Iron beaten upon an Anvil.

Within Doors the Candles gave no Light; and without, not only the Stars diſappeared, but the Moon, nine Days old, tho' the Sky was clear, and

ſhe was then near the Meridian: So that for ſome Seconds, we had perfect Day. It's Height was ſeventy-three Miles and a half. Hence it might be ſeen in all Places, which were not diſtant from it more than two Hundred and twenty Leagues. Accordingly it was ſeen at the ſame Inſtant, over *Spain*, *France*, *Great-Britain*, *Ireland*, *Holland*, and the hither Parts of *Germany*.

P. 96. An Inſtance of the fatal Nature of foul Air happened at *Boſton* in *New England*. Mr. *Adams* and his Servant being employed to repair a Pump, uncovered the Well, and Mr. *Adams* went down by a Rope; but he had not gone ſix Feet, before he dropt ſuddenly without ſpeaking a Word, to the upper Part of the Joint of the Pump, where being ſupported about a Minute, and breathing very ſhort, he then fell to the Bottom, without any Signs of Life. His Servant haſtily went down, to help his Maſter; but at the ſame Diſtance from the Top, was ſtruck, and without diſcovering any Signs of Diſtreſs, fell to the Bottom. The Workmen prepared a Third, with a Tackle about his Waſte. On his Deſcent, he was quickly Speechleſs and ſenſeleſs. Tho' he made no Sign, they drew him up. He was the very Picture of Death, but by the Uſe of proper Means recovered. He remembered nothing of what had paſſed. The other Bodies when taken up, had all the Marks of a violent Death.

May we aſcribe to a Kind of Damp, a Sort of Murrain, which appeared in *Italy*, and made great Havock among the Cattle? It ſpread itſelf in the Form of a blue Miſt, over thoſe Paſtures where they grazed: So that whole Herds came home ſick, and moſt of them died in 24 Hours. Many who went among them, were infected, and died in the ſame Manner. Some imputed this Contagion to noxious Vapours, thrown out of the Earth, by Earthquakes preceeding. It paſſed thro' *Germany* to *Poland*, going without Intermiſſion, eleven or twelve Miles in twenty-four Hours, and

and ſuffering no Cattle in its Way to eſcape, whether within Doors or without. Hence others imagined it was owing to ſome volatile Inſect, which was able to make but ſhort Flights.

P. 97. In all the Territory of *Bologna*, the *fiery Appearances*, vulgarlycalled Will with the Wiſp, are common. There are ſome Places where one may be almoſt ſure of them, every dark Night, as near the Bridge *Della Salcarata*, and in the Fields of *Bagnara*. Both theſe are large: Some Times equal to the Light of a Faggot, rarely leſs than that of a Link. That at *Bagnara* not long ſince kept a Gentleman company for a Mile moving juſt before him, and caſting a ſtronger Light on the Road, than the Link he had with him.

All of them reſemble a Flame, and are continually in Motion, but the Motion is various and uncertain. In Winter, when the Ground is covered with Snow, they are moſt frequent of all. Nor does Rain hinder them: Nay, in wet Weather they give the ſtrongeſt Light: Wind alſo does not diſturb them. As they are not hindered by wet, and ſet nothing on fire, ho' ever ſo combuſtible, may it not reaſonably be ſuppoſed, that they have ſome Reſemblance to that Kind of *Phoſphorus*, which ſhines indeed in the Dark, yet does not burn like common Fire?

The following Experiments ſhew a little more of the Nature of this ſtrange Subſtance.

Salt of *Phoſphorus*, kept in a vitrifying Heat, a laſt runs into perfect Glaſs What a wonderful Subject is this? And how ſurpriſing it is, that ſo ſmall a Body ſhould become Glaſs! Here then is a perfect Tranſmutation of Bodies: The Phoſphorus being tranſmuted into a tranſparent Glaſs of a blue green, coming nearer the Hardneſs of a Diamond than any other Glaſs whatever. And the Glaſs is in the very ſame Quantity with the Phoſphorus, which produces it Ounce for an Ounce.

Another odd Circumſtance relating to Phoſphorous is, cut it ſmall, or ſcrape it with a Knife, and lay it on a Glaſs Diſh in moiſt Air. In a Week it reſolved into a Liquid, near eighty-times its original Weight. This Liquid is the ſame in all Reſpects, with that which comes from the ſublimed Flowers by Deflagation. And this may be turned into the ſame Glaſs with the original Phoſphorus.

P. 99. Some boiled *Mackrel* having been left in the Water for pickle, the Cook a Day or two after, ſtirring the Water, found it become very luminous. Wherever the Drops of it fell on the Ground they ſhined. The next day we repeated the Trial. The Water ſtill ſtirred, gave no light; but when gently ſtirred by the Hand, it ſhone bright; and by a briſker Motion it ſeemed to flame. The Fiſh ſhone, as well from the Inſide as the out. The Fiſh were not yet either fetid or inſipid. When fetid, they did not ſhine at all.

The chief Circumſtances which Mr. *B.* noted concerning *luminous Fleſh* were, 1. It was a Neck of Veal, bought ſome Days before: 2. In this about twenty Places ſhone, tho' not alike: 3. Moſt of theſe were as big as the Nail of a Man's Finger, and irregularly ſhaped: 4. The Parts which ſhone moſt were the griſly, or the bruiſed Parts of the Bones: 5. Some of theſe were ſo bright, that holding a printed Paper to them, I could read ſeveral Letters: 6. One could not diſcern in any of them the leaſt Degree of Heat, neither of Putrefaction: 7. One of theſe being put into a Cup of cold Water, the Light continued the ſame.

Not only Water, Fiſh and Fleſh, but ſome Sort of *Wood* will ſhine as bright as a burning *Coal*. And herein they agree, 1. Both have Light *in themſelves*: 2. Both need the Air, to make them continue ſhining: 3. Both having loſt their Light, by being deprived of Air, recover it, when freſh Air is let in: 4. Both are eaſily quenched by Water, and 5. Neither of them is affected by the Coldneſs of the Air.

But

But herein they differ: 1. The Light of a Coal is put out by Compreſſion: That of Wood is not: 2. The Coal is quite extinguiſhed by withdrawing the Air: That of the Wood is only eclipſed: Let the Air in again within half an Hour, and it immediately recovers: 3. A Coal put into a ſmall, cloſe Glaſs, will not burn many Minutes: A Piece of Wood will ſhine many Days: 4. A burning Coal emits much Smoke: Shining Wood, none at all.

P. 99. Accurate Obſervers have found, that any *Diamond*, by an eaſy Friction in the Dark, by the Finger or a Woollen Cloth, appears in its whole Body to be luminous: And if it has been rubbed a good while, it will keep its Light for a little Time. If when the Sun is ſet, one hold up a Piece of Flannel, ſtretched tight between both Hands at a little Diſtance, and another rubs the Diamond ſwiftly and ſtrongly on the other Side of it, the Light to the Eye of him that holds the Cloth, ſeems much more pleaſant and perfect. What is more ſurprizing is, that a Diamond expoſed to the open Air, in view of the Sky, (even without being in the Sunſhine) gives nearly the ſame Light of itſelf without rubbing, as when rubbed in a dark Room. But if you hold your Hand or any Thing elſe over it, to hinder its Communication with the Sky, let it lie ever ſo long in the open Air, yet it will give no Light.

A well-poliſhed Piece of *Amber*, will yield Light, if rubbed in the Dark.. And if it be drawn ſwiftly thro' a Woollen Cloth, very many little Cracklings are heard, and each produces a little Flaſh of Light. If drawn gently, it produces a Light, but no crackling. Are not moſt of theſe Circumſtances eaſily accounted for on the Principles of Electricity?

P. 111. Prop. 1. *Electricity* in common with *Magneſm* counteracts, and in light Subſtances overcomes the

the Force of Gravity. Like that, it exerts its Force *in vacuo*, as powerfully as in the open Air. And this Force extends to a conſiderable Diſtance, thro' various Subſtances of different Textures and Denſities.

Prop. 2. In common with *Light*, Electricity pervades Glaſs; but it ſuffers no Refraction. Its Direction is ſtill in Right Lines, and that through Glaſſes of different Forms, included one within the other, and large Spaces left between them.

Indeed the electric Attraction through Glaſs is much more powerful, when the Glaſs is made warm: Becauſe warm Glaſs does not condenſe the Water from the Air, which makes the Glaſs a Conductor of Electricity: And alſo becauſe as Heat inlarges the Dimenſions of all known Bodies, and conſequently makes their conſtituent Parts recede from each other, the electric Effluvia find a more eaſy Paſſage thro' the Pores.

Prop. 3. Electricity in common with Light, when its Forces are collected, produces Fire and Flame.

That the electric Matter is far more ſubtle than Air appears, from its paſſing thro' thoſe Bodies which Air cannot penetrate, Glaſs in particular. And that it is elaſtic, appears from its encreaſing the Motion of Fluids, and from its extending itſelf to a conſiderable Diſtance round excited Bodies.

Do not all theſe Experiments ſhew, that the electric Matter, is pure, elementary Fire, an original, diſtinct Principle, formed by the Creator himſelf? And not, as ſome have apprehended, mechanically producible from other Bodies?

And may it not be doubted, whether this be not the only *elaſtic* Body in the Univerſe? Whether it be not the original Spring, which communicates Elaſticity to all other elaſtic Bodies? To the Air in particular: Which is elaſtic no longer, when detached from electric Fire, but commences *fixt* and unelaſtic; and ſeems to recover its Elaſticity, only by recovering that ethereal Fire which had been violently ſeparated from it?

P. 118. Next in Subtelty to this ethereal Fluid, the *Ether of Plants* appears to be. It ſeems to be deſtitute of all groſs Air. For exhauſt this ever ſo accurately, it remains unmoved, and does not emit any Air-bubbles, which immediately ariſe in other Liquors. A little of it poured on the Hand, gives a Senſe of Cold, equal to that cauſed by the Contact of Snow. Blow upon it once or twice, and your Hand is dry. It cauſes an Hiſſing when poured upon warm Water, as if a Piece of hot Iron were thrown into it. Put a Lump of Sugar which has imbibed a little of it, into a Veſſel full of hot Water, the Sugar ſinks; but the Ether ruſhing forth, excites a ſtrong Ebullition. If a Spoonful of it be poured into a Copper-pot, full of boiling Water; hold a Candle near, and inſtantly there iſſues a great Flaſh of Lightning. Hence it appears, that this Ether, is both a very fluid Water, and a moſt ſubtle Fire: So that if kindled in a Thouſand Times the Quantity of cold Water, it burns inextinguiſhably.

It does not manifeſt the leaſt Oilineſs to the Touch; yet is it the true, natural Diſſolvent of all fat Oils and Gums whatever.

It has wonderful Harmony with Gold, even greater than that which is between Gold and Aqua Regia. Diſſolve a Piece of Gold in Aqua Regia: On the Solution cold pour half an Ounce of Ether. Shake the Glaſs and all the Gold will paſs into this, and the Aqua Regia robbed of all its Gold, will depoſit a white Powder, which ſoon turning green, is the Copper wherewith the Gold was adulterated. Ether then is the moſt noble and efficacious Inſtrument in Chymiſtry, and Pharmacy, inaſmuch as Eſſences and eſſential Oils are extracted by it immediately, without the Mediation of Fire, from Woods, Barks, Roots, Herbs, Flowers, Seeds, and the various Parts of Animals.

For

For inſtance. Take Mint, Sage, Cinnamon or all together, cut and bottle them; pour on them a Spoonful or two of Ether, and after it has ſtood an Hour in a cool Place, fill up the Bottle with cold Water, and preſently you will ſee the eſſential Oil, ſwimming upon the Water. In like Manner, tho' not ſo immediately, it extracts the pureſt Gold from any of the baſer Minerals. And the Gold thus extracted, is better and ſooner purified by this one Operation, than by fuſion with Antimony. It is the lighteſt of all Liquors. Seven Ounces of this fill a Phial, which contains twenty even of Oil of Vitriol. And it is the pureſt Flame, leaving neither Soot nor Aſhes after its Deflagration.

The *Heat* in the *Weſt-India* Iſlands would be intolerable, if the Winds riſing as the Sun gathers Strength, did not blow from the Sea, ſo as to temper the Heat even of the Noon-day Sun. On the other Hand, as the Night advances, a Breeze ariſes from the Land, and blows as from its Center toward the Sea, to all Points of the Compaſs at once. It is in the rainy Seaſons the *Hurricans* come, and deſtroy at a Stroke the Labours of many Years. They are ſudden and violent Storms of Wind and Rain, attended with a furious ſwelling of the Sea, and frequently with an Earthquake. As a Prelude, whole Fields of Sugar-cane are inſtantly whirled into the Air. The ſtrongeſt Trees of the Foreſt are torn up by the Roots, and driven about like Stubble. The Windmills are ſwept away in a Moment; the Copper-Boilers and Stills, of ſeveral hundred Weight are wrenched from the Ground, and battered all in Pieces.

P. 210. *Hurricans* are foreſeen at the *Antiſles* by a Calm, and then a ſhifting of Breezes from all Quarters; the Sun ſets Blood red, ſmall Clouds fly to and fro with great Rapidity. Sea Birds quit the Air and ſeek the Shore. Soon after a North Breeze ſprings up, which comes to the North Eaſt. Afterward it is South

South and South-Eaſt, and the Air is darkened by a black Cloud.

In the laſt Hurrican, the Wind ſtood at North-Eaſt, and blew with ſuch Violence, that the largeſt Trees were torn up the Roots, their Trunks broken to Pieces, and not a Leaf left on thoſe other Trees, which yielded to the Fury of the Winds. The Houſes were thrown down, and the Tops of the Sugar-mills, which could not well be thrown down were cruſhed in Pieces. At the End of an Hurrican we ſee Lightning, and hear the Noiſe of Thunder. Then the Wind ſoftens gradually, till all becomes quiet.

When there was a violent Hurrican on *Guadeloupe*, there appeared upon the Iſland, a thick black Cloud, which ſeemed on Fire, and gravitating toward the Earth. It occupied a Space of five or ſix Leagues in Front. Above it the Air was almoſt clear, there appearing only a Kind of Miſt. The whole Force of an Hurrican is lodged, in the very Body of a Cloud, containing Winds, Rain, Lightning and Thunder: Where the Air is compreſſed, and rolling upon itſelf, cauſes the Storms, which nothing can reſiſt. Nor does the Hurrican end, till the Cloud burſts and the Thunder and Lightning come on.

P. 120. It is not univerſally true, that the Tube of a *Water-ſpout* touches the Sea, before the Water riſes at all, for Water-ſpouts happen ſeveral Ways. Sometimes the Water is ſeen to boil and raiſe itſelf for a conſiderable Space about a Foot from the Sea, before the Tube touches it. Above this there appears as it were a thick and black Smoke, in the midſt of which is a Sort of Pipe, reſembling a Tunnel reaching up to the Clouds. At other Times theſe Tunnels come from the Clouds, and ſuck up the Water with great Violence. Sometimes theſe diſcharge themſelves into the Sea, to the unavoidable Deſtruction of ſuch Ships as are in their Way: Sometimes on the Shore, beating

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ing down all they meet with, and raiſing the Sand and Stones to a prodigious Height.

A very diſtinct Account of this Kind was given ſometime ſince by an Eye-witneſs. "We were on the Coaſt of *Barbary*, when three Water-ſpouts came down: One of them bigger than three Maſts, the other two ſcarce half as big: All of them were black, as the Cloud from which they fell; all ſmooth, and ſmaller at the lower End. Sometimes one became ſmaller, and then larger again; ſometimes it diſappeared, and quickly fell down again.

There was always a great boiling and flying up of the Water, like the Appearance of a ſmoaking Chimney in a calm Day. Sometimes it ſtood as a Pillar ſome Yards above the Sea, and then ſpread itſelf and ſcattered like Smoak. One Spout came down to the very Middle of this Pillar, and joined with it. Afterwards it pointed to the Pillar at ſome Diſtance, firſt in a perpendicular, and then in a oblique Line.

It was hard to ſay, whether this Spout fell firſt from the Cloud, or the Pillar roſe firſt from the Sea, both appearing oppoſite to each other, as in the twinkling of an Eye. But in another Place the Water roſe up to a great Height, without any Spout pointing to it. Only here, the Water did not riſe like a Pillar, but flew ſcatteringly, and advanced as a moving Buſh upon the Surface of the Sea. This proves, that the riſing of the Water may begin, before the Spout from the Cloud appears.

All theſe Spouts, but eſpecially the great one toward the End began to appear like a hollow Canal, along the Middle of which one might diſtinctly perceive the Sea-water fly up very ſwiftly: Soon after the Spout broke in the Middle, and diſappeared by little and little; the boiling up, yea the Pillar of Sea-water, continuing a conſiderable Time after.

There is ſomething very uncommon in the *Fetter*, a Lake which parts *Eaſt* and *Weſt-Gothland*. It is about

about eighty Miles long and eighteen broad. Its Water is very clear, and in ſome Places ſo deep, as not to be ſounded by a Line of 300 Fathom. It is often diſturbed by Storms, which ſometimes begin ſo ſuddenly, that the Surface of the Water is agitated before the leaſt Breath of Wind is perceived. And it is not uncommon, for Boats in one Part of the Lake to be toſt by a violent Storm, while others at a ſmall Diſtance, are in a perfect Calm. Immediatly before a Storm, while the Sky is clear, a Noiſe is perceived in the Lake like Thunder. Of this the Inhabitants of *Viſingore*, an Iſland in the Middle of the Lake, are more ſenſible than any others. For from that Part of the Iſland, whence the Wind will blow, they hear a Noiſe like the firing of Cannon. Whenever this is heard in the Eaſt, they expect Hail and Rain to follow. Undoubtedly all theſe Storms are owing to ſubterraneous Winds. To theſe likewiſe we may attribute the ſudden cracking of the Ice upon the Lake in the Spring. This is one Minute ſtrong enough to bear Horſes and Sledges, and the next, broken in Pieces. A ſtrange Noiſe underneath, which precedes the Breach, warns Travellers to make the beſt of their Way. But thoſe who happen to be at a great Diſtance from Land are ſwallowed up, unleſs they can float upon Shoals of Ice, till they meet with Relief. The violent *Under-currents* obſerved in this Lake, are alſo very ſurprizing. Theſe directly oppoſing the Winds, give the Fiſhermen a great deal of Trouble. From theſe, as well as from its unfathomable Depths, it is ſuppoſed to have a Communication under Ground, with another Lake called *Venner*, about forty Miles to the Weſtward.

Part the Fifth.

Of the Syſtem *of the* World: *Of the* Heavenly Bodies, *of the* Cauſes *and* Properties *of Natural Bodies.*

CHAP. I.

Of the Syſtem of the World.

1. *The Orbit of the Planets continually leſſens:*
2. *The Sun ſtays longer in the Northern Signs:*
3. *Advantages from the Rotation of the Earth.*

V. II. P. 141. WHAT a ſtrange Diſcovery is that, which has been lately communicated by an eminent Profeſſor to the Royal Society? "Having carefully examined, the modern Obſervations of the Sun, with thoſe of ſome Centuries paſt, though I have gone no farther back than the fifteenth Century, yet I have obſerved that the Motion of the Sun, (or of the Earth) is ſenſibly accelerated ſince that Time, ſo that the Years are ſhor-

ter

ter now than formerly. The Reaſon of this is very natural. For if the Earth in its Motion ſuffers ſome Reſiſtance, (which cannot be doubted ſince the Space through which the Planets paſs, is full of ſome ſubtle Matter, were it no other than Light) this Reſiſtance will gradually bring the Planets nearer and nearer the Sun. And as their Orbits thereby become leſs, ſo their periodical Times will be diminiſhed. Thus in Time the Earth would come within the Region of Venus, then of Mercury, where it would neceſſarily be burnt. Hence it is manifeſt, that the Planetary Syſtem cannot laſt for ever in its preſent State: As alſo that this Syſtem muſt have had a Beginning; otherwiſe, there muſt have been a Time when the Earth was at the Diſtance of Saturn: Conſequently, no living Creature could ſubſiſt there. This then is a clear Proof, that the World in its preſent State had a Beginning and muſt have an End.

We may likewiſe find Reaſon to think, from the Action of Jupiter on the Earth, that the Earth's Revolution round its Axis, continually becomes more and more rapid. For the Force of Jupiter ſo accelerates the Motion of the Earth round the Sun, that the Diminution of the Years would be ſenſible, if the diurnal Motion had not been accelerated nearly in the ſame Proportion.

It is another Obſervation of Aſtronomers, That the Sun does not ſhine as long on one Side the Line as on the other; that he ſtays longer in the ſix Northern Signs, than in the ſix Southern: So much longer, as to make no leſs a Difference, than that of nine Days. How is this? Did the Earth always obvert her Northern Hemiſphere to the Sun ſo much longer than the Southern? Or has ſhe gradually warped ſo much to one Side, in a Courſe of near 6000 Years?

Let us conſider the Advantages ariſing to us by the *Rotation* of the Earth about its own Axis. We are

ſo made, that once in ſixteen or twenty Hours almoſt, we require a Time for Relaxion. And generally, in healthful People, this Time is pretty equal, between ſix and eight Hours. The Storehouſes of our Spirits will not permit a longer Application than twenty Hours, without Injury to our Conſtitutions. And about ſix Hours are required to fill them again.

It was likewiſe neceſſary, that the Air ſhould be cool and temperate, during the Time of this Reſt; for we generally find thoſe that ſleep while the Sun is above the Horizon, the worſe for it, the Sun and Heat exhaling the natural Perſpirations too violently, and raiſing too quick a Motion in the Blood. And though we generally perſpire more in the Night, yet the Perſpiration is more natural and leſs violent, and more according to the Neceſſities of our Conſtitution, in the Night than in the Day. Beſides, the Darkneſs is leſs ſubject to Noiſe and Diſturbance than the Day. Now all theſe Things are wonderfully provided for, by the Rotation of the Earth about its Axis. For thereby we have the Viciſſitudes of Day and Night, the Day for ſpending our Spirits, the Night to recruit them; as alſo for nouriſhing the Muſcles, Bones, Channels, and other Parts of the Body; for the Buſineſs of Nutrition is moſtly, if not altogether, performed in the Time of Reſt. Likewiſe, how comfortable and refreſhing are the cool Breezes of the Night; and the Trade-winds to thoſe that live under the Equatorial Parts? Without which, Life would both be exceeding ſhort and very grievous.

Theſe Winds, are the neceſſary Effect of the Rotation of the Earth about its Axis, which under the Line makes the Rays of the Sun direct and equal all the Year round; ſo that theſe Parts being conſtantly under the Sun's Influence, his Heat rarifies one Part of the Air, and the cooler and heavier Part preſſes upon the hotter, and ſo makes a continual Wind in his Courſe from Eaſt to Weſt.

Moreover,

Moreover, let us reflect upon our Vegetables which are the Support of Animals; the Sun rarifies and conſequently raiſes the fizy Vegetable Juices at the Roots of the tender Seeds, and thereby forces the folded Branches to expand and enlarge. Now, were the Sun conſtantly ſhining upon them, theſe Juices would not be at Liberty to ſettle, and conſolidate in the fit Places of the Branches; but would be ſtill riſing higher and higher, till at laſt they burſt the Canals; whereas by this Viciſſitude of Heat and Cold, what is raiſed in the Day-time, has Time to ſettle and conſolidate in the Night. Its Cold runs the thin Juices into fizy Subſtances, which the ſupervinding Heat, by exhaling the watery Parts, hardens and fixes. On the other Hand, had not the Earth moved upon its Axis, but only turned round the Sun in its annual Period, we had not only loſt all theſe Advantages, which are ſo neceſſary for both Animals and Vegetables, but had ſuffered alſo ſuch Inconveniencies, as neither of theſe could poſſibly bear. For near half the Year, we ſhould have been in perpetual Darkneſs, the Conſequence of which would have been, that baleful Damps (by the preceeding Heat, generated and raiſed) would have fallen, which would have ſtifled all Animals. Or had they ſurvived that, Snow, Ice and Froſt, would not only have locked up all Fluids, but would have freezed the Blood and Spirits in the Channels, of all the Animals we are acquainted with.

Again, in the enlightened half of the Year, we ſhould have had, huge Deluges of Water, from the preceeding Snow which likewiſe would have produced ſuffocating Miſts. Next all our Ground would have turned into a ſtiff, ſlinking Puddle, being in a Manner diſſolved by the Snow-water. Then would ſultry Heats and a burning Air, have ſcorched and chapped the Earth, and gall'd the animal Tribes, ſo that they would have found Reſt, neither in Houſes nor Dens, till at laſt, the Blood and Spirits of all the Animals of our Globe, would be quite exhaled, or-

by the violent Agitation thereof, they would turn delirious.

Upon all theſe Accounts, the Rotation of the Earth, about her Axis, is one of the moſt ſignal Inſtances of Divine Wiſdom.

P. 145. What Benefits do we receive from our *Moon?* Firſt, the ſupplying Light in the Night-time, for at leaſt three Fourths of the Year. Now how comfortable and delightful a Thing this is, Travellers and Voyagers can beſt tell. Curioſity, Ambition, Luxury, and ſometimes Neceſſity have made it unavoidable, that ſome Part of Mankind ſhould be travelling by Land or Sea, in the Night Seaſons. How pleaſant then is it, to have a Light held out from *Heaven*, to guide our Steps, to direct us in our Courſe, and to point out to us how our Time wears out?

Secondly, ſhe raiſes our Tides, twice in twenty-four Hours, which is abſolutely neceſſary towards the Subſiſtence both of Animals and Vegetables. Every Body knows that a Lake that has no freſh Water running into it, will by the Heat of the Sun in a few Months, and its Stagnation, turn into a ſtinking, rotten Puddle, ſending forth nauſeous and poiſonous Steams. And though many thouſand Rivers daily run into the Sea, yet they are very inconſiderable, in Reſpect of the vaſt Ocean of Salt-water; and would by no Means hinder its Stagnation, and conſequently its Corruption and ſtinking. Now ſuppoſe the Ocean ſtagnated, the firſt Effect would be, all the Places towards the Shores, would be wrought upon by the Sun, and turned to a Memphitis. Then it would get farther, till the whole were become more baneful and poiſonous than the Lake of *Sodom* and *Gomorrah*. Hereby the Fiſhes would be firſt deſtroyed, and afterwards the Plants and Animals: But by this Action of the Moon, the Waters

Waters are lifted up on a Heap, as it were, and then let fall again, whereby the Waters near the Shores are conſtantly ſecured from Stagnation and Corruption, and the beginning Malady ſtifled. This perpetual Change of new Water on the Shores, keeping any one Portion thereof, from being expoſed to the Sun long enough, to have its Mixture corrupted. Now, what a noble Contrivance have we here! By appointing an Attendant to our Earth, all the Animals and Vegetables are preſerved from certain deſtruction. Though indeed to the full Effect of this wiſe Deſign, the Salt of the Sea does very much contribute; as there are many ſaline Rocks and Mountains diſperſed over the Foundations of the great Ocean. Beſides this, how many Conveniencies for our Navigation in Rivers and Harbours does this ebbing and flowing of the Sea afford? Yet if our Earth had more than one Moon attending it, we ſhould receive more Damage than Advantage, by it; for tho' hereby our Light in the Night might be augmented, yet at theirConjunctions and Oppoſitions with one another, and with the Sun, we ſhould have Tides that would raiſe the Waters over too much of our dry Land; and in their Quadratures we ſhould have no Tide at all. Again, if our Moon were bigger or nearer the Earth, or if we had more than one, at any tolerable Diſtance from us, we ſhould be every now and then in Hazard of being ſtifled by the noxious Steams ariſing from the Ocean. From all which it is evident, how wiſely our Satelite has been contrived for our Purpoſes.

P. 148. If the Uſes aſſigned to the *Comets*, by Sir *Iſaac Newton*, be real, as they are not improbable, Nature by the ſupplying the Deficiency and Expences of all Sorts of Fluids neceſſary to the Earth; I mean not only Light and Heat to the Sun, and watry Vapours to our Atmoſphere, but the moſt ſubtle,

tle, moſt uſeful, and neceſſary Part (towards Life and Vegetation) to the Air: Then theſe wandering frightful Bodies, may be juſtly conceived joining in the Chorus, and loudly reſounding the common Hallelujah.

CHAP II.

Of the Heavenly Bodies.

1. *Doubts concerning the Modern Aſtronomy:*
2. *Mr. Kennedy's Objections to it:*
3. *Mr. Boyle's Remarks on the preſent State of Philoſophy:*
4. *Dr. W—n's Remarks.*

P. 149. A Year or two after the preceeding Volumes were publiſhed, the little Sketch of Aſtronomy therein given, (or rather my Doubts concerning it) was warmly attacked, in the *London-Magazine*. The Subſtance of thoſe Objections and of my Anſwer, I have here ſubjoined.

SIR,

I am obliged to you for your Queries and Remarks; and ſo I ſhall be to any who will point out any Thing wherein they think I have been miſtaken. It would not be ſtrange, if there ſhould be many Miſtakes in the "Compendium of Natural Philoſophy:" As Philoſophy is what for many Years I have only looked into at leiſure Hours. Accordingly in the Preface of that Treatiſe I ſaid, "I am thoroughly ſenſible, there are many, who have more Ability, as well as Leiſure, for ſuch a Work than me. But as none of them undertakes it, I have myſelf made ſome little Attempt in the following Volumes."

Q. 1.

Q. 1. " You ſay, The Sun is *ſuppoſed* to be abundantly larger than the Earth. Is it not *demonſtrable*, that he is ſo ?"

I do not know whether it is, or no.

Q. 2. " Why do you ſay, the Moon is *ſuppoſed* to be forty-five Times ſmaller than the Earth, when the Moon's Bulk is nicely known ?"

It is not *known* by me, nor, I doubt, by any Man elſe.

Q. 3. " You ſay, Jupiter is ſuppoſed to be twenty-five Times larger than the Earth : And in the next Page, that his Diameter is ſuppoſed to be 130655 Miles. If ſo, is he not 4096 Times larger than the Earth ?"

Undoubtedly. But I do not undertake to defend either one Suppoſition or the other.

Remark 1. " You ſay, P. 148. Even with Reſpect to the Diſtance of the Sun, it is wiſeſt to confeſs our Ignorance. and to acknowledge we have nothing to reſt upon here, but mere uncertain Conjecture."

I did not ſay this, of the Diſtance of the Sun in particular. My Words, P. 146. are, " With Regard to their *Diſtance* from the Earth (the Diſtance of all the Bodies in the ſolar Syſtem) there is ſuch an immenſe Difference in the Calculations of Aſtronomers, even with Reſpect to the Diſtance of the Sun—that it is wiſeſt to confeſs our Ignorance," namely, with Regard to *their* Diſtance.

To prove that we are not ignorant hereof, you ſay " The Knowledge of the Sun's Diſtance depends on finding its Parallax, or the Angle that the Semi-diameter of the Earth appears under at the Sun, which Angle is ſo very minute, that an Error of but a ſingle Second, will give the Diſtance very conſiderably greater or leſs than the true Diſtance." It will : and therefore I doubt, whether the Diſtance of any heavenly Body can ever be known by this Means.

" But Mr. Keil ſays, we are aſſured by various Methods made uſe of to obſerve the Sun's Parallax, that his Diſtance from us is more than twenty-eight Millions

Millions of Miles." He may be aſſured: But I am not. "He ſays farther, two eminent Aſtronomers have ſince determined the Sun's Diſtance to be about ſeventy-ſix Millions of Miles: Now if the leaſt Diſtance poſſible is *abſolutely determined*, how can it be wiſeſt to confeſs our Ignorance?" If it be—But I doubt, it cannot be determined at all; At leaſt, not by the Sun's Parallax: "Seeing this is ſo very minute that an Error of a ſingle Second will give the Diſtance very conſiderably greater or leſs than the true."

R. 2. "In P. 143, you tell us.——The whole Paragraph runs thus. "It is now almoſt univerſally ſuppoſed, that the Moon is juſt like the Earth, having Mountains and Valleys, Seas with Iſlands, Peninſulas and Promontories, with a changeable Atmoſphere, wherein Vapours and Exhalations riſe and fall. And hence it is generally inferred, that ſhe is inhabited like the Earth, and, by Parity of Reaſon, that all the other Planets, as well as the Earth and Moon, have their reſpective Inhabitant's." [I take this to be the very Strength of the Cauſe. It was this Conſideration chiefly, which induced me to think for many Years, that all the Planets were inhabited.] "But after all comes the celebrated Mr. Huygens, and brings ſtrong Reaſons why the Moon is not, and cannot be inhabited at all, nor any ſecondary Planet whatever. Then" (if the firſt Suppoſition ſinks, on which all the reſt are built) "I doubt we ſhall never prove that the Primary are. And ſo the whole Hypotheſis, of innumerable Suns and Worlds moving round them, vaniſhes into Air."

In order to prove, that there are innumerable Suns, you ſay, 1. "It is found by Obſervations on the Parallax of the Earth's Orbit, that a fixed Star is ten thouſand Times farther from the Sun than we are."

I can build nothing on theſe Obſervations, till Parallaxes can be taken with greater Certainty than they are at preſent. Therefore I ſhall want Proof, that any one fixed Star is one thouſand Times farther from the Sun than we are."

2. "They

2. "They are fiery Bodies." I ſuppoſe they are. But this cannot be proved from their Diſtance, till that Diſtance itſelf is proved.

3. "It is demonſtrable, that Sirius is as big as the Sun."

Demonſtrate it who can.

4. "Seeing the fixed Stars are not much leſs than the Sun they are to be eſteemed ſo many Suns:"

Not much leſs! How is this proved? To argue from the Diſtance, is to prove *ignotum per æque ignotum*.

"You ſee, ſir, the Hypotheſis of innumerable Suns, is ſo far from vaniſhing into Air, that it is *almoſt altogether* founded on Demonſtration."

Indeed I do not ſee one Tittle of Demonſtration yet, from the Beginning to the End.

In order to prove that the Planets are inhabited, you ſay, 1. "The Earth is ſpherical, opake, inlightened by the Sun, caſting a Shadow oppoſite thereto, and revolving round it, in a Time exactly porportioned to its Diſtance. The other Planets reſemble the Earth in all theſe Particulars. Therefore they likewiſe are inhabited." I cannot allow the Conſequence.

2. "The Earth has a regular Succeſſion of Day and Night, Summer and Winter. So probably have all the Planets. Therefore they are inhabited."

I am not ſure of the Antecedent. But however that be, I deny the Conſequence.

3. "Jupiter and Saturn are much bigger than the Earth." Does this prove that they are inhabited?

4. "The Earth has a Moon, Jupiter has four, Saturn five, each of them larger than ours. They eclipſe their reſpective Planets, and are eclipſed by them."

All this does not prove that they are inhabited.

5. "Saturn's Ring reflects the Light of the Sun upon him.

I am not ſure of that. And till the Fact is aſcertained, no certain Inference can be drawn from it.

6. "But

6. "But is it probable, God ſhould have created Planets like our own, and furniſhed them with ſuch amazing Apparatus, and yet have placed no Inhabitants therein?"

Of their Apparatus I know nothing: However if all you aſſert be the *Probability* of their being inhabited, I contend not.

7. "They who affirm, that God created thoſe great Bodies, the fixt Stars, only to give us a ſmall, dim Light, muſt have a very mean Opinion of the Divine Wiſdom."

I do not affirm this, neither can I tell, for what other Ends he created them: He that created them knows. But I have ſo high an Opinion of the Divine Wiſdom, that, I believe, no Child of Man can fathom it. It is our Wiſdom to be very wary how we pronounce, concerning Things which we have not ſeen.

R. 10. "Suppoſe ſome intelligent Beings in one of the Planets, who were

Slaves to no Sect, who ſought no private Road,
But look'd thro' Nature up to Nature's God,

viewed the Earth from thence, they would argue, it muſt be inhabited, as we argue that the other Planets are. But the Superſtitious would oppoſe this Doctrine, and call it mere uncertain Conjecture."

I ſee no Argument in this: But perhaps I do not underſtand it. Are you applauding the ſuppoſed Inhabitants of Venus, for not being *Slaves* to the *Chriſtian Sect?* Otherwiſe what has *Superſtition* to do in the Caſe? Why is this dragged in by Head and Shoulders. If there be Superſtition here, it is on *your* Side, who believe, becauſe you *will* believe: Who aſſent to what you have no Evidence for, and maintain what you cannot prove. At preſent, you are the *Volunteer* in Faith: *You* ſwallow what choaks my Belief.

R. 12. "You quote Dr. Rogers"——But I do not undertake to defend his Hypotheſis, or any other: "Our beſt Obſervators could never find the Parallax

of

of the Sun to be above eleven Seconds." But I cannot depend on their Obſervations: Eſpecially when I find one of the chief of them, in computing the Diſtance of the Sun, to ſtride from twenty eight Millions of Miles, to ſeventy-ſix! Near fifty Millions of Miles at once! After this, let any impartial Man judge, what Streſs is to be laid on Parallaxes!

"But Dr. Rogers ſuppoſes the Parallax of the Sun to be five Minutes, which others cannot find to be above eleven ſeconds. Why, Doctor, if this be true," (namely, that the Parallax which was lately but eleven Seconds, is now increaſed to five Minutes) "the Earth has *approximated* thirty Times *nearer*" (a little harmleſs Tautology) "to the Sun." That is, if both the Computation of Mr. Keil, and that of Dr. Rogers be true? But who ever ſuppoſed this? If the one be true, the other is undoubtedly falſe.

"To conclude. Since there is no arguing againſt Facts, and ſince the Sun's Parallax is found not to exceed eleven Seconds, ought you not to give up that Hypotheſis as abſurd and ridiculous?"

Yes, as ſoon as any of thoſe Facts appear: Till then I neither eſpouſe, nor give it up. But I ſtill look upon it as extremely ingenious, and full as probable as any other.

Before I conclude, permit me, Sir, to give you one Piece of Advice. Be not ſo *poſitive*: Eſpecially with Regard to Things which are neither eaſy nor neceſſary to be determined. I ground this Advice on my own Experience. When I was young, I was *ſure* of every Thing. In a few Years, having been miſtaken a thouſand Times, I was not half ſo ſure of moſt Things as before. At preſent I am hardly ſure of any Thing, but what God has reveal'ed to Man.

Upon the whole, an ingenious Man may eaſily flouriſh on this Head, How much more glorious it is for the great God to have created innumerable Worlds, than this little Globe only! But after all, I would aſk one plain Queſtion. Suppoſe there are more Worlds

than there are Sands on the Sea Shore: Is not the Univerſe finite ſtill? It muſt be, unleſs it be God. And if it be finite, it can ſtill bear no Proportion to him that is infinite: No more than this Ball of Earth does. How large ſo ever it be, ſtill, compared to Him it is as nothing, as the ſmall Duſt of the Ballance. Do you aſk then, what is this Spot to the great God? Why, as much as Millions of Syſtems. *Great* and *little* have Place, with Regard to us: But before him they vaniſh away. Inlarge the Bounds of Creation as much as you pleaſe, ſtill it is but a Drop to the Creator.

And ſtill the Power of his Almighty Hand
Can form another World from every Sand!

Yet were this done, there would be no more Proportion between the World, and its Creator, than there is now!

It will eaſily be obſerved, that I do not *deny*, but only *doubt of* the preſent Syſtem of Aſtronomy. But the ingenious Mr. *Kennedy* goes much farther in his *Aſtronomical Chronology*. I beg Leave to preſent the impartial Searchers after Truth, with a ſhort Extract from it.

" Altho' many Perſons of great Abilities have thought ſacred Chronology worthy their moſt diligent Reſearches, yet they have all failed in the main Point. They have taken it for granted, that the ſcriptural Computations are quite Unaſtronomical. The Title of *The World's Chronology* has been fixt to very different Collection of Years, without looking for any ſcriptural, aſtronomical Æra, to ſupport the Title. This is the firſt Attempt of that Kind which has been made.

" I have largely proved the fundamental Propoſition of the following Scheme, namely, That *Moſes* fixes the Poſition of the Sun and Moon with Regard to each other at the Creation. And this revealed Poſition of the Sun and Moon, with Reſpect to each

other

other at the Creation, I call the ſcriptural, aſtronomical Æra.

By Means of this Æra we may keep even Pace with the two great Luminaries, from the firſt Year of the World till now. And till now my Concluſions are confirmed, by the joint Atteſtations of the Sun and Moon, the two *faithful Witneſſes in Heaven*.

By theſe it is fully proved, that Time commenced at our autumnal Equinox, at the fourth Day of the Creation, at the Full-Moon, or the fifteenth Day of the firſt Month of the firſt lunar Year.

"From the autumnal Equinox at the Creation to the ſame in 1761, have elapſed 5768 Years. Indeed *Capellus* ſuppoſes Time to commence two Years, Archbiſhop *Uſher* four Years later. But could the Error of a ſingle Year be diſcovered in the Series I have collected, all would fall to the Ground.

Touching the common Aſtronomy I obſerve, 1. Aſtronomers ſtill divide the Ecliptic into 360 Degrees. But how unnaturally? Three-Hundred ſixty Degrees, and near one-fourth, are undeniably more correſpondent to the Sun's annual Motion. And upon this Diviſion we can make a truer Calculation, than can be made upon any other.

2. The Inequality of ſolar tropical Years, and the Inequality of the Equations of natural Days, are eſtabliſhed Doctrines. But whoever computes the Times of Equinoxes and Solſtices, and ſubmits his Calculations to the Teſt of the lateſt and beſt Obſervations will find no Room for any Equations at all.

3. Aſtronomers unanimouſly maintain, that at the End of 19 luniſolar Years, the mean New Moons, and the mean Full Moons happen, about an Hour and an half ſooner than they did at the Beginning of the Cycle. On the Contrary, I undertake to evince that the very Reverſe of this is true. I allow, that at the End of nineteen luniſolar Years, the Moon departs from the Sun: But it departs from it, not by a

Retroceſſion

Retroceſſion Weſtward, but by a Progreſſion Eaſtward. That is, the mean New Moons, and the mean Full Moons fall out, not an Hour and an Half ſooner, but almoſt two Hours later. Therefore the Doctrine of Lunar Anticipations has no Foundation in Nature.

4. Altho' the Quantity of a *ſolartrophical Year* is a Concluſion in Aſtronomy, yet ſuch an unhappy Fatality has attended this Reſearch, for almoſt two Thouſand Years paſt, that whoever examines the vaſt Variety of Opinions, muſt ſee, nothing has yet been determined with Certainty. So that inſtead of a preciſe and eſtabliſhed Definition, he finds little more than this general Account, that the Quantity of the natural Year has been long and much ſought after, but with ſmall Succeſs: So that it ſeems at this Day to remain among the yet undiſcovered Secrets of Nature.

Indeed to know this with all Exactneſs, one would think no more is needful, than to examine the Table of Obſervations. Let us then examine that made by *Tycho Brahe*, in Queen *Elizabeth*'s Time, and that by Dr. *Bradley*, an Hundred and ſeventy Years after. But in *Tycho*'s Table of twelve Terminations, ſeven of them differ a Minute from the other five. And this Difference perplexes the Concluſion, and leaves it in a State of Uncertainty. Proceed we then to Dr. *Bradley*'s Tables. But theſe leave a Latitude of twenty-one Minutes. Thus we ſee, how imperfect the Knowledge, even of the ſolar tropical Year ſtill is, and that no true Judgment can be formed concerning it, either from Obſervation, or tabular Calculation.

5. It requires no ſmall Skill, even to determine the Diſtances of the Sun's four Stations, at the vernal and autumnal Equinox, and the Summer and Winter Solſtice. Nay it is a Queſtion, whether this Determination likewiſe muſt not ſtill be reckoned among the Secrets of Nature.

And if we would correct the Tables of theſe by Dr. *Keil*'s Rule, yet this very Correction leaves us four

four Different Meaſures, according to the Majority of *Tycho Brahe*'s Corrections, according to Sir *Iſaac Newton*'s, Dr. *Halley*'s, and Dr. *Bradley*'s Corrections. So that ſtill we come to no Certainty, even as to the ſolar Stations. We are at a Stand, like a Traveller, who arriving at a Place where four Ways meet, is at a full Stop, for Want of a clear Direction, which of them to take.

6. The greateſt Aſtronomers are not agreed, even as to the Length of a natural Day.

Mr. *Ferguſon* obſerves,

The fixt Stars appear to go round the Earth in 23 Hours, 56 Minutes, and four Seconds, and the Sun in 24 Hours. Therefore in the 365 Days meaſured by the Returns of the Sun to the Meridian, there are 366 Days as meaſured by the Stars returning to it. The former are called *Solar* Days, the latter *Sidereal*. But whoever will compare this with the Determinations of Dr. *Keil*, will find them flatly contradictory to each other. And the farther he examines the moſt celebrated Writings, the more deeply he will be convinced, that neither the preciſe Length of a ſidereal Day, nor the Complement of the Solar, has yet been determined with Certainty."

Whoever deſires to ſee theſe Propoſitions proved at large, may have Recourſe to the Book itſelf. But if theſe Things are ſo, what becomes of the whole Fabric of even *Newtonian* Aſtronomy? How can I depend on the Calculations of thoſe concerning the Motions of the Heavens, who know ſo little about the Earth? What Inſtruction can they give me concerning other Syſtems, who are ſo unſkilled with Regard to our own? Why does not ſome eminent Aſtronomer undertake this daring Man, who ſo violently attacks the very Foundations of their Building? For if his Remarks are juſt, ſenſible Men will be inclined to think, that after all the Parade of Mathematical Demonſtration, there is little more Certainty in *Aſtronomy* itſelf, than even in judicial Aſtrology!

And how juſt are the great Mr. *Boyle's* Remarks, upon the whole of *Natural Philoſophy?* "The moſt, ſays he, even of modern Virtuoſo, fancy more Certainty in their Phyſical Theories than a critical Examiner will find. I will touch only on two Subjects, which we commonly think are, and which ſurely ought to be, moſt throughly underſtood: I mean, the Nature of *Body in general*, and the Nature of *Senſation*. As to the firſt, ſince we can turn ourſelves no Way, but we are inviroued by corporeal Subſtances, one would think, an Object that ſo many Ways affects our Senſes, ſhould be perfectly known to us. And yet the Notion of Body in general, or what it is that diſcriminates Bodies from other Subſtances, is not by any Means agreed, even among the modern Philoſophers. And indeed no Account of it which has yet been given, will extricate us out of the Difficulties of that no leſs perplexed than famous Diſpute. "Of the Compoſition of Bodies." But the Difficulties attending this, will, till they are removed, ſpread a thick Night over the Notion of Body in general. For either a corporeal Subſtance is diviſible into extended Parts, and each of theſe diviſible into other Parts ſmaller and ſmaller *in infinitum*, or this Diviſion muſt ſtop ſomewhere. But there are Inconveniences, not to ſay Abſurdities, urged againſt either of theſe Suppoſitions. The Objections on both Sides are ſo ſtrong, that the moſt ſenſible and candid Men, after having tired themſelves and their Readers with ſtriving to ſolve them, have at Length owned them to be inſoluble.

"But tho' we do not underſtand the Nature of Body in general, muſt we not perfectly underſtand what paſſes within ourſelves, in Reference to the particular Bodies we daily ſee, and hear and ſmell, and taſte and touch? Theſe we know by our Senſes: But how little do we know, of the Manner wherein our Senſes inform us of any Thing? Senſation, we allow, is not performed by the Organ, but by the Mind perceiving the Motion produced in the Organ. Aſk

then

then a Philoſopher, how the Soul comes to be wrought on, and that in ſuch various Manners, by thoſe external Bodies, which are the Objects of our Senſes? He will tell you, that by the Impreſſions on the Organs, they variouſly move the nervous Fibres, wherewith thoſe Parts are endowed, by which the Motion is propagated to the Brain: Where theſe Motions being perceived by the Soul, become Senſations, thro' the intimate Union of the Soul with the Body. But give me Leave to take Notice, that this Union of an incorporeal with a corporeal Subſtance, is a Thing ſo difficult to comprehend, that the profoundeſt Secrets of Theology, not to ſay the Incarnation itſelf, are not more abſtruſe than this. For how can we conceive, that a Subſtance purely immaterial, ſhould be united without any Medium (and in this caſe there can be none) with a Body that cannot poſſibly lay hold on it, and which it can pervade, and fly away from at Pleaſure? And 'tis almoſt as difficult to conceive, how any Part of the Body, without excepting the animal Spirits of the Brain (for theſe are as truly corporeal as the other Parts) can make Impreſſions on a Subſtance perfectly incorporeal, and which is not affected by the Motions of any Parts, but the Nerves. Nor is it a ſmall Difficulty to conceive, how a finite Spirit, can either move, or (which is much the ſame Thing) regulate and determine the Motion of the Body.

" And ſuppoſe the Soul in the Brain does perceive the different Motions communicated to the Senſes, yet this, tho' it may give ſome Account of Senſation in general, does not give us any ſatisfactory Reaſons of particular Senſations. For if I demand, for Inſtance, why when I look on a Bell that is ringing ſuch a Motion, in the Brain produces in the Mind the Perception of Seeing and not Hearing: And another Motion, coming from the ſame Bell at the ſame Time, produces in the Perception of Hearing, not Seeing: What can be anſwered, but that ſuch is the good Pleaſure of the Author of Nature. And if we aſk about the

differing

differing Objects of any one Sense, as, Why the Light reflected from Snow, produces a Sensation of Whiteness rather than Redness? Why Castor produces a Stink, and not a Perfume? Why sweet Things generally please, and bitter disgust us? Nay, why a a little of some Objects (suppose Fire) will give Pleasure, a little more of them give Pain: To these and a Thousand other Questions of the same Kind, it can only be answered, Such is the Nature of Man. So plain is it, that we are yet to seek, both for the Definition of a corporeal Substance, and for a satisfactory Account of the Manner of our own Sensations. Yet without the true Notion of a Body, we cannot understand the Object of Physics in general: And without knowing the Nature of Sensation, we are ignorant of that, from which we derive almost all that we know of any Body in particular.

And as our Philosophical Knowledge is not very deep, not reaching with any Certainty to the Bottom of the most obvious Things, nor penetrating to their inmost Nature: So it is not very wide, not being able to give us with any Clearness or Particularity, an Account either of the celestial Parts of the World, or of the deeply subterraneous Parts: Of which the superficial Part is but a small, not to say, contemptible Portion. As to the very Globe we inhabit, (not to mention how many Plants and Minerals we are wholly ignorant of, and how many others we are but slenderly acquainted with) the Objects about which our Enquiries and Experiments are conversant, all belong to the superficial Parts of the Globe, of which the Earth known to us is but the Crust. But what the internal Part of it is we no more know, than what is the Substance of the remotest Stars. Even among the Moderns some think the internal Part of it, is pure, elementary Earth. Others imagine it to be Fire, the Receptacle of natural or hellish Flames. Others will have it to be a solid Magnet; while others believe, it was once a fixt Star: And that tho' it is now degenerated into a Planet, yet its

internal Parts are of the ſame Nature it was before: The Change proceeding only from thick Spots that cover it, (like thoſe frequently obſerved upon the Sun) by the Condenſation whereof the firm Earth which we inhabit was formed. And it is as difficult to demonſtrate the Falſhood, as the Truth, of each of theſe jarring Opinions. For whereas it is at leaſt three Thouſand five Hundred Miles to the Center of the Earth, it does not appear, that Men have been able to penetrate toward it, either by Land or by Sea, above one, or two Miles at the moſt, and that not in above three or four Places. So that as yet we have not grated any Thing deep upon the Huſk, without at all reaching the Kernel of the Globe. And what is this Globe, of which itſelf we know ſo little, to thoſe vaſt Globes, of which we know much leſs? For tho' the former Aſtronomers give us their Diſtances and Magnitudes as exactly as if they had meaſured them, yet the later Mathematicians give us Reaſon to doubt of what thoſe have delivered. For ſince we can obſerve no Parallax in the fixt Stars, (nor perhaps in the higheſt Planets) we muſt ſtill be to ſeek for a Method to meaſure the Diſtance of thoſe Bodies. And not only the Copernicans make it many hundred thouſand Miles greater than the Ptolemeans, but *Ricciolus* makes it vaſtly greater, than the Copernicans themſelves. Nor can we wonder at theſe huge Diſcrepance, (tho' ſome amount to many Millions of Miles) when we conſider that Aſtronomers do not meaſure the Diſtance of the fixt Stars by their Inſtruments, but each accommodates the Diſtance of them, to his peculiar Hypotheſis. From this Uncertainty of the Diſtance of the fixt Stars, 'tis eaſily inferr'd, that we are not ſure of their Bulk: No, not even in Reference to one another; ſince 'tis doubtful, whether the different Sizes they appear to be of, proceed from an Inequality of Bulk, or only from an Inequality of Diſtance. But beſide theſe, there are divers Things relating to the Stars, ſo remote from our Knowledge, that they are not even

enquired

enquired into: Such as theſe, Why the Number of the Stars is neither greater nor leſs than it is? Why ſo many of them are ſo placed, as not to be viſible to the naked Eye? Why of the viſible ones, ſo many are in one Part of the Sky, and ſo few in others? Why they are not placed in ſome Order, but ſcattered over the Sky, as if it were by Chance? Many Queſtions might be added, as concerning the Stars, ſo concerning the interſtellar Parts: As whether they are empty, ſave where they are pervaded by Light, or filled with ethereal Matter? So that our Knowledge is much ſhort of what is generally thought. For the Earth being but a Point, compared to the Orb of the Sun: Which Orb itſelf is but a Point in Reſpect of the Firmament: Of how little Extent muſt our Knowledge be, which leaves us totally Ignorant, of ſo many Things touching the vaſt Bodies, which are above us, and penetrates ſo little a Way into the Earth beneath us, that it ſeems confined to but a ſmall Share of the ſuperficial Part of a Phyſical Point."

We are aſſured by the Obſervations of Aſtronomers, that the Motion of the Earth in its Orbit is not equal; but in ſome Places it moves quicker, in other Places it ſlackens its Pace. In our Summer the Sun is obſerved to go in a ſlow Motion. In our Winter he moves ſomewhat faſter: On which Account, he is obſerved to ſpend near eight Days more in the Northern Signs of the Ecliptic, than in the Southern Signs: So that from the Time of the Sun's being in the Vernal Equinox, 'till his Coming into the Autumnal, there are 186 ½ Days; in which Time by his apparent Motion, he is ſeen to deſcribe one Half of the Ecliptic: But from the Autumnal to the Vernal Equinox, there are only 178 ½, in which Space of Time he finiſhes his apparent Courſe thro' the other Half of the Ecliptic, and viſits all the Southern Conſtellations. We are alſo aſſured by the Obſervation of Aſtronomers, that the apparent Diameter of the

Sun

Sun in Winter, when his Motion is quickeſt,' is greater than the apparent Diameter in Summer, when his Motion is floweſt; and the Difference is ſo great, that when the Sun appears biggeſt. He is ſeen under an Angle of 32 Minutes 47 Seconds: But when he appears leaſt, ſubſends an Angle, only of 31 Minutes 40 Seconds; and therefore the Sun muſt be farther from us in Summer than in Winter; and conſequently he is not in the Centre of the Earth's Orbit.

Perhaps it will be acceptable to calm, diſpaſſionate Men, if I add yet another Extract from a very ſenſible Writer, containing a few ſhort Obſervations, on the whole preſent Syſtem of Philoſophy.

1. "The firſt Axiom in the preſent Philoſophy is, That all *Matter is indifferent to Motion or Reſt.* But do we not here ſtumble at the Threſhold? Laying as a fundamental Truth, what is manifeſtly falſe? For Motion and Reſt are ſuch oppoſites, that it implies a Contradiction, to ſuppoſe an equal Diſpoſition to either, inherent in the ſame Body. The one is a *Poſitive*, which neceſſarily implies Power, the other a mere *Negative*, which implies no Power in any Direction.

2. Matter containing in itſelf no Power of any Kind, can give no *Reſiſtance* to any Impreſſion upon it: Neither can it of itſelf *continue* to exert the Effects of that Impreſſion. Therefore the ſecond Axiom, or rather the Phenomena, from which it is deduced, muſt ariſe, not from Matter in itſelf, but from the Relation which all Matter bears to the univerſal Syſtem of Nature.

3. The third Axiom, concerning *Re-action* is as exceptionable; as the two former. For it may eaſily be ſhewn, that the Re-action of Matter depends entirely on Gravity. If Gravity were ſubſtracted there is no Proof or reaſon to ſuppoſe, that Bodies would exert either Reſiſtance or Re-action. All theſe Axioms therefore, inſtead of being abſolute Laws, are mere

Phenomnia

Phenomena depending on other Cauſes, which Cauſes it is incumbent upon the Philoſopher to look for.

4. The *Projectile Power* never can ballance that of Gravitation, ſo as to maintain the Motion of the Planets. It can never recover its Force when it is reſiſted, whereas Gravity can. Therefore the conſtant bending of its Direction, which muſt be equal to a conſtant proportionable Reſiſtance, muſt uniformly and perpetually weaken its Power and ſtrengthen that of Gravitation: So that the Direction of Motion muſt neceſſarily ſink more and more, and at laſt fall wholly into the Direction of Gravitation. It follows that no Power acting upon an Orb which gravitates toward its Center of Motion, can poſſibly maintain its projectile Motion, in the Direction of a Circle.

5. Even on Suppoſition, that Projection and Gravitation equally retained their Propenſity to Motion tho' reſiſted, yet thoſe Powers could not move the Planets in Ellipſes, becauſe in the ſame Proportion as the one prevailed over the other, in the ſame Proportion it muſt alter the Tendency of Motion toward its own Direction. And none can explain, how when a Quantity of Motion and alſo of Inclination is gained by Gravitation over Projection, the Orb will, while theſe remain unchanged, leave at any Point the Direction of the moving Power that prevails, and recede into the Direction of the weaker Power, or *ẽ contra*.

6. Again. From the Proportions of the Forces required between Gravitation and Projection, in order to move the Orbs in Circles, it is evident that theſe two Powers cannot be the Cauſe of their Motions. For by comparing the Forces of theſe it appears, that the Force of Gravitation is not ſuch in Proportion to that of Projection, as to bend the Direction of the projected Body ſenſibly from the right Line.

7. The

7. The Motion of the *Moon* along with the Earth, cannot be owing to her gravitating toward it, nor to a Projection impreſt upon her, in common with the Earth; becauſe ſhe has a Projection of her own round the Earth. And ſhe cannot be ſo projected as to move in two different Orbits at one and the ſame Time, by the *vis inertiæ* continuing one projectile Motion round the Sun, and another round the Earth. Therefore the Motion of this, and by a Parity of Reaſon, that of all the Secondary Planets, muſt be guided every Moment either by Mechaniſm or by a ſpiritual Power.

Indeed Sir *Iſaac* thought theſe Powers might ariſe from a ſubtle, ethereal Medium, diffuſed through the whole Univerſe: But this is only retiring a Step farther in the dark. For it comes to one, whether the Cauſe of Attraction be aſſigned to groſſer Bodies themſelves, or to the Impulſe of a Medium that penetrates them. If the Powers of that ſuppoſed Medium are unmechanical, they muſt be ſpiritual. And ſeeing the Medium is only ſuppoſed, it is more natural to aſſign theſe unmechanical Powers, to Bodies which we know diſpoſed to theſe Motions, than to ſuppoſed Bodies, which we know nothing of.

Farther. If Sir *Iſaac* ſuppoſes ſuch a Medium for maintaining Attraction, Gravitation and Elaſticity; how came he not to ſuppoſe, that the ſame is concerned, in ſupporting his Axioms or Laws of Motion? For the Knot does not lie in Gravitation or Attraction, or any *particular Kind* of Motion, but in finding Powers to produce and maintain *Motion in general.* If theſe are mechanical, it is eaſy to ſuppoſe, though we ſhould never be able to explain in what Manner, that the Contriver has adjuſted the Mechaniſm to produce all the Motion obſervable in the Creatures. But if they are unmechanical Laws, Properties or whatever we may call them, there is no Occaſion for ſuppoſing any Cauſe of Gravitation, or for taking it amiſs to have it called occult Quality, un-

known Virtue, Charm, Law, or any Word we have no Meaning to.

8. This unmechanical Philoſophy has a bad Influence in obſtructing our Advancement in the Knowledge of Nature. For how can Enquiries into the Powers of Nature, be carried on to any Degree of Perfection, under the Direction of a Syſtem which muffles our Eyes with unmechanical Laws of Matter, ſuppoſes the Baſis of Mechaniſm, inſtead of examining whether theſe themſelves are not the Production of Mechaniſm? Such are the Indifference of Matter to continue itſelf either in Reſt or Motion: Re-action equal to Action: The Reſiſtence of Matter to a Change of State: Gravitation, Attraction, Repulſion, Elaſticity: Preſſure of Fluids in all Directions: A Fluid with no Coheſion of Parts, moving in diverging Lines; whoſe Parts are poſſeſt of different Degrees of Attractability by other Bodies, contrary to that Law which makes Gravitation ſimply as the Quantities of Matter: A Fluid poſſeſt of alternate Fits of Attraction and Repulſion! How weak is it, to make theſe the Baſis of Mechaniſm, rather than the Reſult of it?

9. Let us now examine theſe Matters more cloſely. In the preſent Philoſophy, *Space* is always conſidered in the firſt Place; becauſe without admitting Space void of Matter, the whole Syſtem falls to the Ground

This ſame infinite Space is the moſt wonderful Thing within the whole Range of Being. It is neither God nor his Creature, and yet is inſeparable from the Being either of God or of any Thing he can create. It is infinite both in its Extenſion and in its Duration. It is immovable and indiviſible. If a compleat Definition of it were put into a Lady's Pocket-Book, ſhe would gueſs it to be an Enigma for *nothing*: And would be aſtoniſhed to hear, that it is the Quinteſſence of a moſt metaphiſical and moſt ſubtle Argument, maintained by a moſt celebrated Divine and Philoſopher.

The

The only positive Idea applied to Space is *Extenſion*. But we can apply no Idea to any Subject, which the Subject itſelf does not impreſs. Matter forces upon our Senſes the Idea of its Extenſion. But how can we inveſt with this, a Subject which never excited any Idea in us, and conſequently has no Exiſtence *to us?* Space is only one of the Ideas excited by Matter, and by the Mind abſtracted from its Subject, juſt as we can image a Colour to ourſelves, without connecting any particular Subject with it. A little more of the ſame Metaphyſics, which can prove that *Nothing* is extended, will prove that Space is Purple. But why ſhould I ſay Purple? Space is of all Colours, if Light is reflected by a Vacuum. It is an ingenious Contrivance, to render *Nothing* a Subject of Conception, by dreſſing it in a Suit of Cloaths borrowed from *Something*.

To illuſtrate the Doctrine of Space, a common Experiment ſhews, that by an Image formed in the Air, at a certain Diſtance between a concave Glaſs and any Perſon looking into it, Extenſion becomes an Object of Senſe, where there is neither ſolidity nor any ſenſible Reſiſtance. But this does not prove, that an Image is formed in empty Space, or where there is no Matter. It rather proves, that theſe Spaces which they call empty are full of Matter. For as the Senſes can be effected only by Matter, they infallibly determine where Matter is. So that we are as ſure there is Matter where we ſee any Thing, though we cannot feel it, as that it is there, where we feel, though we cannot ſee it.

10. Let us now more attentively conſider the firſt ſuppoſed Law of Motion, *Matter is indifferent to continue in Motion or in Reſt.*

Reſt and Motion are the two greateſt Oppoſites in Nature, as oppoſite as Matter and Nothing. The Mind therefore cannot be ſtruck with a more palpable Contradiction, by affirming that a Body is equally diſpoſed, to Hardneſs and Softneſs at the ſame

Time, than by ſaying it is equally diſpoſed to Reſt and Motion.

Motion is a poſitive Thing, which implies Action, Power, or Force, wherever it acts. Reſt is a mere Negative, a State wherein Body is diveſted of all theſe. It exerts no Power; it acts or preſſes, neither backward nor forward, neither up nor down. Now the ſame Body cannot be indifferent to the exexerting of Power and to the exerting of none at the ſame Time.

Again. It is impoſſible that Reſt and Motion can be equally indifferent to Matter. When Matter was created, ſhould we ſuppoſe the Creator to ſay, "Let it be," *without* determining in which of theſe States it ſhould commence Being, yet it is impoſſible it could begin to be, both moving and reſting. It could aſſume only one of theſe Conditions, and muſt have remained therein for ever, unleſs ſome farther Divine Energy had given it a new Determination. Now in which ever of theſe Matter began to exiſt, that muſt be called its *Natural State.* And every Alteration of that State, muſt be the Effect of ſome Power ſuperinduced upon it, which muſt ceaſe when the Cauſe ceaſes.

Again. Matter may exiſt in Reſt: but no *living* Matter. All Life in Nature, whether mineral, vegetable, or animal, depends upon Motion and Activity. Therefore Motion ſeems to be not the natural State of Matter, but ſuperadded thereto and conſtantly ſupported, in order to conſtitute Life, Variety and Mutability. Now all know, material Motion proceeds upon, and is regulated by mechanical Laws. And does not Motion uniformly conducted by the Laws of Mechaniſm, imply a conſtant mechanical Cauſe? This mechanical Syſtem is traceable in moſt Caſes, even in the moſt ſubtle and elaborate Works of Nature, ſuch as Plants and Animals. And may not the ſame Heavens which influence every Thing on Earth, rule the Motions of the Earth itſelf; and impreſs

impreſs all Matter which theſe general Tendencies, which are the Baſis of all human Mechanics?

11. Proceed we to what is called *the ſecond Law of Motion.* We can have no Idea of Power, but that it is Matter in Motion, or endeavouring to act: We cannot connect the Idea of Power with Matter at reſt, unleſs that Reſt be the Effect of Power fixing it in its Place, which we may term *mechanical* Power. This Reſt, being an Effect of Power, will exert a Reſiſtance to Motion, when it is preſt upon. But otherwiſe, Matter can have no ſuch Power in itſelf, can exert none; becauſe Power conſiſts in Motion, or a Niſus to it. Therefore Matter reſting *unmechanically* can have no Niſus of any Kind. An unmechanical Niſus in Matter to Reſt, is in other Words, an active Power exerted by it to do nothing.

The States then of Motion or Reſt being the Reſult of abſolute Paſſiveneſs in Matter, and the Effect of no poſitive Niſus, an unmechanical Matter can exert no Reſiſtance to change the State: And of Conſequence an Atom would have as much Power to move a Planet, as a Planet to move an Atom.

An Action or Tendency to Action is plainly implied in a Niſus to any State. And as a Niſus to Paſſiveneſs is a Contradiction in Terms, it follows, that the Properties of Power or Motion, cannot be conſidered in Matter taken abſtractedly, but as compoſed into a Syſtem. Therefore tho' it muſt be allowed, that the Changes of State in Matter are proportioned to the Powers that produce them, yet it is impoſſible to conceive, that the Power ſhall continue in the Body acted upon, after the exterior Power ceaſes to act upon it.

12. The *third* ſuppoſed *Law of Motion* is this. When Matter is put into Motion, it communicates as much Reſiſtance toward ſtopping the Motion of the Body that moves it, as it receives Motion from it.

Philoſophers never had it in their Power to make the Experiments on which this Law is grounded,

upon any Bodies but such as were under the Influence of Gravitation. And if this Axiom can be proved to depend upon Gravitation, it must cease to be an Axiom, as being only an Accident depending upon another acknowledged Cause.

Resistance or Re-action must be produced where-ever Matter in Motion incounters Matter moving or tending to move in an opposite or a different Direction. Now all Bodies tend or gravitate toward the Earth. Therefore this Tendency must re-act or resist according to its Quantity, every Power applied to move a gravitating Body in any other Direction.

We have no Way to estimate the Quantity of Matter contained in any Bodies, but the Quantity of their Gravitation. Hence we must necessarily infer, that the Law of Re-action, is not according to the Quantity of Matter in particular detached Parcels thereof, but according to the Degree of their Gravitation. For where the Gravity of a Body but the Half of what it is now, that Body would re-act but half as much at it does; and of Course, were all its Gravitation to cease, it would not re-act at all.

Again. It is supposed, Gravitation is 23 Times greater on the Surface of the Sun, than on the Surface of the Earth. Hence a Body which weighs one Pound here, would there weigh three and twenty. Consequently, without any Addition of Matter, it would re-act twenty-three Times more than it does here. Therefore this Re-action, supposed an absolute Law of Matter, is only a Circumstance depending on the relative Law of Gravitation.

13. Come we now to the Doctrine of *Centripetal* and *Centrifugal* Forces. In another Age it will be Matter of universal Wonder, that one of the most profound Mathematicians in the World should assume two Powers for circulating the Planets, and even calculate the Quantities of Matter therein, from the Proportions wherein they must act in producing and maintaining the Circuits of the moving Stars: While it is demonstrable to common Sense, from the admit-

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ted Nature of these two Powers, that it is absolutely impossible they can support one single Rotation of an Orb.

Gravitation is allowed by all, to be a constant Power in Bodies, which cannot be altered but by Change of Distance. It cannot be suspended; for though its Effect may be resisted, yet its Tendency thereto is invariable. It is therefore a proper, undestroyable Power, uninterruptedly acting in and upon Bodies.

The Laws assigned to *Projection* are just the Reverse. When any Proportion of the Quantity of Projectile Motion is destroyed, either by direct Opposition, or by Change of its Direction, it exerts no Nisus to recover its first Quantity of Motion. Consequently as long as any Power such as that of Gravitation, is bending the Direction of Projection, it is a continued Resistance to the Power of Projection, which is continually diminished thereby. And as it has no Tendency to recover this, the smallest continued Resistance will at last quite exhaust its Power, tho' originally ever so great. Thus every Projectile on the Earth, however great the projecting Force may be at setting out, is continually retarded 'till it rests in the Direction of a parabolic Curve.

Sir *Isaac* seems not to have reflected on this Circumstance of Gravitation and Projection, that the one retains its whole Tendency to Motion, whether it be retarded or stopt, while the other always loses as much Power, as it meets with Opposition. Neither in ballancing these Powers, does he seem to have reflected on that obvious Truth, That every Alteration in the Direction of a moving Projectile, destroys so much of its Motion, which cannot be repaired, but by a continued Action of the first moving Cause.

Philosophers illustrate the joint Effect of centripetal and centrifugal Force, in making Bodies move in a Circle, by the Experiment of casting round a Weight, suspended by a String in ones Hand. But this Illustration contains a palpable Deception. For the Power of the String restraining the Body from flying

ing off in a ſtrait Line, bears no Analogy to a Power actually drawing a moving Body towards its Center of Motion. The String reſiſts its flying off, but has not the leaſt Tendency to draw it nearer. And whatever is the Cauſe of the Revolution of the Planets, it muſt be ſome Cauſe which ſimply reſiſts their flying off into eccentric Motions. It cannot in the Nature of Things be one, which is uniformly drawing them into their Center of Motion.

But ſuppoſe both Gravitation and Projection had the ſame Property, of ſtill retaining their original Tendency to their reſpective Motions, however they were retarded: Still it is impoſſible that theſe two Powers, acting by immutable Laws, can move an Orb any otherwiſe than in a Circle: Whereas all the Planets are allowed by Philoſophers themſelves to move in Ellipſes.

Theſe Powers moving an Orb in the Figure of an Ellipſes, muſt no leſs than four Times, vary the Proportion of their ſeveral Impulſes, during every compleat Revolution. The Power of Gravitation is uniformly gaining on that of Projection, from the higher Point of the Ellipſes to the lower. Now (not to aſk, how the projectile Force recovers itſelf, but ſuppoſing it had this Property) I aſk, by what Law does Gravitation remit the Strength it has gained, in bringing the Orb from the higher Point to the lower, and at that Point allow Projection to recover the Force it had loſt, in order to carry it back to the higher Point? In like Manner, ſeeing Projection has been gaining on Gravitation, all the Way to that Point, how comes it all at once to loſe its ſuperior Force there? And how comes Gravitation immediately to preponderate, in order to bring the Orb to the lower Point again?

It cannot be ſaid, that the increaſed Velocity, which brings a Planet to the lower, contributes to carry it back to the higher Point. For that increaſed Velocity was not the Effect of Projection but of Gravitation. Therefore the Orb can never get outward

ward again, unleſs at that Point, Gravitation all at once, weakens its Pull of the Planet inward.

There is one Circumſtance more, which Mathematicians ought to conſider well: Namely, That no Figure (Circle or Ellipſis) can be deſcribed by Gravitation and Projection round the Center of Gravity, where that Center of Gravity ſhall not be found in the Center of the Figure. But this is Contrary to all Aſtronomical Obſervation upon the Motion of the Planets, which determines their Center of Gravity to be always in one of the Foci of their elleptical Orbits.

Yet farther. In order to move any Body in a Circle, the moving Powers muſt be equal, or nearly ſo. Now the Proportion of the moving Powers upon one Body to each other, can only be determined by the Velocity of the reſpective Motions. Indeed the Quantity of Motion in different Bodies muſt be determined, by the Quantity of Matter moving and Velocities taken together. But in one and the ſame Body it may be determined ſolely, by the Velocity of its Motions.

Equal Powers then can only be determined by the equal Quantities of Motion they produce. But as to the Powers of Gravitation and Projection, the Proportion between them as aſcertained by the ableſt Mathematicians, is ſo far from being equal, that the immenſe Diſparity between them, can ſcarce be reduced to a Calculation. Therefore it is utterly impoſſible that theſe two Powers ſhould produce the Revolution of the Earth.

If the Sun and Earth were as near each other as the Earth and the Moon are, and were left to the Power of their mutual Attraction, they would move toward each other with the ſame Velocity as it is ſuppoſed the Earth and Moon do, which I think is about ſixteen Feet in a Minute: Except ſo far as the Proportion of Matter in the Earth to that in the Sun, differs from that of the Earth to the Moon. If then the Earth at that Diſtance from the Sun, would gravitate

vitate toward him with the Velocity of ſixteen Feet in a Minute, and if the Decreaſe of Gravitation, be inverſely as the Squares of the Diſtances, (that is, at double Diſtances, four Times leſs) then the Earth being immenſely farther from the Sun than the Moon is from the Earth, the Velocity with which the Earth at her preſent Diſtance from the Sun would move toward him, if left to the Power of Attraction, muſt be immenſely leſs than ſixteen Feet in a Minute. But what is the Force which moves the Earth ſixteen Feet or a Thouſand, to the Force of that Projection, which is ſuppoſed to move it at the Rate of near a thouſand Miles in a Minute?

In ſhort, if the Power of Gravitation draws the Earth toward its Center of Gravity, with the Force of ſixteen Feet, or 1600 in a Minute, while the Power of Projection impreſſes it with the Force of almoſt a thouſand Miles in the ſame Time, it is impoſſible for Mathematics to demonſtrate, that any Orb hurried off by ſuch a Projection, can ever be recalled from its eccentric Motion, by ſuch an inconceivably ſmall and diſproportionate Reſiſtance: Eſpecially as the Power of Gravitation, ſmall as it is, muſt be growing ſmaller every Moment. Nor can the Mathematical Properties of an Ellipſis or any Figure, ever prove that Gravitation, which is continually waſting and ſpinning out into a cobweb Thread, will at any Point recover a Superiority to the projectile Force, and grow at laſt a Cable, maſſy and powerful enough to bring home the wandering Star again.

14. I would add ſome Thoughts on the Motion of the *Satellits*. It is no Wonder, that notwithſtanding all the Arguments for the Motion of the Earth, yet the greateſt Part of Aſtronomers have not pronounced it abſolutely certain, but only probable in an high Degree. Among the Perplexities which attend this highly probable Syſtem, the Doctrine of *abſolute Motion* is not the ſmalleſt. 'Tis certain all the Phenomena of relative Motion, are the very ſame as if the Earth were at Reſt. And it is not eaſy to conceive

ceive, how this can poſſibly be, on the Suppoſition of the Earth's Motion.

The Phenomena of Bodies moving in the ſame Direction with the abſolute Motion of the Earth may be comprehended. That Motion of Bodies croſs the abſolute Motion of the Earth is alſo intelligible. But it is no eaſy Matter to ſatisfy oneſelf, about the Phenomena of Bodies moving Weſtward, or in an oppoſite Direction, to that of abſolute Motion. If we ſhould ſuppoſe that a Ball fired Point-blank Weſt, does not really move Weſtward, but is only reſiſted by the Exploſion from moving ſo faſt Eaſt as the Earth goes in her abſolute Courſe: May it not be aſked, What is it, that keeps the Ball ſuſpended, while the Earth proceeds in her abſolute Motion? For the Reſiſtance given to the progreſſive Motion of the Ball, can be no Reſiſtance to its following the Courſe of its Gravity: As we have no Example to explain, how Reſiſtance applied horizontally will prevent a Body's falling to the Ground in the ſame Time as if it was not ſo reſiſted. If the Ball's abſolute Motion is only the Force of its *vis inertiæ* derived from the Earth's Motion, and its apparent Motion in a contrary Direction is only from another *vis inertiæ*, derived from the Exploſion: What poſſible Conception can be framed of two oppoſite *vis inertiæs*, acting ſo as to prevent a Body for ſome Time from purſuing the Courſe of its Gravity?

On the other Hand, if the Motion Weſtward is *real*, it ſeems to imply a plain Contradiction. For no Body can really move Eaſtward and Weſtward at one and the ſame Time.

But tho' the Doctrine of Projectiles could be reconciled with the Motion of the Earth, yet what ſhall we ſay of ſelf-moving Bodies? That abſolute Motion which all Bodies are ſuppoſed to partake of, is not alledged to be maintained in them, after they are ſeparated from the Earth, by any other Means than their *vis inertiæ*, or their retaining, the Quantity of Motion once impreſt upon them. Now no Body

can

can move in a Direction oppoſite to its *vis inertiæ*, till that is overcome. How is it conceivable then, that Birds, for Example, after they are ſeparated from the Earth, where they acquired their abſolute Motion, ſhould retain it at all? Certainly every Reluctation of theirs in an oppoſite Direction, while on the Wing, muſt deſtroy Part of their abſolute Motion, as they cannot then have any freſh abſolute Motion communicated to them. This ſhould imply a great Change in the Phenomena, with Regard to the Motion of ſelf-moving Bodies. But in Fact all the Phenomena are the ſame, as if the Earth were at reſt. In ſhort, the Motion which Bodies have in common with the Earth, is ſomething which no Re action has any Effect on. Therefore it does not, cannot depend upon the Axioms of the preſent Philoſophy.

When we come to apply the Theory of abſolute Motion to the *Secondary Planets*, in whatever Light we conſider it, it becomes a Matter utterly inconceivable, nay impoſſible. In the firſt Place, we know of no abſolute Motion, communicated from greater to ſmaller Bodies, but where they are ſo intimately connected, that Gravitation at laſt, yea ſoon deſtroys all their projectile Motion. But ſuch is the Diſtance of the Moon from the Earth, and ſo remote is their Connexion, that her Gravitation has never gained any Thing upon her projectile Motion.

Again. The Moon, ſuppoſe her preſent Diſtance from the Earth to be her original one, could never by Means of the weak Connexion of Gravitation, correſpond with the Projection of the Earth. Suppoſe the Moon at her preſent Diſtance, and behind the Earth, juſt in the Courſe of the Earth's Projection: In this Situation, ſuppoſe the Moon advances toward the Earth, at the Rate of ſixteen Feet in a Minute, while the Earth is projected away from the Moon near a thouſand Miles in the ſame Time: Can any one ſuppoſe, that this imperceptible Motion of the Moon toward the Earth, would draw the Moon with-

with the Force of the Earth's abſolute Motion? This Suppoſition is attended with the ſame manifeſt Impoſſibilities, in whatever Part of her Circle the Moon is conſidered, at the Moment of Projection. Suppoſe her in her firſt Quadrature: Then the Gravitation between them and the Projection of the Earth lying nearly in the ſame Direction, nothing could prevent their Colliſion in a few Hours: And till they had met, their mutual Gravitation could have no Effect in communicating the abſolute Motion of the Earth to the Moon. Yet ſuppoſing that the Projection of the Moon round the Earth, commenced at the ſame Inſtant with the Projection of the Earth, does not help: For as it is not that Projection which gives the Moon her abſolute Motion, the whole Impoſſibility remains, yea and is renewed every Month in every ſuppoſable Circumſtance. For it is as impoſſible her abſolute Motion can be maintained by ſuch Means, as that it ſhould commence by them.

It is no leſs impoſſible, that the Moon's abſolute Motion can be owing to a Projection given to herſelf, than that it ſhould be owing to her Gravitation toward the Earth, for this plain Reaſon; Becauſe ſhe has a Projectile Motion quite different from this, namely round the Earth. For nothing is more impoſſible, than for a Body to move in two Directions at the ſame Time. If five Hundred Projections, all in different Directions were applied at the ſame Time, the Projectile would fall into one Courſe, common to them all.

Add to this, that if there can be no real Motion, in an adverſe Direction to abſolute Motion, unleſs there be a Deſtruction, or at leaſt weakening of that *vis inertiæ*, which is ſuppoſed to be the Principle that continues abſolute Motion; then the projectile Courſe of the Moon round the Earth, muſt ſoon deſtroy her abſolute Motion. For every Month the Moon for near 500,000 Miles, ſtruggles in a Courſe, which is in effect, diametrically oppoſite to the *vis inertiæ*,

carrying her in another Direction. And this cannot happen without continually weakening, and at laſt wholly deſtroying it.

For theſe Reaſons, unleſs I can ſee them fairly removed, I muſt conclude, that even ſuppoſing theſe Principles, aſſumed by the preſent Philoſophy are real, yet it is impoſſible to explain the celeſtial Motions by them."

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