Physico-theology, or, A demonstration of the being and attributes of God from his works of creation : being the substance of 16 sermons preached in St. Mary le Bow Church, London, at the Honble Mr. Boyle's lectures, in the years 1711 and 1712 ... / by W. Derham.

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DEMONSTRATION

OF THE

and ATTRIBUTES of GOD,

from the WORKS of CREATION.

The Substance of XVI SERMONS

Preached in St. *Mary le Bow-Church, London,*

at the Honble Mr. BOYLE's LECTURES,

in the Years 1711 and 1712.

To which are NOTES, and many called OBSERVATIONS

By W. DERHAM, Rector of Upminster in

Essex, and F. R. S.

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PHYSICO-THEOLOGY:

OR, A

DEMONSTRATION

OF THE

BEING and ATTRIBUTES of GOD, from his WORKS of CREATION.

Being the Substance of XVI SERMONS Preached in St. *Mary le Bow-Church, London*, at the Hon^ble^ Mr. *BOYLE*'s LECTURES, in the Years 1711 and 1712.

With large NOTES, and many curious OBSERVATIONS

By *W. DERHAM*, Rector of *Upminster* in *Essex*, and F. R. S.

Mala & impia consuetudo est contra Deos disputare, sive animo id fit, sive simulatè. Cicer. de Nat. Deor. L. 2. fine.

The SECOND Edition, with Additions.

LONDON:
Printed for W. INNYS, at the *Princes Arms*, in St. *Paul*'s Church-Yard. MDCCXIV.

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TO THE

Most Reverend Father in GOD,

THOMAS,

Lord ARCH-BISHOP of *Canterbury*, Primate of all *ENGLAND*, &c.

The surviving Trustee of the Honourable Mr. *BOYLE*'s LECTURES.

May it please your Grace,

I May justly put these *Lectures* under your Graces Patronage, their Publication being wholly owing to You. For having the Honour to be a Member of the *Royal Society*, as well as a *Divine*, I was minded to try what I could do towards the Improvement of *Philosophical* Matters to *Theological* Uses; and accordingly laid a Scheme of what I have here published a Part of, and when I had little else to do, I drew up what I had to say, making it rather the divert-

ing Exercises of my *Leisure Hours*, than more serious *Theological Studies*. This Work, although I made a considerable Progress in at first, yet having no Thoughts of Publishing, I laid aside; until your Grace, being informed of my Design by some of my Learned Friends both of the Clergy and Laity, was pleased to call me to the unexpected Honour of Preaching Mr. *Boyle*'s *Lectures*: an Honour I was little aware of in my Country-Privacy, not much acquainted with Persons in high Stations, and not at all with your Grace particularly. So that therefore as it pleased your Grace, not only to confer so unlooked for an Honour upon me, a Stranger, and that too maugre some Opposition Your Grace at first met with in Your Choice of me, but also to continue that Honour and Benefit for Two Years, out of Your good Opinion of my Performance, in some measure, answering Mr. *Boyle*'s End; so I can do no less than make this publick Acknowledgment of your Grace's great and unex-

expected, undeserved Favour, and return you my hearty Thanks for the same.

But besides these particular Favours to my Self, the *Lecture* is indeed greatly indebted to Your Grace's Endeavours formerly, in promoting the Pious Design, and assisting in the Settlement of this Noble Charity in the Honourable Founder's time; and more lately since his Death, in procuring (†) a more certain Sallary to the *Lecturers*, more constantly and duly paid than it was before. These

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(†) It may not only gratify the Reader's Curiosity, but also be of Use to give the following Account of Mr. *Boyle*'s Lectures.

Mr. *Boyle*, by a Codicil dated *July* 28. 1691. and annexed to his Will, charged his Messuage or Dwelling-House in St. *Michael's Crooked-Lane*, *London*, with the Payment of the clear Yearly Rents and Profits thereof to some Learned Divine in *London*, or within the Bills of Mortality, to be Elected for a Term not exceeding Three Years, by his Grace the present *Lord Arch-Bishop* of *Canterbury* (then Dr. *Tenison*) Sir *Henry Ashurst*, Sir *John Rotherham*, and *John Evelyn*, Esq; The Business he appointed those Lecturers was, among others, *to be ready to satisfie real Scruples, and to answer such new Objections and Difficulties, as might be started, to which good Answers had not been made.* And also, *to Preach Eight Sermons in the Year, the first Monday of* January, February, March, April, *and* May,

These Benefits as I my self have been a Sharer of, so I should be very ungrateful should I not duly acknowledge, and repay with my repeated Thanks and good Wishes. And that the infinite Rewarder of well-doing may give Your Grace a plentiful Reward of these, and Your many other, both Publick and Private Benefactions, is the hearty Wish of,

Your Grace's,

Most Humble and Thankful

Son and Servant,

W. DERHAM.

---

and of September, October *and* November. The Subject of these Sermons was to be, *the Proof of the Christian Religion against notorious Infidels*, viz. *Atheists, Theists, Pagans, Jews, and Mahometans, not descending lower to any Controversies that are among Christians themselves.* But by reason the Lecturers were seldom continued above a Year, and that the House sometimes stood empty, and Tenants brake, or failed in due Payment of their Rent, therefore the Salary sometimes remained long unpaid, or could not be gotten without some Difficulty. To remedy which Inconvenience, his present *Grace* of *Canterbury* procured a Yearly Stipend of 50 *l.* to be paid Quarterly for ever, charged upon a Farm in the Parish of *Brill*, in the County of *Bucks*: which Stipend is accordingly very duly paid when demanded, without Fee or Reward.

TO THE READER.

AS *the noble* Founder *of the* Lectures *I have had the Honour of Preaching, was a great Improver of* Natural Knowledge, *so in all probability he did it out of a pious End, as well as in Pursuit of his* Genius. *For it was his settled Opinion, that nothing tended more to cultivate true Religion and Piety in a man's Mind, than a thorough Skill in Philosophy. And such Effect it manifestly had in him, as is evident from divers of his publish'd Pieces; from his constant Deportment in* never mentioning the Name of GOD without a Pause, and visible Stop in his Discourse; *and from the noble Foundation of his Lectures for the Honour of* GOD, *and the generous Stipend he allowed for the same.*

Vid. Bp. Burnet's *Funer. Serm. pag.* 24.

And forasmuch as his Lectures were appointed by him for the Proof of the Christian Religion against Atheists and other notorious

torious Infidels, *I thought, when I had the Honour to be made his Lecturer, that I could not better come up to his Intent, than to attempt a Demonstration of the* Being *and* Attributes of God, *in what I may call Mr.* Boyle's *own, that is a* Physico-Theological, *Way. And besides that it was for this very Service that I was called to this Honour, I was the more induced to follow this Method, by reason none of my learned and ingenious Predecessors in these Lectures, have done it otherwise than in a transient, piece-meal Manner; they having made it their Business to prove the great Points of Christianity in another Way, which they have accordingly admirably done. But considering what our* Honourable Founder's *Opinion was of* Natural Knowledge, *and that his Intent was, that those Matters by passing through divers Hands, should be treated of in different Methods, I hope my Performance may be acceptable, although one of the meanest.*

As for others who have before me done something of this kind, as Mersenne *on* Genesis; *Dr.* Cockburne *in his* Essays; Mr. Ray *in his* Wisdom of God, *&c. and I*

may

may add the first of Mr. Boyle's Lecturers, *the most learned Dr.* Bently *in his* Boyle's Lectures; *the eloquent Arch-Bishop of* Cambray, *and I hear the ingenious* Monſ. Perrault *hath something of this kind, but never saw it: I say, as to these learned and ingenious Authors, as the Creation is an ample Subject, so I industriously endeavoured to avoid doing over what they before had done; and for that Reason did not, for many Years, read their Books until I had finished my own. But when I came to compare what each of us had done, I found my self in many things to have been anticipated by some or other of them, especially by my Friend, the late great Mr.* Ray. *And therefore in some Places I shortened my Discourse, and referred to them; and in a few others, where the Thread of my Discourse would have been interrupted, I have made use of their Authority, as the best Judges; as of Mr.* Ray's, *for instance, with relation to the Mountains and their Plants, and other Products. If then the Reader should meet with any thing mentioned before by others, and not accordingly acknowledged by me, I hope he will candidly think*

me

me no Plagiary, because I can assure him I have all along (where I was aware of it) cited my Authors with their due Praise; and it is scarce possible, when Men write on the same, or a Subject near a-kin, and the Observations are obvious, but that they must often hit upon the same thing: and frequently it happens from Persons making Observations about one and the same thing, without knowing what each other have done; which indeed, since my Book hath been nearly printed off, I find to be my own Case, having (for want of Dr. Hook's Micrography being at hand, it being a very scarce Book) given Descriptions of two or three things, which I thought had not been tolerably well observed before, but are described well by that curious Gentleman.

One is a Feather, the Mechanism of which we in the main agree in, except in his Representation in Fig. 1. Scheme 22. which is somewhat different from what I have represented in my Fig. 18. &c. But I can stand by the Truth, tho' not the Elegance of my Figures. But as to other Differences, they are accidental, occasioned by our taking the

Parts

Parts in a different View, or in a different part of the Vane; and to say the Truth (not flattering my self, or detracting from the admirable Observations of that great Man) I have hit upon a few things that escaped him, being enabled to do so, by the Help of such Microscopes as he made use of, as also by those made by Mr. Wilson, *which exceed all I ever saw, whether of* English, Dutch, *or* Italian *make, several of which Sorts I have seen and examined.*

The other thing we have both of us figured and described, is The Sting of a Bee or Wasp; *in which we differ more than in the last. But by a critical Re-examination, I find, that although Dr.* Hook's *Observations are more critical than any were before, yet they are not so true as mine. For as to the* Scabbard *(as he calls it) I could never discover any Beards thereon, and I dare be confident there are none but what are on the two Spears. And as to the Point of the Scabbard, he hath represented it as tubular, or bluntish at the Top: but it really terminates in a sharp Point, and the two Spears and the Poyson come out at a Slit or longish Hole a little below the Top or Point. And as to*

the Spears he makes them to be but one, and that the Point thereof lies always out of the Scabbard. But by a ſtrict Examination, they will be found to be two, as I have ſaid, and that they always lye within the Scabbard, except in ſtinging, as I have repreſented them in Fig. 21. *from the tranſparent Sting of a Waſp. And as to the Spear being made of Joynts, and parted into two, as his* Fig. 2. Scheme 16. *repreſents, I could never upon a Review, diſcover it to be ſo, but imagine that by ſeeing the Beards lying upon, or behind the Spears, he might take them for Joynts, and by ſeeing the Point of one Spear lie before the other, he might think the Spear was parted in two. But leſt the Reader ſhould think himſelf impoſed upon both by Dr.* Hook *and my* Self, *it is neceſſary to be obſerved that the* Beards (*or* Tenterhooks *as Dr.* Hook *calls them*) *lie only on one ſide of each Spear, not all round them; and are therefore not to be ſeen, unleſs they are laid in due Poſture in the Microſcope, viz. ſideways, not under or a-top the Spear.*

The laſt thing (which ſcarce deſerves mention) is the Mechaniſm of the Hair, *which Dr.* Hook *found to be ſolid, like a long Piece of*

Horn,

Horn, not hollow, as Malpighi *found it in some Animals. And I have found both those great Men to be in some measure in the right, the Hair of some Animals, or in some parts of the Body being very little, if at all tubular; and in others, particularly* Mice, Rats, *and* Cats, *to be as I have represented it in my* Fig. 14, &c.

And now if my Inadvertency in other things hath no worse Effect than it hath had in these, namely, to confirm, correct, or clear other Observations, I hope the Reader will excuse it, if he meets with any more of the like kind. But not being conscious of any such thing (although probably there may be many such) I am more sollicitous to beg the Reader's Candour and Favour, with Relation both to the Text *and* Notes: *in the former of which, I fear he will think I have as much under-done, as in the latter over-done the matter: But for my Excuse here I desire it may be considered that the Textual Part being Sermons, to be delivered in the Pulpit, it was necessary to insist but briefly upon many of the* Works *of* God, *and to leave out many things that might have been admitted in a more free Discourse. So that I wish it*

may

may not be thought I have ſaid too much rather than too little for ſuch an Occaſion and Place. And indeed I had no ſmall Trouble in expunging ſome Things, altering many, and ſoftning the moſt, and, in a Word, giving in ſome meaſure the Whole a different Dreſs than what I had at firſt drawn it up in, and what it now appears in.

And as for the Notes, *which may be thought too large, I confeſs I might have ſhortned them, and had Thoughts of doing it, by caſting ſome of them into the Text, as an ingenious learned Friend adviſed. But when I began to do this, I found it was in a manner to new-make all, and that I ſhould be neceſſitated to tranſcribe the greateſt part of the Book, which (having no Aſſiſtant) would have been too tedious for me. I then thought it beſt to pare off from ſome, and to leave out others, and accordingly did ſo in many Places, and would have done it in more, particularly, in many of the* Citations *of the* Ancients, *both* Poets *and others, as alſo in many of the* Anatomical Obſervations *and many of my own and others Obſervations. But then I conſidered as to the*

Firſt,

First, that those Citations do, many of them at least, shew the Sense of Mankind about God's Works, and that the most of them may be acceptable to Young Gentlemen at the Universities, for whose Service these Lectures are greatly intended by me. And as to the Anatomical Notes, and some others of the like Nature, most of them serve either to the Confirmation, or the Illustration, or Explication of the Text, if not to the Learned, yet to the unskilful, less learned Reader; for whose sake, if I had added more, I believe he would forgive me. And lastly, as to the Observations of my self and some others, where it happens that they are long, it is commonly where a Necessity lay upon me of fully expressing the Author's Sense, or my own or where the Thing was new, and never before Published; in which Case, it was necessary to be more Express and Particular, than in Matters better known, or where the Authors may be referred unto.

How acceptable this Piece may be, I am no Judge. Habent sua fata Libelli. *But if I find Encouragement, I have another Part relating to the* Heavens, *that I can soon fit up to see the Light.*

BOOKS

BOOKS Printed and Sold by William Innys, *at the* Prince's Arms *in* St. Paul's Church-yard

THE Wiſdom of God manifeſted in the Works of the Creation, in Two Parts, *viz.* The Heavenly Bodies, Elements, Meteors, Foſſils, Vegetables, Animals, (Beaſts, Birds, Fiſhes, and Inſects) more particularly in the Body of the Earth, its Figure, Motion, and Conſiſtency, and in the admirable Structure of the Bodies of Man, and other Animals, as alſo in their Generation, *&c.* With Anſwers to ſome Objections. By *John Ray*, late Fellow of the Royal Society. The Sixth Edition, 8*vo.* 1714.

JOannis Raii Synopſis Methodica Avium & Piſcium; Opus Poſthumum, quod vivus recenſuit & perfecit ipſe inſigniſſimus Author: in quo multas ſpecies, in ipſius Ornithologiâ & Ichthyologia deſideratas, adjecit: Methodumque ſuam Piſcium Naturæ magis convenientem reddidit. Cum Appendice, & Iconibus. 8*vo.* 1713.

THREE *Phyſico-Theological* Diſcourſes, concerning I. The Primitive Chaos, and Creation of the World. II. The General Deluge, its Cauſes and Effects. III. The Diſſolution of the World, and future Conflagration. Wherein are largely diſcuſſed, the Production and Uſe of Mountains; the Original of Fountains, of formed Stones, and Sea-Fiſhes Bones and Shells found in the Earth; the Effects of particular Floods, and Inundations of the Sea; the Eruptions of Vulcano's; the Nature and Cauſes of Earthquakes. Alſo an Hiſtorical Account of thoſe Two late remarkable Ones in *Jamaica* and *England*. With Practical Inferences. By *John Ray*, late Fellow of the *Royal Society*. The third Edition, Illuſtrated with Copper-Plates, and much more Enlarged than the former Editions, from the Author's own MSS. 8*vo.* 1713.

All Publiſhed by the Reverend Mr. Derham.

TO THE READER.

HAving drawn up this Analytical Scheme, *for ſome particular Occaſions, many of my Ingenious Friends were earneſt for the Printing of it in the firſt Edition: And accordingly it ſhould have been ſo, but that it would have too long hindered the Publication of my Book; which unfortunately had already been retarded to near the Beginning of the* Long Vacation, *the worſt Time of all the Year to ſend a Book abroad. But that Impreſſion (although large) having the good Fortune to be ſold off by this Time, I have taken Care to have it inſerted in this Second Edition; as alſo that a ſufficient Number be Printed for the Service of the Purchaſers of the Firſt Edition, that they receive as little Damage as may be.*

To the Reader.

This Analyſis, *I confeſs, I think is too particular and large, (as it was neceſſary it ſhould be for the Uſes for which I at firſt drew it up) but my Judicious Friends would not ſuffer me to contract it, and gave me ſome good Reaſons for it.*

As to the Additions, *my Intent was to have made none, and therefore they are but few, and for the moſt part ſuch as I could not well avoid. But that they may not be detrimental to the First Edition, I have here ſpecified the places, in this Second, where they may be found, ſo as to be eaſily tranſcribed, if it be thought worth the while.*

The Additions to this Second Edition are,

Page 24. Note 1. *Concerning the means whereby Snow fructifies the Earth*, &c.

Page 48. Note (†), *An Objection againſt the Diſtribution of the Earth and Waters*

Waters anſwered from the too great Diminution of the Evaporations.

Page 58. Note 6. *Dr.* Tancred Robinſon's *Account of the great Uſe of divers Poyſonous Plants.*

Page 282. Note 18. *Monſieur* Cartes's *Vindication was thought fit to be ſomewhat altered.*

Page 306. *Dr.* Tancred Robinſon's *Ingenious Obſervations about the excellent Contrivance of our Bodies.*

Page 319. Line 4. *After* Variety would never have been, *read the following Lines thus*; And in caſe it had not been, but that Men's Faces had been caſt in the ſame, or not a very different Mould; had their Organs of Speech ſounded the ſame, or not ſo great a Variety of Notes; had the Structure of their Nerves and Muſcles been ſuch, as to have given the Hand the ſame Direction in Writing, what Confuſion, what Diſturbance, &c.

To the READER.

Page 459. Note 15. *Of the Seeds of* Fuci, Fungi, *&c. particularly those of* Puff-Balls.

As to the other Alterations, they are for the most part only the Emendations of some Typographical and lesser Errors.

An

An ANALYTICAL

SCHEME

Of Mr. *DERHAM's*

Physico-Theology.

THE Works of the Creation relating to our Terraqueous Globe, are such as are visible in the

- Outworks or Appendages of the Globe, *viz.* these three.
  - 1. The Atmosphere
    - Composed of Air and Vapours, *Page* 4.
    - Useful to
      - Respiration and Animal Life 5.
      - Vegetation of Plants 9.
      - Conveyance of
        - The Winged Tribes.
        - Sound 11.
      - The Functions of Nature.
      - Reflecting and Refracting Light 12.
    - Containing the
      - Winds, which are of great Use and Necessity
        - To the Salubrity and Pleasure of the Air 15.
        - In various Engines 18.
        - In Navigation.
      - Clouds and Rain: Of great Use to the
        - Refreshment of the Earth, and the things therein 20.
        - Origine of Fountains, according to some 23.
  - 2. Light. Its
    - Fountain 26.
    - Wonderful Necessity and Use.
    - Improvement by Glasses 28.
    - Velocity.
    - Expansion 30.
  - 3. Gravity.

- Its great Benefit 33
- Cauſe of *Levity*, which is of great Uſe in the World 35.

Terraqueous Globe it ſelf. Of which I take a View in

General of,

- Its Spherical Figure, which is the moſt commodious in regard of
  - Light 40.
  - Heat.
  - Lodgment of the Waters.
  - The Winds 42.
- Its Bulk 43.
- Its Motions 44.
  - Annual.
  - Diurnal.
- Its Place and Diſtance from the Sun, and other heavenly Bodies 46.
- Its Diſtribution, ſo as to cauſe all the Parts of the Globe to
  - Balance each other 48.
  - Be helpful to one another.
- The great Variety and Quantity of all things ſerving for Food, Phyſick, Building, and every Uſe and Occaſion of all Ages, Places, and Creatures 53.
- An Objection anſwered 55.

Particular, of the Earth alone: of its

Conſtituent Parts, *viz.* Its

- Soils and Moulds, neceſſary to the
  - Growth of various Vegetables 61.
  - Various Occaſions of Man, and other Animals 62.
- Various Strata or Beds, affording Materials for
  - Tools.
  - Firing.
  - Building.
  - Dying, and thouſands of other things 65.
  - Conveyance of the ſweet Fountain-Waters 66.
- Subterraneons Caverns and Vulcano's; of great Uſe to the Countries where they are 68.
- Mountains and Valleys, which are not rude Ruins, but Works of Deſign, inaſmuch as this Structure of the Earth is
  - The moſt beautiful and pleaſant.
  - The moſt ſalubrious: to ſome Conſtitutions, the Hills; to ſome, the Valleys 72.
  - Beſt to skreen us, and other things 73.
  - Beneficial to the
    - Production of various Vegetables.
    - Harbour and Maintenance of various Animals 74.
    - Generation of Minerals and Metals 75.
  - Abſolutely neceſſary to the Conveyance of the Rivers; and in all probability to the Origine of Fountains 76.

Con-

Concluſion againſt blaming God 81.
Its Inhabitants; which are either *Senſitive* or *Inſenſitive*. Concerning the
Senſitive, ſome things are
Common to all the Tribes, particularly theſe Ten:
I. The five Senſes and their Organs; the 86
Eye, an admirable Piece of Mechaniſm in regard of its
Form, for the moſt part Spherical, which is beſt for
The Reception of Objects.
Motion of the Eye 90.
Situation in the moſt commodious part of the Body of every Creature.
Motion, in ſome Animals,
Every way.
Fixed; and the excellent
Proviſion in the caſe 92.
Size: Which is in
All Creatures, according to their Occaſions.
Such as live abroad in the Light, larger.
Such as live under-ground, leſs.
Number, in ſome Animals:
Two 95.
More: Together with the wiſe Proviſion to prevent double Viſion.
Parts; ſome of which are viewed
Tranſiently, the Arteries, Veins, and ſome of the Muſcles and Tunicks.
More ſtrictly ſome of the
Muſcles, and the excellent Proviſion made for their peculiar Uſes, Equilibration, &c. 98.
Tunicks: Among which the various Apertures, Forms, and Poſitions of the Pupil are particularly noted 100.
Humours, eſpecially the prodigious Finery and Compoſition of the Cryſtalline, according to Mr. *Leewenhoeck*.
Nerves 106.
Optick,
Motory.
Guard and Security, provided for by
The Reparation of the Aqueous Humour.
Covering of the Eye-lids.
Strong and curious Bones.
Hard and firm Tunicks.
Withdrawing them into their Heads 111.
Of Erect Viſion 112.

Hearing. Its
- Organ, the Ear, 114.
  - Double, enabling us to hear every way, and a good Proviſion for the Loſs or Hurt of one.
  - Situated in the very beſt place for Information, Security, and near the Eye and Brain.
  - The Fabrick of the
    - Outward Ear, which is in
      - All Creatures formed, guarded, placed, and every way accoutered according to their various Places and Occaſions 116.
      - Man, ſuitable to his erect Poſture; and all its Parts, the *Helix*, *Tragus*, *Concha*, *&c.* admirably ſuited to the Reception and Meliora-tion of Sounds, and the Security of the Part.
    - Inward Ear: - In which I take a View of the 121.
      - Auditory Paſſage, curiouſly tunnelled, tortous, and ſmooth; and being always open, is lined with the nauſeous Ear-wax for a Guard.
      - Tuba Euſtachiana 123.
      - Bone, particularly hard and context for Guard, and to aſſiſt the Sound.
      - Tympanum, and its Membrane, Muſcles, and four little Bones to correſpond to all kinds of Sound.
      - Labyrinth, Semicircular Canals, Cochlea; all made with the utmoſt Art 128.
      - Auditory Nerves, one of which is ramified to the Eye, Tongue, Muſcles of the Ear, and to the Heart; whence a great Sympathy between thoſe Parts 129.
  - Object, Sound. Under which I conſider,
    - The Improvements thereof by the Wit of Man 130.
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      - In the Waters with Scales, hard for Guard; ſmooth for Paſſage; or with ſtrong Shells to guard ſuch as move more ſlowly 222.
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- Man, whose Reason and Art supplies the Defect of Natural Armature.
- Irrational Creatures; who
  - As they are on one hand sufficiently guarded by their
    - Shells, Horns, Claws, Stings, &c. 240.
    - Changing their Colours.
    - Wings, Feet, and Swiftness.
    - Diving in and tinging the Waters.
    - Ejecting Juyces out of their Body.
    - Accurate Smell, Sight and Hearing.
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- All Seaſons 252.
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Faculty of Nurſing their Young, by
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  - How ſutable this Food is.
  - How willingly parted with by all, even the moſt ſavage.
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  - Various Genii, or Inclinations of Men, which is a wiſe Proviſion for the Diſpatch of all the World's Affairs, and that they may be performed with Pleaſure 274.
  - Inventive Faculty. In which it is remarkable that
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    - Things of greateſt Neceſſity and Uſe were ſoon and eaſily found out; but things leſs uſeful later; and dangerous things not yet. Here of divers particular Inventions, with an Exhortation to exerciſe and improve our Gifts.
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    - The moſt convenient for a Rational Being 293.
    - Manifeſtly intended, as appears from the Structure of ſome particular Parts mentioned 296.
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- Figure and Shape of Man's Body moſt agreeable to his Place and Buſineſs 298.
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  - Without Botches and Blunders
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  - Of the beſt Form.
  - Moſt accurately accommodated to their proper Offices.
- Lodgment of the Parts, as the
  - Five Senſes 307.
  - Hand.
  - Legs and Feet.
  - Heart.
  - Viſcera.
  - Several Bones and Muſcles, *&c.* 308.
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  - Prevent Evils by the
    - Situation of the Eyes, Ears, Tongue and Hand 310.
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  - The Parts miniſtering to it, eſpecially the Legs and Feet, ſized and made in ſome for
    - Strength and ſlow Motion 325.
    - Agility and Swiftneſs.
    - Walking and Running.
    - Walking and Swimming.
    - Walking and Flying.
    - Walking and Digging.

- Traverſing the Plains.
- Traverſing Ice, Mountains, &c.
- Its Uſefulneſs to
  - Gather Food 327.
  - Catch Prey.
  - Climb, Leap and Swim.
  - Guard themſelves.
  - Carry Burdens, Till the Ground, and other Uſes of Man.
- Parts differing from thoſe of Man.
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  - Its Shape, commonly agreeable to the Animal's Motion.
  - The Brain, which is,
    - Leſſer than in Man 329.
    - Placed lower than the Cerebellum.
  - The Nictitating Membrane 331.
  - Carotid Arteries, and Rete Mirabile.
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  - Anſwering the Length of the Legs 332.
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  - Correſponding to the ſeveral Species 334.
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  - Ventricles, in ſome
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- Body and Motion; where I conſider
  - The Parts concerned in their Motion 343.
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    - Feathers, which are
      - Moſt exactly made for Lightneſs and Strength.
      - All well placed in every part, for the Covering and Motion of the Body.
      - Pruned and dreſſed 344.
    - Wings, which are
      - Made of the very beſt Materials, *viz.* of *Bones* light and ſtrong; *Joynts* exactly opening, ſhutting,

ting, and moving, as the Occaſions of Flight require; and the *Pectoral Muſcles* of the greateſt Strength of any in the whole Body.
Placed in the niceſt Point of the Body of every Species, according to their Occaſions of Flight, Swimming or Diving.
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To counterpoiſe the Body in Flight.
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  - The Knowledge Birds have of
    - Their Times of Paſſage 358.
    - The Places proper for them.
  - Their Accommodations for long Flights by long or elſe ſtrong Wings.
- Incubation, which is conſiderable for
  - The Egg, and its Parts 361.
  - Act it ſelf; that theſe Creatures ſhould betake themſelves to it, know this to be the way to produce their Young, and with Delight and Patience ſit ſuch a due Number of Days.
  - The Neglect of it in any, as the Oſtrich, and the wonderful Proviſion for the Young in that caſe 365.
- Nidification. Of which before.

Inſects. Which, although a deſpiſed Tribe, doth in ſome reſpects more ſet forth the infinite Power and Wiſdom of the Creator, than the larger Animals.

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- Body 370.
  - Shaped, not ſo much for long Flights, as for their Food, and Condition of Life.
  - Built not with Bones, but with what ſerves both for Bones and Covering too.
  - Eyes, reticulated to ſee all ways at once 371.
  - Antennæ and their Uſe 372.
  - Legs and Feet made for
    - Creeping 373.
    - Swimming and Walking.
    - Hanging on ſmooth Surfaces.
    - Leaping.
    - Digging.
    - Spinning and Weaving Webs and Caſes.
  - Wings, which are
    - Nicely diſtended with Bones 376.
    - Some incomparably adorned with Feathers and elegant Colours.
    - Some joynted and folded up in their Elytra, and diſtended again at Pleaſure.
    - In Number either
      - Two, with Poiſes.
      - Four, without Poiſes.
  - Surprizing Minuteneſs of ſome of thoſe Animals themſelves, eſpecially of their Parts, which are as numerous and various as in other Animal-Bodies 378.
- State; which ſets forth a particular Concurrence of the Divine Providence, in the wiſe and careful Proviſion that is made for their

Security

Security againſt Winter, by their
- Subſiſting in a different, *viz.* their Nympha or Aurelia-ſtate 380.
- Living in Torpitude, without any Waſt of Body, or Spirits 381.
- Laying up Proviſions before-hand.

Preſervation of their Species by
- Their Chuſing proper Places to lay up their Eggs and Sperm, ſo that the
  - Eggs may have due Incubation 384.
  - Young ſufficient Food.
- Care and Curioſity in repoſiting their Eggs in neat Order, and with the proper Part uppermoſt 393.
- Incomparable Art of Nidification, by being endowed with
  - Parts proper for, and agreeable to their ſeveral ways of Nidification, and the Materials they uſe in it.
  - Architectonick Sagacity to build and Niave their Cells, or to make even Nature her ſelf their Hand-Maid 397.

Reptiles. Which agreeing with other Animals in ſomething or other before treated of, I conſider only their

Motion, which is very remarkable, whether we conſider the
- Manner of it, as
  - Vermicular 405.
  - Sinuous.
  - Snail-like.
  - Catterpillar-like.
  - Multipedous.
- Parts miniſtering to it.

Poyſon, which ſerves to
- Scourge Man's Wickedneſs 409.
- Their eaſy Capture and Maſtery of their Prey.
- Their Digeſtion.

Watery Inhabitants, conſiderable for their
- Great Variety 410.
- Prodigious Multitudes.
- Vaſt Bulk of ſome, and ſurprizing Minuteneſs of others 412.
- Incomparable Contrivance and Structure of their Bodies.
- Supplies of Food.
- Reſpiration.
- Adjuſtment of their Organs of Viſion to their Element.
- Poiſe and Motion of their Body every way 413.

Inſenſitive Inhabitants. Among which having mentioned Foſſils and others, I inſiſt only upon *Vegetables*, and that in a curſory manner upon their
- Great Variety for the ſeveral Uſes of the World 415.
- Anatomy.
- Leaves 417.
- Flowers, and their admirable Gaiety.
- Seed, remarkable for its

Ge-

Generation.
Make.
Containing in it a compleat Plant 419.
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All Places 430.
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Heal ſome Local Diſtempers.
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1. Are great and excellent 436.
2. Ought to be enquired into, with a Commendation of ſuch as do ſo 438.
3. Are manifeſt to all, and therefore Atheiſm unreaſonable 439.
4. Ought to excite Fear and Obedience 442.
5. Ought to excite Thankfulneſs 443.
6. Should move us to pay God his due Homages and Worſhip, particularly that of the Lord's Day: Which is an Appointment

The moſt ancient 446.
Wiſely contrived for Diſpatch of Buſineſs, and to prevent Carnality.
Whoſe proper Buſineſs is, To ceaſe from Worldly, and to follow Spiritual Employments, the chief of which is the Publick Worſhip of God.

A

SURVEY

OF THE

Terraqueous Globe.

INTRODUCTION.

IN *Pſal.* 111. 2. The Pſalmiſt aſſerts, That *the* (1) *Works of the Lord are great; ſought out of all them that have Pleaſure therein.* This is true of all *God's Works*, particularly of his *Works of Creation:* Which, when *ſought out*, or, as the *Hebrew* Word (2) ſignifieth, when *heedfully* and *deeply pried into, ſolicitouſly obſerv'd, and enquir'd out*, eſpecially when clearly diſcovered to us; in this

(1) It is not unlikely that the Pſalmiſt might mean, at leaſt have an Eye to, the *Works of the Creation* in this Text, the Word מַעֲשֵׂה being the ſame in that *Pſal.* 19. 1. is tranſlated *God's Handy-work*, which is manifeſtly applied to the Works of *Creation*, and properly ſignifieth *Factum, Opus, Opificium*, from עָשָׂה *Fecit, Paravit, Aptavit.* And ſaith *Kircher, ſignificat talem effectionem, quâ aliquid exiſtit vel realitèr, vel ornatè, vel ut non ſit in priſtino ſtatu quo fuit.* Concord. p. 2. col. 931.

(2) דָּרַשׁ *Quaſivit, perquiſivit, ſciſcitatus eſt*, Buxtor. in verb. *Et ſimul importat curam, & ſolicitudinem.* Conrad. Kirch. ib. p. 1. col. 1174.

Caſe, I ſay, we find thoſe Works of *GOD* abundantly to deſerve the Pſalmiſt's Character of being *Great* and Noble; inaſmuch as they are made with the moſt exquiſite Art, (3) contrived with the utmoſt Sagacity, and ordered with plain wiſe Deſign, and miniſtering to admirable Ends. For which Reaſon St. *Paul* might well affirm of thoſe ποιήματα of God, (4) That the *inviſible Things of God, even his eternal Power and Godhead, are underſtood by them.* And indeed they are the moſt eaſy and intelligible Demonſtrations of the *Being* and *Attributes* of God; (5) eſpecially to ſuch as are unacquainted with the

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(3) *Quod ſi omnes mundi partes ita conſtitutæ ſunt, ut neque ad uſum meliores potuerint eſſe, neque ad ſpeciem pulchriores; videamus utrum ea fortuita ſint, an eo ſtatu, quo cohærere nullo modo potuerint, niſi ſenſu moderante, divinâque providentiâ Si ergo meliora ſunt ea, quæ Natura, quàm illa, quæ Arte perfecta ſunt: Nec Ars efficit quid ſine ratione: Ne Natura quidem rationes expers eſt habenda. Quî igitur convenit, ſignum, aut tabulam pictam cum adſpexeris, ſcire adhibitam eſſe artem; cumque procul curſum navigii videris, non dubitare, quin id ratione atque arte moveatur: aut cum Solarium, &c. Mundum autem, qui & has ipſas artes, & earum artifices, & cuncta complectatur, conſilii & rationes eſſe expertem putare? Quod ſi in Scythiam, aut in Britanniam, Sphæram aliquis tulerit hanc, quam nuper familiaris noſter effecit Poſidonius, cujus ſingulæ converſiones idem efficiunt in Sole, &c.——quod efficitur in cœlo ſingulis diebus & noctibus; quis in illâ barbarie dubitet, quin ea Sphæra ſit perfecta ratione? Hi autem dubitant de Mundo, ex quo & oriuntur, & fiunt omnia, caſune ipſe ſit effectus, —— an ratione, an mente divinâ? Et Archimedem arbitrantur plus valuiſſe in imitandis Sphæræ converſionibus, quam Naturam in efficiendis, præſertim cùm multis partibus ſint illa perfecta, quam hæc ſimulata, ſolertius, &c.* Cic. de Nat. l. 2.

(4) And a little before he ſaith of *Nature* it ſelf, *Omnem ergo regit Naturam ipſe* [Deus,] *&c.*

(5) *Mundus codex eſt Dei, in quo jugitèr legere debemus,* Bernard. Serm.

Arbitror nullam gentem, neque Hominum ſocietatem, apud quos ulla Deorum eſt religio, quidquam habere ſacris Eleuſiniis aut Samothraciis ſimile: Ea tamen obſcurè docent quæ profitentur: Naturæ vero opera in omnibus animantibus ſunt perſpicua. Galen. de Uſpart. l. 17. c. 1.

Subtilties

Subtilties of Reaſoning and Argumentation; as the greateſt part of Mankind are.

It may not therefore be unſuitable to the Nature and Deſign of Lectures (6) founded by one of the greateſt Virtuoſo's of the laſt Age, and inſtituted too on purpoſe for the Proof of the Chriſtian Religion againſt Atheiſts and other Infidels, to improve this occaſion in the Demonſtration of the *Being* and *Attributes* of an infinitely wiſe and powerful Creator, from a curſory Survey of the Works of *Creation*, or (as often as called) of *Nature*.

Which Works belong either to our *Terraqueous Globe*, or the *Heavens*.

I ſhall begin with our *own Globe*, being neareſt, and falling moſt under our Senſes. Which being a Subject very various and copious, for the more methodical and orderly Proceeding upon it, I ſhall diſtribute the Works therein.

I. Into ſuch as are not properly Parts, but *Appendages* or *Out-works* of the Globe.

II. The *Globe* it ſelf.

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(6) *Philoſophia eſt Catechiſmus ad Fidem.* Cyril. 1. contr. Jul.

BOOK I.

Of the Out-works of the Terraqueous Globe; the Atmosphere, Light, and Gravity.

CHAP. I.

Of the Atmosphere in general.

THE Atmosphere, or Mass of Air, Vapours and Clouds, which surrounds our Globe, will appear to be a matter of Design, and the infinitely wise Creator's Work, if we consider its *Nature* and *Make* (1), and its *Use* to the World (2).

1. Its Nature and Make, a Mass of Air, of subtile penetrating Matter, fit to pervade other Bodies, to penetrate into the inmost Recesses of Nature, to excite, animate, and spiritualize; and in short, to be the very Soul of this lower World. A thing consequently

2. Of greatest Use to the World; useful to the Life, the Health, the Comfort, the Pleasure, and Business of the whole Globe. It is the Air the

(1) *Mundi pars est Aer, & quidem necessaria: Hic est enim qui cælum terramque connectit*, &c. Senec. Nat. Qu. l. 2. c. 4.

(2) *Ipse Aer nobiscum videt, nobiscum audit, nobiscum sonat; nihil enim eorum sine eo fieri potest*, &c. Cicer. de Nat. Deor. l. 2.

whole

whole Animal World breathes, and liveth by; not only the Animals inhabiting the Earth (‖) and Air,

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(‖) As the Air is of abſolute Neceſſity to Animal Life, ſo it is neceſſary that it ſhould be of a due Temperament or Conſiſtence; not foul, by reaſon that ſuffocateth; nor too rare and thin, becauſe that ſufficeth not: With Examples of each of which, I ſhall a little entertain the Reader. In one of Mr. *Hawksbee*'s Compreſſing Engines, I cloſely ſhut up a *Sparrow* without forcing any Air in; and in leſs than an Hour the Bird began to pant, and be concerned; and in leſs than an Hour and a Half to be ſick, vomit, and more out of Breath; and in two Hours time was nearly expiring

Another I put in, and compreſſed the Air, but the Engine leaking, I frequently renewed the Compreſſure; by which means, (although the Bird panted a little after the firſt Hour,) yet after ſuch frequent Compreſſures, and Immiſſion of freſh Air, it was very little concerned, and taken out ſeemingly unhurt after three Hours.

After this I made two other Experiments in compreſſed Air, with the Weight of two Atmoſpheres injected, the Engine holding tight and well; the one with the *Great Titmouſe*, the other with a *Sparrow*. For near an Hour they ſeem'd but little concerned; but after that grew fainter, and in two Hours time ſick, and in three Hours time died. Another thing I took notice of, was, that when the Birds were ſick and very reſtleſs, I fancied they were ſomewhat relieved for a ſhort Space, with the Motion of the Air cauſed by their fluttering, and ſhaking their Wings, (a thing worth trying in the *Diving-Bell*.) I ſhall leave the ingenious Reader to judge what the cauſe was of both the Birds living longer in compreſſed, than uncompreſſed Air; whether a leſſer quantity of Air was not ſooner fouled and rendered unfit for Reſpiration, than a greater.

From theſe Experiments, two Things are manifeſted; one is, that Air, in ſome meaſure compreſſed, or rather heavy, is neceſſary to Animal Life. Of which by and by. The other, that freſh Air is alſo neceſſary. For pent up Air, when overcharged with the Vapours emitted out of the Animal's Body, becomes unfit for Reſpiration. For which Reaſon, in the *Diving-Bell*, after ſome time of ſtay under Water, they are forced to come up, and take in freſh Air. But the famous *Cornel Drebell* contrived not only a Veſſel to be rowed under Water, but alſo a Liquor to be carried in that Veſſel, that would ſupply the want of freſh Air. The Veſſel was made for King *James* I. It car-

ried twelve Rowers, beſides Paſſengers. It was tryed in the River of *Thames*; and one of the Perſons that was in that ſubmarine Navigation was then alive, and told it one, that related the Matter to our famous Founder, the Honourable, and moſt Ingenious Mr. *Boyle*. As to the Liquor, Mr. *Boyl* ſaith, he diſcovered by a Doctor of Phyſick, who married *Drebell*'s Daughter, that it was uſed from time to time when the Air in the ſubmarine Boat was clogged by the Breath of the Company, and thereby made unfit for Reſpiration; at which time, by unſtopping a Veſſel full of this Liquor, he could ſpeedily reſtore to the troubled Air ſuch a proportion of vital Parts, as would make it again for a good while fit for Reſpiration. The Secret of this Liquor *Drebell* would never diſcloſe to above one Perſon, who himſelf aſſured Mr. *Boyl* what it was. *Vid. Boyl. Exp. Phyſ. Mech. of the Spring of the Air. Exp.* 41. in the *Digreſ.* This Story I have related from Mr. *Boyl*, but at the ſame time much queſtion whether the Vertues of the Liquor were ſo effectual as reported.

And as too groſs, ſo too rare an Air is unfit for Reſpiration. Not to mention the forced Rarefactions made by the Air-Pump, in the following Note; it is found, that even the extraordinary natural Rarefactions, upon the Tops of very high Hills, much affect Reſpiration. An Eccleſiaſtical Perſon, who had viſited the high Mountains of *Armenia*, (on which ſome fancy the Ark reſted) told Mr. *Boyl*, that whilſt he was on the upper part of them, he was forced to fetch his Breath oftener than he was wont. And taking notice of it when he came down, the People told him, that it was what happened to them when they were ſo high above the Plain, and that it was a common Obſervation among them. The like Obſervation the ſame Eccleſiaſtick made upon the Top of a mountain in the *Cevennes*. So a learned Traveller, and curious Perſon, on one of the higheſt Ridges of the *Pyrenees*, called *Pic de Midi*, found the Air not ſo fit for Reſpiration, as the common Air, but he and his Company were fain to breathe ſhorter and oftener than in the lower Air. *Vid. Phil. Tranſact.* No. 63, or *Lowthorp*'s *Abridg.* Vol. 2. p. 226.

Such another Relation the learned *Joſeph Acoſta* gives of himſelf and his Company, that, when they paſſed the nigh Mountains of *Peru*, which they call *Periacaca*, (to which he ſaith, *the Alps themſelves ſeemed to them but as ordinary Houſes, in regard of high Towers,*) *He and his Companions were ſurprized with ſuch extreme Pangs of Straining and Vomiting, (not without caſting up of Blood too,) and with ſo violent a Diſtemper, that he concludes he ſhould undoubtedly have died; but that this laſted not above three or four Hours, before they came into a more convenient and natural Temperature of the Air.* All which he concludes proceeded from the too great Subtilty and Delicacy of the Air, which is not proportionable to humane Reſpiration, which requires a more groſs and temperate Air. *Vid. Boyl, ubi ſupra.*

Thus

Air (4), but those of the Waters (5) too. Without it most

Thus it appears, that an Air too Subtile, Rare and Light, is unfit for Respiration: But the Cause is not the Subtilty or too great Delicacy, as Mr. *Boyl* thinks, but the too great Lightness thereof, which renders it unable to be a Counterballance, or an Antagonist to the Heart, and all the Muscles ministering to *Respiration*, and the *Diastole* of the Heart. Of which see Book 4. Chap 7. Note 1.

And as our Inability to live in too rare and light an Air may discourage those vain Attempts of Flying, and Whimsies of passing to the Moon, *&c.* so our being able to bear an heavier State of the Air is an excellent Provision for Mens Occasions in Mines, and other great Depths of the Earth; and those other greater Pressures made upon the Air, in the *Diving-Bell*, when we descend into great Depths of the Waters.

(4) That the Inhabitants of the Air, (Birds and Insects,) need the Air as well as Man, and other Animals, is manifest from their speedy dying in too feculent, or too much rarefied Air; of which see the preceeding and following Note 6. But yet Birds and Insects (some Birds at least) can live in a rarer Air than Man. Thus Eagles, Kites, Herons, and divers other Birds, that delight in high Flights, are not affected with the Rarity of the Medium, as those Persons were in the preceeding Note. So Insects bear the Air-Pump long, as in the following Note 6.

(5) Creatures inhabiting the Waters need the Air, as well as other Animals, yea, and fresh Air too. The *Hydrocanthari* of all Sorts, both great and small; the *Notonecti*, *Squillæ aquaticæ* of all Sorts, the *Nymphæ* of *Gnats*, and many other Water-Insects, have a singular Faculty, and an admirable Apparatus, to raise their back Parts to the top of the Waters, to take in fresh Air. It is pretty to see, for Instance, the *Hydrocanthari* come and thrust their Tails out of the Water, and take in a Bubble of Air, at the tip of their Vaginæ and Tail, and then nimbly carry it down with them into the Waters; and, when that is spent, or fouled, to ascend again and recruit it.

So Fishes also are well known to use Respiration, by passing the Water through their Mouths and Gills. Cut *Carps* will live out of the Water, only in the Air; as is manifest by the Experiment of their way of Fatting them in *Holland*, and which hath been practised here in *England*, viz. they hang them up in a Cellar, or some cool Place, in wet Moss in a small Net, with their Head out, and feed them with white Bread soaked in Milk for many Days. This was told me by a Man very curious, and

moſt Animals live ſcarce half a Minute *(6)*; and others, that are the moſt accuſtomed to the want of it, live not without it many Days.

And

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of great Honour and Eminence, whoſe Word (if I might name him) no Body would queſtion: And it being an Inſtance of the Reſpiration of Fiſhes very ſingular, and ſomewhat out of the way, I have for the Reader's Diverſion taken notice of it.

(6) By Experiments I made my ſelf in the Air-Pump, in *September* and *October*, 1704; I obſerved that Animals whoſe Hearts have two *Ventricles*, and no *Foramen Ovale*, as Birds, Dogs, Cats, Rats, Mice, *&c.* die in leſs than half a Minute counting from the very firſt Exſuction; eſpecially in a ſmall Receiver.

A *Mole* (which I ſuſpected might have born more than other Quadrupeds) died in one Minute (without Recovery) in a large Receiver; and doubtleſs would hardly have ſurvived half a Minute in a ſmall Receiver. A *Bat* (although wounded) ſuſtained the Pump two Minutes, and revived upon the re-admiſſion of the Air. After that, he remained four Minutes and a half, and revived. Laſtly, After he had been in five Minutes, he continued gaſping for a time, and after twenty Minutes I re-admitted the Air, but the *Bat* never revived.

As for *Inſects: Waſps*, *Bees*, *Hornets*, *Graſhoppers*, and *Lady-Cows* ſeemed dead in Appearance in two Minutes, but revived in the open Air in two or three Hours time, notwithſtanding they had been in Vacuo twenty four Hours.

The *Earwig*, the great *Staphylinus*, the great black lowſy *Beetle*, and ſome other Inſects would ſeem unconcerned at the Vacuum a good while, and lie as dead; but revive in the Air, although ſome had lain ſixteen Hours in the exhauſted Receiver.

Snails bear the Air-Pump prodigiouſly, eſpecially thoſe in Shells; two of which lay above twenty four Hours, and ſeemed not much affected. The ſame Snails I left in twenty eight Hours more after a ſecond Exhauſtion, and found one of them quite dead, but the other revived.

Frogs and *Toads* bear the Pump long, eſpecially the former. A large Toad, found in the Houſe, died irrecoverably in leſs than ſix Hours. Another Toad and Frog I put in together, and the Toad was ſeemingly dead in two Hours, but the Frog juſt alive. After they had remained there eleven Hours, and ſeemingly dead, the Frog recovered in the open Air; only

weak,

And not only Animals themselves, but even Trees and Plants, and the whole vegetable Race, owe their Vegetation and Life to this useful Element; as will appear when I come to speak of them, and as is manifest from their Glory and Verdure in a free Air, and their becoming Pale and Sickly, and Languishing and Dying, when by any means excluded from it (7).

Thus useful, thus necessary, is the Air to the Life of the animated Creatures; and no less is it to the Motion and Conveyance of many of them. All the winged Tribes owe their Flight and Boyancy (8) to it, as shall be shewn in proper Place: And even the watery Inhabitants themselves cannot ascend

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weak, but the Toad was quite dead. The same Frog being put in again for Twenty Seven Hours, then quite died.

The Animalcules in *Pepper-Water* remained in Vacuo Twenty Four Hours. And after they had been exposed a Day or two to the open Air, I found some of them dead, some alive.

(7) That the Air is the principal Cause of the Vegetation of Plants, *Borelli* proves in his excellent Book *De Mot. Animal.* Vol. 2. Prop. 181. And in the next Proposition, he asserteth, *In Plantis quoque peragi Aeris respirationem quandam imperfectam, à quâ earum vita pendet, & conservatur.* But of this more, when I come to survey Vegetables.

Some Lettice-Seed being sown upon some Earth in the open Air, and some of the same Seed at the same time upon other Earth in a Glass-Receiver of the Pneumatick Engine, afterwards exhausted of Air: The Seed exposed to the Air was grown up an Inch and half high within Eight Days; but that in the exhausted Receiver not at all. And Air being again admitted into the said emptied Receiver, to see whether any of the Seed would then come up, it was found, that in the Space of one Week it was grown up to the Height of Two or Three Inches. Vid. Phil. Trans. No. 23. Lowth. Abridg. Vol. 2. p. 206.

(8) *In volucribus pulmones perforati aerem inspiratum in totam ventris cavitatem admittunt. Hujus ratio, ut propter corporis truncum Aere repletum, & quasi extensum, ipsa magis volatilia evadunt, faciliusque ab aere externo, propter intimi penum, sustententur. Equidem pisces, quò levius in aquis natent, in Abdomine vesicas*

aſcend and deſcend in their Element, well without it (9).

But

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veſicas Aere inflatas geſtant: pariter & volucres, propter corporis truncum Aere impletum & quaſi inflatum, nudo Aeri incumbentes, minùs gravantur, proindeque leviùs & expeditiùs volant. Willis de Anim. Brut. p. 1. c. 3.

(9) *Fiſhes by reaſon of their Bladder of Air within them, can ſuſtain, or keep themſelves in any Depth of Water: For the Air in that Bladder being more or leſs compreſſed, according to the Depth the Fiſh ſwims at, takes up more or leſs Space; and conſequently, the Body of the Fiſh, Part of whoſe Bulk this Bladder is, is greater or leſs according to the ſeveral Depths, and yet retains the ſame Weight. Now the Rule* de Inſidentibus humido *is, that a Body, that is heavier than ſo much Water, as is equal in Quantity to the Bulk of it, will ſink; a Body that is lighter, will ſwim; a Body of equal Weight will reſt in any Part of the Water. By this Rule, if the Fiſh, in the middle Region of the Water, be of equal Weight to the Water, that is commenſurate to the Bulk of it, the Fiſh will reſt there, without any Tendency upwards or downwards: And if the Fiſh be deeper in the Water, the Bulk of the Fiſh becoming leſs by the Compreſſion of the Bladder, and yet retaining the ſame Weight, it will ſink, and reſt at the Bottom. And on the other ſide, if the Fiſh be higher than the middle Region, the Air dilating it ſelf, and the Bulk of the Fiſh conſequently increaſing, but not the Weight, the Fiſh will riſe upwards and reſt at the Top of the Water. Perhaps the Fiſh by ſome Action can emit Air out of its Bladder,* —— *and, when not enough, take in Air,* —— *and then it will not be wondered, that there ſhould be always a fit Proportion of Air in all Fiſhes to ſerve their Uſe,* &c. Then follows a Method of Mr. *Boyl* to experiment the Truth of this. After which, in Mr. *Lowthorp*'s Abridgment, follow Mr. *Ray*'s Obſervations, *I think, that* —— *hath hit upon the true Uſe of the Swimming-Bladders in Fiſhes. For,* 1. *It hath been obſerved, that if the Swimming-Bladder of any Fiſh be pricked or broken, ſuch a Fiſh ſinks preſently to the Bottom, and can neither ſupport or raiſe it ſelf up in the Water.* 2. *Flat Fiſhes, as Soles, Plaiſe,* &c. *which lie always grovelling at the Bottom, have no Swimming-Bladders that ever I could find.* 3. *In moſt Fiſhes there is a manifeſt Channel leading from the Gullet* —— *to the ſaid Bladder, which without doubt ſerves for the conveying Air thereunto.* —— *In the Coat of this Bladder is a muſculous Power to contract it when the Fiſh liſts.* See more very curious Obſervations relating to this Matter, of the great Mr. *Ray*,

But it would be tedious to deſcend too far into Particulars, to reckon up the many Benefits of this noble Appendage of our Globe in many uſeful Engines (10); in many of the Functions and Operations of Nature (11); in the Conveyance of Sounds; and a Thouſand Things beſides. And I ſhall but juſt

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Ray, as alſo of the curious anonymous Gentleman in the ingenious Mr. *Lowthorp*'s Abridgement, before cited, *p.* 845. *from Phil. Tranſ. N.* 114, 115.

(10) Among the Engines in which the Air is uſeful, Pumps may be accounted not contemptible ones, and divers other Hydraulical Engines, which need not to be particularly inſiſted on. In theſe the Water was imagined to riſe by the power of Suction, to avoid a *Vacuum*, and ſuch unintelligible Stuff; but the juſtly famous Mr. *Boyl* was the firſt that ſolved theſe Phænomena by the Weight of the Atmoſphere. His ingenious and curious Obſervations and Experiments relating hereto may be ſeen in his little Tract, *Of the Cauſe of Attraction by Suction*, and divers others of his Tracts.

(11) It would be endleſs to ſpecify the Uſes of the Air in Nature's Operations: I ſhall therefore, for a Sample only, name its great Uſe to the World in conſerving Animated Bodies, whether endowed with Animal or Vegetative Life, and its contrary Quality of diſſolving other Bodies; by which means many Bodies, that would prove Nuſances to the World, are put out of the Way, by being reduced into their firſt Principles, (as we ſay,) and ſo embodied with the Earth again. Of its Faculty as a Menſtruum, or its Power to diſſolve Bodies; I may inſtance in Chryſtal-Glaſſes, which, with long keeping, eſpecially if not uſed, will in Time be reduced into a Powder, as I have ſeen. So divers Minerals, Earths, Stones, Foſſil-Shells, Wood, *&c.* which from *Noah*'s Flood, at leaſt for many Ages, have lain under Ground, ſo ſecure from Corruption, that, on the contrary, they have been thereby made much the ſtronger, have in the open Air ſoon mouldered away. Of which laſt, Mr. *Boyl* gives an Inſtance (from the *Diſſertation de admirandis Hungar. Aquis*) of a great Oak, like a huge Beam, dug out of a Salt Mine in *Tranſilvania*, *ſo hard, that it would not eaſily be wrought upon by Iron Tools, yet, being expoſed to the Air out of the Mine, it became ſo rotten that in Four Days it was eaſy to be broken, and crumbled between One's Fingers.* Boyl's Suſpic. about ſome hid. Qual. in the Air, *p.* 28. So the Trees

turned

juſt mention the admirable uſe of our Atmoſphere in miniſtring to the enlightening of the World, by its reflecting the Light of the heavenly Bodies to us (12); and refracting the Sun-beams to our Eye, before it ever ſurmounteth our Horizon (13); by which means the Day is protracted throughout the whole Globe; and the long and diſmal Nights are ſhortned in the frigid Zones, and Day ſooner approacheth

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turned out of the Earth by the Breaches at *Weſt-Thurrock* and *Dagenham*, near me, although probably no other than *Alder*, and interred many Ages ago in a rotten oazy Mold, were exceedingly tough, hard, and ſound at firſt; but being expoſed to the Air and Water, ſoon became ſo rotten as to be crumbled between the Fingers. See my Obſervations in *Philoſ. Tranſact. No.* 335.

(12) *By Reflecting the Light of the heavenly Bodies to us*, I mean that Whiteneſs, or Lightneſs which is in the Air in Day-time, cauſed by the Rays of Light ſtriking upon the Particles of the Atmoſphere, as well as upon the Clouds above, and the other Objects beneath upon the Earth. To the ſame Cauſe alſo we owe the Twilight, *viz.* to the Sun-beams touching the uppermoſt Particles of our Atmoſphere, which they do when the Sun is about Eighteen Degrees beneath the Horizon. And as the Beams reach more and more of the Airy Particles, ſo Darkneſs goes off, and Day-light comes on, and encreaſeth. For an Exemplification of the Experiment may ſerve of tranſmitting a few Rays of the Sun through a ſmall Hole into a dark Room: By which means the Rays which meet with Duſt, and other Particles flying in the Air are rendered viſible; or (which amounts to the ſame) thoſe ſwimming ſmall Bodies are rendered viſible, by their reflecting the Light of the Sun-beams to the Eye, which, without ſuch Reflection would it ſelf be inviſible.

The Azure Colour of the Sky Sir *Iſaac Newton* attributes to Vapours beginning to condenſe, and that are not able to reflect the other Colours. *V. Optic. l.* 2. *Par.* 3. *Prop.* 7.

(13) By the Refractive Power of the Air, the Sun, and the other heavenly Bodies ſeem higher than really they are, eſpecially near the Horizon. What the Refractions amount unto, what Variations they have, and what Alterations in time they cauſe, may be briefly ſeen in a little Book called, *The Artificial Clock-Maker*, Chap. 11.

Although

proacheth them; yea the Sun it self riseth in Appearance (when really it is absent from them) to the great Comfort of those forlorn Places (14).

But passing by all these Things with only a bare mention, and wholly omitting others that might have been named, I shall only insist upon the excellent Use of this noble circumambient Companion of

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Although this inflective Quality of the Air be a great Incumbrance and Confusion of Astronomical Observations; ——*yet it is not without some considerable Benefit to Navigation; and indeed in some Cases, the Benefit thereby obtained is much greater, than would be the Benefit of having the Ray proceed in an exact straight Line.* [Then he mentions the Benefit hereof to the Polar Parts of the World.] *But this by the by,* (saith he.) *The great Advantage I consider therein, is the first Discovery of Land upon the Sea; for by means hereof, the Tops of Hills and high Lands are raised up into the Air, so as to be discoverable several Leagues farther off on the Sea, than they would be were there no such Refraction, which is of great Benefit to Navigators for steering their Course in the Night, when they approach near Land; and likewise for directing them in the Day-time, much more certainly than the most exact Celestial Observations could do by the Help of an uninflected Ray, especially in such Places as they have no Soundings.* [Then he proposes a Method to find by these means the Distance of Objects at Sea.] V. Dr. *Hooke*'s *Post. Works.* Lect. of Navig. p. 466.

(14) *Cum Belgæ in nova Zembla hybernarent, Sol illis apparuit 16 diebus citius, quam revera in Horizonte existeret, hoc est, cum adhuc infra Horizontem depressus esset quatuor circiter gradibus, & quidem aere sereno.* Varen. Geog. c. 19. Pr. 22.

[These Hollanders] *found, that the Night in that place shortned no less than a whole Month; which must needs be a very great Comfort to all such Places, as lie very far towards the North and South Poles, where length of Night, and want of seeing the Sun, cannot chuse but be very tedious and irksome.* Hook. Ibid.

[By means of the Refractions,] *we found the Sun to rise twenty Minutes before it should; and in the Evening to remain above the Horizon twenty Minutes* (or thereabouts) *longer than it should.* Captain *James*'s Journ. in *Boyl* of Cold. Tit. 18. p. 190.

(15) *Aer*

of our Globe, in respect of two of its Meteors, the Winds, and the Clouds and Rain (15.

CHAP. II.

Of the Winds. (*)

TO pass by other Considerations, whereby I might demonstrate the Winds to be the infinite Creator's Work, I shall insist only upon their great usefulness to the World. And so great is their Use,

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(15) *Aer——in Nubes cogitur; humoremque colligens terram auget imbribus: tum effluens huc & illuc, ventos efficit. Idem annuas frigorum & calorum facit varietates: idemque & volatus Alitum sustinet, & spiritu ductus alit & sustentat animantes.* Cicer. de Nat. Deor. l. 2.

(1) *Ventus est aer fluens*, is *Seneca*'s Definition, *Na. Qu. l.* 5. And as Wind is a Current of the Air, so that which excites or alters its Currents may be justly said to be the Cause of the Winds. An æquipoise of the Atmosphere produceth a Calm; but if that æquipoise be more or less taken off, a Stream of Air, or Wind, is thereby accordingly produced either stronger or weaker, swifter or slower. And divers things there are that may make such Alterations in the æquipoise or balance of the Atmosphere, *viz.* Eruptions of Vapours from Sea or Land; Rarefactions and Condensations in one place more than other; the falling of Rain, pressure of the Clouds, *&c.* *Pliny*, l. 2. c. 45. tells us of a certain *Cavern* in *Dalmatia*, called, *Senta*, *in quem*, saith he, *dejecto levi pondere, quamvis tranquillo die, turbini similis emicat procella.* But as to Caves it is observed, that they often emit Winds more or less. Dr. *Conner*, taking notice of this matter, specifies these, *In regno Neopolitano ex immani Cummanæ Sibyllæ antro tenuem ventum effluentem percepi.* The like he observed at the Caves at *Baiæ*, and in some of the Mines of *Germany*, and in the large Salt-Mines of *Cracow* in *Poland*. *Ubi*, saith he, *opifices, & ipse fodinæ dominus Andreas Morstin, Nob. Polonus, mihi asseruerunt, quod tanta aliquando Ventorum tempestas ex ambagiosis hujus fodinæ,*

Uſe, and of ſuch abſolute Neceſſity are they to the Salubrity of the Atmoſphere, that all the World would be poiſoned without thoſe Agitations thereof. We find how putrid, fætid, and unfit for Reſpiration, as well as Health and Pleaſure, a ſtagnating, confined, pent up Air is. And, if the whole Maſs of Air and Vapours was always at Reſt, and without Motion, inſtead of refreſhing and animating, it would ſuffocate and poiſon all the World: But

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fodinæ receſſibus ſurgere ſolebat, quod laborantes foſſores humi proſternebat, nec non portas & domicilia (quæ ſibi in hâc fodinâ artifices exſtruunt) penitùs evertebat. Bern. Connor Diſſert. Med. Phyſ. p. 33. Artic. 3.

And as great Caves, ſo great Lakes ſometimes ſend forth Winds. So *Gaſſendus* ſaith the *Lucus Leginus* doth, *Equo dum exoritur fumus, nubes haud dubiè creanda eſt, quæ ſit brevi in tempeſtatem ſæviſſimam exoneranda.* Gaſſend. Vit. Peirisk. l. 5. p. 417

But the moſt univerſal and conſtant Alterations of the Ballance of the Atmoſphere are from Heat and Cold. This is manifeſt in the General Trade-Winds, blowing all the Year between the Tropicks from Eaſt to Weſt: The cauſe of which is doubtleſs the Sun's daily Progreſs round that part of the Globe, and by his Heat rarefying one part of the Air, whilſt the cooler and heavier Air behind preſſeth after. So the Sea and Land Breezes in Note 4. And ſo in our Climate, the Northerly and Southerly Winds (commonly eſteemed the Cauſes of cold and warm Weather,) are really the Effects of the Cold or Warmth of the Atmoſphere. Of which I have had ſo many Confirmations, that I have no doubt of it. As for Inſtance, it is not uncommon to ſee a warm Southerly Wind, ſuddenly changed to the North, by the fall of Snow or Hail; to ſee the Wind in a Froſty Cold Morning North, and when the Sun hath well warmed the Earth and Air, to ſee it wheel about towards the Southerly Quarters; and again to turn Northerly or Eaſterly in the cold Evening. It is from hence alſo, that in Thunder-ſhowers the Wind and Clouds are oftentimes contrary to one another, (eſpecially if Hail falls,) the ſultry Weather below directing the Wind one way; and the Cold above the Clouds another Way. I took Notice laſt *March* the 10th $171\frac{0}{1}$, (and divers ſuch like Inſtances I have had before and ſince,) that

But the perpetual Commotions it receives from the Gales, and Storms, keep it pure and healthful (2).

Neither are thoſe Ventilations beneficial only to the Health, but to the Pleaſure alſo of the Inhabitants of the Terraqueous Globe; witneſs the Gales which fan us in the Heat of Summer, without which, even in this our temperate Zone, Men are ſcarce able to perform the Labours of their Calling, or

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that the Morning was Warm, and what Wind ſtirred was Weſt-South-Weſt, but the Clouds were Thick and Black, (as generally they are when Snow enſues:) A little before Noon the Wind veered about to North by Weſt, and ſometimes to other Points, the Clouds at the ſame time flying ſome North by Weſt, ſome South Weſt: About One of the Clock it rained apace, the Clouds flying ſometimes North-Eaſt, then North, and at laſt both Wind and Clouds ſetled North by Weſt, at which time Sleet fell plentifully, and it grew very Cold. From all which I obſerve, 1. That although our Region below was warm, the Region of the Clouds was Cold, as the black ſnowy Clouds ſhewed. 2. That the ſtruggle between the warmth of ours and the cold of the cloudy Region ſtopped the airy Currents of both Regions. 3. That the falling of the Snow through our warmer Air melted it into Rain at firſt; but that it became Sleet after the ſuperiour Cold had conquered the inferiour Warmth. 4. That, as that Cold prevailed by Degrees ſo by Degrees it wheeled about both the Winds and Clouds from the Northwards towards the South.

Hippocrates, l. 2. *De Vict. rat. omnes Ventos vel a nive, glacie, vehementi gelu, fluminibus*, &c. *ſpirare neceſſe judicat.* Bartholin. de uſu Nivis. c. 1.

(2) *It is well obſerved in my Lord* Howard's *Voyage to* Conſtantinople, *that at* Vienna *they have frequent Winds, which if they ceaſe, long in Summer, the Plague often enſues: So that it is now grown into a Proverb, that if* Auſtria *be not windy, it is ſubject to Contagion.* Bohun of Wind. p. 213.

From ſome ſuch Commotions of the Air I imagine it is, that at *Grand Cairo* the Plague immediately ceaſes, as the ſoon as the *Nile* begins to overflow; although Mr. *Boyl* attributes it to nitrous Corpuſcles. *Determ. Nat. of Effluv.* Chap. 4.

or not without Danger of Health and Life, (3) But especially, witness the perpetual Gales which throughout the whole Year do fan the Torrid Zone, and make that Climate an healthful and plea-

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All this is more evident, from the Cause assigned to malignant epidemical Diseases, particularly the Plague, by my ingenious learned Friend, Dr. *Mead*; and that is, an hot and moist Temperament of the Air, which is observed by *Hippocrates*, *Galen*, and the general Histories of epidemical Diseases, to attend those Distempers. *Vid. Mead of Poisons*, *Essay* 5. p. 161. But indeed, whether the Cause be this, or poisonous, malignant Exhalations, as others think, the Winds are however very salutiferous in such Cases, in cooling the Air, and dispersing and driving away the moist or pestiferous Vapours.

(3) *July* 8. 1707, (called for some time after the *Hot-Tuesday*,) was so excessively hot and suffocating, by reason there was no Wind stirring, that divers Persons died, or were in great Danger of Death, in their Harvest-work. Particularly one who had formerly been my Servant, a healthy, lusty, young Man, was killed by the Heat: And several Horses on the Road, dropped down and died, the same Day.

In the foregoing Notes, having taken Notice of some things relating to Heat, although it be somewhat out of the way, I hope the Reader will excuse me, if I entertain him with some Observations I made about the Heat of the Air under the Line, compared with the Heat of our Bodies. *J. Patrick*, who, as he is very accurate in making Barometrical and Thermometrical Instruments, had the Curiosity for the nicer adjusting his Thermometers, to send Two abroad under the Care of Two very sensible ingenious Men, one to the Northern Lat. of 81; the other to the Parts under the Æquinoctial: In these two different Climates, the Places were marked where the Spirits stood at the severest Cold, and greatest Heat. And according to these Observations he graduates his Thermometers. With his Standard I compared my Standard Thermometer, from all the Degrees of Cold, I could make with *Sal Armoniack*, &c. to the greatest Degrees of Heat, our Thermometers would reach to. And with the same Thermometer (of mine) I experimented the greatest Heat of my Body, in *July* 1709. First in an hot Day without Exercise, by putting the Ball of my Thermometer under my Armpits, and other hottest Parts of my Body. By which means the Spirits were raised 284 Tenths of an Inch above the Ball. After that, in a much hotter

pleaſant Habitation, which would otherwiſe be ſcarce habitable.

To theſe I might add many other great Coveniencies of the Winds in various Engines, and various Buſineſſes. I might particularly inſiſt upon its great Uſe to tranſport Men to the fartheſt diſtant Regions of the World, and I might particularly ſpeak of the general and coaſting Trade-Winds, the Sea, and the Land-Breezes; (4) the one ſerving to carry the Mariner in long Voyages from Eaſt to Weſt; the other ſerving to waft him to particular Places;

Day, and indeed nearly as hot as any Day with us, and after I had heated my ſelf with ſtrong Exerciſe too, as much I could well bear, I again tried the ſame Experiment, but could not get the Spirits above 288 Tenths; which I thought an inconſiderable Difference, for ſo ſeemingly a very different Heat of my Body. But from ſome Experiments I have made (altho' I have unfortunately forgotten it) in very cold Weather, I imagine the Heat of an healthy Body to be always much the ſame in the warmeſt Parts thereof, both in Summer and Winter. Now between thoſe very Degrees of 284 and 288, the Point of the equatorial Heat falleth. From which Obſervation it appears, that there is pretty nearly an equal Contemperament of the Warmth of our Bodies, to that of the hotteſt Part of the Atmoſphere inhabited by us.

If the Proportion of the Degrees of Heat be deſired from the Freezing-point, to the Winter, Spring, and Summer Air, the Heat of Man's Body, of heated Water, melted Metals, and ſo to actual Fire; an Account may be met with of it, by my moſt ingenious Friend, the great Sir *Iſaac Newton*, in *Phil. Tranſact.* Nr. 270.

(4) Sea-Breezes *commonly riſe in the Morning about Nine a Clock.* ——*They firſt approach the Shore ſo gently, as if they were afraid to come near it.* —— *It comes in a fine, ſmall, black Curle upon the Water, whereas all the Sea between it, and the Shore (not yet reached by it) is as ſmooth and even as Glaſs in Compariſon. In half an Hour's time after it has reached the Shore, it fans pretty briskly, and ſo increaſeth gradually till Twelve a Clock; then it is commonly ſtrongeſt, and laſts ſo till Two or Three a very brisk Gale. —After Three it begins to die away again, and gradually withdraws its force till all is ſpent; and about Five a Clock —— it is lulled aſleep, and comes no more till next Morning.*

And

Places; the one ſerving to carry him into his Harbour, the other to bring him out. But I ſhould go too far to take notice of all Particulars (5). Leaving therefore the Winds, I proceed in the next Place to the Clouds and Rain.

And as the Sea-Breezes do blow in the Day, and reſt in the Night; ſo on the contrary [the Land-Breezes] *blow in the Night, and reſt in the Day, alternately ſucceeding each other.* —— *They ſpring up between Six and Twelve at Night, and laſt till Six, Eight, or Ten in the Morning.* Dampier's Diſc. of Winds, ch. 4.

(5) One thing more I believe ſome of my Friends will expect from me is, that I ſhew the Reſult of comparing my own Obſervations of the Winds, with others they know I have from *Ireland*, *Switzerland*, *Italy*, *France*, and ſome of our Parts of *England*. But the Obſervations being ſome of them but of one Year, and moſt of the reſt of but a few Years, I have not been able to determine any great Matters. The chief of what I have obſerved is, that the Winds in all theſe places ſeldom agree, but when they moſt certainly do ſo, it is commonly when the Winds are ſtrong, and of long continuance in the ſame Quarter: And more I think in the Northerly and Eaſterly, than other Points. Alſo a ſtrong Wind in one Place, is oftentimes a weak one in another Place, or moderate, according as Places have been nearer, or farther diſtant. *Vid. Phil. Tranſ.* Nr. 297, & 321. But to give a good and tolerable Account of this or any other of the Weather, it is nececeſſary to have good Hiſtories thereof from all Parts; which, as yet we have but few of, and they imperfect, for Want of longer and ſufficient Obſervations.

CHAP. III.

Of the Clouds and Rain.

THE Clouds and Rain (1) we ſhall find to be no leſs uſeful Meteors than the laſt mentioned; as is manifeſt in the refreſhing pleaſant Shades which the Clouds afford, and the fertile Dews and Showers which they pour down on the Trees and Plants,

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(1) Clouds and Rain are made of Vapours raiſed from Water, or Moiſture only. So that I utterly exclude the Notion of Dry, Terrene Exhalations, or Fumes, talked much of by moſt Philoſophers; Fumes being really no other than the humid Parts of Bodies reſpectively Dry.

Theſe Vapours are demonſtratively no other than ſmall Bubbles, or Veſiculæ detached from the Waters, by the Power of the Solar, or Subterraneous Heat, or both. Of which ſee *Book* 2. *Chap.* 5. *Note* 2. And being lighter than the Atmoſphere, are buoyed up thereby, until they become of an equal Weight therewith, in ſome of its Regions aloft in the Air, or nearer the Earth; in which thoſe Vapours are formed into Clouds, Rain, Snow, Hail, Lightning, Dew, Miſts, and other Meteors.

In which Work the grand Agent is Cold; which commonly, if not always, occupies the ſuperior Regions of the Air; as is manifeſt from thoſe Mountains which exalt their lofty Tops into the upper and middle Regions, and are always covered with Snow and Ice.

This Cold, if it approaches near the Earth, preſently precipitates the Vapours, either in *Dews*; or if the Vapours more copiouſly aſcend, and ſoon meet the Cold, they are then condenſed into *Miſling*, or elſe into Showers of *ſmall Rain*, falling in numerous, thick, ſmall Drops: But if thoſe Vapours are not only copious, but alſo as heavy as our lower Air it ſelf, (by means their Bladders are thick and fuller of Water,) in this Caſe they become viſible, ſwim but a little Height above the Earth, and make what we call a *Miſt* or *Fog*. But if they are a Degree lighter, ſo as to mount higher, but not any great Height, as alſo meet not with Cold enough to condenſe them, nor Wind to diſſipate them, they then form an heavy, thick, *dark Sky*, laſting oftentimes for ſeveral Weeks without either Sun or Rain. And in this Caſe, I have

ſcarce

Plants, which would languiſh and die with perpetual Drought, but are hereby made Verdant and Flouriſhing, Gay and Ornamental; ſo that (as the

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ſcarce ever known it to rain, till it hath been *firſt Fair, and then Foul.* And Mr. *Clarke*, (an ingenious Clergy-man of *Norfolk*, who in his Life-time, long before me, took notice of it, and kept a Regiſter of the Weather for Thirty Years, which his learned Grandſon, Dr. *Samuel Clarke* put into my Hands, he, I ſay) ſaith, he ſcarce ever obſerved the Rule to fail in all that time; only he adds, *If the Wind be in ſome of the eaſterly Points.* But I have obſerved the ſame to happen be the Wind where it will. And from what hath been ſaid, the Caſe is eaſily accounted for, *viz.* whilſt the Vapours remain in the ſame State the Weather doth ſo too. And ſuch Weather is generally attended with moderate Warmth, little or no Wind to diſturb the Vapours, and an heavy Atmoſphere to ſupport them, the Barometer being commonly high then. But when the Cold approacheth, and by condenſing, drives the Vapours into Clouds or Drops, then is way made for the Sun-beams, till the ſame Vapours, being by further Condenſation, formed into Rain, fall down in Drops.

The Cold's approaching the Vapours, and conſequently the Alteration of ſuch dark Weather I have before-hand perceived, by ſome few ſmall Drops of Rain, Hail, or Snow, now and then falling, before any Alteration hath been in the Weather; which I take to be from the Cold meeting ſome of the ſtraggling Vapours, or the uppermoſt of them, and condenſing them into Drops, before it arrives unto, and exerts it ſelf upon the main Body of Vapours below.

I have more largely than ordinary inſiſted upon this part of the Weather, partly, as being ſomewhat out of the way; but chiefly, becauſe it gives light to many other Phænomena of the Weather. Particularly we may hence diſcover the Original of Clouds, Rain, Hail, and Snow; that they are Vapours carried aloft by the Gravity of the Air, which meeting together ſo as to make a Fog above, they thereby form a *Cloud*: If the Cold condenſeth them into Drops, they then fall in *Rain*, if the Cold be not intenſe enough to freeze them: But if the Cold freezeth them in the Clouds, or in their Fall through the Air, they then become *Hail*, or *Snow*.

As to *Lightning*, and other enkindled Vapours, I need ſay little in this Place, and ſhall therefore only obſerve, that they owe alſo their Riſe to Vapours; but ſuch Vapours as are detached from mineral Juyces, or at leaſt that are mingled with them, and are fired by Fermentation.

the Pſalmiſt ſaith, *Pſal.* 65. 12, 13.) *The little Hills rejoice on every ſide, and the Valleys ſhout for joy, they alſo ſing.*

And,

Another *Phænomenon* reſolvable from what hath been ſaid is, why a *cold*, is always a *wet* Summer, *viz.* becauſe the Vapours riſing plentifully then, are by the Cold ſoon collected into Rain. A remarkable Inſtance of this we had in the Summer of 1708, part of which, eſpecially about the *Solſtice*, was much colder than uſually. On *June* 12. it was ſo cold, that my Thermometer was near the point of Hoar Froſt, and in ſome places I heard there was an Hoar Froſt; and during all the cool Weather of that Month, we had frequent, and large Rains, ſo that the whole Month's Rain amounted to above two Inches Depth, which is a large Quantity for *Upminſter*, even in the wetteſt Months. And not only with us at *Upminſter*, but in other places, particularly at *Zurich* in *Switzerland*, they ſeem to have had as unſeaſonable Cold and Wet, as we. *Fuit hic menſis —— præter modum humidus, & magno quidem vegetabilibus hominibuſque damno. Multum computruit Fœnum*, &c. complains the induſtrious and learned Dr. *J. J. Scheuchzer.* Of which, and other Particulars I have given a larger Account in *Phil. Tranſ.* Nr. 321.

In which *Tranſaction* I have obſerved farther, that about the Equinoxes we (at *Upminſter* at leaſt) have oftentimes more Rain, than at other Seaſons. The Reaſon of which is manifeſt from what hath been ſaid, *viz.* in Spring, when the Earth and Waters are looſed from the brumal Conſtipations, the Vapours ariſe in great plenty: And the like they do in Autumn, when the Summer Heats, that both diſſipated them, and warmed the ſuperior Regions, are abated; and then the Cold of the ſuperior Regions meeting them, condenſeth them into Showers, more plentiful than at other Seaſons, when either the Vapours are fewer, or the Cold that is to condenſe them is leſs.

The manner how Vapours are precipitated by the Cold, or reduced into Drops, I conceive to be thus: Vapours being, as I ſaid, no other than inflated Veſiculæ of Water; when they meet with a colder Air, than what is contained in them, the contained Air is reduced into a leſſer Space, and the watery Shell or Caſe rendered thicker by that means, ſo as to become heavier than the Air, by which they are buoyed up, and conſequently muſt needs fall down. Alſo many of thoſe thickened *Veſiculæ* run into one, and ſo form Drops, greater or ſmaller, according to the Quantity of Vapours collected together.

As to the Rain of different places, I have in ſome of our *Tranſactions* aſſigned the Quantities, particularly in the laſt cited *Tranſaction*, I have aſſigned theſe, *viz.* the Depth of the Rain one Year with

And, If to these Uses, we should add the Origine of Fountains and Rivers, to Vapours and the Rains,

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with another, in *English* Measure, if it was to stagnate on the Earth, would amount unto, at *Townley* in *Lancashire* 42 ½ inches; at *Upminster* in *Essex* 19 ¼ Inches; at *Zurich* in *Switzerland* 32 ½ Inches; at *Pisa* in *Italy* 43 ¼ Inches; at *Paris* in *France* 19 Inches; and at *Liste* in *Flanders* 24 Inches.

It would be endless to reckon up the *Bloody* and other *prodigious Rains*, taken notice of by Historians, and other Authors, as præternatural and ominous Accidents; but, if strictly pried into, will be found owing to natural Causes. Of which, for the Reader's Satisfaction, I will give an Instance or two. A bloody Rain was imagined to have fallen in *France*, which put the Country People into so great a fright, that they left their Work in the Fields, and in great haste flew to the neighbouring Houses. *Peiresc* (then in the Neighbourhood) strictly enquiring into the Cause, found it to be only red Drops coming from a sort of Butter-fly, that flew about in great Numbers at that time, as he concluded from seeing such red Drops come from them; and because these Drops were laid, *Non supra ædificia, non in devexis lapidum superficiebus, uti debuerat contingere, si è cælo sanguine pluisset; sed in subcavis potius, ac in foraminibus.* —— *Accessit, quod parietes iis tingebantur, non qui in mediis oppidis, sed qui agrorum vicini erant, neque secundum partes elatiores, sed ad mediocrem solùm altitudinem, quantam volitare Papiliones solent.* Gassend in vit. Peiresk. L. 2. p. 156.

So Dr. *Merret* saith also, *Pluvia Sanguinis quam certissimè constat esse tantum Insectorum excrementa: Pluvia Tritici quam nihil aliud esse quam Hederæ bacciferæ grana à Sturnis devorata excretaque comparanti liquidissimè patet.* Pinax rerum, &c. pag. 220.

The curious *Worm* tells of the raining of Brimstone, *An.* 1646 *Maii* 16. *Hic Hafniæ cum ingenti pluviâ tota urbs, omnesque ita inundarentur plateæ, ut gressus hominum impediret, Sulphureoque odore aërem inficeret, dilapsis aliquantulum aquis, quibusdam in locis colligere licuit Sulphureum pulverem, cujus portionem servo, colore, odore, & aliis verum Sulphur ferentem.* Mus. Worm. L. 1. c. 11. Sect. 1.

Together with the Rain we might take notice of other Meteors, particularly *Snow*; which although an irksom Guest, yet hath its great Uses, if all be true, that the famous *T. Bartholin* saith of it, who wrote a Book *de Nivis usu Medico.* In which he shews, of what great Use Snow is in fructifying the Earth, preserving from the Plague, curing Feavers, Cholicks, Head-Achs, Tooth-Achs, Sore Eyes, Pleurisies, (for which Use, he saith his Country-women of *Denmark* keep Snow-water gathered in *March*,) also in prolonging Life, (of which he instanceth in the *Alpine* Inhabitants,

Rains, as ſome of the moſt eminent modern Philoſophers

that live to a great Age,) and preſerving dead Bodies; Inſtances of which he gives in Perſons buried under the Snow in paſſing the *Alpes*, which are found uncorrupted in the Summer, when the Snow is melted, which ſad ſpectacle he himſelf was an Eye-witneſs of. And at *Spitzberge* in *Greenland*, dead Bodies remain entire and uncorrupted for Thirty Years. And laſtly, concerning ſuch as are ſo preſerv'd when ſlain, he ſaith they remain in the ſame Poſture and Figure. Of which he gives this odd Example, *Viſum id extra urbem noſtram* [Haſniam] *quum*, 11. *Feb.* 1659. *oppugnantes hoſtes repellerentur, magnaque ſtrage occumberent; alii enim rigidi iratum vultum oſtendebant, alii oculos elatos, alii ore diducto ringentes, alii brachiis extenſis gladium minari, alii alio ſitu proſtrati jacebant.* Barthol. de uſu Niv. c. 12.

But although Snow be attended with the Effects here named, and others ſpecified by the learned *Bartholin*; yet this is not to be attributed to any peculiar Virtue in the Snow, but ſome other Cauſe. Thus when it is ſaid to *fructify the Earth*, it doth ſo by guarding the Corn, and other Vegetables againſt the intenſer Cold of the Air, eſpecially the cold piercing Winds; which the Huſbandmen obſerve to be the moſt injurious to their Corn, of all Weathers. So for *Conſerving Dead Bodies*, it doth it by conſtipating ſuch Bodies, and preventing all ſuch Fermentations, or internal Conflicts of their Particles, as would produce Corruption.

Such an Example is ſaid to have happened ſome Years ago at *Paris*, in digging in a Cellar for ſuppoſed hidden Treaſure; in which after digging ſome Hours, the Maid going to call her Maſter, found them all in their digging Poſtures, but dead. This being noiſed abroad, brought in, not only the People, but Magiſtrates alſo, who found them accordingly; *Ille qui ligone terram effoderat, & ſocius qui palâ effoſſam terram removerat, ambo pedibus ſtabant quaſi ſuo quiſque operi affixus incubuiſſet, uxor unius quaſi ab opere defeſſa in ſcamno, ſollicito quodam vultu, ſedebat, inclinato in palmam manûs genibus innitentis capite; puerulus laxatis braccis in margine excavatæ foveæ defixis in terram oculis alvum exonerabat; omnes in naturali ſitu, carneæ tanquam ſtatuæ rigidi, apertis oculis & vultu vitam quaſi reſpirante, exanimes ſtabant.* Dr. Bern. Connor, Diſſert. Med. Phyſ. p. 15.

The Doctor attributes all this to Cold; but I ſcarce think there could be Cold enough to do all this at *Paris*, and in a Cellar too. But his following Stories are not improbable, of Men and Cattle killed with Cold, that remain in the very ſame Poſture in which they died; of which he gives this Inſtance from a

Spaniſh

loſophers (2) have done, we ſhould have another Inſtance of the great Uſe and Benefit of that Meteor.

And now, if we reflect upon this neceſſary Appendage of the Terraqueous Globe, the *Atmoſphere*; and conſider the abſolute Neceſſity thereof to many Uſes of our Globe, and its great Convenience to the whole: And in a Word, that it anſwereth all the Ends and Purpoſes that we can ſuppoſe there can be for ſuch an Appendage: Who can but own this to be the Contrivance, the Work of the great Creator? Who would ever ſay or imagine ſuch a Body, ſo different from the Globe it ſerves, could be made by Chance, or be adapted ſo exactly to all thoſe fore-mentioned grand Ends, by any other Efficient, than by the Power and Wiſdom of the infinite *GOD!* Who would not rather, from ſo noble a Work, readily acknowledge the Workman, (3) and as eaſily conclude the Atmoſphere to be made

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Spaniſh Captain, that happened two Years before, of a Soldier that happened unluckily to ſtraggle from his Company that were forraging, and was killed with the Cold, but was thought to have fallen into the Enemies Hands. But ſoon after their return to their Quarters, they ſaw their Comrade returning ſitting on Horſeback, and coming to congratulate him, found him dead, and that he had been brought thither in the ſame Poſture on Horſeback, notwithſtanding the jolting of the Horſe. *Ibid. p.* 18.

(2) Of this Opinion was my late moſt ingenious and learned Friend, Mr. *Ray*, whoſe Reaſons ſee in his *Phyſico Theolog. Diſcourſes*, Diſc. 2. p. 90, *&c.* So alſo my no leſs learned and ingenious Friends Dr. *Halley*, and the late Dr. *Hook*, many of the *French* Vertuoſo's alſo, and divers other very conſiderable Men before them, too many to be ſpecified here.

(3) *An Polycletum quidem admirabimur propter partium Statuæ — convenientiam ac proportionem? Naturam autem non modo non laudabimus, ſed omni etiam arte privabimus, quæ partium proportionem non ſolùm extrinſecus more Statuariorum, ſed in profundo etiam ſervavit? Nonne & Polycletus ipſe Naturæ eſt imitator, in quibus ſaltem eam potuit imitari? Potuit autem in ſolis externis partibus in quibus artem conſideravit.* With much more to the like purpoſe. *Galen. de Uſ. Part. l.* 17. *c.* 1.

(1) It

made by *GOD*, as an Instrument wrought by its Power, any Pneumatick Engine, to be contrived and made by Man!

CHAP. IV.

Of Light.

THUS much for the first Thing ministering to the Terraqueous Globe, the Atmosphere, and its Meteors; the next Appendage is *Light*. (1) Concerning which, I have in another part of this Survey (2) shewed, what admirable Contrivances the infinitely wise Creator hath for the affording this noble, glorious, and comfortable Benefit to other Globes, as well as ours; the Provision he hath made by Moons, as well as by the Sun, for the Communication of it.

And

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(1) It is not worth while to enumerate the Opinions of the *Aristotelians*, *Cartesians*, and others about the Nature of Light; *Aristotle* making it a Quality; *Cartes* a Pulsion, or Motion of the Globules of the second Element. *Vid. Cartes Princip.* p. 3. § 55, &c. But with the Moderns, I take *Light* to consist of material Particles, propagated from the Sun, and other luminous Bodies, not instantaneously, but in time, according to the Notes following in this Chapter. But not to insist upon other Arguments for the Proof of it, our noble Founder hath proved the Materiality of Light and Heat, from actual Experiments on Silver, Copper, Tin, Lead, Spelter, Iron, Tutenag, and other Bodies, exposed (both naked, and closely shut up) to the Fire: All which were constantly found to receive an Increment of Weight. I wish he could have met with a favourable Season, to have tried his Experiments with the Sun-beams as he intended. *Vid. Boyl Exp. to make Fire and Flame ponderable.*

(2) In my Survey of the Heavens, not yet Published.

(3) Gen.

And now let us briefly consider the great Necessity and Use thereof to all our Animal World. And this we shall find to be little less than the very Life and Pleasure of all those Creatures. For what Benefit would Life be of, what Pleasure, what Comfort would it be for us to live in perpetual Darkness? How could we provide our selves with Food and Necessaries? How could we go about the least Business, correspond with one another, or be of any Use in the World, or any Creatures be the same to us, without Light, and those admirable Organs of the Body, which the great *Creator* hath adapted to the Perception of that great Benefit.

But now by the help of this admirable, this first-made, (3) because most necessary, Creature of God, by this, I say, all the Animal World is enabled to go here and there, as their occasions call; they can transact their Business by Day, and refresh and recruit themselves by Night, with Rest, and Sleep. They can with Admiration and Pleasure, behold the glorious Works of God; they can view the Glories of the Heavens, and see the Beauties of the flowry Fields, the gay Attire of the feathered Tribe, the exquisite Garniture of many Quadrupeds, Insects, and other Creatures; they can take in the delightsome Landskips of divers Countries, and Places; they can with admiration see the great Creator's wonderful Art and Contrivance in the Parts of Animals and Vegetables: And in a word, behold the Harmony of this lower World, and of the Globes above; and survey the exquisite Workmanship in every Creature.

To

(3) Gen. 1. 3. *And God said, Let there be Light, and there was Light.*

(4) It

To all which I might add the Improvements, which the Sagacity of Men hath made of this noble Creature of God, by the Refractions and Reflections of Glaſſes. But it would be endleſs to enumerate all it's particular Uſes and Benefits to our World.

But before I leave this Point, there are two things concerning Light, which will deſerve an eſpecial Remark; and that is, it's ſwift and almoſt inſtantaneous Motion; and it's vaſt Extenſion.

1. It is a very great Act of the Providence of God, that ſo great a Benefit as Light is, is not long in its Paſſage from Place to Place. For was the Motion thereof no ſwifter than the Motion of the ſwifteſt Bodies on Earth, ſuch as of a Bullet out of a great Gun, or even of a Sound (4) (which is the ſwifteſt Motion we have next Light) in this Caſe Light would take up in it's Progreſs from the Sun to us, above thirty two Years, at the Rate of the firſt, and above ſeventeen Years, at the Rate of the latter.

The

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(4) It may not be ungrateful to the Curious to take Notice of the Velocity of theſe two Things.

According to the Obſervations of *Merſennus*, a Bullet ſhot out of a great Gun, flies 92 Fathoms in a Second of Time, [*Baliſt* ———] which is equal to 589½ Feet *Engliſh*; and according to the Computation of Mr. *Huygens*, it would be 25 Years in paſſing from the Earth to the Sun. But according to my own Obſervations made with one of Her Majeſty's *Sakers*, and a very accurate Pendulum-Chronometer, a Bullet, at it's firſt Diſcharge, flies 510 Yards in five Half-ſeconds, which is a Mile in a little above 17 Half-ſeconds. And allowing the Sun's Diſtance, as in the next Note, a Bullet would be 32½ Years in flying with its utmoſt Velocity to the Sun.

As to the Velocity of Sound, ſee *Book* 4. *Chap.* 3. *Note* 28. according to which rate there mentioned, a Sound would be near 17½ Years in flying as far as from the Earth to the Sun. Confer here the Experiments of the *Acad. del Ciment*, p. 140, *&c.*

(5) Mr.

The Inconveniencies of which would be, it's Energy and Vigour would be greatly cooled and abated; it's Rays would be leſs penetrant; and Darkneſs would with greater Difficulty and much ſluggiſhneſs, be diſſipated, eſpecially by the fainter Lights of our ſublunary luminous Bodies. But paſſing with ſuch prodigious Velocity, with nearly the iuſtantaneous Swiftneſs of above two Hundred and ſixty Thouſand Engliſh Miles in one Second of Time, (5) or (which is the ſame thing) being but about ſeven or Eight Minutes of an Hour in coming from

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(5) Mr. *Romer*'s ingenious Hypotheſis about the Velocity of Light, hath been eſtabliſhed by the *Royal Academy*, and in the *Obſervatory* for eight Years, as our *Phil. Tranſ.* No. 136. obſerve from the *Journ. des Scavans:* our moſt eminent Aſtronomers alſo in *England* admit it: But Dr. *Hook* thinks with Monſieur *Cartes*, the Motion of Light inſtantaneous. *Hook Poſt. Works, pag.* 77. And this he endeavours to explain, *pag.* 130, &c.

What Mr. *Romer*'s Hypotheſis is, may be ſeen in the *Phil. Tranſact.* before-cited: As alſo in the before-mentioned Sir *Iſaac Newton*'s *Opticks: Light is propagated from luminous Bodies in time, and ſpends about ſeven or eight Minutes of an Hour in paſſing from the Sun to the Earth. This was firſt obſerved by* Romer, *and then by others, by means of the Eclipſes of the Satellites of Jupiter. For theſe Eclipſes, when the Earth is between the Sun and Jupiter, happen about ſeven or eight Minutes ſooner than they ought to do by the Tables; and when the Earth is beyond the* ☉, *they happen about ſeven or eight Minutes later than they ought to do: The reaſon being, that the Light of the Satellites hath farther to go in the latter Caſe than in the former, by the Diameter of the Earth's Orbit.* Newt. Opt. L. 2. Part. 3. Prop. 11.

Now, foraſmuch as the Diſtance between the ☉ and ☊, is according to ſome 10000 Diameters of the Earth, according to others 20000; but according to our moſt ingenious Savilian Profeſſor, Dr. *Halley*, the middle between them, 15000, which (according to *Note* 1. *l.* 2. *c.* 2.) makes 119032125 Miles; therefore at the Rate of $7\frac{1}{2}$ Minutes, or 450 Seconds in paſſing from the ☉, Light will be found to fly 264516 Miles in one Second; which is vaſtly more than what Dr. *Hook* (no doubt by ſome Miſtake) hath it in his *Poſth. Works* before-cited.

(6) Dr.

from the Sun to us, therefore with all ſecurity and ſpeed, we receive the kindly Effects and Influences of that noble and uſeful Creature of God.

2. Another thing of great conſideration about Light is, it's vaſt Expanſion, it's almoſt incomprehenſible, and inconceivable Extenſion, which as a late ingenious Author (6) ſaith, " Is as boundleſs " and unlimited as the Univerſe it ſelf, or the Ex- " panſum of all material Beings: The vaſtneſs of " which is ſo great, that it exceeds the Comprehen- " ſions of Man's Underſtanding. Inſomuch that " very many have aſſerted it abſolutely Infinite, " and without any Limits or Bounds.

And that this noble Creature of God is of this Extent, (7) is manifeſt from our ſeeing ſome of the fartheſt diſtant Objects, the heavenly Bodies, ſome with our naked Eye, ſome with the help of Optical Inſtru-

(6) Dr. *Hook* Poſt. Works. Left of Light. *pag.* 76.

(7) For the proof of this vaſt Extent of Light, I ſhall take the Computation of the ſame great Man, *pag.* 77. *If*, ſaith he, *we conſider firſt the vaſt Diſtance between us and the Sun, which from the beſt and lateſt Obſervations in Aſtronomy, is judged to be about* 10000 *Diameters of the Earth, each of which is about* 7925 *Engliſh Miles*; *therefore, the Sun's diſtance is* 79250000 *Miles*; *and if we conſider that according to the Obſervation, which I publiſhed to prove the Motion of the Earth*, [which were Obſervations of the Parallax of ſome of the fixt Stars in the Head of *Draco*, made in 1669] *the whole Diameter of this Orb.* viz. 20000, *made the Subtenſe but of one Minute to one of the fixt Stars, which cannot therefore be leſs diſtant than* 3438 *Diameters of this Great Orb, and conſequently* 68760000 *Diameters of the Earth: And if this Star be one of the neareſt, and that the Stars that are of one Degree leſſer in Magnitude (I mean not of the Second Magnitude, becauſe there may be many Degrees between the Firſt and Second) be as much farther*; *and another ſort yet ſmaller be three times as far*; *and a fourth four times as far, and ſo onward, poſſibly to ſome* 100 *Degrees of Magnitude, ſuch as may be diſcovered by longer and longer Teleſcopes, that they may be* 100 *times as far*; *then certainly this material Expanſion, a part of which we are, muſt be ſo great, that 'twill infinitely exceed our ſhallow Conception to imagine. Now, by what I laſt mentioned, it is*

evident

Inſtruments, and others in all probability farther and farther, with better and better Inſtruments: And had we Inſtruments of Power, equivalent to the Extent of Light, the luminous Bodies of the utmoſt Parts of the Univerſe, would for the ſame Reaſon be viſible too.

Now as Light is of greateſt Uſe to impower us ſee Objects at all, ſo the Extenſion thereof is no leſs uſeful to enable us to ſee Objects afar off. By which means we are afforded a Ken of thoſe many glorious Works of the infinite Creator, viſible in the Heavens, and can improve them to ſome of the nobleſt Sciences, and moſt excellent Uſes of our own Globe.

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evident, that Light extends it ſelf to the utmoſt imaginable Parts, and by the help of Teleſcopes, we collect the Rays, and make them ſenſible to the Eye, which are emitted from ſome of the almoſt inconceivably remote Objects, &c. —— *Nor is it only the great Body of the Sun, or the vaſt Bodies of the fixt Stars, that are thus able to diſperſe their Light through the vaſt Expanſum of the Univerſe; but the ſmalleſt Spark of a lucid Body muſt do the very ſame thing, even the ſmalleſt Globule ſtruck from a Steel by a Flint,* &c.

CHAP. V.

Of Gravity.

THE laſt thing ſubſervient to our Globe, that I ſhall take notice of, is *Gravity* (1), or that Tendency which Bodies have to the Center of the Earth. If

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(1) According to the Principles of the *Newtonian* (the moſt rational of any) Philoſophy, the Cauſe of *Gravity*, is that univerſal Law of Matter, imprinted on it at it's Creation by the infinite Creator, namely *Attraction*: Which is congenial with all the Mat-

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If by the kind Reception of this, I have Encouragement to publiſh my *Survey of the Heavens*, I ſhall ſhew of what abſolute Neceſſity, and what a noble

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ter in the Univerſe; to Bodies Simple and Compound, Solid and Fluid, in the Heavens and the Earth; to the largeſt Globes, and even to the minuteſt, component Particles of Bodies. Theſe all *attract* one another in proportion to the quantity of their Matter, and to the Square of their Diſtances. Which Attraction, or Tendency (particularly of the leſſer Bodies to that greater, and moſt prevalent Attracter the Earth) is called their *Gravity*.

This Attraction, or Gravity, as its Force is in a certain proportion, ſo makes the Deſcent of Bodies to be at a certain rate. And was it not for the Reſiſtance of the Medium, all Bodies would deſcend to the Earth at the ſame rate; the lighteſt Down as ſwiftly as the heavieſt Mineral: As is manifeſt in the *Air-Pump*, in which the lighteſt Feather, Duſt, *&c.* and a piece of Lead, drop down ſeemingly in the ſame Time, from the Top to the Bottom of a tall exhauſted Receiver.

The rate of the Deſcent of heavy Bodies, according to *Galilæo*, Mr. *Huygens*, and Dr. *Halley* (after them) is 16 Feet 1 Inch in one Second of Time; and in more Seconds, as the Squares of thoſe Times. But in ſome accurate Experiments made in St. *Paul's Dome*, June 9. 1710, at the Height of 220 Feet, the Deſcent was ſcarcely 14 Feet in the firſt Second. The Experiments were made in the Preſence of ſome very conſiderable Members of the Royal Society, by Mr. *Hawksbee*, their Operator, with glaſs hollow Balls, ſome empty, ſome filled with Quick-ſilver, the Barometer at 29,7, the Thermometer 60 Degrees above Freezing. The Weight of the Balls, their Diameters, and Time of the Deſcent is in this Table.

Balls filled with ☿.			Empty Balls.			
Weight.	Diameter.	Time.	Weight.	Diameter.		Time.
Grains.	Tenth Inch.	$\frac{1}{2}$ Seconds.	Grains.	Inch.	Tenth.	$\frac{1}{2}$ Seconds.
908	8	8	510	5	1	17
993	8	8 leſs	642	5	2	16
866	8	8	599	5	1	16
747	7 $\frac{1}{2}$	8 more	515	5 nearly		16 $\frac{1}{2}$
808	7 $\frac{1}{2}$	8	483	5 nearly		17
784	7 $\frac{1}{2}$	8 more	641	5	1 2	16

For

noble Contrivance this is of keeping the ſeveral Globes of the Univerſe from ſhattering to pieces, as they evidently muſt do in a little time by their ſwift Rotation round their own Axes (2). The Terraqueous Globe particularly, which circumvolves

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The reaſon why the heavy, full Balls fell in half the time of the hollow ones, was the Reſiſtance of the Air. Which Reſiſtance is very ingeniouſly and accurately aſſigned by Dr. *Wallis*, in Philoſ. Tranſ. N. 186. And the cauſe of the Reſiſtance of all Fluids, (as Sir *Iſaac Newton*, *Opt.* Q. 20.) is partly from the *Friction* of the parts of the Fluid, partly from the *Inertia* thereof. The Reſiſtance a ſpherical Body meets with from Friction, is as the right Angle under the Diameter, and the Velocity of the moving Body: And the Reſiſtance from the *Vis Inertiæ*, is as the Square of that Product.

For a farther account of the Properties and Proportions, *&c.* of Gravity in the fall or projection of Bodies, I ſhall refer to the larger Accounts of *Gallilæus*, *Torricellius*, *Huygens*, Sir *Iſaac Newton*, &c. or to the ſhorter Accounts of Dr. *Halley*, in Philoſ. Tranſ. abridged by Mr. *Lowthorp*, Vol. I. p. 561. or of Dr. *Clarke* in his Notes on *Rohault's Phyſ.* p. 2. c. 28. §. 13, 16. And for the Reſiſtance of Fluids, I refer to Dr. *Wallis* before cited, and the *Act. Erudit. Lipſ.* May 1693. where there is a way to find the Force of Mediums upon Bodies of different Figures.

(2) That the heavenly Bodies move round their own Axes is, beyond all doubt, manifeſt to our Eye, in ſome of them, from the Spots viſible on them. The Spots on the Sun (eaſily viſible with an ordinary Glaſs) do manifeſt him to revolve round his own Axis in about 25 ¼ Days. The Spots on ♃ and ♂ prove thoſe two Planets to revolve alſo from Eaſt to Weſt, as Dr. *Hook* diſcovered in 1664, and 1665. And ♀ alſo (although near the ſtrong Rays of the Sun) hath, from ſome Spots, been diſcovered by Mr. *Caſſini*, in 1666, and 1667, to have a manifeſt Rotation. *V. Lowth. Abridg.* Vol. I. p. 382, and 423, 425. And ſuch Uniformity hath God obſerved in the Works of Nature, that what is obſervable in one, is generally to be found in all others of the ſame kind. So that ſince 'tis manifeſt the Sun and three of his Planets whirl round, it is very reaſonable to conclude all the reſt do ſo too, yea, every Globe of the Univerſe.

volves at the rate of above 1000 Miles an Hour (3), would by the centrifugal force of that Motion, be ſoon diſſipated, and ſpirtled into the circumambient Space, was it not kept together by this noble Contrivance of the Creator, this natural inherent Power; namely, the Power of Attraction, or Gravity.

And as by this Power our Globe is defended againſt Diſſipation, ſo all its parts are kept in their proper place and order. All material things do naturally gravitate thereto, and unite themſelves therewith, and ſo preſerve its Bulk intire (4). And the fleeting Waters, the moſt unruly of all its Parts, do by this means keep their conſtant æquipoiſe in the Globe (5), and remain in *that place which*, the Pſalmiſt ſaith, *God had founded for them, a bound he had*

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(3) The Earth's Circumference being 24930 Miles, (according to *Book II. Chap.* 2. *Note* 1.) if we divide that into 24 Hours, we ſhall find the Motion of the Earth to be nearly 1039 Miles in an Hour. Which, by the bye, is a far more reaſonable and leſs rapid Rate, than that of the Sun would be, if we ſuppoſe the Earth to ſtand ſtill, and the Sun to move round the Earth. For according to the Proportions in Note 5, of the preceding Chapter, the Circumference of the *Magnus Orbis* is 748201929 *Engliſh* Miles, which divided by 24 Hours, gives 31175080 Miles in an Hour. But what is this to the Rapidity of the fixt Stars, if we ſuppoſe them, not the Earth, to move? Which is a good Argument for the Earth's Motion.

(4) *Nihil majus, quam quod ita ſtabilis eſt Mundus, atque ita cohæret ad permanendum, ut nihil ne excogitari quidem poſſit aptius. Omnes enim partes ejus undique medium locum capeſſentes nituntur æqualitèr: maximè autem corpora inter ſe juncta permanent, cum quodam quaſi vinculo circumdata colligantur: quod facit ea natura, quæ per omnem mundum omnia mente, & ratione conficiens, funditur, & ad medium rapit, & convertit extrema.* Cicer. de Nat. Deor. l. 2.

(5) *Eadem ratione Mare, cum ſupra terram ſit, medium tamen terræ locum expetens, conglobatur undique æqualitèr, neque redundat unquam, neque effunditur.* Id paulo poſt.

(6) That

had ſet, which they might not paſs; that they turn not again to cover the Earth, Pſal. 104. 8, 9. So, that even in a natural way, by virtue of this excellent Contrivance of the Creator, the obſervation of the Pſalmiſt is perpetually fulfilled, *Pſal.* 89. 9. *Thou ruleſt the raging of the Sea; when the Waves thereof ariſe, thou ſtilleſt them.*

To theſe, and an Hundred other uſes of Gravity that I might have named, I ſhall only juſt mention another thing owing to it, and that is *Levity* (6), that whereby, what we call light Bodies ſwim; a thing no leſs uſeful to the World than its oppoſite, Gravity, is in many reſpects, to divers Tribes of Animals, but particularly ſerviceable to the raiſing up of Vapours (7), and to their conveyance about the World.

And

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(6) That there is no ſuch thing as *poſitive Levity*, but that Levity is only a leſſer Gravity, is abundantly manifeſted by the acute, *Seig. Alph. Borelli de Mot. Nat. a Grav. pend.* cap. 4. See alſo the Annotations of the learned and ingenious Dr. *Clark on Rohaulti Phyſ.* p. 1. c. 16. Not 3. Alſo the Exper. of the *Acad. del Cimento* p. 118, &c. Dr. *Wallis's Diſ. of Gravity and Gravitation before the Royal Society*, Nov. 12. 1674. p. 28, &c.

(7) I have before in *Note* 1. *Chap.* 3. ſhewn what *Vapours* are, and how they are raiſed. That which I ſhall here note is their Quantity. Concerning which the before commended, Dr. *Halley* hath given us ſome curious Experiments in our *Phil. Tranſact.* which may be met with together in Mr. *Lowthorp's Abridg. Vol. II. pag.* 108, *and* 126. Mr. *Sedileau* alſo at *Paris* obſerved it for near three Years. By all their Obſervations it appears, that in the Winter Months the Evaporations are leaſt, and greateſt in Summer, and moſt of all in windy Weather. And by *Monſieur Sedileau's* Obſervations it appears, that what is raiſed in Vapours, exceeds that which falleth in Rain. In the Seven laſt Months of the Year 1688, the Evaporations amounted to 22 Inches 5 Lines; but the Rain only to 11 Inches 6 ½ Lines: In 1689, the Evaporations were 32 Inches 10 ½ Lines; but the Rain 18 Inches 1 Line: In 1690, the Evaporations 30 Inches 11 Lines; the Rain 21 Inches ½ of a Line. *Vid. Mem. de Math. Phyſ. Ann.* 1692. pag. 25.

And now from this tranſient View of no other than the Out-works, than the bare Appendages of the Terraqueous Globe, we have ſo manifeſt a Sample of the Wiſdom, Power, and Goodneſs of the infinite Creator, that it is eaſy to imagine the whole Fabrick is of a piece, the Work of at leaſt a skilful Artiſt. A Man that ſhould meet with a Palace (8), beſet with pleaſant Gardens, adorned with ſtately Avenues, furniſhed with well-contrived Aquæducts, Caſcades, and all other Appendages, conducing to Convenience or Pleaſure, would eaſily imagine, that proportionable Architecture, and Magnificence were within: But we ſhould conclude the Man was out of his Wits, that ſhould aſſert and plead that all was the Work of Chance, or other than of ſome wiſe and skilful Hand. And ſo when we ſurvey the bare Out-works of this our Globe, when we ſee ſo vaſt a Body, accouter'd with ſo noble a Furniture of Air, Light, and Gravity; with every thing, in ſhort, that is neceſſary to the Preſervation and Security of the Globe it ſelf, or that conduceth to the Life, Health, and Happineſs, to the Propagation, and Increaſe of all the prodigious variety of Creatures the Globe is ſtocked with; when we ſee nothing wanting, nothing redundant, or frivolous, nothing botching, or ill-made, but that every thing, even

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If it be demanded, what becomes of the overplus of Exhalations that deſcend not in Rain? I anſwer; They are partly tumbled down and ſpent by the Winds, and partly deſcend in Dews, which amount to a greater quantity than is commonly imagined. Dr. *Halley* found the deſcent of Vapours in Dews ſo prodigious at St. *Helena*, that he makes no doubt to attribute the origine of Fountains thereto. And I my ſelf have ſeen in a Still cool Evening, large thick Clouds hanging without any Motion in the Air, which in two or three Hours time have been melted down by Degrees, by the cold of the Evening, ſo that not any the leaſt remains have been of them left.

(8) See *Book II. Chap.* 3. *Note* 3.

(1) *Liect*

even in the very Appendages alone, exactly ânſwereth all its Ends, and Occaſions: What elſe can be concluded, but that all was made with manifeſt Deſign, and that all the whole Structure is the Work of ſome intelligent Being; ſome Artiſt, of Power and Skill equivalent to ſuch a Work?

BOOK II.

Of the Terraqueous Globe it ſelf, in general.

IN the foregoing Book having diſpatch'd the Out-works, let us take a Survey of the Principal Fabrick, *viz.* the *Terraqueous Globe* it ſelf. a moſt ſtupendous Work in every particular of it, which doth no leſs aggrandize it's Maker *(1)*, than every

(1) Licet——oculis quodammodo contemplari pulchritudinem earum rerum, quas divina providentia dicimus conſtitutas. Ac principo Terræ univerſa cernatur, locata in mediâ mundi ſede, ſolida, & globoſa—— veſtita floribus, herbis, arboribus, frugibus. Quorum omnium incredibilis multitudo, inſatiabili varietate diſtinguitur. Adde huc Fontium gelidas perennitates, liquores perlucidos Amnium, Riparum veſtitus viridiſſimos, Speluncarum concavas altitudines, Saxorum aſperitates, impendentium Montium altitudines, immenſitateſque Camporum: adde etiam reconditas Auri——venas——Quæ verò, & quam variæ genera Beſtiarum? ——Qui volucrum lapſus, atque cantus? Qui Pecudum paſtus?——Quid de Hominem genere dicam? Qui quaſi cultores terræ conſtituti, &c. ——Quæ ſi, ut animis, ſic oculis videre poſſemus, nemo cunctam intuens terram, de divinâ ratione dubitaret. Cicer. de Nat. deor. l. 2.

every curious compleat Work doth its Workman. Let us caſt our Eyes here and there, let us ranſack all the Globe, let us with the greateſt accuracy inſpect every part thereof, ſearch out the inmoſt Secrets of any of the Creatures; let us examine them with all our Gauges, meaſure them with our niceſt Rules, pry into them with our Microſcopes, and moſt exquiſite Inſtruments (‖), ſtill we find them to bear teſtimony to their infinite Workman; and that they exceed all humane Skill ſo far, as that the moſt exquiſite Copies and Imitations of the beſt Artiſts, are no other than rude bungling Pieces to them. And ſo far are we from being able to eſpy any defect or fault in them, that the better we know them, the more we admire them; and the father we ſee into them, the more exquiſite we find them to be.

And for a Demonſtration of this; I ſhall,

I. Take a general Proſpect of the Terraqueous Globe.

II. Survey its Particulars.

I. The things which will fall under a general Proſpect of the Globe, will be its *Figure*, *Bulk*, *Motion*, *Place*, *Diſtribution* into Earth and Waters, and the great *Variety* of all things upon it, and in it.

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(‖) *I cannot here omit the Obſervations that have been made in theſe later Times, ſince we have had the Uſe and Improvement of the* Microſcope, *concerning the great difference, which by the help of that, doth appear betwixt* Natural *and* Artificial *Things. Whatever is Natural, doth by that appear adorned with all imaginable Elegance and Beauty——Whereas the moſt curious Works of Art, the ſharpeſt fineſt Needle, doth appear as a blunt rough Bar of Iron, coming from the Furnace or the Forge. The moſt accurate Engravings or Emboſsments ſeem ſuch rude, bungling, deformed Works, as if they had been done with a Mattock, or a Trowel. So vaſt a difference is there betwixt the Skill of* Nature, *and the Rudeneſs and Imperfection of* Art. *Bp.* Wilk. Nat. Rel. L. 1. Ch. 6.

(1) Although

CHAP. I.

Of the Figure of the Terraqueous Globe.

THIS I ſuppoſe I may take for granted to be ſpherical, or nearly ſo (1). And this muſt be allowed to be the moſt commodious apt Figure for a World on many Accounts; as it is moſt capacious, as it's Surface is equi-diſtant from the Center, not

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(1) Although the Terraqueous Globe be of an orbicular Figure, yet it is not ſtrictly ſo, 1. On account of its Hills and Vallies. But theſeare inconſiderable to the Earth's Semidiameter, that they are but as the Duſt upon a common Globe. But, 2. Our modern Aſtronomers aſſign a much greater Variation from a globous Form, namely, that of a prolate Sphæroid, making the Polar about 34 Miles ſhorter than the Equatorial Diameter. The cauſe of which they make to be the centrifugal Force of the diurnal Rotation of the Globe.

This Figure they imagine is in *Jupiter*, his Polar being to his Equatorial Diameter, as 39 $\frac{3}{4}$ to 40 $\frac{3}{4}$. But whether it be ſo or no, I confeſs I could never perceive, although I have often viewed that Planet through very good, and long Glaſſes, particularly a tolerable good one of 72 Feet in my Hands: And although by reaſon of cloudy Weather, and (at preſent) *Jupiter*'s proximity to the Sun, I have not yet been able to view that Planet; yet *Saturn* (ſo far as his Ring would permit,) and *Mars* appear perfectly round through Mr. *Huygens*'s long Glaſs of 126 Feet, which by Will he bequeathed, with its whole Apparatus, to our *R. S.* by whoſe Favour it is now in my Hands. And moreover, I believe it difficult, next to impoſſible, to meaſure the two Diameters to a 40th Part, by reaſon of the ſmallneſs of ♃ apparent Diameter, and by reaſon he is moving all the time of meaſuring him.

As to what is alledged from lengthening the Pendulums of Clocks, to make them keep the ſame time under the Equator, as they do in our Climes; I have ſhewn from the like Variations in the Air-pump, that this may ariſe from the rarity of the Air there, more than here. *V. Phil. Tranſ. N.* 294. But if the Degrees of a Meridian grow larger, the more we go towards

not only of the Globe, but (at leaſt nearly) of Gravity and Motion too, and as ſome have thought, of the central Heat and Waters. But theſe, and divers other things I ſhall paſs over, and inſiſt only upon two or three other Benefits of this globous Figure of the Earth and Waters.

1. This Figure is the moſt commodious in regard of Heat, and I may add of Light alſo in ſome Meaſure. For by this means, thoſe two great Benefits are uniformly and equally imparted to the World: They come harmoniouſly and gradually on, and as gradually go off again. So that the daily and yearly Returns of Light and Darkneſs, Cold and Heat, Moiſt and Dry, are Regular and Workman-like, (we may ſay,) which they would not be, eſpecially the former, if the Maſs of Earth and Waters were (as ſome fancied (2) it) a large Plain; or as others like

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the Line, (as Mr. *Caſſini* affirms they do, by an 800th Part in every Degree, in *Phil. Tranſ. N.* 278.) then there is great reaſon to conclude in behalf of this Sphæroidal Form.

The natural Cauſe of this Sphericity of our Globe is (according to Sir *Iſaac Newton*'s Principles) that *Attraction*, which the infinite Creator hath ſtamp'd on all the Matter of the Univerſe, whereby all Bodies, and all the parts of Bodies mutually attract themſelves and one another. By which means, as all the parts of Bodies tend naturally to their Center, ſo they all betake themſelves to a globous Figure, unleſs ſome other more prevalent Cauſe interpoſe. Thus drops of Quick-ſilver put on a ſpherical Form, the parts thereof ſtrongly attracting one another. So drops of Water have the ſame Form, when falling in the Air; but are Hemiſpherical only when they lie on an hard Body, by reaſon their Gravity doth ſo far overpower their ſelf-attracting Power, as to take off one half of their Sphericity. This Figure is commonly attributed to the preſſure of the circumambient Air: But that this can't be the cauſe, is manifeſt from the Air-pump; the caſe being the very ſame in an exhauſted Receiver, as in the open Air, and not any the leaſt Alteration of the Figure that I could perceive, in all the Trials that I have made.

(2) It would be trivolous, as well as endleſs to reckon up the various Opinions of the Ancients about the Figure of the Terraqueous

like a large Hill in the midſt of the Ocean; or of a multangular Figure; or ſuch like.

2. This Figure is admirably adapted to the commodious and equal Diſtributions of the Waters in the Globe. For ſince, by the Laws of Gravity, the Waters will poſſeſs the loweſt place; therefore, if the Maſs of Earth was cubick, priſmatick, or any other angular Figure, it would follow that one (too vaſt a part) would be drowned; and another be too dry. But being thus orbicular, the Waters are equally and commodiouſly diſtributed here and there, according as the Divine Providence ſaw moſt fit; of which I ſhall take notice by and by.

3. The orbicular Figure of our Globe, is far the moſt beneficial to the Winds, and Motions of the Atmoſphere. It is not to be doubted, if the Earth was of ſome other, or indeed any other Figure, but that the Currents of Air would be much retarded, if not wholly ſtopped. We find by Experience what influence large and high Mountains, Bays, Capes, and Head-lands have upon the Winds; how they ſtop ſome, retard many, and divert and change (near the Shores) even the *General* and *conſtant*

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raqueous Globe; ſome of them may be ſeen in *Varen. Geogr. l.* 1. *c.* 3. *init.* or *Jonſton*'s *Thaumatogr. c.* 1. *Artic.* 3. But among the variety of Opinions, one of the principal was, that the viſible Horizon was the bounds of the Earth, and the Ocean the bounds of the Horizon, that the Heavens and Earth above this Ocean, was the whole viſible Univerſe; and that all beneath the Ocean was *Hades*, or the *inviſible World*. Hence, when the Sun ſet, he was ſaid *tingere ſe Oceano*; and when any went to *Hades*, they muſt firſt paſs the Ocean. Of this Opinion were not only the ancient Poets, and others among the Heathens, but ſome of the Chriſtian Fathers too, particularly *Lanctantius*, St. *Auguſtine*, and others, who thought their Opinion favoured by the Pſalmiſt, in *Pſal.* 24. 2. and 136. 6. See *Bp. Uſher's Anſ. to a Jeſ. Chall.* p. 336, &c.

(3) *Neither*

ſtant Winds (3) that blow round the Globe in the Torrid Zone. And therefore, ſince this is the effect of ſuch little Excreſcences, which have but little proportion to our Globe; what would be the conſequences of much vaſter Angles, which would equal a Quarter, Tenth, or but an Hundredth Part of the Globe's Radius? Certainly theſe muſt be ſuch a Barricade, as would greatly annoy, or rather abſolutely ſtop the Currents of the Atmoſphere, and thereby deprive the World of thoſe ſalutiferous Gales, that I have ſaid keep it ſweet and clean.

Thus the Figure of our Globe doth manifeſt it to be a Work of contrivance, inaſmuch as it is of the moſt commodious Figure; and all others would be liable to great and evident Inconveniencies.

CHAP.

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(3) *Neither do theſe conſtant* Trade-winds, *uſually blow near the Shore, but only in the Ocean, at leaſt* 30 *or* 40 *Leagues off at Sea, clear from any Land; eſpecially on the Weſt Coaſt, or Side of any Continent: For indeed on the Eaſt ſide, the Eaſterly Wind being the true Trade-wind, blows almoſt home to the Shore; ſo near as to receive a check from the Land-wind.* Dampier's Winds Ch. 1.

And not only the *general Trade-winds*, but alſo the *conſtant coaſting Trade-winds*, are in like manner affected by the Lands. Thus, for inſtance, on the Coaſt of *Angola* and *Peru*. But this, ſaith the curious Captain *Dampier*, the Reader muſt take notice of, *That the Trade-winds that blow on any Coaſt, except the North Coaſt of* Africa, *whether they are conſtant, and blow all the Year, or whether they are ſhifting Winds, do never blow right in on the Shore, nor right along Shore, but go ſlanting, making an acute Angle of about* 22 *Degrees. Therefore, as the Land trends more Eaſt or Weſt, from the North or South on theſe Coaſts; ſo the Winds do alter accordingly.* Ibid. Ch. 2.

CHAP. II.

Of the Bulk of the Terraqueous Globe.

THE next thing remarkable in the Terraqueous Globe, is the prodigious Bulk thereof (†): A Mass of above 260 Thousand Millions of Miles solid Content. A Work too grand for any thing less than a God to make. To which in the next place we may add,

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CHAP. III.

The Motions of the Terraqueous Globe.

THE Motions the Terraqueous Globe hath, are round its own Axis, and round its Fountain of Light and Heat, the Sun (1). That so vast a body as the Earth and Waters should be moved at all,

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(†) It is not difficult to make a pretty near Computation of the Bulk of the Terraqueous Globe, from those accurate Observations of a Degree, made by Mr. *Norwood* in *England*, and Mr. *Picart*, and others in *France*: Both whose Measures surprizingly agree, within about a quarter of a Mile. By the *French* Measure, the Diameter of our Globe appears to be 6538594 Parisian Toises, which are 41899310,352 *English* Feet, or 7935,475 *English* Miles. Its Ambit therefore is 24930 Miles, and (supposing it Spherical) its Surface is 197831392 Miles: Which multiplied into $\frac{1}{3}$ of its Semi-diameter, gives its solid Content, *viz.* 261631995920 Miles.

(1) With the *Copernicans*, I take it here for granted, that the Diurnal and Annual Revolutions are the Motions of the Terraqueous Globe, not of the Sun, *&c.* but the Proof thereof I shall reserve for my Survey of the Heavens. See *Book I. Chap.* 5. *Note* 3.

(2) *Every*

all (2), that it ſhould undergo two ſuch different Motions, as the Diurnal and Annual are, and that theſe Motions ſhould be ſo conſtantly and regularly (3) performed for near 6000 Years, without any the leaſt Alteration ever heard of (except ſome Hours which we read of in *Joſh.* 10. 12, 13. and in *Hezekiah*'s time, which, if they cannot be accounted for ſome other way, do greatly increaſe the

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(2) *Every thing that is moved, muſt of neceſſity be moved by ſomething elſe; and that thing is moved by ſomething that is moved either by another thing, or not by another thing. If it be moved by that which is moved by another, we muſt of neceſſity come to ſome* primo Mover, *that is not moved by another. For it is impoſſible, that what moveth, and is moved by another, ſhould proceed* in infinitum. Ariſtot. Phyſ. l. 8. c. 5.

Solum quod ſeipſum movet, quia nunquam deſeritur a ſe, nunquam ne moveri quidem deſinit, quinetiam cæteris quæ moventur, hic fons: hoc principium eſt movendi, Principii autem nulla origo: nam ex principio oriuntur omnia; ipſum autem nulla ex re alia naſci poteſt: nec enim eſſet id principium, quod gigneretur aliunde. Cicer. Tuſc. Queſt. L. 1.

Cogitemus quî fieri poſſit, ut tanta magnitudo, ab aliqua poſſit natura, tanto tempore circumferri? Ego igitur aſſero Deum cauſam eſſe, nec alitèr poſſe fieri. Plato in Epinom.

(3) Among the Cauſes which *Cleanthes* is ſaid in *Tully* to aſſign for Mens Belief of a Deity, one of the chief is, *Æquabilitatem motus, converſionem Cœli, Solis, Lunæ, Siderumque omnium diſtinctionem, varietatem, pulchritudinem, ordinem: quarum rerum aſpectus ipſe ſatis indicaret, non eſſe fortuita. Ut ſiquis in domum aliquam, aut in gymnaſium, aut in forum venerit; cum videat omnium rerum rationem, modum, diſciplinam, non poſſit ea ſine cauſâ fieri judicare, ſed eſſe aliquem intelligat, qui præſit, & cui pareatur: multo magis in tantis motibus, tantiſque viciſſitudinibus, tam multarum rerum, atque tantarum ordinibus, in quibus nihil unquam immenſa, & infinita vetuſtas mentita ſit, ſtatuat neceſſe eſt ab aliquâ mente tantos naturæ motus gubernari.* Cic. de Nat. Deor. L. 2.

Homines cæperunt Deum agnoſcere, cum viderent Stellas, tantam concinnitatem efficere; ac dies, nocteſque æſtate, & hyeme, ſuos ſervare ſtatos ortus, atque obitus. Plutarch de placit, l. 1. c. 6.

(4) We

the Wonder (4); these things, I say,) do manifestly argue some divine infinite Power to be concerned therein (5): But especially, if to all this we add the wonderful Convenience, yea absolute Necessity of these Circumvolutions to the Inhabitants, yea all the Products of the Earth and Waters. For to one of these we owe the comfortable Changes of Day and Night; the one for Business, the other for Repose; (6) the one for Man, and most other Animals

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(4) We need not be solicitous to elude the History of these Miracles, as if they were only poetical Strains, as *Maimonides*, and some others fancy *Joshua*'s Day to have been, *viz.* only an ordinary Summer's Day; but such as had the Work of many Days done in it, and therefore by a poetical Stretch made, as if the Day had been lengthened by the Sun standing still. But in the History they are seriously related, as real Matters of Fact, and with such Circumstances as manifest them to have been miraculous Works of the Almighty: And the Prophet *Habakkuk*, 3. 11. mentions that of *Joshua* as such. And therefore taking them to be miraculous Perversions of the Course of Nature, instead of being Objections, they are great Arguments of the Power of God. For in *Hezekiah*'s Case to wheel the Earth it self backward, or by some extraordinary Refractions to bring the Sun's Shadow backward 10 Degrees: Or in *Joshua*'s Case, to stop the diurnal Course of the Globe for some Hours, and then again give it the same Motion; to do, I say, these things, required the same infinite Power which at first gave the Terraqueous Globe its Motions.

(5) *Nam cum dispositi quæsissem fœdera Mundi,*
Præscriptosque Maris fines, Annique meatus,
Et Lucis, Noctisque vices: tunc omnia rebar
Consilio firmata Dei, qui lege moveri
Sidera, qui fruges diverso tempore nasci,
Qui variam Phœben alieno jusserit igne
Compleri, Solemque suo; porrexerit undis
Littora; Tellurem medio libraverat axe.
Claudian in Rufin. L. 1. initio.

(6) *Diei noctisque vicissitudo conservat animantes, tribuens aliud agendi tempus, aliud quiescendi. Sic undique omni ratione concluditur, mente, consilioque divino omnia in hoc mundo ad salutem omnium, conservationemque admirabiliter administrari.* Cicer. de Nat. Deor. L. 2.

(7) The

mals to gather and provide Food, Habitation, and other Neceſſaries of Life; the other to reſt, refreſh, and recruit their Spirits (7), waſted with the Labours of the Day. To the other of thoſe Motions we owe the Seaſons of Summer and Winter, Spring and Autumn, together with the beneficial Influences and Effects which theſe have on the Bodies and State of Animals, Vegetables, and all other things both in the Torrid, Temperate, and Frigid Zones.

(7) The acute Dr. *Cheyne* in his ingenious *Philoſ. Princ. of Natural Religion*, among other Uſes of Day and Night ſaith, the Night is moſt proper for Sleep; becauſe when the Sun is above the Horizon Sleep is prejudicial, by Reaſon the Perſpirations are then too great. Alſo that Nutrition is moſtly, if not altogether, performed in time of Reſt; the Blood having too quick a Motion in the Day: For which Reaſon, weak Perſons, Children, *&c.* are nouriſhed moſt, and recruit beſt by Sleep.

CHAP. IV.

Of the Place and Situation of the Terraqueous Globe, in reſpect of the Heavenly Bodies.

ANother thing very conſiderable in our Globe, is its Place and Situation at a due Diſtance from the Sun (†), its Fountain of Light and Heat; and

(†) It is a manifeſt Sign of the Creator's Management and Care, in placing the Terraqueous Globe at that very Diſtance it is from the Sun, and contemporating our own Bodies, and all other things ſo duly to that Diſtance. For was the Earth farther from the Sun, the World would be ſtarved, and frozen with Cold: And was it nigher, we ſhould be burnt, at leaſt the moſt combuſtible things would be ſo, and the World would be vexed with perpetual Conflagrations. For we ſee that a few of the Rays of the Sun, even no more than what fall within the Compaſs of half an Inch, or an Inch in a Burning Glaſs, will fire combuſtible Bodies, even in our own Climate.

(1) The

and from its neighbouring Planets of the ſolar Syſtem, and from the fixt Stars. But theſe things I have ſpoken more largely of in my Survey of the Heavens, and therefore only barely mention them now, to inſiſt more largely upon.

CHAP. V.

The Diſtribution of the Earth and Waters.

THE Diſtribution of the Waters and the dry Land, although it may ſeem rude and undeſigned to a careleſs View, and is by ſome taxed as ſuch (1), yet is admirably well adjuſted to the Uſes and Conveniences of our World. For

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(1) The moſt eminent Author I have met with, that finds fault with the Diſtribution of the Earth and Waters, and indeed with the whole preſent Structure of the Globe, is the learned and eloquent Theoriſt, Dr. *Burnet*, who frequently exclaims on this Point, *Tellus noſtra, ſi totam ſimul complectamur, non eſt ordinata & venuſta rerum compages —— ſed moles aggeſta vario, incertoque ſitu partium, nullâ ordinis aut venuſtatis habitâ ratione.* Theor. Sacr. l. 1. c. 7. *Ecquis autem a Deo hæc ita facta?* &c. ib. *Quo autem Herculeo labore opus eſſet ad excavandam terram in tantum hiatum? —— Si immediatè a cauſâ primâ effectus fuiſſet hic alveus, aliquem ſaltem ordinem, menſuram, & proportionem notare licuiſſet in ipſius formâ, & partium diſpoſitione; —— ſed confuſa omnia,* &c. ib. c. 8. *Tellus noſtra cùm exigua ſit, eſt etiam rudis: Et in illâ exiguitate multa ſunt ſuperflua, multa inelegantia. Dimidiam terræ ſuperficiem inundat Oceanus; magnâ ex parte, ut mihi videtur, inutilis.* And then he goes on to ſhew how this Part of the Creation might be mended, *ib. c.* 10. All this is to me ſurprizing from an Author of great Ingenuity, who ſeems in his Book to have a juſt Opinion of, and due Veneration for God. But certainly ſuch Notions are very inconſiſtent with the Belief of God's creating, eſpecially his governing and ordering the World. But ſuppoſe the Terraqueous Globe was ſuch a rude, confuſed, inconvenient Maſs, as he pretends; yet is it well enough for a ſinful World. But beſides, what others have long ago abundantly anſwered, the following

For in the first place, the Distribution is so well made, the Earth and Waters so handsomely, so Workman-like laid, every where all the World over, that there is a just æquipoise of the whole Globe. The *Northern* balanceth the *Southern Ocean*; the *Atlantick* the *Pacifick Sea*. The *American dry Land*, is a Counterpoise to the *European*, *Asiatick* and *African*.

In the next place, the Earth and the Waters are so admirably well placed about in the Globe, as to be helpful to one another, to minister to one another's Uses. The great Oceans, and the lesser Seas, and Lakes, are so admirably well distributed throughout the Globe (†), as to afford sufficient Vapours (2) for Clouds

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lowing Survey will, I hope, sufficiently manifest it to be the Work of a wise and beneficent, as well as omnipotent Creator.

(†) Some have objected against the Distribution of the Earth and Waters, as if the Waters occupied too large a part of the Globe, which they think would be of greater Use if it was dry Land. But then they do not consider that this would deprive the World of a due Quantity of Vapours and Rain. For if the Cavities which contain the Sea, and other Waters, were deeper, although the Waters were no less in quantity, only their Surfaces narrower and lesser, the Evaporations would be so much the less; inasmuch as those Evaporations are made from the Surface, and are, consequently, in proportion to the Surface, not the Depth or Quantity of Water.

(2) I took notice before in *Book* I. *Chap.* 3. *Note* 1. That the Vapours constituting Clouds and Rain, are *Vesiculæ* of Water detached by Heat. The manner of which I conceive to be thus; Heat being of an agile Nature, or the lightest of all Bodies, easily breaks loose from them; and if they are humid, in its Passage, carries along with it Particles, or little Cases of the Water: which being lighter than Air, are buoyed up thereby, and swim in it; until by knocking against one another, or being thickened by the Cold, (as in the Note before-cited,) they are reduced into Clouds and Drops. Having mentioned the manner how Vapours are raised, and there being more room here than in the Note before-cited, I shall, for the Illustration of Nature's Process, take notice of three Things observable to our purpose, in Water over the Fire. 1. That the Evaporations are proportional to the Heat ascending

Clouds and Rains, to temperate the Cold (3) of the Northern frozen Air, to cool and mitigate the Heats

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cending out of the Water. A ſmall Heat throws off but few Vapours, ſcarce viſible: A greater Heat, and aſcending in greater Quantities, carries off groſſer, larger, and more numerous Veſiculæ, which we call a *Steam*: And if the Heat breaks through the Water with ſuch Fury, as to lacerate, and lift up great Quantities or Bubbles of Water, too heavy for the Air to carry or buoy up, it cauſeth what we call *Boyling*. And the Particles of Water thus mounted up by the Heat, are viſibly Sphærules of Water, if viewed with a Microſcope, as they ſwim about in a Ray of the Sun let into a dark Room, with warm Water underneath; where ſome of the Vapours appear large, ſome ſmaller Sphærules, according (no doubt) to the larger or leſſer Quantities of Heat blowing them up, and carrying them off. 2. If theſe Vapours be intercepted in their Aſcent by any context, eſpecially cold Body, as Glaſs, Marble, *&c.* they are thereby reduced into Drops, and Maſſes of Water, like thoſe of Rain, *&c.* 3. Theſe Vapours in their Aſcent from the Water, may be obſerved in cold frofty Weather, either to riſe but a little above the Water, and there to hang, or to glide on a little above its Surface: Or if the Weather be very Cold, after a little aſcent, they may be ſeen to fall back again into the Water; in their aſcent and deſcent deſcribing a Curve ſomewhat like that of an Arrow from a Bow. But in a warmer Air, and ſtill, the Vapours aſcend more nimbly and copiouſly, mounting up aloft, till they are out of ſight. But if the Air be warm and windy too, the Vapours are ſooner carried out of ſight, and make way for others. Aud accordingly I have often obſerved, that hot Liquors, if not ſet too thin, and not frequently ſtirred, cool ſlower in the greateſt Froſts, than in temperate Weather, eſpecially if Windy. And it is manifeſt by good Experiments, that the Evaporations are leſs at thoſe times, than theſe: leſs by far in the Winter, than the warmer Months.

(3) As our Northern Iſlands are obſerved to be more temperate than our Continents, (of which we had a notable Inſtance in the great Froſt in 1708, which *Ireland* and *Scotland* felt leſs of, than moſt Parts of *Europe* beſides; of which ſee *Book* IV. *Chap.* 12. *Note* 3.) ſo this Temperature is owing to the warm Vapours afforded chiefly by the Sea; which by the preceeding Note, muſt neceſſarily be warm, as they are Vapours, or Water inflated by Heat.

The Cauſe of this Heat, I take to be partly that of the Sun, and partly Subterraneous. That it is not wholly that of the Sun, is manifeſt from Vapours, being as, or more copiouſly raiſed when the Sun-beams are weakeſt, as when ſtrongeſt; there being greater

Heats (4) of the Torrid Zone, and to refresh the Earth with fertile Showers; yea, in some measure to minister fresh Waters to the Fountains and Rivers. Nay, so abundant is this great Blessing, which the most indulgent Creator hath afforded us by means of this Distribution of the Waters I am speaking of, that there is more than a scanty, bare provision, a mere sufficiency; even a Plenty, a Surplusage of this useful Creature of God, the fresh Waters afforded to the World; and they so well ordered, as not to drown the Nations of the Earth, nor to stagnate, stink, and poison, or annoy them; but to be gently carried through convenient Channels back again to their grand Fountain (5) the Sea; and many of them

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Rains and Winds at the one time than the other. And that there is such a thing as *Subterraneous Heat* (whether Central, or from the meeting of Mineral Juices; or Congenial or Connatural to our Globe, I have not Time to enquire, but, I say, that such a thing is,) is evident not only from the Hot-Baths, many fiery Eruptions and Explosions, *&c.* but also from the ordinary Warmth of Cellars, and Places under Ground, which are not barely comparatively warm, but of sufficient Heat to raise Vapours also: As is manifest from the smoking of perennial Fountains in frosty Weather, and Water drawn out of Pumps and open Wells at such a Time. Yea, even Animals themselves are sensible of it, as particularly *Moles*, who dig before a Thaw, and against some other Alterations of the Weather; excited, no doubt, thereunto by the same warm Vapours arising in the Earth, which animate them, as well produce the succeeding Changes of the Weather.

(4) Besides the *Trade-Winds*, which serve to mitigate the excessive Heats in the Torrid Zone; the Clouds are a good Skreen against the scorching Sun-beams, especially when the Sun passeth their Zenith; at which Time is their Winter, or coolest Season, by reason they have then most Clouds and Rain. For which Service, that which *Varene* takes notice of, is a great Providence of God, *viz. Pleraque loca Zonæ Torridæ vicinum habent mare, ut India, Insulæ Indicæ, lingua Africæ, Guinea, Brasilia, Peruvia, Mexicana Hispania: Pauca loca Zonæ Torridæ sunt Mediterranea*, Varenii Geogr. L. 2. C. 26. Prop. 10. §. 7.

(5) That Springs have their Origine from the Sea, and not from Rains and Vapours, among many other strong Reasons, I conclude

them through such large Tracts of Land, and to such prodigious Distances, that it is a great wonder the Foun-

conclude from the Perennity of divers Springs; which always afford the same Quantity of Water. Of this sort there are many to be found every where. But I shall, for an Instance, single out one in the Parish of *Upminster*, where I live, as being very proper for my purpose, and one that I have had better Opportunities of making Remarks upon above twenty Years. This in the greatest Droughts is little, if at all diminished, that I could perceive by my Eye, although the Ponds all over the Country, and an adjoining Brook have been dry for many Months together; as particularly in the dry Summer Months of the Year 1705. And in the wettest Seasons, such as the Summer and other Months were preceding the violent Storm in *November*, 1703. (*Vid. Philos. Transf. Nr.* 289.) I say in such wet Seasons I have not observed any Increment of its Stream, excepting only for violent Rains falling therein, or running down from the higher Lands into it; which discolloureth the Waters oftentimes, and makes an Increase of only a Day's, or sometimes but a few Hours Continuance. But now, if this Spring had its Origine from Rain and Vapours, there would be an Increase and Decrease of the one, as there should happen to be of the other: As actually it is in such temporary Springs, as have undoubtedly their Source from Rain and Vapours.

But besides this, another considerable thing in this *Upminster* Spring (and Thousands of others) is, that it breaks out of so inconsiderable an Hillock, or Eminence of Ground, that can have no more Influence in the Condensation of the Vapours, or Stopping the Clouds, (which the Maintainers of this Hypothesis suppose) than the lower Lands about it have. By some Critical Observations I made with a very nice portable Barometer, my House stands between 80 and 90 Feet higher than the Low-water Mark in the River of *Thames*, nearest me, and that part of the River being scarce Thirty Miles from the Sea; I guess, (and am more confirmed from some later Experiments,) that we cannot be much above 100 Feet above the Sea. The Spring I judge nearly level with, or but little higher than where my House stands; and the Lands from whence it immediately issues, I guess about 15 or 20 Feet higher than the Spring; and the Lands above that, of no very remarkable Height. And indeed, by actual Measure, one of the highest Hills I have met with in *Essex*, is but 363 Feet high, (*Vid. Phil. Transf. Nr.* 313. *p.* 16.) and I guess by some very late Experiments I made, neither that, nor any other Land in *Essex*, to be above 400 Feet

Fountains should be high enough (6), or the Seas low enough, ever to afford so long a Conveyance. Witness the *Danube* (7) and *Wolga* of *Europe*, the *Nile* (8) and

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above the Sea. Now what is so inconsiderable a rise of Land, to a perennial Condensation of Vapours, fit to maintain even so inconsiderable a Fountain, as what I have mentioned is? Or indeed the High-lands of the whole large County of *Essex*, to the maintaining all its Fountains and Rivulets?

But I shall no farther prosecute this Argument, but refer to the late learned, curious and industrious Dr. *Plot*'s *Tentamen Phil. de Orig. Font.* in which he hath fully discussed this Matter.

As to the manner how the Waters are raised up into the Mountains, and higher Lands, an easy and natural Representation may be made of it, by putting a little heap of Sand, Ashes, or a little Loaf of Bread, *&c.* in a Bason of Water; where the Sand will represent the dry Land, or an Island, and the Bason of Water the Sea about it. And as the Water in the Bason riseth to, or near to the top of the Heap in it, so doth the Waters of the Sea, Lakes, *&c.* rise in the Hills. Which case I take to be the same with the ascent of Liquids in capillary Tubes, or between contiguous Planes, or in a Tube filled with Ashes: Of which the industrious and compleat Artificer in Air-Pumps Mr. *Hawksbee*, hath given us some not contemptible Experiments, in his *Phys. Mech. Exp.* pag. 139, *&c.*

Among the many Causes assigned for this Ascent of Liquors, there are two that bid the fairest for it, *viz.* the *Pressure of the Atmosphere*, and the *Newtonian Attraction*. That it is not the former appears from the Experiments succeeding, as well, or better in *Vacuo*, than in the open Air, the Ascent being rather swifter in *Vacuo*. This then being not the Cause, I shall suppose the other is; but for the Proof thereof, I shall refer to some of our late *English* Authors, especially some very late Experiments made before our most famous *R. S.* which will be so well improved by some of that illustrious Body, as to go near to put the Matter out of doubt.

(6) See *Book* III. *Chap.* 4.

(7) *The* Danube *in a sober account performs a Course of above* 1500 *Miles*, (i. e. in a straight Line) *from it's rise to it's fall.* Bohun's Geogr. Dict.

(8) *Tractus* f. *Longitudo* [Nili] *est milliarium circiter* 630 *Germ sive Ital.* 2520, *pro quibus ponere licet* 3000 *propter curvaturas.* Varen. Geogr. l. 1. c. 16. p. 27.

(9) *Varene*

and the *Niger* (9) of *Africk*, the *Ganges* (10) and *Euphrates* of *Asia*, and the *Amazons River* (11) and *Rio de la Plata* of *America*, and many others which might be named; some of which are said to run above 5000 Miles, and some no less than 6000 from their Fountains to the Sea. And indeed such prodigious Conveyances of the Waters make it manifest, that no accidental Currents and Atterrations of the Waters themselves, no Art, or Power of Man, nothing less than the Fiat of the Almighty could ever have made or found so long and commodious Declivities and Channels for the Passage of the Waters.

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(9) *Varene* reckons the Course of the *Niger*, at a middle Computation, 600 *German* Miles, that is 2400 *Italian*.

(10) That of the *Ganges*, he computes at 300 *German* Miles. But if we add the Curvatures to these Rivers, their Channels are of a prodigious Length.

(11) *Oritur flumen (quod plerumque Amazonum*, &c.) *haud procul Quito in montibus——Cum per Leucas Hispanicas* 1356 *cursum ab occidente in orientem continuarit, ostio* 84 *leucas lato——in Oceanum præcipitatur.* Chr. D'Acugna Relatio de flumine Amaz. in Act. Erud. Aug. 1683.

(1) *Non*

CHAP. VI.

The great Variety and Quantity of all things upon, and in the Terraqueous Globe, provided for the Uses of the World.

THE last Remark I shall make about the Terraqueous Globe in general is, the great variety of Kinds, or Tribes, as well as prodigious Number of Individuals of each various Tribe there is of all

Creatures (1). There are so many Beasts, so many Birds, so many Insects, so many Reptiles, so many Trees, so many Plants upon the Land; so many Fishes, Sea-Plants, and other Creatures in the Waters; so many Minerals, Metals, and Fossiles in the Subterraneous Regions; so many *Species* of these *Genera*, so many *Individuals* of those *Species*, that there is nothing wanting to the Use of Man, or any other Creature of this lower World. If every Age doth change its Food, its way of Cloathing, its way of Building; if every Age (2) hath its Variety of Diseases; nay, if Men, or any other Animal was minded to change these things every Day, still the Creation would not be exhausted, still nothing would be wanting for Food, nothing for Physick, nothing for Building and Habitation, nothing for Cleanliness and Refreshment, yea even for Recreation

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(1) *Non dat Deus beneficia? Unde ergo ista quæ possides?——Unde hæc innumerabilia, oculos, aures & animum mulcentia? Unde illa luxuriam quoque instruens copia? Neque enim necessitatibus tantummodo nostris provisum est: usque in delicias amamur. Tot arbusta, non uno modo frugifera, tot herbæ salutares, tot varietates ciborum, per totum annum digestæ, ut inerti quoque fortuita terræ alimenta præberent. Jam animalia omnis generis, alia in sicco, &c.——ut omnis rerum naturæ pars tributum aliquod nobis conferret.* Senec. de Benef. l. 4. c. 5. ubi plura vide.

Hic, ubi habitamus non intermittit suo tempore Cœlum nitescere, arbores frondescere——tum multitudinem pecudum partim ad vescendum, partim ad cultus agrorum, partim ad vehendum, partim ad corpora vestienda: hominemque ipsum quasi contemplatorem cœli ac deorum, ipsorumque cultorem.——Hæc igitur, & alia innumerabilia cùm cernimus, possumusne dubitare, quin his præsit aliquis vel effector, si hæc nata sunt, ut Platoni videtur: vel, si semper fuerint, ut Aristoteli placet, Moderator tanti operis & muneris? Cicer. Tusc. Quæst. L. 1.

(2) *Sunt & gentium differentiæ non mediocres——quæ contemplatio ausert rursus nos ad ipsorum animalium naturas ingenitasque iis vel certiores morborum omnium medicinas. Enimvero rerum omnium Parens, nullum animal ad hoc tantùm ut pasceretur, aut alia satiaret nasci voluit: artesque salutares iis inseruit.* Plin. N. H. l. 27. c. 13.

(3) This

creation and Pleaſure. But the Munificence of the Creator is ſuch, that there is abundantly enough to ſupply the Wants, the Conveniences, yea, almoſt the Extravagancies of all the Creatures, in all Places, all Ages, and upon all Occaſions.

And this may ſerve to anſwer an Objection againſt the Excellency of, and Wiſdom ſhewed in the Creation; namely, What need of ſo many Creatures (3), particularly of ſo many Inſects, ſo many Plants, and ſo many other things; and eſpecially of ſome of them, that are ſo far from being uſeful, that they are very noxious; ſome by their Ferity, and others by their poiſonous Nature? *&c.*

To which I might anſwer, that in greater Variety, the greater Art is ſeen; that the fierce, poiſonous, and noxious Creatures ſerve as Rods and Scourges to chaſtiſe us (4), as means to excite our Wiſ-

(3) This was no very eaſy Queſtion to be anſwered by ſuch, as held, that *all things were made for Man*, as moſt of the Antients did; as *Ariſtotle*, *Seneca*, *Cicero* and *Pliny*, (to name only ſome of the chief.) And *Cicero* cites it as the celebrated *Chryſippus*'s Opinion, *Præclarè enim Chryſippus, Cætera nata eſſe Hominum cauſâ, & Deorum.* De fin. bon. & mal. L. 3. And in his *De Nat. Deor. L.* 2. *fin.* he ſeriouſly proves the World it ſelf to have been made for the Gods and Man, and all things in the World to have been made and contrived for the Benefit of Man *(parata & inventa ad fructum Hominum*, are his Words.) So *Pliny* in his Preface to his 7th Book ſaith, Nature made all things for Man; but then he makes a doubt, whether ſhe ſhewed her ſelf a more indulgent Parent, or cruel Step-mother, as in *Book* IV. *Chap.* 12. *Note* 2. But ſince the Works of God have been more diſcovered, and the Limits of the Univerſe have been found to be of infinitely greater Extent than the Antients ſuppoſed them; this narrow Opinion hath been exploded. And the Anſwer is eaſy to theſe Queſtions, Why ſo many uſeleſs Creatures? In the Heavens, Why ſo many fixt Stars, and the greateſt part of them ſcarce viſible? Why ſuch Syſtems of Planets, as in *Jupiter*, *Saturn*, &c. In the Earth and Waters, Why ſo many Creatures of no uſe to Man?

(4) *Nec minus clara exitii documenta ſunt etiam ex contemnendis animalibus. M. Varro author eſt, a cuniculis ſuffoſſum in Hiſpaniâ oppidum, a talpis in Theſſaliâ: ab ranis civitatem in Galliâ pulſam, ab locuſtis in Africâ: ex Gyaro, Cycladum inſulâ, incolas a*

Wiſdom, Care, and Induſtry, with more to the ſame purpoſe. But theſe things have been fully urged

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muribus fugatos; in Italia Amyclas a ſerpentibus deletas. Citrà Cynamolgos Æthiopas latè deſerta regio eſt, a ſcorpionibus & ſolpugis gente ſublata: & a ſcolopendris abactos Trerienſes, author eſt Theophraſtus. Plin. Nat. Hiſt. l. 8. c. 29.

To theſe Inſtances may be added, the Plague they ſometimes ſuffer from a kind of Mice, (they call *Leming*, *Leminger*, *Lemmus*, &c.) in *Norway*, which eat up every green thing. They come in ſuch prodigious Numbers, that they fancy them to fall from the Clouds; but *Ol. Magnus*, rather thinks they come from ſome of the Iſlands. *Hiſt. l.* 8. *c.* 2. If the Reader hath a mind to ſee a large Account of them, with a Diſpute about their Generation, a handſome Cut of them, with the Prayers, and an Exorciſm againſt them uſed in the Church of *Rome*, I ſhall refer him (it being too tedious to recite in theſe Notes) to *Muſeum Wormian. l.* 3. *c.* 23.

Quare patimur multa mala a creaturâ quam fecit Deus, niſi quia offendimus Deum?——De pœnâ tuâ peccatum tuum accuſa, non judicem. Nam propter Superbiam inſtituit Deus creaturam iſtam minimam & abjectiſſimam, ut ipſa nos torqueret, ut cum ſuperbus fuerit homo, & ſe jactaverit adverſus Deum,——cum ſe erexerit, Pulicibus ſubdatur. Quid eſt, quod te inflas humana ſuperbia?—— Pulicibus reſiſte, ut dormias. Cognoſce qui ſis. Nam propter ſuperbiam noſtram domandam.——creata illa quæ moleſta ſunt: populum Pharaonis ſuperbum potuit Deus domare de Urſis, de, &c. Muſcas & Ranas illis immiſit, ut rebus viliſſimis ſuperbia domaretur Omnia ergo per ipſum——facta ſunt; & ſine ipſo factum eſt nihil. Auguſt. Tract. 1. in S Johan.

But although the infinitely wiſe Creator hath put it in the Power of ſuch vile Animals to chaſtiſe us, yet hath he ſhewed no leſs Wiſdom and Kindneſs in ordering many, if not moſt of them ſo, as that it ſhall be in the Power of Man, and other Creatures to obviate or eſcape their Evils. For, beſides the noble Antidotes afforded by Minerals, Vegetables, *&c.* many, if not moſt of our *European* venomous Animals carry their Cure, as well as Poiſon in their own Bodies. The Oil, and I doubt not, the Body of *Scorpions* too, is a certain Remedy againſt its Stroke. A *Bee*, *Waſp*, or *Hornet* cruſhed, and rubbed, or bound upon the Place, I have always found to be a certain Cure for the Sting of thoſe Creatures. And I queſtion not, but the Fleſh, eſpecially the Head of *Vipers*, would be found a Remedy for their Bites.

Our Viper-Catchers have a Remedy in which they place ſo great Confidence, as to be no more afraid of the Bite [of a Viper] *than of a common*

urged by others; and it is ſufficient to ſay, that this great Variety is a moſt wiſe Proviſion for all the Uſes of the World in all Ages, and all Places. Some for Food, ſome for Phyſick (5), ſome for Habitation, ſome for Utenſils, ſome for Tools and Inſtruments of Work, and ſome for Recreation and Pleaſure, either to Man, or to ſome of the inferiour Creatures themſelves; even for which inferiour Creatures, the liberal Creator hath provided all things neceſſary, or any ways conducing to their happy, comfortable living in this World, as well as for Man.

And it is manifeſt, that all the Creatures of God, Beaſts, Birds, Inſects, Plants, and every other *Genus* have,

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common Puncture, immediately curing themſelves by the Application of their Specifick. This though they keep as a great Secret, I have upon ſtrict Enquiry found to be no other than Axungia Viperina, *preſently rubbed into the Wound.* This Remedy the learned Doctor tried himſelf with good Succeſs in a young Dog, that was bitten in the Noſe. *Vid. Mead of Poiſons*, p. 29.

And as to the means to eſcape the Miſchief of ſuch noxious Animals, beſides what may be effected by the Care, Induſtry and Sagacity of Man; ſome of them are ſo contrived and made, as to give Warning, or Time to Creatures in danger from them. Thus, for Inſtance, the *Rattle-Snake*, the moſt poiſonous of any Serpent, who darts its poiſonous Vapours to ſome Diſtance, and in all Probability was the *Baſilisk* of the Ancients, ſaid to kill with its Eyes, this involuntarily gives warning by the Rattle in its Tail. So the *Shark*, the moſt rapacious Animal of the Waters, is forced to turn himſelf on his Back, (and thereby gives an Opportunity of Eſcape) before he can catch his Prey.

(5) *Hæc ſola Naturæ placuerat eſſe remedia parata vulgo, inventu facilia, ac ſine impendio, ex quibus vivimus. Poſtea fraudes hominum & ingeniorum capturæ officinas invenere iſtas, in quibus ſua cuique homini vænalis promittitur vita. Statim compoſitiones & miſturæ inexplicabiles decantantur. Arabia atque India in medio æſtimantur, ulcerique parvo medicina a Rubro mari imputatur, cum remedia veræ quotidie pauperrimus quiſque cænet.* Plin. l. 24. c. 1.

Non ſponte ſua ex tellure germinant Herbæ, quæ contra quoſcunque morbos accommodæ ſunt; ſed ea voluntate Opificis, ad noſtram utilitatem productæ ſunt. Baſil. Aſcet. Tom. 2.

Conſult here, *Book* X. *Note* 23, 24, 25.

(6) Among

have, or may have, their ſeveral Uſes even among Men. For although in one Place many things may lie neglected, and out of Uſe, yet in other Places they may be of great Uſe. So what hath ſeemed uſeleſs in one Age, hath been received in another; as all the new Diſcoveries in Phyſick, and all the Alterations in Diet do ſufficiently witneſs. Many things alſo there are which in one Form may be pernicious to Man; but in another of great Uſe. There are many Plants (6), many Animals, many Minerals, which in one Form deſtroy, in another heal. The *Caſſada* Plant

(6) Among poiſonous Vegetables, none more famous of old than *Hemlock*, accounted at this Day alſo very dangerous to Man, of which there are ſome diſmal Examples in our *Phil. Tranſ. Wepfer*, &c. But yet this Plant is food for *Goats*, and its Seeds to *Buſtards*; and as *Galen* ſaith, to *Starlings* alſo. Neither is this ſo pernicious a Plant, only Food, but alſo Phyſick to ſome Animals. An Horſe troubled with the *Farcy*, and could not be cured with the moſt famed Remedies, cured himſelf of it in a ſhort time by eating *Hemlock*, of which he eat greedily. *Vid. Phil. Tranſ. Nr.* 231. *And a Woman cured of the Plague, and wanting Sleep did with very good Effect, eat* Hemlock *for ſome time; till falling ill again of a Fever, and having left off the Uſe of this Remedy, he* [Nic. Fontanus] *endeavoured to procure reſt by repeated Doſes of* Opium, *which had no Operation; till the Help of* Cicuta, *was again called in with deſired Succeſs.* Mead of Poiſ. p. 144.

And not only *Hemlock*, but many other, if not moſt Plants accounted poiſonous, may have their great Uſe in Medicine. Of which take the Opinion of an able Judge, my ingenious and learned Friend Dr. *Tancred Robinſon*, in a Letter I have of his to the late great Mr. *Ray*, of *Nov.* 7. 1684. *viz. According to my Promiſe, I here ſend you a few Obſervations concerning ſome Plants, ſeldom uſed in Medicine, being eſteemed poiſonous, which if truly corrected, or exactly doſed, may perhaps prove the moſt powerful and effectual Medicines yet known.* Having then given an Account of ſome of their Correctives, he gives theſe following Examples, *viz.* 1. *The Hellebores incorporated with a Sapo, or Alkaly-ſalts alone, are ſucceſsful Remedies in Epilepſies, Vertigo's, Palſies, Lethargies, and Mania's. Doſ. a* ℈j *to* ʒß. 2. *The Radic. Aſſari, Cicuta, and the Napellus, in Agues, and periodical Pains. Doſ.* ℈j *to* ʒß. 3. *The Hyoſcyamus in Hæmorrhagies, violent Heats and Perturbations of the Blood, and alſo in all great Inflammations. Doſ.* ℈j *to* ʒß. 4. *The Semen Stramoniæ*

is

Plant unprepared poiſoneth, but prepared, is the very Bread of the *Weſt-Indies* (7); *Vipers* and *Scorpions* and many Minerals, as deſtructive as they are to Man, yet afford him ſome of his beſt Medicines.

Or if there be many things of little immediate Uſe to Man, in this, or any other Age; yet to other Creatures they may afford Food or Phyſick, or be of ſome neceſſary Uſe. How many Trees, and Plants, nay, even the very Carcaſſes of Animals, yea, the very Duſt of the Earth (8), and the moſt refuſe, contemptible things to be met with; I ſay, how many ſuch things are either Food, or probably Medicine to many Creatures, afford them Retreat, are Places of Habitation, or Matrixes for their Generation, as ſhall be ſhewed in proper Place? The prodigious Swarms of Inſects in the Air, and in the Waters, (many of which may be perhaps at preſent of no great Uſe to Man) yet are Food to Birds, Fiſhes, Reptiles, Inſects themſelves, and other Creatures (9); for whoſe happy and comfortable Subſiſtence, I have ſaid the bountiful Creator hath liberally provided, as well as for that of Man.

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is a very good Anodyne, uſeful in Vigilia's, Rheumatiſms, Hyſterick Caſes, in all the Orgaſms of the Blood or Spirits, and wherever there is an Indication for a Paregorick. Doſ. ℈j *to* ʒß 5. *Elaterium thus corrected may be given from gr.* x. *to* 15, *in Hydropical Caſes, without any ſenſible Evacuation or Diſturbance. So may the Soldanella, and Gratiola in greater Doſes.* 6. *Opium corrected as afore-mentioned loſes its Narcotick Faculty, may be given very ſafely in great Doſes, and proves more than uſually prevalent in Convulſive Caſes, Fluxes, Catarrhs, and all painful Paroxyſms,* &c.

(7) *It is of the moſt general Uſe of any Proviſion, all over the* Weſt-Indies; *eſpecially in the hotter Parts, and is uſed to victual Ships.* *Dr.* Sloan's Nat. Hiſt. of *Jamaica*, Vol. 1. ch. 5. § 12.

(8) I have ſhewn in the *Phil. Tranſ.* that the *Pediculus fatidicus*, *Mortiſaga*, *Pulſatorius*, or *Death-watch* there deſcribed, feedeth upon Duſt; but that this Duſt they eat, is powdered Bread, Fruits, or ſuch like Duſt, not powdered Earth; as is manifeſt from their great Diligence and Curioſity in Hunting among the Duſt. See more in *Phil. Tranſ. Nr.* 291.

(9) *Vid.* Book IV. Chap. 11.

BOOK III.

Of the Terraqueous Globe in particular, more especially the Earth.

HAving thus taken a general Prospect of our Terraqueous Globe; I shall in this Book come to its Particulars. But here we have such an immense Variety presenting it self to our Senses, and such amazing Strokes of Power and Wisdom, that it is impossible not to be at a Stand, and very difficult to know where to begin, how to proceed, or where to end. But we must however attempt.

And for the more clear and regular proceeding on this copious Subject; I shall distribute the Globe into its two grand constituent Parts.

I. The *Earth* and its Appurtenances.

II. The *Waters* and Theirs.

The first of these only, is what at present I shall be able to take into this Survey.

And in Surveying the *Earth*, I intend,

1. To consider its constituent Parts, or Things peculiar to its self.

2. The Inhabitants thereof, or the several Kinds of Creatures that have their Habitation, Growth, or Subsistence thereon.

1. As to the Earth it self; the most remarkable things that present themselves to our View, are,

1. Its

1. Its various Moulds and Soils.
2. Its ſeveral Strata, or Beds.
3. Its very Subterraneous Paſſages, Grotto's, and Caverns.
4. Its Mountains and Vallies.

CHAP. I.

Of the Soils and Moulds in the Earth.

THE various Soils and Moulds are an admirable and manifeſt Contrivance of the Allwiſe Creator, in making this Proviſion for the various Vegetables (1), and divers other Uſes of the Creatures. For, as ſome Trees, ſome Plants, ſome Grains dwindle and die in a diſagreeable Soil, but thrive

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(1) It is not to be doubted, that although Vegetables delight in peculiar Soils, yet they owe not their Life and Growth to the Earth it ſelf, but to ſome agreeable Juices, or Salts, *&c.* reſiding in the Earth. Of this the great Mr. *Boyl* hath given us ſome good Experiments. He ordered his Gardiner to dig up and dry in an oven ſome Earth fit for the purpoſe, to weigh it, and to ſet therein ſome *Squaſh-Seeds*, (a kind of *Indian* Pompion.) The Seeds when ſown were watered with Rain or Spring-water only. But although a Plant was produced in one Experiment of near 3 *l.* and in another of above 14 *l.* yet the Earth when dried, and weighed again, was, ſcarce diminiſhed at all in its Weight.

Another Experiment he alledges is of *Helmont*'s, who dried 200 *l.* of Earth, and therein planted a Willow weighing 5 *l.* which he watered with Rain or diſtilled Water: And to ſecure it from any other Earth getting in, he covered it with a perforated Tin Cover. After five Years, weighing the Tree with all the Leaves it had born in that time, he found it to weigh 169 *l.* 3 Ounces; but the Earth to be diminiſhed only about 2 Ounces in its Weight. *Vid. Boyl's Scept. Chym. Part* 2. *pag.* 114.

(2) Tis

thrive and flouriſh in others; ſo the All-wiſe Creator hath amply provided for every Kind a proper Bed.

If ſome delight in a warm, ſome a cold Soil; ſome in a lax or ſandy, ſome a heavy or clayie Soil; ſome in a mixture of both, ſome in this, and that and the other Mould, ſome in moiſt, ſome in dry Places (2); ſtill we find Proviſion enough for all theſe Purpoſes: Every Country abounding with its proper Trees and Plants (3), and every Vegetable flouriſhing, and gay, ſomewhere or other about the Globe, and abundantly anſwering the Almighty Command of the Creator, when the Earth and Waters were ordered to their peculiar place, *Gen.* 1. 11. *And God ſaid, let the Earth bring forth Graſs, the Herb yielding Seed, and the Tree yielding Fruit after his kind.* All which we actually ſee is ſo.

To this convenience which the various Soils that coat the Earth are of to the Vegetables, we may add their great Uſe, and Benefit to divers Animals, to many kinds of Quadrupeds, Fowls, Inſects, and Reptiles;

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(2) Τὰς δὲ τόπους ζητεῖ τὰς οἰκείους, ἃ μόνον τὰ πεπεπὰ —— τ' δένδρων, &c. Τὰ μὲν γὰρ φιλεῖ ξηρὰς, τὰ δ' ἐνύδρους, τὰ δ' χειμερινὰς, τὰ δ' θερσόπλους, τὰ δ' παλισκίους, καὶ ὅλως, τὰ μὲν ὀρεινὰς, τὰ δ' ἐλώδεις. —— Ζητεῖ γὰρ τὰ θερσφορα κατ' τ' κράσιν, ἔτι δ' ἀδενῆ, καὶ ἰσχνὰ, καὶ βαθύρριζα, καὶ ὀπωλαιόρριζα, καὶ ἕτις ἄλλη διαφορὰ κατὰ τὰ μέρη. —— Πάντα γὰρ ταῦτα, ἔτι δ' τὰ ὅμοια ζητεῖ τὸ ὅμοιον, καὶ τὰ ἀνόμοια μὴ τ' αὐτὸν, ὅταν ἡ τις παραλλαγὴ τ' φύσεως. *Theophraſt. de Cauſ. Plant. l. 2. c. 9.*

(3) *Nec vero Terræ ferre omnes omnia poſſunt.*
Fluminibus Salices, craſſiſque paludibus Alni
Naſcuntur; ſteriles ſaxoſis montibus Orni:
Littora Myrtetis lætiſſima: denique apertos
Bacchus amat colles: Aquilonem & frigora Taxi.
Aſpice & extremis domitum cultoribus orbem,
Eoaſque domos Arabum, pictoſque Gelonos:
Diviſæ arboribus patriæ, &c. Virg. Georg. L. 2.

(1) Al-

Reptiles; who make in the Earth their places of Repoſe and Reſt, their Retreat in Winter, their Security from their Enemies, and their Neſts to repoſe their Young; ſome delighting in a lax and pervious Mould, admitting them an eaſy paſſage; and others delighting in a firmer and more Solid Earth, that will better ſecure them againſt Injuries from without.

CHAP. II.

Of the various Strata or Beds obſervable in the Earth.

THE various *Strata* or *Beds*, although but little different from the laſt, yet will deſerve a diſtinct conſideration.

By the *Strata* or *Beds*, I mean thoſe Layers of Minerals (1), Metals (2), Earth, and Stone (3),

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(1) Altho' Minerals, Metals, and Stones lie in Beds, and have done ſo ever ſince *Noah*'s Flood, if not from the Creation; yet it is greatly probable that they have a Power of *growing* in their reſpective Beds: That as the Beds are robbed and emptied by Miners, ſo after a while they recruit again. Thus *Vitriol*, Mr. *Boyl* thinks will grow by the Help of the Air. So *Alum* doth the ſame. *We are aſſured* (he ſaith) *by the experienced* Agricola, *that the Earth or Ore of* Alum, *being robbed of its Salt, will in tract of time recover it by being expoſed to the Air.* Boyl's Suſpic. about ſome Hid. Qual. in the Air, p. 18.

(2) As to the Growth of *Metals*, there is great Reaſon to ſuſpect that alſo, from what Mr. *Boyl* hath alledged in his *Obſervations about the Growth of Metals:* And in his *Scept. Chym. Part 6. pag.* 362. Compare alſo *Hakewil's Apol. pag.* 164.

And particularly as to the Growth of *Iron*, to the Inſtances he gives from *Pliny*, *Fallopius*, *Ciſalpinus*, and others; we may add, what is well known in the *Foreſt of Deane* in *Gloceſterſhire*: That the

(3), lying under that upper Stratum, or Tegument of the Earth laſt ſpoken of, all of prodigious Uſe to Mankind: Some being of great Uſe for Building; ſome

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the beſt Iron, and moſt in Quantity, that is found there, is in the old Cinders, which they melt over again. This the Author of the *Additions to Gloceſterſhire in Cambd. Brit.* of the laſt Edition, *p.* 245. attributes to the Remiſſneſs of the former Melters, in not exhauſting the Ore: But in all probability it is rather to be attributed to the new Impregnations of the old Ore, or Cinders, from the Air, or from ſome ſeminal Principle, or plaſtick Quality in the Ore it ſelf.

(3) As for the Growth of *Stone*, Mr. *Boyl* gives two Inſtances. One is that famous place in *France*, called *Les Caves Goutieres*: *Where the Water falling from the upper Parts of the Cave to the Ground, doth preſently there condenſe into little Stones, of ſuch Figures as the Drops falling either ſeverally, or upon one another, and coagulating preſently into Stones, chance to exhibit.* Vid. Sceptic. Chym. pag. 360.

Such like Caves as theſe, I have my ſelf met with in *England*; particularly on the very Top of *Bredon-Hill* in *Worceſterſhire*, near the *Precipice*, facing *Perſhore*, in or near the old Fortreſs, called *Bembsbury-Camp*; I ſaw ſome Years ago ſuch a Cave, which (if I miſ-remember not) was lined with thoſe *Stalactical Stones*, on the Top and Sides. On the Top, they hung like Icicles great and ſmall, and many lay on the Ground. They ſeemed manifeſtly to be made by an Exſudation, or Exſtillation of ſome petrifying Juices out of the rocky Earth there. On the ſpot, I thought it might be from the Rains ſoaking through, and carrying with it Impregnations from the Stone, the Hill being there all rocky. Hard by the Cave is one or more vaſt Stones, which (if I miſtake not) are incruſtrated with this Sparry, Stalactical Subſtance, if not wholly made of it. But it is ſo many Years ago ſince I was at the Place, and not being able to find my Notes about it, I cannot ſay, whether the whole Stone is (in all probability) Spar, (as I think it it is,) or whether I found it only caſed over with it, notwithſtanding I was very nice in examining it then, and have now ſome of the Fragments by me, conſiſting, among other ſhining Parts, of ſome tranſparent angular Ones.

The other Inſtance of Mr. *Boyl*, is from *Linſchoten*, who ſaith, that in the *Eaſt-Indies*, when they have clear'd the Diamond Mines of all the Diamonds, *In a few Years time they find in the ſame place new Diamonds produced.* Boyl. Ibid.

(4) It

ſome ſerving for Ornament; ſome furniſhing us with commodious Machines, and Tools to prepare our Food, and for Veſſels and Utenſils, and for multitudes of other Uſes; ſome ſerving for Firing to dreſs our Food, and to guard us againſt the Inſults of Cold and Weather; ſome being of great Uſe in Phyſick, in Exchange and Commerce, in Manuring and Fertilizing our Lands, in Dying and Colouring, and ten Thouſand other Conveniences, too many to be particularly ſpoken of: Only there is one grand Uſe of one of theſe Strata or Beds, that cannot eaſily be omitted, and that is, thoſe ſubterraneous Strata of Sand, Gravel, and laxer Earth that admit of, and facilitate the Paſſage of the ſweet Waters (4), and may probably be the Colanders whereby they are ſweetened, and then at the

(4) It is not only agreeable to Reaſon, but I am told by Perſons converſant in digging of Wells throughout this County of *Eſſex*, where I live, that the ſureſt Beds in which they find Water, are *Gravel*, and a coarſe dark coloured *Sand*; which Beds ſeldom fail to yield Plenty of ſweet Water: But for *Clay*, they never find Water therein, if it be a ſtrong, ſtiff Clay; but if it be lax and ſandy, ſometimes Springs are found in it; but ſo weak, that they will ſcarcely ſerve the Uſes of the ſmalleſt Family. And ſometimes they meet with thoſe Beds lying next under a looſe black Mould, (which, by their Deſcription, I judged to be a ſort of oazy, or to have the Reſemblance of an ancient ruſhy Ground,) and in that Caſe the Water is always naught and ſtinks. And laſtly, another ſort of Bed they find in *Eſſex*, in the clayie Lands, particularly that part called the *Rodings*, which yields Plenty of ſweet Water, and that is a Bed of white Earth, as though made of Chalk and white Sand. This they find, after they have dug through forty or more feet of Clay; and it is ſo tender and moiſt, that it will not lie upon the Spade, but they are forced to throw it into their Bucket with their Hands, or with Bowls; but when it comes up into the Air, it ſoon becomes an hard white Stone.

Thus much for the Variety of Beds wherein the Waters are found. That it is in theſe Beds only, or chiefly the Springs run, is farther manifeſt from the forcible Eruption of the Waters ſometimes

the ſame time alſo conveyed to all Parts of the habitable World, not only through the temperate and torrid Zones, but even the fartheſt Regions of the frozen Poles.

That theſe Strata are the *principal Paſſages* of the ſweet Fountain-Waters, is, I think, not to be doubted, conſidering that in them the Waters are well known to paſs, and in them the Springs are found by thoſe that ſeek for them. I ſay, the principal Paſſages, becauſe there are other Subterraneous Guts and Channels, Fiſſures and Paſſages, through which many times the Waters make their way.

Now that which in a particular manner doth ſeem to me to manifeſt a ſpecial Providence of God in the repoſiting theſe watery Beds is, that they ſhould be diſperſed all the World over, into all Countries, and almoſt all Tracts of Land: That they ſhould ſo entirely, or for the moſt part, conſiſt of lax, incohæring Earth, and be ſo ſeldom blended with other impervious Moulds, or if they are ſo, it is commonly but accidentally: And that they are interpoſed between the other impervious Beds, and ſo are as a Prop and Pillar to guard them off, and to prevent their ſinking in, and ſhutting up the Paſſages of the Waters.

The time when thoſe Strata were laid, was doubtleſs at the Creation, when *God ſaid*, (Gen. 1. 9.) *let the Waters under the Heaven be gathered together unto one place, and let the dry Land appear*; or elſe at the Deluge, if, with ſome ſagacious Naturaliſts, we

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times out of thoſe watery Beds. Of which ſee *Chap.* 4. *Note* 10. This Eruption ſhews, that the Waters come from ſome Eminence or other, lying at a diſtance, and being cloſely pent up within the *watery Stratum*, by the clayie Strata, the Waters with force mount up, when the Strata above are opened.

we ſuppoſe the Globe of Earth to have been diſſolved by the Flood (5). At that time (whatever it was) when the Terraqueous Globe was in a chaotick State, and the earthy Particles ſubſided, then thoſe ſeveral Beds were in all probability repoſited in the Earth, in that commodious Order in which they now are found; and that, as is aſſerted, according to the Laws (6) of Gravity.

CHAP.

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(5) V. Dr. *Woodward*'s Eſſay, Part. 2.

(6) Id. Ib. *pag.* 28. and *pag.* 74. But Dr. *Leigh* in his *Nat. Hiſtory of Lancaſhire*, ſpeaking of the Coal-pits, denies the Strata to lie according to the Laws of Gravitation, ſaying the *Strata* are a Bed of *Marle*, afterwards *Free-Stone*, next *Iron-Stone*, then *Coal*, or *Kennel-Mine*, then ſome other Strata, and again *Coal*, *&c.*

But upon a ſtricter Enquiry into the matter, finding I had reaſon to ſuſpect that few, if any, actually had tried the Experiment, I was minded to bring the thing to the Teſt of Experiment my ſelf; and having an Opportunity, on *April* 11. 1712, I cauſed divers places to be bored, laying the ſeveral *Strata* by themſelves; which afterwards I weighed with all ſtrictneſs, firſt in Air, then in Water, taking care that no Air-bubbles, *&c.* might obſtruct the Accuracy of the Experiment. The Reſult was, that in my Yard, the Strata were gradually ſpecifically heavier and heavier, the lower and lower they went; and the upper which was Clay, was conſiderably ſpecifically lighter than the lower *Stratum*; which was firſt a looſe Sand, then a Gravel. In which Stratum principally the Springs run that ſupply my Well.

But in my Fields, where three places were bored (to no great Depth) I found below the upper, ſuperficial *Stratum*, a deep Bed of Sand only, which was of different Colours and Conſiſtence, which I weighed as before, together with the Virgin-mould; But they were all of the ſame, or nearly the ſame ſpecifick Gravity, both out of the ſame Hole, and out of different Holes, although the Sand was at laſt ſo gravelly, that hindered our boring any deeper.

Upon this, fearing leſt ſome Errour might be in the former Experiments, I tryed them over again; and that with the ſame Succeſs.

CHAP. III.

Of the Subterraneous Caverns, and the Vulcano's.

I Shall take notice of the Subterraneous Caverns, Grotto's, and Vulcano's, becauſe they are made an Objection (1) againſt the preſent Contrivance and Structure of the Globe. But, if well conſidered, they will be found to be wiſe Contrivances of the Creator, ſerving great Uſes of the Globes, and Ends of God's Government. Beſides many ſecret grand Functions and Operations of Nature in the Bowels of the Earth, that in all probability theſe things may miniſter unto, they are of great Uſe to the Countries where they are (2). To inſtance in the very worſt of all the things named, *viz.* the *Vulcano*'s

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After this, I made ſome Experiments in ſome deep Chalk-Pits, with the Flints, Chalk, *&c.* above and below; but the Succeſs was not ſo uniform as before.

Acquainting our juſtly renowned *R. S.* with theſe Experiments, they ordered their Operator to experiment the *Strata* of a Coal-Pit; the Succeſs whereof may be ſeen in *Philoſ. Tranſ Nr.* 336.

(1) *Nemo dixerit terram pulchriorem eſſe quòd cavernoſa ſit, quòd debiſcat in multis locis, quòd diſrupta caveis & ſpatiis inanibus; iiſque nullo ordine diſpoſitis, nullâ formâ: nec quæ aliud contineant quam tenebras & ſordes; unde graves & peſtiferæ exhalationes, terræ motus*, &c. Burnet ubi ſupr. c 7.

(2) The *Zirchnitzer* Sea in *Carniola*, is of great Uſe to the Inhabitants of that Country, by affording them Fiſh, Fowls, Fodder, Seeds, Deer, Swine and other Beaſts, Carriage for their Goods, *&c. Vid. Phil. Tranſ. Nr.* 191, &c. or *Lowth. Abridg. Vol.* 2. *p.* 306, &c. where you have put together in one View, what is diſperſed in divers of the *Tranſactions*. This Sea or Lake proceeds from ſome Subterraneous Grotto, or Lake, as is made highly probable by Mr. *Valvaſor. Ibid.*

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Vulcano's and Ignivomous Mountains; although they are some of the most terrible Shocks of the Globe, and dreadful Scourges of the sinful Inhabitants thereof, and may serve them as Emblems, and Presages of Hell it self; yet even these have their great Uses too, being as Spiracles or Tunnels (3) to the Countries where they are, to vent the Fire and Vapours that would make dismal Havock, and oftentimes actually do so, by dreadful Succussions and Convulsions of the Earth. Nay, if the Hypothesis of a central Fire and Waters be true, these Out-lets seem to be of greatest Use to the peace and quiet of the Terraqueous Globe, in venting the Subterraneous Heat and Vapours; which, if pent up, would make dreadful and dangerous Commotions of the Earth and Waters.

It may be then accounted as a special Favour of the Divine Providence, as is observed by the Author before praised (4), "That there are scarcely any "Countries, that are much annoyed with Earth-"quakes, that have not one of these fiery Vents. "And these, (saith he,) are constantly all in "Flames whenever any Earthquake happens; they "disgorging that Fire, which whilst underneath, "was the Cause of the Disaster. Indeed, (saith "he,) were it not for these *Diverticula*, whereby it "thus gaineth an *Exit*, 'twould rage in the Bowels

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The *Grotto Pedpetschio* may be another Instance, that the very Subterraneous Lakes may be of use even to the Inhabitants of the Surface above: Of which see *Lowth. ubi supr. pag.* 317. *Sturmius* also may be consulted here in his *Philos. Eclect. Exercit.* 11. *de Terræ-mot.* particularly in *Chap.* 3. some of the most eminent Specuses are enumerated, and some of their Uses.

(3) *Crebri specus* [remedium] *præbent. Præconceptum enim spiritum exhalant: quod in certis notatur oppidis, quæ minus quatiuntur, crebris ad eluviem cuniculis cavata.* Plin. Plin. Hist. Nat. l. 2. c. 82.

(4) *Woodward*'s Essay, *Part* 3, *Sect.* 13.

" of the Earth much more furiouſly, and make " greater Havock than now it doth. So, that " though thoſe Countries, where there are ſuch " *Vulcano's*, are uſually more or leſs troubled with " Earth-quakes; yet, were theſe *Vulcano's* wanting, " they would be much more annoyed with them " than now they are; yea, in all probability to that " Degree, as to render the Earth, for a vaſt Space " around them, perfectly uninhabitable. In one " word, (ſaith he) ſo beneficial are theſe to the " Territories where they are, that there do not " want Inſtances of ſome which have been reſcued, " and wholly delivered from Earthquakes by the " breaking forth of a new *Vulcano* there; this con- " tinually diſcharging that matter, which being till " then barricaded up, and impriſoned in the Bowels " of the Earth, was the occaſion of very great and " frequent Calamities". Thus far that ingenious Author.

CHAP. IV.

Of the Mountains and Valleys.

THE laſt thing I ſhall take notice of relating to the Earth, ſhall be the *Hills* and *Valleys*. Theſe the eloquent *Theoriſt* owns to " contain ſomewhat " auguſt and ſtately in the beholding of them, that " inſpireth the Mind with great Thoughts and Paſ- " ſions, that we naturally on ſuch occaſions think " of God and his Greatneſs". But then, at the ſame time he ſaith, " The Hills are the greateſt Exam- " ples of Ruin and Confuſion; that they have nei- " ther Form nor Beauty, nor Shape, nor Order, " any more than the Clouds in the Air; that they " conſiſt not of any proportion of Parts, referrable

" to

" to any Design, nor have the least Footsteps of " Art or Counsel ". Consequently one grand part of this lower Creation, even the whole present Face of our Terraqueous Globe, according to this ingenious Author, is a Work of mere Chance, a Structure in which the Creator did not concern himself.

Part of this Charge I have already briefly answered, and my Survey now leads me to shew, that the Mountains are so far from being a Blunder of Chance, a Work without Design, that they are a noble, useful, yea, a necessary Part of our Globe (1).

And in the first place, as to the Business of Ornament, Beauty, and Pleasure, I may appeal to all Mens Senses, whether the grateful Variety of Hills and Dales, be not more pleasing than the largest continued Plains. Let those who make it their business to visit the Globe, to divert their Sight with the various Prospects of the Earth; let these, I say, judge whether the far distant Parts of the Earth

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(1) *Though there are some that think Mountains to be a deformity to the Earth, &c. yet if well considered, they will be found as much to conduce to the Beauty and Conveniency of the Universe, as any of the other Parts. Nature* (saith *Pliny*) *purposely framed them for many excellent Uses; partly to tame the violence of greater Rivers, to strengthen certain Joints within the Veins and Bowels of the Earth, to break the force of the Sea's Inundation, and for the safety of the Earth's Inhabitants, whether Beasts or Men. That they make much for the Protection of Beasts, the Psalmist testifies,* The highest Hills are a Refuge for the Wild-Goats, and the Rocks for Conies. *The kingly Prophet had likewise learnt the safety of those by his own Experience, when he also was fain to make a Mountain his Refuge from the fury of his Master* Saul, *who persecuted him in the Wilderness. True indeed, such places as these keep their Neighbours Poor, as being most barren, but yet they preserve them safe, as being most strong; witness our unconquered* Wales *and* Scotland.——*Wherefore a good Author doth rightly call them* Nature's Bulwarks, *cast up at God Almighty's Charges, the Scorns and Curbs of Victorious Armies. Which made the* Barbarians *in* Curtius *so confident of their own safety, &c.* Bishop *Wilkins*'s World in the Moon, *pag.* 114.

would be so well worth visiting, if the Earth was every where of an even, level, globous Surface, or one large Plain of many 1000 Miles; and not rather, as now it is, whether it be not far more pleasing to the Eye, to view from the Tops of the Mountains the subjacent Vales and Streams, and the far distant Hills; and again from the Vales to behold the surrounding Mountains. The elegant Strains, and lofty Flights, both of the ancient and modern Poets on these Occasions, are Testimonies of the Sense of Mankind on this Configuration of the Earth.

But be the Case as it will as to Beauty, which is the least valuable Consideration, we shall find as to Convenience, this Configuration of the Earth far the most commodious on several Accounts.

1. As it is the most Salubrious, of great Use to the Preservation, or Restoration of the Health of Man. Some Constitutions are indeed of so happy a Strength, and so confirmed an Health, as to be indifferent to almost any Place or Temperature of the Air. But then others are so weakly and feeble, as not to be able to bear one, but can live comfortably in another place. With some, the finer and more subtile Air of the Hills doth best agree, who are languishing and dying in the feculent, and grosser Air of great Towns, or even the warmer and vaporous Air of the Valleys and Waters. But contrarywise, others languish on the Hills, and grow lusty and strong in the warmer Air of the Valleys.

So that this opportunity of shifting our Abode from the warmer and more vaporous Air of the Valleys, to the colder and more subtile Air of the Hills, or from the Hills to the Vales, is an admirable Easement, Refreshment, and great Benefit to the Valetudinarian, feeble Part of Mankind; affording those an easy and comfortable Life, who would otherwise

otherwise live miserably, languish, and pine away.

2. To this salutary Conformation of the Earth, we may add another great Convenience of the Hills, and that is in affording commodious Places for Habitation; "serving (as an eminent Author (2) wordeth it) "as Skreens to keep off the cold and nipping Blasts of the Northern and Easterly Winds, "and reflecting the benign and cherishing Sun-Beams, and so rendering our Habitations both "more comfortable, and more chearly in Winter; "and promoting the growth of Herbs and Fruit-Trees, and the Maturation of their Fruits in "Summer.

3. Another benefit of the Hills is, that they serve for the Production of great Varieties of Herbs and Trees (3). And as there was not a better Judge of those Matters, so I cannot give a better Account of this Convenience, than in the Words of the last cited famous Author, the late most eminent and learned Mr. *Ray* (4), (who hath so fully discussed this Subject I am upon, that it is scarce possible to tread out of of his Steps therein.) His Observation is "That the Mountains do especially abound with "different Species of Vegetables, because of the "great Diversity of Soils that are found there, every

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(2) Ray's *Wisdom of God*, &c. pag. 251. *Dissolution of the World*, pag. 36.

(3) *Theophrastus* having reckoned up the Trees that delight most in the Hills, and others in the Valleys, observeth, Ἅπαντα ὅσα κοινὰ τῶν ὀρῶν καὶ τῶν πεδίων, μείζω μὲν καὶ καλλίω τῇ ὄψει τὰ ἐν τοῖς πεδίοις γίνεται· κρείττω δὲ τῇ τε χρήσει τῶν ξύλων καὶ τῶν καρπῶν, τὰ ὀρεινά· *Theoph. Hist. Pl. l.* 3. *c.* 4. Ἅπαντα δὲ ἐν τοῖς οἰκείοις τόποις καλλίω γίνεται, καὶ μᾶλλον εὐδοκιμεῖ· —— Τὰ μὲν γὰρ φιλεῖ τὰς ἐφύδρους καὶ ἑλώδεις —— Τὰ δὲ, τὰς εὐσκεπεῖς καὶ εὐηλίους. *Ib. l.* 4. *c.* 1.

(4) *Wisdom of God*, p. 252.

(6) *Ubi*

" ry *Vertex*, or Eminency, almoſt affording new " Kinds. Now theſe Plants (ſaith he,) ſerve part- " ly for the Food and Suſtenance of ſuch Animals " as are proper to the Mountains, partly for Medi- " cinal Uſes; the chief Phyſick Herbs and Roots, " and the beſt in their Kinds growing there: It be- " ing remarkable, that the greateſt and moſt luxu- " riant Species in moſt Genera of Plants are native " of the Mountains.

4. Another Convenience which my laſt named learned Friend obſerves (5) is, " That the Mountains " ſerve for the Harbour, Entertainment, and Main- " tenance of various Animals; Birds, Beaſts, and " Inſects, that breed, feed and frequent there. " For, (ſaith he,) the higheſt Tops and Pikes of " the *Alps* themſelves are not deſtitute of their In- " habitants, the *Ibex*, or *Stein-buck*, the *Rupicapra*, " or *Chamois*, among Quadrupeds; the *Lagopus* " among Birds. And I may ſelf, (ſaith he) have " obſerved beautiful *Papilio*'s, and Store of other " Inſects upon the Tops of ſome of the *Alpine* Moun- " tains. Nay, the higheſt Ridges of many of theſe " Mountains, ſerve for the Maintenance of Cattle, " for the Service of the Inhabitants of the Valleys.

5. Another thing he obſerves is, " That thoſe " long Ridges and Chains of lofty and topping " Mountains, which run through whole Continents " Eaſt and Weſt (6), ſerve to ſtop the Evagation of " the Vapours to the North and South in hot Coun- " tries,

(5) *Ubi ſupra.*

(6) Many have taken Notice that ſome of the greateſt Eminences of the World run generally Eaſt and Weſt, of which take the late ingenious and learned Dr. *Nichols*'s Account, [*Confer. with a Theiſt.* Part. 2. pag. 191.] *To go no farther than our own Country,* all our great Ridges of Hills in *England*, run Eaſt and Weſt; ſo do the *Alps*, *in* Italy, *and in ſome meaſure the* Pyrenees; *ſo do the Mountains of the* ❩ *in* Africk, *and ſo do Mount* Taurus *and* Caucaſus.

" tries, condenſing them like Alembick Heads into " Water, and ſo (according to his Opinion) by a " kind of external Diſtillation giving original to " Springs and Rivers; and likewiſe by amaſſing, " cooling and conſtipating of them, turn them into " Rain, by thoſe means rendering the fervid Regions " of the torrid Zone habitable.

To theſe might be added ſome other Uſes and Conveniencies (7); as that the Hills ſerve to the Generation of Minerals and Metals (8), and that in them principally are the moſt uſeful Foſſils found; or if not found and generated only in them, yet at leaſt all theſe Subterraneous Treaſures are moſt eaſily

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Caucaſus. This he ſaith *is a wiſe Contrivance to prevent the Vapours, which would all run Northwards, and leave no Rains in the* Mediterranean *Countries.*

(7) That the Generation of many of the Clouds is owing to the Hills, appears from the Obſervations of the ingenious and learned Dr. *Joh. Jam. Scheuchzer* of *Zurich*, and *M. Joach. Frid. Creitlovius* cited by him. They obſerved at Sun-riſing divers Clouds detached by the Heat of the Sun from ſome of the Tops of the *Alps*, &c. upon all which their Obſervations, the Concluſion is, *Mirati ſummam Creatoris ſapientiam, qui & id, quod paulò antè nullî nobis uſui eſſe videbatur, maximis rebus deſtinaverat, adeoque ex illo tempore dubitare cœpi num Nubes eſſent futuræ, ſi iſtiuſmodi Montes & Petræ non darentur. Hypotheſi hâc ſtante, eluceſceret permagna utilitas, imò neceſſitas, quam Helveticæ Alpes non nobis tantùm accolis, ſed & vicinis aliis regionibus præſtant, diſpenſando, quas gignunt Nubes, Ventos, Aquas.* Scheuch. Iter Alpin. 2. p. 20.

(8) Let us take here *Ol. Mag.* Obſervation of his Northern Mountains, *Montes excelſi ſunt, ſed pro majori parte ſteriles, & aridi; in quibus fere nil aliud pro incolarum commoditate & conſervatione gignitur, quam inexhauſta pretioſorum Metallorum ubertas, qua ſatis opulenti, fertileſque ſunt in omnibus vitæ neceſſariis, forſitan & ſuperfluis aliunde ſi libet conquirendis, unanimique robore, ac viribus, ubi vis contra hæc naturæ dona intentata fuerit, defendendis. Acre enim genus hominum eſt*, &c. *Ol. Mag.* Hiſt. L. 6. Præf. See alſo Sir *Robert Sibbald*'s Prodr. Nat. Hiſt. Scot. p. 47.

(9) See

eaſily come at in them: Alſo their Uſe to ſeveral Nations of the Earth in being Boundaries and Bulwarks to them. But there is only one Uſe more that I ſhall inſiſt on, and that is,

Sixthly, and laſtly, That it is to the Hills that the Fountains owe their Riſe, and the Rivers their Conveyance. As it is not proper, ſo neither ſhall I here enter into any Diſpute about the Origine of Springs, commonly aſſigned by curious and learned Philoſophers. But whether their Origine be from condenſed Vapours, as ſome think (9); or from Rains falling, as others; or whether they are derived from the Sea by way of Attraction, Percolation, or Diſtillation; or whether all theſe Cauſes concur, or only ſome, ſtill the Hills are the grand Agent in this prodigious Benefit to all the Earth: Thoſe vaſt Maſſes and Ridges of Earth ſerving as ſo many huge *Alembicks*, or *Cola* in this noble Work of Nature.

But be the *Modus*, or the Method Nature takes in this great Work as it will; it is ſufficient to my Purpoſe, that the Hills are a grand Agent in this ſo noble and neceſſary a Work. And conſequently, that thoſe vaſt Maſſes, and lofty Piles are not, as they are charged, ſuch rude and uſeleſs Excreſcences of our ill-formed Globe; but the admirable Tools of Nature, contrived and ordered by the infinite Creator, to do one of its moſt uſeful Works, and to diſpenſe this great Bleſſing to all Parts of the Earth; without which neither Animals could live, nor Vegetables ſcarcely grow, nor perhaps Minerals, Metals, or Foſſils receive any Increaſe. For was the Surface of the Earth even and level, and the middle Parts of its Iſlands and Continents, not Moun-

(9) See *Book* I. *Chap.* 3. *Note* 2.

(10) *Monſieur*

Mountainous and High, (as now it is,) it is moſt certain there could be no Deſcent for the Rivers, no Conveyance for the Waters; but inſtead of gliding along thoſe gentle Declivities which the higher Lands now afford them quite down to the Sea, they would ſtagnate, and perhaps ſtink, and alſo drown large Tracts of Land.

But indeed, without Hills as there could be no Rivers, ſo neither could there be any Fountains or Springs about the Earth; becauſe, if we could ſuppoſe a Land could be well watered (which I think not poſſible) without the higher Lands, the Waters could find no Deſcent, no Paſſage through any commodious Out-lets, by Virtue of their own Gravity, and therefore could not break out into thoſe commodious Paſſages and Currents, which we every where almoſt find in, or near the Hills, and ſeldom, or never in large and ſpacious Plains; and when in them, at great and inconvenient Depths of the Earth; nay, thoſe very Subterraneous Waters that are any where met with by digging in the Plains, are in all Probability owing to the Hills, either near or far diſtant. As among other Inſtances may be made out from the forcible Eruption of the Subterraneous Waters in digging Wells, in the *lower Auſtria*, and the Territories of *Modena* and *Bologna* in *Italy*, mentioned by my fore-named learned Friend Mr. *Ray* (10). Or if there be any ſuch Place found throughout the Earth, that is devoid of Mountains, and yet well watered, as perhaps

(10) *Monſieur* Blundel, *related to the* Pariſian *Academy, what Device the Inhabitants of the lower* Auſtria, *(which is encompaſſed with the Mountains of* Stiria) *are wont to uſe to fill their Wells with Water. They dig in the Earth to the Depth of* 25 *and* 20 *Feet, till they come to an Argilla* [*clammy Earth*] ——— *which they bore through*

haps ſome ſmall Iſlands may; yet in this very Caſe that whole Maſs of Land is no other than as one Mountain deſcending (though unperceivedly) gently down from the Mid-land Parts to the Sea, as moſt other Lands do; as is manifeſt from the Deſcent of their Rivers, the principal of which in moſt Countries have generally their Riſe in the more lofty Mid-land Parts.

And now conſidering what hath been ſaid concerning this laſt Uſe of the Hills, there are two or three Acts of the Divine Providence obſervable therein. One is, that all Countries throughout the whole World ſhould enjoy this great Benefit, of Mountains, placed here and there, at due and proper Diſtances, to afford the ſeveral Nations this excellent, and moſt neceſſary Element the Waters. For according to Nature's Tendency, when the Earth and Waters were ſeparated, and ordered to their ſeveral Places, the Earth muſt have been of an even

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through ſo deep, till the Waters break forcibly out; which Water it is probable comes from the neighbouring Mountains in Subterraneous Channels. And Caſſinus *obſerved, that in many Places of the Territory of* Modena *and* Bologna *in* Italy, *they make themſelves Wells by the like Artifice,* &c. *By this means the ſame* Seig. Caſſini *made a Fountain at the Caſtle of* Urbin, *that caſt up the Water five Foot high above the level of the Ground.* Ray's Diſc. 1. pag. 40. *ubi plura.*

Upon Enquiry of ſome Skilful Workmen, whoſe Buſineſs it is to dig Wells, *&c.* whether they had ever met with the like Caſe, as theſe in this Note, they told me they had met with it in *Eſſex*, where after they had dug to 50 Foot Depth, the Man in the Well obſerved the clayie Bottom to ſwell and begin to ſend out Water, and ſtamping with his Foot to ſtop the Water, he made way for ſo ſuddain and forceable a Flux of Water, that before he could get into his Bucket, he was above his Waſte in Water; which ſoon aſcended to 17 Feet height, and there ſtayed: And altho' they often with great Labour endeavoured to empty the Well, in order to finiſh their Work, yet they could never do it, but were forced to leave it as it was.

(11) As

even Surface, or nearly ſo, The ſeveral component Parts of the Earth muſt have ſubſided according to their ſeveral ſpecifick Gravities, and at laſt have ended in a large even ſpherical Surface, every where equi-diſtant from the Center of the Globe. But that inſtead of this Form, ſo incommodious for the Conveyance of the Waters, it ſhould be jetted out every where into Hills and Dales ſo neceſſary for that Purpoſe, is a manifeſt Sign of an eſpecial Providence of the wiſe Creator.

So another plain Sign of the ſame eſpecial Providence of God in this matter is, that generally throughout the whole World, the Earth is ſo diſpoſed, ſo ordered, ſo well laid, I may ſay, that the Mid-land Parts, or Parts fartheſt from the Sea, are commonly the higheſt. Which is manifeſt, I have ſaid, from the Deſcent of the Rivers. Now this is an admirable Proviſion the wiſe Creator hath made for the commodious Paſſages of the Rivers, and for draining the ſeveral Countries, and carrying off the ſuperfluous Waters from the whole Earth, which would be as great an Annoyance, as now they are a Convenience.

Another providential Benefit of the Hills ſupplying the Earth with Water is, that they are not only inſtrumental thereby to the Fertility of the Valleys; but to their own alſo (11), to the Verdure of the Vegetables without, and to the Increment and Vigour of the Treaſures within them.

Thus

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(11) As the Hills being higher, are naturally diſpoſed to be drier than the Valleys; ſo kind Nature hath provided the greater Supplies of Moiſture for them, ſuch at leaſt of them, as do not aſcend above the Clouds and Vapours. For, beſides the Fountains continually watering them, they have more Dews and Rains commonly than the Valleys. They are more frequently covered with Fogs; and by retarding, ſtopping, or compreſſing the

Thus having vindicated the preſent Form and Fabrick of the Earth, as diſtributed into Mountains and Valleys, and thereby ſhewn in ſome Meaſure the Uſe thereof, particularly of the Mountains, which are chiefly found fault with: I have, I hope, made it in ſome meaſure evident, that God was no idle Spectator (12), nor unconcerned in the ordering of the Terraqueous Globe, as the former bold Charges againſt it do infer; that he did not ſuffer ſo grand a Work, as the Earth, to go unfiniſhed out of his Almighty Hand; or leave it to be ordered by Chance, by natural Gravity, by caſual Earthquakes, &c. but that the noble Strokes, and plain Remains of Wiſdom and Power therein do manifeſt it to be his Work. That particularly the Hills and Vales, though to a peeviſh weary Traveller, they may ſeem incommodious and troubleſome, yet are a noble Work of the great Creator, and wiſely appointed by him for the Good of our ſublunary World.

And ſo for all the other Parts of our Terraqueous Globe, that are preſumed to be found fault with by ſome, as if careleſsly ordered, and made without any Deſign or End; particularly the Diſtribution of

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the Clouds, or by their greater Cold condenſing them, they have larger Quantities of Rain fall upon them. As I have found by actual Experience, in comparing my Obſervations with thoſe of my late very curious and ingenious Correſpondent, *Richard Townley*, Eſq; of *Lancaſhire*, and ſome others, to be met with before, *Chap.* 2. *Note* 1. From which it appears, that above double the Quantity of Rain falleth in *Lancaſhire*, than doth at *Upminſter*. The Reaſon of which is, becauſe *Lancaſhire* hath more, and much higher Hills than *Eſſex* hath. See *Book* II. *Chap.* 5. *Note* 5.

(11) *Accuſandi ſanè meâ ſententiâ hîc ſunt Sophiſtæ, qui cùm nondum invenire, neque exponere opera Naturæ queant, eam tamen inertiâ atque inſcitiâ condemnant.* &c. Galen. de Uſ. Part. 1. l. 10. c. 9.

(12) *Vide*

of the dry Land and Waters; the laying the ſeveral Strata, or Beds of Earth, Stone, and other Layers before Spoken of; the Creation of noxious Animals, and poiſonous Subſtances; the boiſterous Winds; the Vulcano's, and many other things which ſome are angry with, and will pretend to amend: I have before ſhewn, that an infinitely wiſe Providence, an Almighty Hand was concerned even in them, that they all have their admirable Ends, and Uſes, and are highly inſtrumental and beneficial to the Being, or Well-being of this our Globe, or to the Creatures reſiding thereon.

So alſo for Humane Bodies, it hath been an ancient (‖) as well as modern Complaint, that our Bodies are not as big as thoſe of other Animals, that we cannot run as ſwift as Deer, fly like Birds, and that we are out-done by many Creatures in the Accuracy of the Senſes, with more to the ſame purpoſe. But theſe Objections are well anſwered by *Seneca* (†), and will receive a fuller Solution from what I ſhall obſerve of Animal Bodies hereafter.

But

(‖) *Vide quam iniqui ſint divinorum munerum æſtimatores, etiam quidam profeſſi ſapientiam. Queruntur quod non magnitudine corporis æquemus Elephantes, velocitate Cervos, levitate Aves, impetu Tauros; quod ſolidior ſit cutis Belluis, decentior Damis, denſior Urſis, mollior Fibris; quod ſagacitate nos narium Canes vincant, quod acie luminum Aquilæ, ſpatio ætatis Corvi, multa Animalia nandi facilitate. Et cùm quædam ne coire quidem in idem Natura patiatur, ut velocitatem corporis & vires pares animalibus habeamus; ex diverſis & diſſidentibus bonis Hominem non eſſe compoſitum, injuriam vocant; & in negligentes noſtri Deos querimoniam jaciunt, quod non bona valetudo, & vitiis inexpugnabilis data ſit, quod non futuri ſcientia. Vix ſibi temperant quin eouſque impudentiâ provehantur, ut Naturam oderint, quod infra Deos ſumus, quod non in æquo illis ſtetimus.* Seneca de Benef. l. 2. c. 29.

(†) *Quanto ſatius eſt ad contemplationem tot tantorumque beneficiorum reverti, & agere gratias, quod nos in hoc pulcherrimo domicilio voluerunt* [Dii] *ſecundos ſortiri, quod terrenis præfecerunt.*

But indeed after all, it is only for want of our knowing these things better, that we do not admire (13) them enough; it is our own Ignorance, Dulness, or Prejudice, that makes us charge those noble Works of the Almighty, as Defects or Blunders, as Ill-contrived, or Ill-made.

It is therefore fitter for such finite, weak, ignorant Beings, as we, to be humble and meek, and conscious of our Ignorance, and jealous of our own Judgment, when it thus confronteth infinite Wisdom. Let us remember how few things we know, how many we err about, and how many we are ignorant of: and those, many of them, the most familiar, obvious things; things that we see and handle at Pleasure, yea our own very Bodies, and that very part of us whereby we understand at all, our Soul. And should we therefore pretend to censure what God doth! Should we pretend to amend his Work! Or to advise infinite Wisdom! Or to know the Ends and Purposes of his infinite Will, as if we were of his Council! No, let us bear in mind, that these Objections are the Products, not of Reason, but of Peevishness. They have been incommoded by Storms and Tempests; they have been terrified with the burning Mountains, and Earthquakes; they have been annoyed by the noxious Animals, and fatigued by the Hills; and therefore are angry, and will pretend to amend these Works of the Almighty. But in the Words of St. *Paul*,

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Then having reckoned up many of the Privileges and Benefits, which the Gods, he saith, have conferred upon us, he concludes, *Ita est: cariſſimos nos habuerunt Dii immortales, habentque. Et qui maximus tribui honos potuit, ab ipſis proximos collocaverunt. Magna accepimus, majora non cepimus.* Senec. ibid.

(13) *Naturam maximè admiraberis, ſi omnia ejus opera perluſtraris.* Galen. de Uſ. Part l. 11. *concluſ.*

(14) Rom.

Paul (14), we may ſay, *Nay, but, O Man, who art thou that replieſt againſt God? Shall the thing formed ſay to him that formed it, Why haſt thou made me thus? Hath not the Potter power over the Clay, of the ſame lump to make one Veſſel to honour, and another to diſhonour?* If the Almighty Lord of the World had for his own Pleaſure made this our World more inconvenient for Man; it would better become us to ſit ſtill, and be quiet, to lament our own great infirmities and failings, which deſerve a worſer place, a more incommodious Habitation, than we meet with in this elegant, this well-contrived, well-formed World; in which we find every thing neceſſary for the Suſtentation, Uſe and Pleaſure both of Man, and every other Creature here below; as well as ſome Whips, ſome Rods to ſcourge us for our Sins (15). But yet ſo admirably well tempered is our State, ſuch an Accord, ſuch an Harmony is there throughout the Creation, that if we will but purſue the Ways of Piety and Virtue, which God hath appointed, if we will form our Lives according to the Creator's Laws, we may eſcape the Evils

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(14) Rom. 9. 20, 21.

(15) *Neither are they* [noxious Creatures] *of leſs Uſe to amend our Minds; by teaching us Care, and Diligence, and more Wit. And ſo much the more, the worſe the Things are we ſee, and ſhould avoid.* Weeſles, Kites, *and other miſchievous Animals, induce us to Watchfulneſs:* Thiſtles *and* Moles, *to good Husbandry.* Lice *oblige us to Cleanlineſs in our Bodies;* Spiders *in our Houſes; and the* Moth *in our Clothes. The Deformity and Filthineſs of* Swine, *make them the Beauty ſpot of the Animal Creation, and the Emblems of all Vice.— The Truth is, things are hurtful to us, only by Accident; that is, not of Neceſſity, but through our own Negligence, or Miſtake. Houſes decay, Corn is blaſted, and the Weevle breeds in Mault, ſooneſt towards the South. Be it ſo, it is then our own Fault, if we uſe not the Means, which Nature and Art have provided againſt theſe Inconveniencies.* Grew's Coſmol. c. 2. §. 49, 50.

Evils of this our frail State, and find sufficient means to make us happy whilst we are in the Body. The natural Force and Tendency of our Vertue will prevent many of the Harms (16), and the watchful Providence of our Almighty Benefactor will be a Guard against others; and then nothing is wanting to make us happy as long as we are in this World, there being abundantly enough to entertain the Minds of the most contemplative; Glories enough to please the Eye of the most curious and inquisitive; Harmonies and Consorts of Nature's own, as well as Man's making, sufficient to delight the Ear of the most harmonious; all sorts of pleasant Gusto's to gratify the Taste and Appetite even of the most luxurious; and fragrant Odours to please the nicest and tendereſt Smell; and in a word, enough to make us love and delight in this World rather too much, than too little, considering how nearly we are allied to another World, as well as this.

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(16) *Non est gemendus, nec gravi urgendus nece,*
Virtute quisquis abstulit fatis iter.
Senec. Hercul. Oet. Act. 5. Car. 1833.
Nunquam Stygias fertur ad umbras
Inclyta virtus. Id. ibid. Car. 1982.

BOOK IV.

Of Animals in general.

IN the laſt Book having ſurveyed the Earrh it ſelf in Particular, I ſhall next take a view of the Inhabitants thereof; or the ſeveral kinds of Creatures (1) that have their Habitation, Growth, or Subſiſtence thereon.

Theſe Creatures are either ſenſitive, or inſenſitive Creatures.

In ſpeaking of thoſe endowed with Senſe, I ſhall conſider.

1. Some things common to them all.
2. Things peculiar to their Tribes.

1. The things in common, which I intend to take notice of, are theſe Ten.

1. The five *Senſes*, and their Organs.
2. The great Inſtrument of Vitality, *Reſpiration.*
3. The *Motion*, or Loco-motive Faculty of Animals.
4. The

(1) *Principio cælum, ac terras, campoſque liquentes,*
Lucentemque globum Lunæ, Titaniaque aſtra
Spiritus intus alit, totamque infuſa per artus
Mens agitat molem, & magno ſe corpore miſcet.
Inde hominum, pecudumque genus, vitæque volantum.
Et quæ marmoreo fert monſtra ſub æquore pontus.
Igneus eſt illis vigor, & cæleſtis origo
Seminibus. Virgil. Æneid. L. 6.

4. The *Place*, in which they live and act.
5. The *Balance* of their Numbers.
6. Their *Food.*
7. Their *Cloathing.*
8. Their *Houſes*, *Neſts*, or *Habitations.*
9. Their Methods of *Self-Preſervation.*
10. Their *Generation*, and *Conſervation* of their Species by that means.

CHAP. I.

Of the five Senſes in general.

THE firſt thing to be conſidered in common to all the ſenſitive Creatures, is their faculty of *Seeing*, *Hearing*, *Smelling*, *Taſting*, and *Feeling*; and the *Organs* miniſtring to theſe five *Senſes*, together with the exact Accommodation of thoſe Senſes and their Organs to the State and Make of every Tribe of Animals (2). The Conſideration of which Particulars alone, were there no other Demonſtrations of God, is abundantly ſufficient to evince the infinite Wiſdom, Power and Goodneſs of the great Creator. For who can but ſtand amazed at the Glories of theſe Works; at the admirable Artifice of them, and at their noble Uſe and Performances! For ſuppoſe an Animal, as ſuch, had Breath and Life, and could move it ſelf hither and thither; yet how could it know whither to go, what it was about, where to find its Food, how to avoid

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(2) *Ex Senſibus ante cætera Homini Tactus, deinde Guſtatus: reliquis ſuperatur a multis. Aquilæ clariùs cernunt: Vultures ſagaciùs odorantur: liquidiùs audiunt Talpæ obrutæ terra, tam denſo atque ſurdo naturæ elemento.* Plin. Nat. Hiſt. L. 10. c. 69.

(3) *Oculi,*

avoid thouſands of Dangers (3), without Sight! How could Man particularly, view the Glories of the Heavens, ſurvey the Beauties of the Fields, and enjoy the Pleaſure of beholding the noble Variety of diverting Objects, that do, above us in the Heavens, and here in this lower World, preſent themſelves to our View every where; how enjoy this, I ſay, without that admirable Senſe of *Sight* (4)! How could alſo the Animal without *Smell* and *Taſte* diſtinguiſh its Food, and diſcern between wholſome and unwholſome; beſides the Pleaſures of delightful Odours, and reliſhing Guſto's! How without that other Senſe of *Hearing*, could it diſcern many Dangers that are at a diſtance, underſtand the Mind of others, perceive the harmonious Sounds of Muſick, and be delighted with the Melodies of the winged Choir, and all the reſt of the Harmonies the Creator hath provided for the Delight and Pleaſure of his Creatures! And laſtly, how could Man, or any other Creature diſtinguiſh Pleaſure from Pain, Health from Sickneſs, and conſequently be able to keep their Body ſound and entire, without the Senſe of *Feeling*! Here, therefore, we have a glorious Oeconomy in every Animal, that commandeth Admiration, and deſerveth our Contemplation: As will better appear by coming to Particulars, and diſtinctly conſidering the Proviſion which the Creator hath made for each of theſe Senſes.

CHAP.

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(3) *Oculi, pars corporis pretioſiſſima, & qui lucis uſu vitam diſtinguant a morte.* Plin. Nat. Hiſt. l. 11. c. 37.

(4) *Fœminæ aliquæ Megarenſes ſolis oculis diſcernere valebant inter Ova quæ ex Gallinâ nigrâ, & quæ ex albâ natæ ſunt*, is what is affirmed (how truly I know not) by *Grimald. de Lumin. & Color. Pr.* 43. §. 60.

CHAP. II.

Of the Eye.

FOR our clearer proceeding in the Consideration of this noble Part (1), and understanding its Oeconomy, I shall consider,

1. The *Form* of the Eye.
2. Its *Situation* in the Body.
3. Its *Motions*.
4. Its *Size*.
5. Its *Number*.
6. Its *Parts*.
7. The *Guard* and Security Nature hath provided for this so useful a part.

As this eminent part hath not been pretermitted by Authors, that have made it their particular Design and Business to speak of the Works of God; so divers of the aforesaid Particulars have been touched upon by them. And therefore I shall take in as little as possible of what they have said, and as near as

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(1) *In Dissectionibus anatomicis vix aliquid admirabilius, aut artificiosius, structura Oculi humani, meo quidem judicio, occurrit: ut merito per excellentiam Creatoris appelletur Miraculum.* Gul. Fabr. Hildan. Cent. 2. Observ. 1.

So likewise that accurate Surveyor of the Eye, Dr. *Briggs*, whose *Ophthalmography* I have met with since my penning this part of my Survey. His Character of this curious Piece of God's Work is, *Inter præcipuas corporis animati partes, qua magni Conditores nostri sapientiam ostendunt, nulla sanè reperitur, quæ majori pompâ elucet quam ipse Oculus, aut quæ elegantiori formâ concinnatur. Dum enim aliæ partes vel minori satellitio stipantur, vel in tantam venustatem haud assurgunt; Ocelli peculiarem honorem & decus a supremo Numine afflatum referunt, & nunquam non stupendæ suæ Potentiæ characteres repræsentant. Nulla sanè pars tam divino artificio & ornatu*, &c. Cap. 1. §. 1.

(2) It

as I can, mention chiefly what they have omitted. And,

1. For the *Form* of the Eye; which is for the moſt part Globous, or ſomewhat of the ſphæroidal Form: Which is far the moſt commodious optical Form, as being fitteſt to contain the Humours within, and to receive the Images of Objects from without (2). Was it a Cube, or of any multangular Form, ſome of its Parts would lie too far off (3), and ſome too nigh thoſe lenticular Humours, which by their Refractions cauſe Viſion. But by means of the Form before-mentioned, the Humours of the Eye

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(2) It is a good reaſon *Frier Bacon* aſſigns for the Sphæricity of the Eye: *Nam ſi eſſet planæ figuræ, ſpecies rei majoris oculo non poſſet cadere perpendiculariter ſuper eum.——Cum ergo Oculus videt magna corpora, ut ferè quartam cæli uno aſpectu, manifeſtum eſt, quod non poteſt eſſe planæ figuræ, nec alicujus niſi ſphæricæ, quoniam ſuper ſphæram parvam poſſunt cadere perpendiculares infinitæ, quæ a magno corpore veniunt, & tendunt in centrum Sphæræ: Et ſic magnum corpus poteſt ab Oculo parvo videri.* For the Demonſtration of which he hath given us a Figure. *Rog. Bacon. Perſpect.* Diſtinct. 4. Cap. 4.

Dr. *Briggs* ſaith, *Pars antica, (ſive Cornea,) convexior eſt poſticâ: hâc enim ratione radii melius in pupillam detorquentur, & Oculi fundus ex alterâ parte in majorem (propter imagines rerum ibidem delineandos) expanditur.* Ibid. §. 2.

(3) Suppoſe the Eye had the Retina, or back-part flat for the Reception of the Images, as in *Fig.* 1. ABA it is manifeſt, that if the Extremes of the Image AA were at a due focal Diſtance, the middle B would be too nigh the Cryſtalline, and conſequently appear confuſed and dim; but all parts of the Retina lying at a due focal Diſtance from the Cryſtalline, as at ACA, therefore the Image painted thereon is ſeen diſtinct and clear. Thus in a dark Room, with a Lens at a hole in the Window, (which *Sturmius* calls his Artificial Eye, in his *Exercit. Acad.* one of which he had made for his Pupils, to run any where on Wheels. In this Room, I ſay,) if the Paper that receives the Images be too nigh, or too far off the Lens, the Image will be confuſed and dim; but in the Focus of the Glaſs, diſtinct, clear, and a pleaſant Sight.

(4) *Blemmyis*

Eye are commodiouſly laid together, to perform their Office of Refraction; and the *Retina*, and every other part of that little darkned Cell, is neatly adapted regularly to receive the Images from without, and to convey them accordingly to the common Senſory in the Brain.

To this we may add the Aptitude of this Figure to the Motion of the Eye. For as it is neceſſary for the Eye to move this way, and that way to adjuſt it ſelf to the Objects it would view, ſo by this Figure it is well prepared for ſuch Motions, ſo that it can with great Facility and Dexterity direct it ſelf as Occaſion requires.

And as the Figure, ſo no leſs commodious is,

2. The *Situation* of the Eye, namely in the Head (4), the moſt erect, eminent Part of the Body, near the moſt ſenſible, vital Part, the Brain. By its Eminence in the Body, it is prepared to take in the more (5) Objects. And by its Situation in the Head, beſides its Proximity to the Brain, it is in the moſt convenient Place for Defence and Security. In the Hands, it might indeed (in Man) be rendered more eminent than the Head, and be turned about here and there at Pleaſure. But then it would be expoſed to many Injuries in that active Part, and the Hands (6) rendered a leſs active and uſeful

(4) *Blemmyis traduntur capita abeſſe, Ore & Oculis pectori affixis.* Plin. Nat. Hiſt. l. 5. c. 8. *Occidentem verſus quoſdam ſine cervice Oculos in humeris habentes.* lb. l. 7. c. 2. From theſe, and other ſuch like Fables, in this laſt cited Chapter, no doubt our famous Romancer Sir *J. Mandevile*, had his Romantick Stories, related in his Travels.

(5) See *Book* V. *Chap.* 2. *Note* 5.

(6) *Galen* deſerves to be here conſulted, who in his Book *De Uſu Partium*, from many conſiderations of the Hand, ſuch as what is here mentioned, as alſo its Structure, Site and Uſe, largely proves and reflects upon the Wiſdom and Providence of the Contriver and Maker of that Part.

(7) Thus

uſeful Part. And the like may be ſaid to its Site in any other Part of the Body, but where it is. But in the Head, both of Man, and other Animals, it is placed in a Part that ſeems to be contrived and made chiefly for the Action of the principal Senſes.

Another thing obſervable in the Site of the Eye, is the manner of its Situation in the Head, in the Fore-part, or Side-part thereof, according to the particular Occaſions of particular Animals. In Man, and ſome other Creatures, it is placed to look directly forward chiefly, but withal it is ſo ordered, as to take in near the Hemiſphere before it. In Birds, and ſome other Creatures, the Eyes are ſo ſeated, as to take in near a whole Sphere, that they may the better ſeek their Food, and eſcape Dangers. And in ſome Creatures they are ſeated, ſo as to ſee beſt behind them (7), or on each ſide, whereby they are enabled to ſee their Enemy that purſues them that way, and ſo make their Eſcape.

And for the Aſſiſtance of the Eyes, and ſome of the other Senſes in their Actions; the Head is generally made to turn here and there, and move as Occaſion requires. Which leads me to the

3. Thing to be remarked upon, the *Motions* of the Eye it ſelf. And this is generally upwards, downwards, backwards, forwards, and every way (8), for the better, more eaſy, and diſtinct Reception of the viſual Rays.

But

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(7) Thus in *Hares*, and *Conies*, their Eyes are very protuberant, and placed ſo much towards the ſides of their Head, that their two Eyes take in nearly a whole Sphere: whereas in *Dogs*, (that purſue them,) the Eyes are ſet more forward in the Head, to look that way, more than backward.

(8) *Sed lubricos Oculos fecit* [Natura] *& mobiles, ut & declinarent ſiquid noceret; & aſpectum, quo vellent, facilè converterent.* Cicer. de Nat. Deor. L. 2.

(9) *The*

But where Nature any way deviateth from this Method, either by denying Motion to the Eyes, or the Head (9), it is a very wonderful Provision she hath made in the Case. Thus for a Remedy of this inconvenience, in some Creatures their Eyes are sent out at a Distance (10) from the Head, to be circumvolved here and there, or one this, the other that

(9) *The Eyes of* Spiders, (in some four, in some six, and in some eight) *are placed all in the fore front of their Head, (which is round, and without any Neck,) all diaphanous and transparent, like a Locket of Diamonds,* &c. *neither wonder why Providence should be so anomalous in this Animal, more than in any other we know of. For,* 1. *Since they wanting a Neck cannot move their Head, it is requisite that defect should be supplied by the multiplicity of Eyes.* 2. *Since they were to live by catching so nimble a Prey as a Fly is, they ought to see her every way, and to take her* per saltum *(as they do) without any Motion of the Head to discover her: which Motion would have scared away so timorous an Insect.* Power's Microsc. Observ. p. 11.

The Eyes of the Cameleon *resemble a Lens, or Convex Glass, set in a versatile globular Socket, which she turneth backward, or any way, without moving her Head; and ordinarily the one a contrary, or quite different way from the other.* Dr. *Goddard* in Phil. Transf. Nr. 137.

But what is more extraordinary in this Motion [of the *Cameleon's* Eye] *is to see one of the Eyes move, whilst the other remains immoveable; and the one to turn forward, at the same time that the other looketh behind; the one to look up to the Sky, when the other is fixed on the Ground. And all these Motions to be so extream, that they do carry the Pupilla under the Crest, which makes the Eye-brow, and so far into the Canthi, or Corners of the Eyes, that the Sight can discern whatever is done justly behind it, and directly before, without turning the Head which is fastened to the Shoulders.* Mem. for a Nat. Hist. in Anatom. dissect. at Paris. Diss. of Gamel. pag. 22.

(10) *Snails* send out their Eyes at a Distance, they being contained in their four Horns, *like atramentous Spots, fixed to the end of their Horns; or rather to the ends of those black Filaments or optick Nerves, which are sheathed in her Horns, as* Dr. *Power* wordeth it. *Obs.* 31. *pag.* 36. So the ingenious Dr. *Lister Exercit. Anat. Cochl. & Limac.*

(11) *Vid.*

that way, at Pleaſure. And in Creatures, whoſe Eyes are without Motion, as in divers Inſects, in this Caſe either they have more than two Eyes, or their Eyes are nearly two protuberant Hemiſpheres, and each Hemiſphere often conſiſting of a prodigious Number of other little Segments of a Sphere (11). By which means thoſe Creatures are ſo far from being denyed any Benefit of that noble and moſt neceſſary Senſe, of Sight, that they have probably more of it than other Creatures, anſwerable to the Rapidity of their Flight, and briſk Motion; and to their Inqueſts after Food, Habitation, or Repoſitories of Generation, or ſuch other Neceſſity of the Animal.

4. Another admirable Proviſion in the Eye is, its Size; in ſome Animals large, in ſome little. It would be endleſs here to enumerate Particulars; as thoſe of Quadrupeds, Birds, Inſects, and other Terreſtrial Animals. And as for Fiſhes, they will fall under another part of my Survey.

I ſhall, therefore, only take notice of its Size in one Creature, the *Mole* (12). As the Habitation of that uncouth Animal is wholly Subterraneous, its Lodging,

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(11) *Vid. l.* 8. *c.* 3. *Note* 1.

(12) *Severinus* is of *Ariſtotle*'s, *Pliny*'s, and *Alb. Magnus*'s Opinion, that the *Mole* hath no Sight; *G. Seger* denies any Humour to be therein, but thinks they may probably ſee, becauſe Nature made nothing in vain. But *Borrichius* ſaith, their Eyes have *appendiculam nerveam in cerebrum euntem cujus beneficio globuli illi* [the little eyes] *extra pellem facilè poterant exſeri, retrahique pro arbitrio.——In illis oculorum globulis humor aqueus copioſè ſatis natabat; cæterorum non niſi tenue veſtigium.* Blaſ. Anat. Anim. c. 35.

Et quoniam Natura hoc vitæ genus ipſi deſtinavit, etiam perquam exiguos Oculos—dedit eo conſilio, ut ii, pretioſiſſima corporis pars, a terræ pulvere ne affligerentur. Ii inſuper pilis tecti, &c. *Humores illis oculis inſunt, & tunica nigra, uvea, ſe prodit. Ad hos tramite alio nervus venit.* Schneider in Blaſ. ibid.

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Lodging, its Food, its Exerciſes, nay, even all its Paſtimes and Pleaſures are in thoſe Subterraneous Receſſes and Paſſages, which its own Induſtry hath made for it ſelf; ſo it is an admirable Proviſion made in the Size of the Eye of that little Creature, to anſwer all its Occaſions, and at the ſame time to prevent Inconveniences. For as a little Light will ſuffice an Animal living always under Ground; ſo the ſmalleſt Eye will abundantly ſupply that Occaſion. And as a large protuberant Eye, like that of other Animals, would much annoy this Creature in its principal Buſineſs, of digging for its Food and Paſſage; ſo it is endowed with a very ſmall one, commodiouſly ſeated in the Head, and well fenced and guarded againſt the Annoyances of the Earth.

5. Another thing remarkable in this noble part of Animals is, its *Numbers*; not leſs than two (13) in

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Some time ſince I made divers accurate Diſſections of the *Eyes* of *Moles*, with the help of Microſcopes, having a doubt whether what we take to be Eyes, were ſuch or no. But upon a ſtrict Scrutiny I plainly could diſtinguiſh the *Vitreous*, and *Chryſtalline* Humours; yea, the *Ligamentum Ciliare*, and the atramentaceous *Mucus*. The *Pupil* I could manifeſtly diſcern to be round, and the *Cornea* copped, or conical: The Eye is at a great Diſtance from the Brain, the Optick Nerve very ſlender, and long, reaching from the Eye through the intermediate Fleſh, and ſo paſſeth to the Brain, along with the pair of Nerves reaching to the Noſe, which are much the largeſt in all the Animal. Theſe Creatures, I imagine, have the faculty of withdrawing their Eyes, if not quite into the Head, as *Snails*, yet more or leſs within the Hair, as they have more or leſs occaſion to uſe, or guard their Eyes.

Galen ſaith, *Moles* have Eyes, the *Cryſtalline* and *Vitreous* Humours, encompaſſed with *Tunicks*. *De Uſ. Part. l.* 14. *c.* 6. So accurate an Anatomiſt was he for his Time.

(13) *Pliny* tells us of a ſort of *Heron* with but one Eye, but 'twas only by hear-ſay. *Inter Aves Ardeolarum genere, quos Leucos vocant, altero oculo carere tradunt.* Nat. Hiſt. l. 11. c. 37. So the King of the

in any Inſtance, that I know of; and in ſome Animals more, as I have already hinted (14).

Now this is an admirable Proviſion; firſt, for the Convenience of taking in the larger Angle or Space: And in the next place, the Animal is by this Proviſion, in ſome Meaſure, prepared for the Misfortune of the loſs of one of theſe noble, and neceſſary Organs of its Body.

But then beſides all this, there is another thing conſiderable in this multiplicate Number of the Eye; and that is, that the Object ſeen is not multiplied as well as the Organ, but appears but one, though ſeen with two, or more Eyes (15). A manifeſt Sign of the infinite Skill of the Contriver of this ſo noble a Part, and of the exquiſite Art he employed

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the *Nigræ* that hath but one Eye, and that in his Forehead, *l. 6. c.* 30. Which Fables I take notice of more for the Reader's Diverſion, than any Truth in them.

(14) *Supra*, Note 9.

(15) The moſt celebrated Anatomiſts differ greatly about the reaſon why we ſee not double with two Eyes. This *Galen*, and others after him, generally thought to be from a Coalition or Decuſſation of the Optick Nerves, behind the *Oſ. Sphænoides.* But whether they decuſſate, coaleſce, or only touch one another, they do not well agree. The *Bartholines* expreſly aſſert they are united, *non per ſimplicem contactum vel interſectionem in homine, ſed totalem ſubſtantiæ confuſionem*, Anat. l. 3. c. 2. And whereas *Veſalius*, and ſome others had found ſome Inſtances of their being diſunited; they ſay, *ſed in pleriſque ordinariè confunditur interior ſubſtantia, ut accuratâ diſquiſitione deprehendi.*

But our learned Dr. *Gibſon*, (*Anat. l.* 3. *c.* 10.) ſaith, they *are united by the cloſeſt Conjunction, but not Confuſion of their Fibres.*

But others think the reaſon is not from any Coaleſcence, Contact, or Croſſing of the Optick Nerves, but from a Sympathy between them. Thus Monſieur *Cartes* is of Opinion, that the *Fibrillæ* conſtituting the medullary Part of thoſe Nerves being ſpread in the *Retina* of each Eye, have each of them correſponding Parts in the Brain; ſo that when any of thoſe *Fibrillæ* are ſtruck by any part of an Image, the correſponding Parts of the Brain are there-

by

employed in the formation thereof. But the Design and Skill of the infinite Workman, will best be set forth by

6. Surveying the *Parts* and *Mechanism* of this admirable Organ the Eye. And here indeed we cannot but stand amazed, when we view its admirable Fabrick, and consider the prodigious exactness, and the exquisite Skill employed in every part ministering to this noble and necessary Sense. To

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by affected, and the Soul thereby informed, *&c.* but see more hereafter under Note 38, from *Cartes* himself.

Somewhat like this is the Notion of our judicious Dr. *Briggs*, who thinks the Optick Nerves of each Eye consist of *Homologous Fibres*, having their rise in the *Thalamus Nervorum Opticorum*, and thence continued to both the *Retinæ*, which are made of them: And farther, that those *Fibrillæ* have the same Parallelism, Tension, *&c.* in both Eyes; and consequently when an Image is painted on the same corresponding, sympathizing Parts of each *Retina*, the same Effects are produced, the same Notice or Information is carried to the *Thalamus*, and so imparted to the Soul, or judging Faculty. That there is such an Ὁμοιοπάθεια between the *Retinæ*, &c. he makes very probable from the ensuing of double Vision upon the Interruption of the Parallelism of the Eyes; as when one Eye is depressed with the Finger, or their Symphony interrupted by Disease, Drunkenness, *&c.* And lastly, that simple Vision is not made in the former way, *viz.* by a Decussation or Conjunction of the Optick Nerves, he proves, because those Nerves are but in few Subjects decussated, and in none conjoined otherwise than by a bare Contact, which is particularly manifest in Fishes; and in some Instances it hath been found, that they have been separated without any double Vision ensuing thereupon. *Vid. Brig. Opthalmogr.* cap. 11. & 5. and *Nov. Vis. Theor. passim.*

After the same manner our justly eminent Sir *Isaac Newton*. *Are not the Species of Objects seen with both Eyes united where the Optick Nerves meet before they come into the Brain, the Fibres on the right side of both Nerves uniting there,* &c. *For the Optick Nerves of such Animals as look the same way with both Eyes, (as of Men, Dogs, Sheep, Oxen,* &c.*) meet before they come into the Brain; but the Optick Nerves of such Animals as do not look the same way with both Eyes, (as of Fishes and of the Chameleon) do not meet, if I am rightly informed.* Newt. Opt. Q. 15.

(16) *Nigra*

To pass by its Arteries and Veins, and such other Parts common to the rest of the Body, let us cast our Eye on its *Muscles*. These we shall find exactly and neatly placed for every Motion of the Eye. Let us view its *Tunicks*; and these we shall find so admirably seated, so well adapted, and of so firm a Texture, as to fit every place, to answer every occasion, and to be proof against all common Inconveniences, and Annoyances. Let us examine its three *Humours*; and these we shall find all of exquisite Clearness and Transparency, for an easy Admission of the Rays; well placed for the refracting of them, and formed (particularly the *Crystalline Humour*) by the nicest Laws of Opticks, to collect the wandering Rays into a point. And to name no more, let us look into its darkned Cell, where those curious Humours lie, and into which the Glories of the Heavens and the Earth are brought, and exquisitely Pictured; and this Cell we shall find, without, well prepared by means of its Texture, Aperture, and Colour, to fence off all the useless, or noxious Rays; and within, as well coated with a dark Tegument, that it may not reflect, dissipate, or any way confuse, or disturb the beneficial Rays (16).

But to descend to Particulars, although it would be a great Demonstration of the Glory of God, yet would take up too much Time, and hath been in some Measure done by others, that have written of God's Works. Passing over therefore what they have

(16) *Nigra est* [Uvea] *ut radios (ab Oculi fundo ad anteriorem ejus partem reflectios) obumbret; ne hi (ut ait clar. Cartesius) ad Oculi fundum retorti ibidem confusam visionem efficerent. Alia forsan ratio hujus nigredinis statuatur, quod radii in visione superflui, qui ab objectis lateralibus proveniunt hoc ritu obsorbeantur. Ita enim e loco obscuro interdiu objecta optimè intuemur, quia radii tunc temporis circumfuso lumine non diluuntur.* Brigg's Ophthal. c. 3. §. 5.

have obſerved, I ſhall under each principal Part take a tranſient Notice of ſome things they have omitted, or but ſlightly ſpoken of.

And my firſt Remark ſhall be concerning the *Muſcles* of the Eye, and their Equilibration. Nothing can be more manifeſtly an act of Contrivance and Deſign, than the *Muſcles* of the Eye, admirably adapted to move it any, and every way; upwards, downwards, to this ſide, or that, or howſoever we pleaſe, or there is occaſion for, ſo as to always keep that Paralleliſm of the Eye which is neceſſary to true Viſion. For the Performance of which Service, the Form, the Poſition, and the due Strength of each Muſcle is admirable. And here I might inſtance the peculiar and artificial Structure of the *Trochlearis*, and the Augmentation of its Power by the *Trochlea* (17); the Magnitude and Strength of the *Attollent Muſcle*, ſomewhat exceeding that of its Antagoniſt; the peculiar Muſcle called the *Seventh*, or *Suſpenſory Muſcle* (18), given to Brutes, by reaſon of the prone Poſture of their Bodies, and frequent Occa-

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(17) *Admirandum Dei artificium ex diverſorum animalium comparatione indies evadit manifeſtiùs. Mirantur omnes Trochlearem in in oculis Hominum & Quadrupedum, & quidem jure: ſed admirationem omnem ſuperat, quòd ſine Trochleâ oculum movens in Avibus novum genus Trochleæ longè artificioſius Nictitandi Membranæ dederit.* Blaſ. Anat. Animal. p. 2. c. 4. *ex Stenon.*

[Muſculum Trochlearem] *per intermediam trochleam traductum, nunquam intueor, quin admirabundus mecum,* Ὁ Θεὸς, *exclamem,* ὃ μόνον ἀεὶ γαμετρεῖ, ἀλλὰ καὶ ἀεὶ μηχανᾶται. *I. C. Sturmii Exercit. Acad. 9. de Viſ. Org. & Rat.* c. 3. §. 4. p. 446.

(18) *Obſervare eſt quod Quadrupedes, qui oculos in terram pronos, ac pendulos gerunt, Muſculum peculiarem habent, quo Oculi globus ſuſpenditur.——Hoc Muſculo Bos, Equus, Ovis, Lepus, Porcus, &c. præditi ſunt: hoc etiam Canis inſtruitur, ſed alio modo conformatum habet.* Willis de An. Brut. p. 1. c. 15.

Of this Opinion alſo was *Bartholine Anat.* l. 3. c. 8. and divers other eminent Anatomiſts.

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Occaſions to hang down their Heads: and I might ſpeak alſo of the peculiar Origine, and Inſertion of the *lower oblique Muſcle* (19), which is very notable, and many other things relating to theſe Parts: but it would be tedious to deſcend too much to thoſe admirable Particulars. And therefore to cloſe up theſe Remarks, all I ſhall farther take Notice of, ſhall be only the exquiſite Equilibration of all theſe *Oppoſite* and *Antagoniſt Muſcles*, effected partly by the equality of their Strength; which is the caſe of the *Adducent* and *Abducent Muſcles*: partly by their peculiar Origine, or the Addition of the *Trochlea*; which is the Caſe of the *Oblique Muſcles* (20): and partly by the natural Poſture of the Body, and the Eye; which is the Caſe of the *Attollent* and *Depri-*

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But Dr. *Briggs* is of Opinion that the *Adnata*, and the Muſcles ſufficiently anſwer all thoſe Ends aſcribed to that Muſcle by former Anatomiſts, and thinks *Probabiliùs itaque eſſe hunc Muſculum nervi Optici actionem (per vices) confirmare, ne a prono Brutorum inceſſu & copioſo affluxu humorum debilitetur.* Ophthal. c. 2. §. 2.

The *Muſculus Suſpenſorius* being in the *Porpeſs*, as well as Brutes, Dr. *Tyſon* thinks the Uſe of it is not to ſuſpend the Bulk of the Eye; but rather by its equal Contraction of the *Sclerotis*, to render the Ball of the Eye more or leſs Spherical, and ſo fitter for Viſion. *Tyſon*'s *Anat of the Porpeſs*, p. 39.

(19) *Muſculus obliquus inferior oritur a peculiari quodam foramine in latere Orbitæ ocularis facto, (contra quam in cæteris, &c.) quo fit ut ex unâ parte a Muſculo trochleari, ex alterâ verò ab hujus Muſculi commodiſſimâ poſitione, Oculus in æquilibrio quodam conſtitutus, irretorto obtutu verſus objecta feratur, nec plus juſto accedat verſus internum externumve canthum; quæ quidem Libratio omnino nullâ fuiſſet, abſque hujus Muſculi peculiari origination (cujus ratio omnes hucuſque Anatomicos latuit.)* And ſo this curious Anatomiſt goes on to ſhew farther the ſtupendous Artifice of the great Creator in this Poſition of the *Oblique Muſcles*. Brigg's *Nova Viſ. Theor.* p. 11. *meo libro.*

(20) Beſides thoſe particular Motions which the Eye receives from the *Oblique Muſcles*, and its Libration alſo in ſome Meaſure, ſome Anatomiſts aſcribe another no leſs conſiderable Uſe to them; namely, to lengthen and ſhorten the Eye (by ſqueezing

ment Muſcles. By this ſo curious and exact a Libration, not only unſeemly Contortions, and incommodious Vagations of the Eye are prevented, but alſo it is able with great readineſs, and exactneſs to apply it ſelf to every Object.

As to the *Tunicks* of the Eye, many things might be taken Notice of, the prodigious Fineneſs of the *Arachnoides*, the acute Senſe of the *Retina*, the delicate Tranſparency of the *Cornea* (21), and the firm and ſtrong Texture of that, and the *Sclerotica* too; and each of them in theſe, and every other reſpect in the moſt accurate manner adapted to the place in which it is, and the Buſineſs it is there to perform. But for a Sample, I ſhall only take Notice of that part of the *Uvea* which makes the *Pupil.* It hath been obſerved by others, particularly by our Honourable Founder (22), That as we are forced to uſe various Apertures to our optick Glaſſes, ſo Nature hath made a far more compleat Proviſion in the Eyes of Animals, to ſhut out too much, and to admit ſufficient Light, by the Dilatation and Contraction of the Pupil (23). But it deſerveth our eſpecial Remark, that theſe Pupils are in divers Animals

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and compreſſing it) to make it correſpond to the Diſtances of all Objects, according as they are nigh, or far off. Thus the ingenious Dr. *Keil*; *The Aqueous Humour being the thinneſt, and moſt liquid, eaſily changeth its Figure, when either the* Ligamentum Ciliare *contracts, or both the* Oblique Muſcles *ſqueeze the middle of the Ball of the Eye, to render it Oblong, when Objects are too near us.* Keil's *Anat. Chap.* 4. *Sect.* 4. See *Note* 22.

(21) *Quis vero Opifex præter Naturam, quâ nihil poteſt eſſe callidiùs tantam ſolertiam perſequi potuiſſet in Senſibus? quæ primùm Oculos membranis tenuiſſimis veſtivit, & ſepiit; quas primùm perlucidas fecit, ut per eas cerni poſſet: firmas autem, ut continerentur.* Cicer. de Nat. Deor. L. 2.

(22) *Boyl* of *Final Cauſes.*

(23) It is eaſy to be obſerved, that the *Pupil* openeth in dark Places; as alſo when we look at far diſtant Objects, but contracts by

Animals of divers Forms, according to their peculiar Occaſions. In ſome (particularly in Man) it is round; that being the moſt proper Figure for the Poſition of our Eyes, and the Uſe we make of them both by Day and Night. In ſome other Animals it is of a longiſh Form: in ſome Tranſverſe (24), with its Aperture large; which is an admirable Proviſion for ſuch Creatures to ſee the better laterally, and thereby avoid Inconveniencies, as well as to help them to gather their Food on the Ground, both by Day and Night. In other Animals the Fiſſure of the Pupil is erect (25), and alſo capable of opening wide, and ſhutting up cloſe.

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by an Increaſe of Light, and when Objects are nigh. This Motion of the Pupil ſome ſay, is effected by the circular and ſtraight Fibres of the *Uvea*, and ſome attribute it to the *Ligamentum Ciliare*. But I have no great doubt but that they both concur in that Action, and that the *Ligamentum Ciliare* doth, at the ſame time the Pupil opens or ſhuts, dilate or compreſs the *Cryſtalline*, and bring it nigher unto, or carry it farther off the *Retina*. For the Structure of the *Ligamentum Ciliare*, and its two Sorts of Fibres, drawn with the help of a Microſcope, I ſhall refer to Mr. *Cowper*'s *Anat.* T. 11.

(24) *In Bove, Capra, Equo, Ove, & quibuſdam aliis elliptica eſt* [Pupilla] *ut eo magis in hiſce forſan animalibus, quæ prono inceſſu victum in agris quæritant, radios laterales ad mala & incommoda utrinque devitanda admittat.* Briggs's *Ophthal.* c. 7. §. 6.

Homini erecto, aliiſque, &c. *caput erigere, & quaquaverſus circumſpicere ſolitis, plurima ſimul objecta, tum ſuprà, tum infrà, tum e latere utroque——viſu excipiuntur; quapropter Oculi Pupilla rotunda eſſe debet.——Attamen Bovi*, &c. *caput ferè ſemper pronum——gerentibus, tantùm quæ coràm, & paulo a latere obverſantur, intuitu opus eſt: quapropter Pupilla——oblonga eſt*, &c. Willis *de Anim. Brut.* p. 1. c. 15.

(25) Thus *Cats* (their Pupils being erect, and the ſhutting of their Eye-lids tranſverſe thereto) can ſo cloſe their Pupil, as to admit of, as it were, one only ſingle Ray of Light; and by throwing all open, they can take in all the fainteſt Rays. Which is an incomparable Proviſion for theſe Animals, that have occaſion to watch and way-lay their Prey both Day and Night.

The latter of which ſerveth to exclude the brighter Light of the Day; and the former to take in the more faint Rays of the Night, thereby enabling thoſe Nocturnal Animals (in whom generally this erect Form of the Pupil is) to catch their Prey with the greater Facility in the dark (26), to ſee upwards and downwards, to climb, *&c.* Thus much for the *Tunicks*.

The next thing I ſhall Notice of, will relate to the *Humours* of the Eye, and that only concerning the Mechaniſm of the *Cryſtalline Humour*; not its incomparable Tranſparency; nor its exact lenticular Form; nor its curious Araneous Membrane,

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(26) There is beſides this large opening of the Pupil in ſome Nocturnal Animals, another admirable Proviſion, enabling them to catch their Prey in the dark, and that is a Radiation of the Eyes. Of which Dr. *Willis* thus: *Hujus uſus eſt Oculi Pupillam, quaſi jubari inſito illuminare, ut res noctu, & in tenebris poſitas conſpicere valeat: quare in Fele plurimùm illuſtris eſt: at Homini, Avibus, & Piſcibus deeſt.* This Illumination he ſpeaks of, is from the *Tapetum* in the Bottom of the Eye, or the Shining of the *Retina* round the Optick Nerve.

Beſides which, he ſaith, the *Iris* hath a Faculty alſo, in ſome, of darting out Rays of Light, ſo as to enable them to ſee in the dark. Of which he tells this Story; *Novi quendam cerebro calidiori præditum, qui poſt uberiorem vini generoſi potum in nocte atratâ, ſive tenebris profundis, literas diſtinctè legere potuit. Cujus ratio videtur eſſe, quòd ſpiritus animales velut accenſi, adeoque ab hâc Iride irradiantes, jubare inſito Medium illuminabant.* Willis Ibid.

Such another thing *Pliny* tells us was reported of *Tiberius Cæſar*. *Ferunt Tib. Cæſ. nec alii genitorum mortalium, fuiſſe naturam, ut expergefactus noctu pauliſper, haud alio modo quàm luce clarâ, contueretur omnia.* Nat. Hiſt. l. 11. c. 37.

So Dr. *Briggs*. *Virum ſanè calidæ indolis novi in comitatu Bedfordienſi degentem, qui Oculis felineis——donatus eſt; adeo ut epiſtolam——mirè admodùm in loco obſcuro (ubi eadem mihi vix apparuit) perlegit. Hujus verò Oculi (niſi quod Pupillas inſigniores obtinuere) ab aliorum formatione neutiquam diſcrepabant.* Ophthal. c. 5. §. 12.

(27) The

Membrane (27), that conſtringeth and dilateth it, and ſo varieth its Focus, (if any ſuch Variation there

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(27) The *Tunica Aranea* is taken notice of by *Frier Bacon*, who calls it *Tela Aranea*, and ſaith *in hâc continetur —— glaciale vel Cryſtallinum*. Rog. Bacon's *Perſpect. Diſtinct.* 2. *c.* 3. The wrinkling of this, and the *Cornea* (as the Skin is of old Perſons) he thinks is the cauſe of the Obſcurity of the Sight in ſuch Perſons. *Bacon* Ib. par. 2. cap. 2. But this *Tunick* ſome deny, and others allow of: Dr. *A. M.* of *Trinity-College*, *Dublin*, (in his *Relat. of Anat. Obſ.* in the Eyes of Animals in a Letter to Mr. *Boyl*, *Ann.* 1682. annexed to his *Anat. Account of the Elephant burnt in Dublin*, p. 57.) affirms the *Tunica Aranea*, and ſaith, *I have often ſeen it before 'twas expoſed to the Air one Minute, notwithſtanding what Dr.* Briggs *ſaith to the contrary*, &c. But Dr. *Briggs* his Opinion is, *Humor Cryſtallinus, niſi aeri diutiùs expoſitus, vel lenitèr coctus (inſtar lactis) cuticulam non acquirit: quæ verò impropriè Tunica Aranea dicitur, cùm ſit tantum adventitia, ut in Oculo Bovis recens execto appareat.* Brigg's *Ophthalm. c.* 3.

The *Cryſtalline Humour* being of a double Subſtance, outwardly like a Gelly, towards the Center as conſiſtent as Suet, upon occaſion whereof its Figure may be varied; which Variation may be made by the *Ligamentum Ciliare*, Dr. *Grew* doth, upon theſe Accounts, not doubt to aſcribe to the *Ligamentum Ciliare* a Power of making the *Cryſtalline* more Convex, as well as of moving it to, or from the *Retina*. See *Grew*'s *Coſmolog. Sacr.* l. 1. c. 4. Now it is certain by the Laws of Opticks, that ſomewhat of this is abſolutely neceſſary to diſtinct Viſion, inaſmuch as the Rays proceeding from nigh Objects do more diverge, and thoſe from diſtant Objects leſs: which requires either that the *Cryſtalline Humour* ſhould be made more Convex, or more Flat; or elſe an Elongation or Shortening of the Eye, or of the Diſtance between the *Cryſtalline Humour* and the *Retina*.

But although Dr. *Briggs* (ſo good a Judge) denies the *Tunica Cryſtallina*, contrary to the Opinion of moſt former Anatomiſts, yet there is great reaſon to conclude he was in a Miſtake, in my Opinion, from the Obſervations of the *French Anatomiſts* of the *Cryſtalline* of the Eye of the *Gemp* or *Chamois*, who ſay, The *Membrana Arachnoides was very thick, and hard, ſo that it was eaſily ſeparated from the Cryſtallinus*, p. 145.

The ſame Anatomiſts alſo favour the Surmiſe of Dr. *Grew*. *This* [Contraction of the Fibres of the *Ligamentum Ciliare* on one ſide, and Dilatation on the other] *would make us think that theſe*

there be, as ſome affirm with great probability,) nor laſtly, its admirable Approach to, or from the *Retina*, by help of the *Ciliar Ligament* (28), according as Objects are far off or near, becauſe theſe things

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Fibres of the Ligamentum Ciliare *are capable of a Contraction and voluntary Dilatation, like to that of the Fibres of the Muſcles; and that this Action may augment or diminiſh the Convexity of the Cryſtallinus, according as the need which the Diſtance of the Objects may make it to have on the Eye to ſee more clearly and diſtinctly.* Anat. Deſcript. of a *Bear*, p. 49.

Since my penning the foregoing Notes, having as critically as I could, diſſected many Eyes, I manifeſtly found the *Membrana Arachnoides*, and will undertake to ſhew it any one, with great Eaſe and Certainty. It is indeed ſo Tranſparent, as not to be ſeen diſtinct from the *Cryſtalline*. But if the *Cornea* and *Uvea* be taken off before, or the *Vitreous Humour* behind it, and the out-ſide of the *Cryſtalline* be gently ſlaſhed, the *Arachnoides* may be ſeen to open, and the *Cryſtalline* will eaſily leap out, and part from the *Ligamentum Ciliare*; which otherwiſe it would not do. For it is by the *Arachnoides* braced to the *Ligamentum Ciliare*. This Membrane or Tunick, in the Ox, is ſo ſubſtantial and ſtrong, though thin, that it yields to, or ſinks under the ſharpeſt Lancet, and requires (for ſo thin and weak a Membrane in appearance) a ſtrong Preſſure to pierce it.

(28) As Birds and Fiſhes are in divers things conformable, ſo in ſome ſort they are in their Eye; to enable it to correſpond to all the Convergencies and Divergencies of the Rays, which the Variations of each of the Mediums may produce. For this Service the *Tunica Choroeides* in Fiſhes hath a Muſculous Subſtance at the bottom of it, lying round the Optick Nerve at a ſmall Diſtance from it: by which means I imagine they are able to contract and dilate the *Choroeides*, and thereby to lengthen and ſhorten the Eye. For the helping in which Service I imagine it is that the *Choroeides* and *Sclerotica* are in a great Meaſure parted, that the *Choroeides* may have the greater Liberty of acting upon the Humours within.

But in Birds, although the *Choroeides* be parted from the *Sclerotica*, yet the *Choroeides* hath no Muſcle, but inſtead thereof a curious pectinated Work ſeated on the Optick Nerve, repreſented in Fig. 2. In which *c. a. e. b. d.* repreſents the *Choroeides* and *Sclerotica*: *a. b* the part of the *Optick Nerve* that is within the Eye: *v. v. v.* the *Vitreous Humour*: *a. f. g. b.* the *Pecten*: *b. i.* the *Cryſtalline*. For the Reception of this *Pecten*, the *Optick Nerve*

things are what are usually taken Notice of: but that which I shall observe is, the Prodigious Art and Finery

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Nerve comes farther within the Eye, than in other Creatures. The Structure of this *Pecten* is very like that of the *Ligamentum Ciliare*, and in the Eye of a *Magpy*, and some others, I could perceive it to be musculous towards the Bottom. This *Pecten* is so firmly fixed unto, or embodied in the *Vitreous Humour*, that the *Vitreous Humour* hangs firmly to it, and is not easily parted from it. By which means all the Motions of the *Pecten* are easily communicated to the *Vitreous Humour*, and indeed to all contained in the *Choroeides*. And forasmuch as the *Crystalline* is connected to the *Vitreous Humour*, therefore all the Alterations in the *Vitreous Humour* affect also the *Crystalline*; and the *Crystalline* is hereby brought nearer unto, or farther from the *Retina*, as occasion is.

Besides all which Observables in the *Choroeides* and inner Eye, there is this farther remarkable in the *Sclerotica* and outer-part of of the Eye of Birds, *viz.* That the fore-part of the *Sclerotica* is horny and hard, the middle-part thin and flexible, and *Braces* intervene between the fore and hind-part, running between the *Choroeides* and *Sclerotica*. By which means the *Cornea* and Back-part of the Eye are brought to the same Conformity, that the rest of the Eye hath.

The great End and Design of this singular and curious Apparatus in the Eyes, both of Birds and Fishes I take to be, 1. To enable those Creatures to see at all Distances far off, or nigh; which (especially in the Waters) requireth a different Conformation of the Eye. In Birds also, this is of greatest Use, to enable them to see their Food at their Bill's End, or to reach the utmost Distances their high Flights enable them to view; as to see over great Tracts of Sea or Land, whither they have Occasion to fly; or to see their Food or Prey, even small Fishes in the Waters, and Birds, Worms, *&c.* on the Earth, when they sit upon Trees, high Rocks, or are hovering high in the Air. 2. To enable those Animals to adapt their Eye to all the various Refractions of their *Medium*. Even the Air it self varies the Refractions, according as it is rarer or denser, more or less compressed; as is manifest from the learned and ingenious Mr. *Lowthorp*'s Experiment in *Phil. Transf. Nr.* 257. and some other Experiments since of the before-commended Mr. *Hawksbee*, both in natural, rarified and compressed Air; in each of which the Refractions constantly varied in exact Proportion to the Rarity or Density of the Air. *Vid. Hawksbee*'s *Exp.* pag. 175. *&c.*

Besides

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Medullary Part (30) terminating in the Brain it ſelf, the Teguments propagated from the *Meninges*, and terminating in the Coats of the Eye; and their commodious Inſertions into the Ball of the Eye; in ſome directly oppoſite to the Pupil of the Eye, in others obliquely towards one ſide (31). But moſt of theſe things have been treated of, and the Convenice hereof ſet forth by others that have written of God's Works. I ſhall therefore take notice only of one wiſe Proviſion the Creator hath made about the Motion of the Eye, by uniting into one the *Third Pair* of Nerves, called the *Motory-Nerves* (32); each of which ſending its Branches into each Muſcle of each Eye, would cauſe a Diſtortion in the Eyes; but being united into one, near their Inſertion into the Brain, do thereby cauſe both Eyes to have the ſame Motion; ſo that when one Eye is moved this way, and that way, to this and that Object, the other Eye is turned the ſame way alſo.

Thus

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(30) *S. Malpighi* obſerved the middle of the *Optick-Nerve* of ſhe *Sword-Fiſh*, to be nothing elſe but a large Membrane folded according to its Length in many Doubles, almoſt like a Fan, and inveſted by the *Dura Mater*: whereas in Land-Animals it is a Bundle of Fibres. *V. Phil. Tranſ. Nr.* 27.

(31) *Certiſſimum eſt, quòd in omnibus Oculis Humanis (quos ſaltem mihi diſſecare contigit) Nervus Opticus Pupillo è diametro opponitur*, &c. *Briggs*'s Ophthal. c. 3. §. 15. Ita *Willis de Anim. Brut.* p. 1. c. 15.

Nervi Optici in Nobis, item in Cane, Fele (& in cæteris forſan animalibus calidis) ad fundum Oculi delati Pupillæ regioni proſpiciunt, dum interim in aliis Quadrupedibus, uti etiam in Piſcibus & Volucribus obliquè ſempr Tunicæ Sclerodi inſeruntur. Unde, &c. *Willis ib.* c. 7. §. 11.

(32) *This Pair is united at its Riſe; whence is commonly drawn a Reaſon why one Eye being moved towards an Object, the other is directed alſo to the ſame.* Gibſon's Anat. *Book* III. *Chap.* 11. So *Bartholine Anat.* Libellus 3. c. 2.

(33) Among

Thus from this tranſient and ſlight View (I may call it) of the Parts of the Eye, it appears what an admirable Artiſt was the Contriver thereof. And now in the

Seventh, and laſt Place, Let us conſider what Proviſion this admirable Artiſt hath made for the *Guard* and *Security* of this ſo well formed Organ (33). And here we ſhall find the Guard equivalent to the Uſe

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(33) Among all the other Security the Eye hath, we may reckon the Reparation of the *Aqueous Humour*. By which means the Eye when wounded, and that in all Appearance very dangerouſly too, doth often recover its Sight. Of which *Bern. Verzaſcha* gives divers Examples Ancient and Modern. One is from *Galen* of a Boy ſo wounded, that the *Cornea* fell, and became flaccid, but yet recovered his Sight, Other ſuch like Inſtances alſo he gives from *Realdus Columbus*, *Rhodius*, and *Tulpius*; and one that he cured himſelf in theſe Words, *Ego in Nobiliſſimi viri Filiolâ ſimilem caſum obſervavi: hæc dum levibus de cauſis cum Fratre altercaret, iſte iracundiâ percitus cultellum Scriptorium apprehendit, & ſororis oculo vulnus infligit, unde humor aqueus effluxit. Vocatus præſentem Chirurgum juſſi ſequens collyrium anodynum & exſiccans tepidè ſæpiùs admovere.* ℞ *aq. Plantag.* ℥iv *Roſar. Sanicul. Euphraſ. aa* ℥i *Trochiſc. alb. Rhas. cum Opio* ℈ii *Tutiæ ppp* ℈i *Crocì orient.* ℈ſs. M. *Hoc Collyrium inflammationem compeſcuit, vulnus ſiccavit & ſanavit. Hinc poſt aliquot menſes Humor aqueus ſuccrevit. Nam Viſus, ſed debilior cum ſummo Parentum gaudio rediit.* B. Verzaſchæ Obſerv. Medicæ Obſ. 14.

Another Cure of this Kind was experimented by Dr. *Daniel Major* upon a *Gooſe*, Ann. 1670. the *Aqueous Humour* of both whoſe Eyes they let out, ſo that the Eyes fell, and the *Gooſe* became quite Blind. But without the Uſe of any Medicine, in about two Days time, Nature repaired the watery Humour again, the Eyes returned to their former Turgency, and the *Gooſe* was in a Week after produced ſeeing before Twenty Eight or Thirty Spectators. *Ephem. Germ.* T. 1. Add. ad Obſ. 117.

From the ſame Cauſe, I doubt not, it was that the Eye of a Gentleman's Daughter, and thoſe of a Cock, when wounded, ſo that the *Cornea* ſunk, were reſtored by a *Lithuanian* Chymiſt, that paſſed for a Conjurer, by the Uſe of a Liquor found in *May*, in the Veſiculæ of *Elm*. Of which ſee Mr. *Ray's Catal. Cantab.* in *Ulmus*, from *Hern. ab Heers.*

(34) *Pal-*

Uſe and Excellency of the Part. The whole Organ fortified, and fenced with ſtrong, compact Bones, lodged in a ſtrong, well-made Socket, and the Eye it ſelf guarded with a nice-made Cover (34). Its Humours, and its inward Tunicks, are indeed tender,

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(34) *Palpebræ, quæ ſunt tegumenta Oculorum, molliſſimæ tactu, ne læderent aciem, aptiſſimæ factæ, & ad claudendas Pupillas, ne quid incideret, & ad aperiendas; idque providit, ut identidem fieri poſſet cum maximâ celeritate. Munitæque ſunt Palpebræ tanquam valla pilorum: quibus & apertis oculis, ſi quid incideret, repelleretur, & ſomno conniventibus, cùm Oculis ad cernendum non egerimus, ut qui, tanquam involuti, quieſcerent. Latent præterea utilitèr, & excelſis undique partibus ſepiuntur. Primùm enim ſuperiora Supercilliis obducta ſudorem a capite, & fronte defluentem repellunt. Genæ deinde ab inferiore parte tutantur ſubjectæ, leviterque eminentes.* Cicer. de Nat. Deor. L. 2.

Tully, in the Perſon of a *Stoick*, having ſo well accounted for the Uſe of the *Eye-lids*, I ſhall for a further Manifeſtation of the Creator's Contrivance and Structure of them, take notice of two or three Things. 1. They conſiſt of a thin and flexible, but ſtrong Skin; by which means they the better wipe, clean, and guard the *Cornea*. 2. Their Edges are fortified with a ſoft *Cartilage*; by which means they are not only enabled the better to do their Office, but alſo to cloſe and ſhut the better. 3. Out of theſe Cartilages grow a Palliſade of ſtiff Hairs of great Uſe to warn the Eye of the Invaſion of Dangers, to keep off Motes, and to ſhut out too exceſſive Light, &c, and at the ſame time to admit of (through their Intervals) a ſufficient Paſſage for Objects to approach the Eye. And it is remarkable, that theſe Hairs grow but to a certain, commodious Length, and need no cutting, as many other Hairs of the Body do: Alſo, that their Points ſtand out of the way, and in the upper-lid bend upwards, as they do downwards in the lower-lid, whereby they are well adapted to their Uſe. From which laſt Obſervables we may learn how critical and nice the great Author of Nature hath been in even the leaſt and moſt trivial Conveniences belonging to Animal Bodies; for which Reaſon I have added it to *Tully*'s Remarks. And more might have been added too, as particularly concerning the curious Structure and Lodgment of the *Right Muſcle*, which opens the Eye-lids; and the *Orbicularis* or *Circular* one, that ſhuts them: the nice Apparatus of Glands that keep the Eye moiſt, and ſerve for *Tears*; together with the Reaſon why Man alone,

who

der, proportionate to their tender, curious Uſes: but the Coats, without, are context and callous, firm and ſtrong. And in ſome Animals, particularly

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who is a ſociable Animal, doth exhibit his ſocial Affections by ſuch outward Tokens, as *Tears*; the *Nerves* alſo, and other Organs acting in this Miniſtry. I might alſo ſpeak of the Paſſages for diſcharging the ſuperfluous Moiſture of the Eyes through the Noſtrils, and much more of the like kind. But it would take up too much Room in theſe Notes; and therefore it ſhall ſuffice to give only ſuch Hints, as may create a Suſpicion of a noble Oeconomy and Contrivance in this (I had almoſt ſaid) leaſt conſiderable part of the Eye. But for particulars I ſhall refer to the Anatomiſts; and for ſome of theſe things, particularly to Dr. *Willis*'s *Cereb. Anat*, and *de Anim Brut*. and Mr. *Cowper*'s Elegant Cuts in the 11 *Tab*. of his *Anatomy*.

To the Eye-lids we may add another Guard afforded the Eyes of moſt Quadrupeds, Birds, and Fiſhes, by the *nictitating Membrane*, which Dr. *Willis* gives this Account of, *Plurimis* [Animalibus] *quibus Muſculus Suſpenſorius adeſt* (which Limitation he needed not to have added) *etiam alter Membranoſus conceditur, qui juxta interiorem oculi canthum ſitus, quando elevatur, Oculi globum ferè totum obtegit. Hujus uſus eſſe videtur, ut cum Beſtiæ inter gramina*, &c. *capita ſua propter victum capeſſendum demergunt, hic Muſculus Oculi Pupillam, ne a ſtipularum incurſu feriatur, occulit munitque*. De Anim Brut. p. 1. c. 15.

This Membrane Man hath not, he having little Occaſion to thruſt his Head into ſuch Places of Annoyance, as Beaſts, and other-Animals have; or if he hath, he can defend his Eyes with his Hands. But Birds (who frequent Trees and Buſhes) and Quadrupeds, (Hedges, and long Graſs,) and who have no part ready, like the Hand, to fence off Annoyances; theſe, I ſay, have this incomparable Proviſion made for the Safety of their Eyes. And for Fiſhes, as they are deſtitute of Eye-lids, becauſe in the Waters there is no Occaſion for a Defenſative againſt Duſt and Motes, offenſive to the Eyes of Land-Animals, nor to moiſten and wipe the Eyes, as the Eye-lids do; ſo the nictitating-Membrane is an abundant Proviſion for all their Occaſions, without the Addition of the Eye-lids.

And now, if we reflect, are theſe the Works of any thing but a wiſe and indulgent Agent?

(35) Although

larly Birds (35), some Part of those Tunicles have the Nature, and Hardness of Bone, or Horn.

But for Creatures, whose Eyes, like the rest of their Body, are tender, and without the Guard of Bones; there Nature hath provided for this necessary, and tender Sense, a wonderful kind of Guard, by endowing the Creature with a Faculty of withdrawing its Eyes into its Head (36), and lodging them in the same Safety with the Body.

Thus have I survey'd this first Sense of Animals, I may say, in a cursory, not accurate, strict manner, considering the Prodigious Workmanship thereof; but so as abundantly to demonstrate it to be the Contrivance, the Work of no less a Being than the infinitely Wise, Potent, and Indulgent Creator (37). For none less could compose so admirable an Organ, so adapt all its Parts, so adjust it to all Occasions, so nicely provide for every Use, and for every Emergency: In a Word, none less than *GOD*, could I say, thus contrive, order, and provide an Organ,

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(35) Although the Hardness and Firmness of the *Adnata* or *Sclerotica* in Birds is a good Guard to their Eyes, yet I do not think it is made thus so much for a Defence, as to minister to the lengthening and shortening the Eye, mentioned before in *Note* 27.

(36) *Cochleis oculorum vicem Cornicula bina prætentu implent.* Plin. Nat. Hist. l. 11. c. 37. See more of the Eyes of *Snailes* before in *Note* 10: and in *Note* 11. I said that I suspected *Moles* also might thrust out, or withdraw their Eyes more or less within the Hair and Skin.

(37) The diligent *Sturmius* was fully perswaded there could not be any speculative Atheism in any one that should well survey the Eye. *Nobis*, saith he, *fuit persuasissimum Atheismum, quem vocant speculativum, h. e. obfirmatum de Deitate in Universo nullâ persuasionem, habere locum aut invenire non posse in eo homine qui vel unius corporis organici, & speciatim Oculi fabricam attento animo inspexerit.* Sturm. Exerc. Acad. 9. De Vis. Organ. & Rat. in Epilogo.

(38) The

Organ, as magnificent and curious, as the Senſe is uſeful. A Senſe without which, as all the Animal World would be in perpetual Darkneſs, ſo it would labour under perpetual Inconveniencies, be expoſed to perpetual Harms, and ſuffer perpetual Wants and Diſtreſſes. But now by this admirable Senſe, the great *GOD* who hath placed us in this world, hath as well provided for our comfortable Reſidence in it; enabled us to ſee, and chuſe wholſome, yea delicate Food, to provide our ſelves uſeful, yea gaudy Cloathing, and commodious Places of Habitation and Retreat. We can now diſpatch our Affairs with Alacrity and Pleaſure; go here and there as our Occaſions call us. We can, if need be, ranſack the whole Globe, penetrate into the Bowels of the Earth, deſcend to the Bottom of the Deep, travel to the fartheſt Regions of this World, to acquire Wealth, to encreaſe our Knowledge, or even only to pleaſe our Eye and Fancy. We can now look about us, diſcern and ſhun the Precipices, and Dangers, which every where encloſe us, and would deſtroy us. And thoſe glorious Objects which fill the Heavens and the Earth, thoſe admirable Works of God which every where ſurround us, and which would be as nothing to us, without being ſeen, do by means of this noble Senſe preſent their Glories to us (38), and fill us with Admiration and Pleaſure. But I need not expatiate in the Uſefulneſs and Praiſes

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(38) The Glorious Landskips, and other Objects that preſent themſelves to the Eye, are manifeſtly painted on the *Retina*, and that not erect, but inverted as the Laws of Opticks require, and is manifeſt to the Eye, from *Monſieur Cartes* Experiment, of laying bare the Vitreous Humour on the back-part of the Eye, and clapping over it a bit of white Paper, or the Skin of an Egg; and then placing the fore-part of the Eye to the Hole of the Window of a darkened Room. By which means we have a pretty Landskip of the Objects abroad invertedly painted on the

Praiſes of this Sence, which we receive the Benefit of every Moment, and the want, or any defect of which, we lament among our greateſt Misfortunes.

Leaving then this Senſe, I ſhall proceed to the other Four, but more briefly treat of them, by reaſon we have ſo ample a Sample of the divine Art in the laſt, and may preſume that the ſame is exerted in all as well as one. For a Demonſtration of which, let us in the next place carry our Scrutiny to the Senſe of *Hearing*.

CHAP.

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the Paper, on the back of the Eye. But now the queſtion is, how in this caſe the Eye comes to ſee the Objects erect? *Monſieur Cartel's* anſwer is, *Notitiâ illius ex nullâ imagine pendet, nec ex ulla actione ab objectis veniente, ſed ex ſolo ſitu exiguarum partium cerebri, e quibus Nervi expullulant.* —— *E. g cogitandum in Oculo*——*ſitum capillamenti nervi optici* —— *reſpondere ad alium quendam partis cerebri*——*qui facit ut anima ſingula loca cognoſcat, quæ jacent in rectâ, aut quaſi rectâ lineâ; ut ita mirari non debeamus corpora in naturali ſitu videri, quamvis imago in oculo delineata contrarium habeat.* Dioptr. c. 6. But our moſt Ingenious Mr. *Molyneaux* anſwereth thus, *The Eye is only the Organ or Inſtrument, 'tis the Soul that ſees by means of the Eye. To enquire then how the Soul perceives the Object erect, by an inverted Image, is to enquire into the Soul's Faculties.*——*But erect and inverted are only Terms of Relation to up and down, or farther from, or nigher to the Center of the Earth, in parts of the ſame thing.* ——*But the Eye, or viſive Faculty takes no notice of the internal Poſture of its one Parts, but uſeth them as an Inſtrument only, contrived by Nature for the exerciſe of ſuch a Faculty.*——*Let us imagine, that the Eye* [on its lower Part] *receives an impulſe* [by a Ray from the uper Part of an Object,] *muſt not the viſive Faculty be neceſſarily directed hereby to conſider this Stroke, as coming from the top rather than the bottom* [of the object] *and conſequently be directed to conclude it the Repreſentation of the Top? Hereof we may be ſatisfied, by ſuppoſing a Man ſtanding on his Head. For here, though the upper Parts of objects are Painted on the upper Parts of the Eye, yet the Objects are judged to be Erect. What is ſaid of Erect and Reverſe, may be underſtood of Iniſter and Dexter.* Molyneaux's Dioptr. Nov. Part 1. Prop. 28.

CHAP. III.

Of the Senſe of Hearing.

CONcerning the Senſe of *Hearing*, I ſhall take Notice of two things; the Organ, the *Ear*; and its Object, *Sound*.

1. For the Organ, the *Ear*. I ſhall paſs by its convenient Number of being double, which (as in the laſt Senſe) ſerves for the commodious Hearing every way round us; as alſo is a wiſe Proviſion for the utter Loſs, or Injury (1) of one of the Ears. But I ſhall a little inſiſt upon its Situation, and its admirable Fabrick and Parts.

1. It

(1.) I preſume it will not be ungrateful to take notice here of the admirable, as well as uſeful Sagacity of ſome deaf Perſons, that have learnt to ſupply their want of *Hearing* by underſtanding what is ſaid, by the Motion of the Lips. My very ingenious Friend Mr. *Waller*, *R. S. Secr.* gives this Account, *There live now, and have from their Birth in our Town, a Man, and his Siſter, each about fifty Years Old, neither of which have the leaſt Senſe of Hearing,——yet both theſe know, by the Motion of the Lips only, whatever is ſaid to them, and will anſwer pertinently to the Queſtion propoſed to them.——The Mother told me they could hear very well, and ſpeak when they were Children, but both loſt that Senſe afterwards, which makes them retain their Speech: though that, to Perſons not uſed to them, is a little uncouth and odd, but intelligible enough.* Phil. Tranſ. Nr. 312.

Such another Inſtance is that of Mr. *Gody*, Miniſter of St. *Gervais* in *Geneva*, his Daughter. *She is now about Sixteen Years old. Her Nurſe had an extraordinary Thickneſs of Hearing: at a Year old, the Child ſpake all thoſe little Words that Children begin to ſpeak at that Age.——At two Years old they perceived ſhe had loſt her Hearing, and was ſo Deaf, that ever ſince, though ſhe hears great Noiſes, yet ſhe hears nothing that one can ſpeak to her.——But by obſerving the Motions of the Mouth and Lips of others, ſhe hath acquired ſo many Words, that out of theſe ſhe hath formed a ſort of Jargon, in which ſhe can hold Converſation whole Days with thoſe, that can*

ſpeak

1. It is ſituated in the moſt convenient part of the Body, (like as I ſaid the Eye is,) in a part near the common Senſory in the Brain, to give the more ſpeedy Information; in a Part where it can be beſt guarded, and where it is moſt free from Annoyances and Harms it ſelf, and where it gives the leaſt Annoyance, and Hindrance to the Exerciſes of any other Part; in a Part appropriated to the peculiar Uſe of the principal Senſes; in the moſt lofty, eminent Part of the Body; where it can perceive the moſt Objects, and receive the greateſt Information: And laſtly, in a Part in the Neighbourhood of its Siſter Senſe the Eye; with whom it hath peculiar and admirable Communication by its Nerves, as I intend to ſhew in its proper place. In reſpect then of its Situation and Place in the Body, this Senſe is well deſigned and contrived, and may ſo far be accounted the work of ſome admirable Artiſt. But,

2 If we ſurvey its Fabrick and Parts, it will appear to be an admirable Piece of the divine Wiſdom, Art and Power. For the Manifeſtation of which, let us diſtinctly ſurvey the outward, and the inward Part of this curious Organ.

1. For the *outward Ear*. If we obſerve its Structure in all kinds of Animals, it muſt needs be acknowledged

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ſpeak her own Language. I could underſtand ſome of her Words, but could not comprehend a Period, for it ſeemed to be but a confuſed Noiſe. She knows nothing that is ſaid to her, unleſs ſhe ſeeth the Motion of their Mouths that ſpeak to her; ſo that in the Night, when it is neceſſary to ſpeak to her, they muſt light a Candle. Only one thing appeared the ſtrangeſt Part of the whole Narration: She hath a Siſter, with whom ſhe hath practiſed her Language more than with any other; And in the Night by laying her Hand on her Siſter's Mouth, ſhe can perceive by that what ſhe ſaith, and ſo can diſcourſe with her in the Night. Biſhop *Burnet's* Let. 4. pag. 248.

knowledged to be admirably Artificial, it being so nicely prepared, and adjusted to the peculiar Occasions of each respective Animal. In Man (2), it is of a form proper for the erect Posture of his Body. In Birds, of a form proper for Flight; not protuberant, because that would obstruct their Progress, but close and covered, to afford the easier passage through the Air. In quadrupeds, its Form is agreeable to the Posture, and slower Motion of their Bodies: and in these too, various, according to their various Occasions. In some large, erect, and open, to hear the least approaches of Dangers (3), in others covered,

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(2) I cannot but admire that our most eminent modern Anatomists should not agree, whether there be any Muscles in the outward Ear of Man or not. Dr. *Keil* saith, there are two; Dr. *Drake* the same Number; and Dr. *Gibson* makes them to be four. So also doth *Monsieur Dionis*, and so did the ancient Anatomists: But Dr. *Schelhammer* expresly denies there are any, and saith, *Seduxit autem reliquos Brutorum Anatome, in quorum plerisque tales Musculi plures inveniuntur; putarunt autem fortassis ignominiosum Homini, si non & his instructus esset, & minus inde perfectum animal fore.* Schel. de Auditu. p. 1. c. 1. §. 7. But *Valsalva* who wrote very lately, and is very accurate in his survey of the Ear, saith, *Musculi auriculæ posteriores quandoque quatuor, quandoque duo; sed ut plurimum tres adnotantur; & quando solum duo se manifestant, tunc unus ex illis duplicato tendine versus Concham deferri solet. Horum musculorum in numero varietatem non solum in diversis; verum etiam in eodem subjecto quandoque vidi.——Ex quibus differentiis subortæ sunt Auctorum discrepantiæ in harum Musculorum numero, & positu:——quod non evenisset, si pluries in diversis Corporibus iidem Musculi quæsiti essent.* Ant. Mar. *Valsalva de Aur. Human.* c. 1. §. 6. But Dr. *Drake* thinks some of *Valsalva*'s Muscles the product of Fancy. Mr. *Cowper* makes them to be three, one *Attollent*, and two *Retrahent Muscles*. See *Anat.* Tab. 12.

(3) *Inter cætera* [animalia aurita] *maximè admirabilis est auris Leporinæ fabrica, quod cùm timidissimum animal sit, & prorsus inerme, natura id tum auditu acutissimo, tanquam hostium exploratore ad persentienda pericula, tum pedibus ceu armis ad currendum aptis munisse videtur.* A. Kircher's *Phonurg.* l. 1, §. 7. Technas. 2.

(4) *Mole*

covered, to keep out noxious Bodies. In the ſubterraneous Quadrupeds, who are forced to mine, and dig for their Food, and Habitation, as a protuberant Ear, like that of other Quadrupeds, would obſtruct their Labours, and be apt to be torn and injured; ſo they have the contrary (4), their Ears ſhort, lodged deep, and backward in their Head, and paſſing

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(4) *Moles* have no protuberant Ear, but only a round Hole between the Neck and Shoulder; which Situation of it, together with the thick ſhort Furr that covers it, is a ſufficient Defenſative againſt external Annoyances. The *Meatus Auditorius* is long, round, and cartilaginous, reaching to the under part of the Skull. Round the inſide runs a little Ridge reſembling two Threads of a Skrew, at the Bottom whereof is a pretty Inlet, leading to the Drum, made on one ſide with the aforeſaid cochleous Ridge, and on the other with a ſmall Cartilage. I obſerved there was *Cerumen* in the *Meatus*.

As to the *inner Ear* it is ſomewhat ſingular, and different from that of other Quadrupeds, and much more from Birds, although I have met with ſome Authors that make it agreeing with that of Birds. There are three ſmall Bones only (all Hollow) by which the *Drum* (to uſe the old Appellation) or the *Membrana Tympani* (as others call it) acteth upon the *Auditory Nerve*. The firſt is the *Malleus*, which hath two Proceſſes nearly of equal Length; the longer of which is braced to the *Membrana Tympani*, the ſhorter to the ſide of the Drum or *Os Petroſum*; the back part of it reſembles the Head and Stalk of a ſmall *Muſhroom*, ſuch as are pickled. On the back of the *Malleus* lies the next ſmall Bone, which may be called the *Incus*, long, and without any Proceſs, having ſomewhat the Form of the ſhort Scoop wherewith Water-Men throw the Water out of their Wherries. To the End of this, the Third and laſt ſmall Bone is tacked by a very tender Brace. This little Bone bears the Office of the *Stapes*, but is only forked without any Baſe. One of theſe Forks is at one *Feneſtra*, or *Foramen*, the other at another; in which *Feneſtræ* I apprehend the Forks are tacked to the Auditory Nerve. Theſe *Feneſtræ* (equivalent to the *Feneſtra Ovalis*, and *Rotunda* in others) are the Inlets into the *Cochlea* and *Canales Semicirculares*, in which the *Auditory Nerve* lieth. The *Semicircular Canals* lie at a Diſtance from the *Drum*, and are not lodged (as in other Animals) in a ſtrong thick Body of Bone, but are thruſt out with-

passing to the under part thereof, and all sufficiently fenced and guarded. And as for Insects, Reptiles, and the Inhabitants of the Waters; if they enjoy this Sense, (as there is great reason to think they do,) it may probably be lodged commodiously under the same Security and Guard, as the Smelling, or some other Sense is.

And moreover, as the Form of this Organ is various in various Animals, so in each of them its Structure is very curious and observable, being in all admirably contrived to collect the wandering, circumambient Impressions, and Undulations of Sound, and to convey them to the Sensory within. If I should run over the several Genera of Animals, we might find a notable Prospect of the Handy-Work of God (5), even in this so inconsiderable Part of Animals. But I shall only carry my Survey to that

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in the Skull, making an *Antrum*, with an handsome *Arch* leading into it, into which a part of the Brain enters.

One Leg of the *Malleus* being fastened to the *Membrana Tympani*, and the *Incus* to the back of the *Malleus*, and the top of that to the top of the *Stapes*, and the Forks or Branches of the *Stapes* to the *Auditory Nerve*, I observed that whenever I moved the Membrane, all the little Bones were at the same time moved, and consequently the *Auditory Nerve* thereby affected also.

I hope the Reader will excuse me for being so particular in this Organ only of the *Mole*, a despised Creature, but as notable an Example of *God's* Work, as its Life is different from that of other Quadrupeds; for which reason it partly is that I have enlarged on this part differing from that of others, and which no Body that I know of, hath taken much notice of, and which is not discoverable without great Patience and Application; and partly because by comparing these Observations with *Book VII. Chap* 2. *Note* 4. we may judge how the Sense of Hearing is performed.

(5) *Among many Varieties, both in the inner, and outer Ear, those which appear in the Passage into the Rock-bone, are remarkable. For in an* Owl, *that perches on a Tree or Beam, and hearkens after the Prey beneath her, it is produced farther out above, than it is below,*

that of Man. And here the first thing that offereth it self to our View is the *Helix*, with its tortuous Cavities, made to stop, and collect the sonorous Undulations, to give them a gentle Circulation and Refraction, and so convey them to the *Concha*, or larger and more capacious round Cell at the entrance of the Ear. And to bridle the Evagation of the Sound, when arrived so far, but withal not to make a Confusion thereof, by any disagreeable Repercussions, we may take notice of a very curious Provision in those little Protuberances, called the *Tragus*, and *Antitragus* of the outward Ear, of a commodious Form and Texture (6), and conveniently lodged for this Use. The great Convenience and Benefit of this Form and Contrivance of the outward Ear, is sufficiently manifest by the want thereof, which causeth a *confusion in the Hearing, with a certain Murmur, or Swooing like the fall of Waters* (7).

Another

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below, for the better Reception of the least Sound. But in a Fox, *that scouteth underneath the Prey at Roost; it is for the same reason, produced farther out below. In a* Pole-Cat, *which hearkens straight forward, it is produced behind, for the taking of a forward Sound. Whereas in an* Hare, *which is very quick of hearing, and thinks of nothing but being pursued, it is supplied with a bony Tube; which as a natural Otocoustick, is so directed backward, as to receive the smallest, and most distant Sound that comes behind her.* Grew's Cosmolog. Sacr. *lib.* 1. c. 5. §. 6.

(6) The Texture of the *Tragus* and *Antitragus*, is softer than that of the *Helix*; which serveth gently to blunt, not forcibly to repel the Sound in the *Concha*.

(7) Dr. *Gibson*'s Anatomy, *Chap.* 22. *Book* III.

Those whose Ears are cut off, have but a confused way of Hearing, and are obliged either to form a Cavity round the Ear with their own Hands, or else to make use of a Horn, and apply the end of it to the inner Cavity of the Ear, in order to receive the agitated Air. 'Tis likewise observed, that those whose Ears jut out, hear better than flat-eared Persons. Monsieur Dionis's *Anat. Demonstr.* 8.

Another wiſe Proviſion of the Creator is in the Subſtance of the outward Ear, which is Cartilaginous, the fitteſt for this place. For (as an ingenious Anatomiſt (8) obſerves) " if it had been Bone, it " would have been troubleſome, and might by ma- " ny Accidents have been broken off: If Fleſh, it " would have been ſubject to Contuſion ". But indeed a worſer Conſequence than this would have enſued ſuch a ſoftneſs as that of Fleſh, and that is, it would neither have remained expanded, neither would it ſo kindly receive and circulate the Sounds, but abſorb, retard, or blunt their Progreſs into the inward Organ. But being hard, and curiouſly ſmooth and tortuous, Sounds find an eaſie paſſage, with a regular Volutation and Refraction; as in a well-built Arch, Grotto, or muſical Inſtrument, which magnify and meliorate Sounds; and ſome of which convey even a whiſper to a large Diſtance (9). But from the outward, let us carry our Survey,

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(8) *Gibſ.* ibid.

(9) It would nauſeate the Reader to reckon up the places famed for the Conveyance of Whiſpers, ſuch as the Priſon of *Dionyſius* at *Syracuſe*, which is ſaid to encreaſe a Whiſper to a Noiſe; the clapping ones Hands to the Sound of a Cannon, *&c.* nor the *Aqueducts* of *Claudius*, which carry a Voice ſixteen Miles, and many others both Ancient and Modern. If the Reader hath a mind to be entertained in this way, he may find enough in *Kircher's Phonurgia*. But it may not be irkſome to mention one or two of our own in *England*. Among which, one of the moſt famed is the *Whiſpering-place* in *Glouceſter Cathedral*; which is no other than a Gallery above the Eaſt-end of the Choir, leading from one ſide thereof to the other. It conſiſteth, (if I miſtake not) of five Angles, and ſix Sides, the middle-moſt of which is a naked, uncovered Window, looking into a Chappel behind it. I gueſs the two Whiſperers ſtand at about twenty-five Yards Diſtance from one another. But the *Dome* of St. *Paul's*, *London*, is a more conſiderable *Whiſpering-place*, where the

2. To the inward part of this admirable Organ. And here we find the moſt curious and artful Proviſion for every Emergency and Occaſion. The *auditory Paſſage*, in the firſt place, curiouſly tunnelled, and artfully turned, to give Sounds an eaſie Paſſage, as well as a gentle Circulation and Refraction; but withal, ſo as to prevent their too furious ruſhing in, and aſſaulting the more tender parts within.

And foraſmuch as it is neceſſary that this Paſſage ſhould be always open, to be upon the Watch (10), therefore to prevent the Invaſion of noxious Inſects, or other Animals, (who are apt to make their retreat in every little Hole,) Nature hath ſecured this Paſſage (11) with a bitter nauſeous Excrement (12), afforded

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the Ticking of a Watch (when no Noiſe is in the Streets) may be heard from Side to Side; yea, a Whiſper may be ſent all round the Dome. And not only in the Gallery below, but above, upon the Scaffolds, I tried, and found that a Whiſper would be carried over one's Head round the top of the Arch, notwithſtanding there is a large Opening in the middle of it into the upper part of the Dome.

(10) *Auditus autem ſemper patet: ejus enim ſenſu etiam dormientes egemus. A quo cùm ſonus eſt acceptus, etiam e ſomno excitamur. Flexuoſum iter habet, ne quid intrare poſſit, ſi ſimplex, & directum pateret; proviſum etiam, ut, ſiqua minima beſtiola conaretur irrumpere, in ſordibus aurium, tanquam in viſco, inhæreſceret.* Cicer. de Nat. Deor. L. 2.

It deſerves a particular Remark here, that in Infants in the Womb, and newly Born, the *Meatus Auditorius* is ſhut up very cloſely, partly by the Conſtriction of the Paſſage, and partly by a glutinous Subſtance, whereby the *Tympanum* is guarded againſt the Water in the *Secundinæ*, and againſt the injuries of the Air as ſoon as the Infant is Born.

(11) It is remarkable, that in moſt, if not all Animals, whoſe Ears are tunnelled, or where the *Meatus Auditorius* is long enough to afford harbour to *Ear-wigs*, or other Inſects; that, I ſay, in the Ears of ſuch, *Ear-wax* is conſtantly to be found. But in Birds, whoſe Ears are covered with Feathers, and where the *Tympanum* lies but a little way within the Skull, no *Ear-wax* is

(12), afforded from the Glands (13) appointed for that purpose.

From hence let us approach the most inward Parts, in which we shall see Strokes of the most exquisite Art. To pass over the *innate Air* that most Authors talk of (14), (because there is no such) the passage to

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is found, because none is necessary to Ears so well guarded, and so little tunnelled.

(12) The *Ear-wax* was thought by the old Anatomists to be an Excrement of the Brain: *Humor biliosus a cerebro expurgatus*, the *Bartholines* say of it, *L.* 3. *c.* 9. But as *Schelhammer* well observes, *Nil absurdius, quam cerebri excrementum hoc statuere. Nam & ratio nulla suadet, ut in cerebro fieri excrementum tale credamus:——neque viæ patent per quas ab eo seclusum in meatum auditorium possit inde penetrare.* As to its Taste, *Casserius* gives Instances of its being sweet in some Creatures. But *Schelhammer* says, *Ego vero semper cum amaritie aliquid dulcedinis in illo deprehendi.* Vid. Schel. de Audit *p.* 1. *c.* 2. § 10. But I could never distinguish any Sweetness in it; but think it insipid mixed with a Bitterness.

(13) *Cerumina amara Arteriolis exudantia.* Willis's de Anim. Brut. *par.* 1. *c.* 14. *In the Skin——are little Glands, which furnish a yellow and bitter Humour.* Monsieur Dionis's Dem. 18. An handsome Cut of those *Glandulæ ceruminosæ* is in Dr. *Drake*, from *Valsalva*.

Pliny attributes great Vertue to the *Ear-wax*; *Morsus hominis inter asperrimos numeratur: medentur sordes ex auribus: ac ne quis miretur, etiam Scorpionum ictibus Serpentiumque, statim impositæ* Plin. Nat. Hist *l* 28. *c.* 4. And that it hath an healing Quality, and may be accounted a good Balsam, I my self have experienced.

(14) That there is such a thing as the *innate Air*, (talked of much by most Authors on this Subject) *Schelhammer* very justly, I think, denies; by reason there is a passage into the inner Ear from the Throat, through which the *innate Air* may pass out, and the outward Air enter in. *V. Par. Alt.* p. 2. c. 1. § 10. When by stopping our Breath, and Straining, we force the external Air into the Ear, it may be heard rushing in; and if much be forced in, it may be felt also to bear against the *Tympanum*. When the Passage to the Throat is by any means stop'd, as by a Cold in the Head, *&c.* the Hearing thereby becomes dull and blunt; by reason the Communication between the outward and

to the Palate (15), and their Uſes, with divers other curious things that might be named, let us ſtop a little at the part containing the reſt, namely, the Bone (16). The particular texture and hardneſs of which above other Bones of the Body is very remarkable, whereby it ſerves not only as a ſubſtantial Guard to the Senſory, but alſo to oppoſe the Impulſes of the æthereal Matter, that there may be no loſs, nor confuſion of the Sound; but that it may,

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and inward Air, are obſtructed: but when by ſtrong Swallowing or ſuch like Motion of the Throat, the Paſſage is opened, we perceive it by a ſudden Smack or Crack, and we immediately hear very clearly; the load of feculent Air, being at that time diſcharged from the inner Ear.

It is a wiſe Proviſion, that the Paſſage for the Air into the Ear, is from the Throat; *Ut non ſtatim quivis aer externus irrumpere queat* (as *Schelhammer* ſaith, *Par. Ult.* c. 4. §. 8.) *ſed nonnihil immutatus, ac temperatus, calore ex medio ventre exſpirante; imo fortaſſis non facilè alius, niſi ex pulmonibus.*

(15) *Valſalva* hath given us a more accurate Deſcription of the *Tuba Euſtachiana*, or *Paſſage to the Palate*, than any other Author, to whom I therefore refer. *De Aur. Human.* c. 2. §. 16, *&c.*

The chief Uſe hereof he thinks is to give way to the inner Air, upon every Motion of the *Membrana Tympani*, the *Malleus*, *Incus*, and *Stapes*. This Paſſage, if it be ſhut up, Deafneſs enſues. Of which he gives two Inſtances: one a Gentleman, who loſt his Hearing by a Polypus in the Noſe reaching to the *Uvula*; the other a Yeoman, labouring with an Ulcer above the left ſide of the *Uvula*; which when he ſtopt with a Tent dipped in Medicine, he loſt his Hearing in the left Ear, and recovered it, as ſoon as the Tent was out. *Ibid.* c. 5. §. 10.

(16) *Os* [petroſum] *ex quo interiores ſingularum* [Labyrinthi] *cavitatum parietes conflati ſunt, album, duriſſimum, necnon maxime compactum. Id autem a Naturâ ita comparatum eſſe videtur, ut materia ætherea Sonorum objectorum impreſſionibus onuſta, dum prædictis impingitur Parietibus, nihil aut ſaltem ferè nihil motûs ſui amittat, atque adeo illum qualem ab Objectis ſonoris accepit, talem communicet Spiritui animali contento intra expanſiones rami mollioris Nervorum Auris.* Dr. *Raym.* Vieuſſens of *Montpellier*, in Phil. Tranſ. Nr. 258.

(17) The

may be conveyed regularly, and intirely to the Auditory Nerves.

The next part I ſhall take notice of, may be that fine Membrane, called the *Tympanum*, or *Membrana Tympani* (17), with its inner Membrane (18); together with the four little appendant Bones (19), and the three inner Muſcles to move them, and adjuſt the

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(17) The *Tympanum* of the Ear, or as *Valſalva* and the Moderns, the *Membrana Tympani* was taken notice of as early as *Hippocrates*'s time. In Birds, it is ſtrained towards the outward Parts; in other Animals towards the Brain, or inner Parts. Monſieur *Dionis* ſaith, *It is not equally faſtened to the whole Circumference of the bony Circle, in which it is inchaſed; for on the upper ſide it hath a free diſengaged Part, by which ſome can give vent to the Smoak in their Mouth.* Demonſtr. 8. That there is ſome paſſage I doubt not, but I queſtion whether Monſieur *Dionis* ever ſaw the diſengaged Part he mentions. I have my ſelf carefully ſearched divers Subjects, and do not remember to have ſeen any ſuch Paſſage; and I perceive it eſcaped the diligent *Schelhammer*'s Eye. *Valſalva* alſo by injecting in through the *Tuba Euſtachiana*, could not force any Liquor into the *Meatus Auditorius*. But yet he imagines he found the Paſſage out in another place of the Drum, in ſome morbid, and one ſound Head. *Valſalv. de Aur. Hum.* c. 2. §. 8. Mr. *Cowper* alſo affirms there is a Paſſage by the upper part of the Membrane. *Anat. Ap.* Fig. 8.

(18) Dr. *Vieuſſens* before-named, diſcovered a Membrane, *tenuiſſimæ rarǽque admodum texturæ intra cavitatem Tympani*; as he deſcribes it. Whoſe uſe he ſaith is, 1. *Occludens Labyrinthi januam impedit ne naturalis puriſſimus ac ſubtiliſſimus Aer intra cavitates —— communicationem —— habeat cum aere craſſo.* 2. *Labyrinthi baſin calefacit*, &c. *ubi ſupra.* Probably this double Membrane may be ſuch, or after the ſame manner as it is in the *Tympanum* of Birds: Of which ſee my Obſervations in *Book* VII. *Chap.* 2. *Note* 4.

(19) The four little Bones being treated of by all that have concerned themſelves about this Senſe of Hearing ſince their diſcovery, I ſhall take notice of only two things concerning them. 1. The diſcovery of them is owing wholly to the Diligence and Sagacity of the latter Ages; of which *Schelhammer* gives this Account from *Fallopius*. *Hæc Officula antiquis Anatomicis —— ignota fuere; primuſque qui in lucem produxit* [Malleum & Incum] *fuit Jac. Carpenſis; primus quoque procul omni dubio anatomicæ*

the whole Compages to the ſeveral purpoſes of Hearing, to hear all manner of Sounds, loud or languid, harſh or grateful (20).

From

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anatomicæ artis, quam Veſalius poſtea perfecit, reſtaurator. Tertium [Stapedem] *invenit ac promulgavit primus Joh. Phil. ab Ingraſſia, Siculus, Philoſophus ac Medicus doctiſſimus.—Quartum, Thoma Bartholino teſte, viro longè celeberrimo, Fran. Sylvio debetur.* Schel. *ubi ſupr.* c. 3. §. 9. 2. Their Difference in different Animals: In *Man*, and *Quadrupeds*, they are four, curiouſly inarticulated with one another; with an external and internal Muſcle to draw, or work them, in extending, or relaxing the *Drum*. But in *Fowls* the caſe is very different. *His unum Oſſiculum ſolum largita eſt Natura, quod Columellam forte appellaveris: teres enim eſt & ſubtiliſſimum, baſi innitens latiori, rotundæ. Huic adnexa eſt Cartilago valde mobilis, quæ in Tympanum videtur terminari.* Id. ib. §. 8. *In the Ears of all the Fowl that I could examine, I never found any more than one Bone and a Cartilage, making a Joynt with it, that was eaſily moveable. The Cartilage had generally an Epiphyſe, or two, one on each ſide.—The Bone was very hard and ſmall, having at the end of it a broad Plate, of the ſame Subſtance, very thin, upon which it reſted, as on its Baſis.* Dr. *Al. Moulen* in Phil. Tranſ. Nr. 199.

Theſe are the moſt material things I find obſerved by others concerning the Ears of Fowls, and ſome of them hardly, I believe, obſerved before. To which I ſhall ſubjoyn ſome other things I have my ſelf diſcovered, that I preſume eſcaped the Eyes of thoſe moſt curious and inquiſitive Anatomiſts. Of which ſee the laſt cited *Book* VII. *Chap.* 2. *Note* 4.

(20) *Videtur quòd Tympanum Auditionis inſtrumentum prælimi-nare, & quaſi præparatorium fuerit, quod Soni impreſſionem, ſive ſpecies ſenſibiles primò ſuſcipiens, eas in debitâ proportione, & aptâ conformitate, verſus Senſorium, quod adhuc interiùs ſitum eſt, dirigat: ſimili officio fungitur reſpectu Auditûs, ac tunicæ Oculi Pupillam conſtituentes reſpectu Viſûs; utræque Membranæ Species ſenſibiles refringunt, & quaſi emolliunt, eaſque Senſorio non niſi proportionatas tradunt, cui nudo ſi adveniant, teneriorem ejus craſin facilè lædant, aut obruant. Reverà Tympanum non audit, ſed meliori tutiorique Auditioni confert. Si hæc pars deſtruatur, Senſio adhuc aliquandiu, rudi licèt modo, peragi poſſit; quippe experimento olim in Cane facto, &c.—Janitoris officio ut Tympanum rectè defungi poſſit, expanſum ejus pro datâ occaſione ſtringi, aut relaxari debet, veluti nimirum Oculi Pupilla.—Quapropter huic Auris Tympano, non ſecus ac bellico, machinæ, ſive taniæ quædam appo-*

nuntur,

From this Region of the *Tympanum*, I might pass to

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nuntur, quæ superficiem ejus modo tensiorem, modo laxiorem reddant: hoc enim efficiunt tria Ossicula, cum Musculo, &c. *Willis*'s de Anim. Brut. *c.* 14.

For this Opinion of Dr. *Willis*, Dr. *Schelhammer* is very severe upon him, deriding the Refractions he speaks of; and therefore seriously proves that they are the Humours, not Tunicks of the Eye, that refract the Rays of Light; and then jeeringly demandeth, whether the sonorous Rays are refracted by passing through a different Medium? Whether the Convexity or Concavity of the Drum collects those Rays into a focal Point, or scatters them, *&c?* And then saith, *Ob has rationes a clariss. Viri, ac de re Medicâ præclarè meriti, sententiâ non possumus non esse alieniores; in quo uti ingenium admiror, quoties medicamentorum vires, aut morborum causas explicat, sic ubi forum suum egressus, Philosophum agit, ac vel Partium usum, vel Chymicarum rerum naturam scrutetur, ejus haud semel non modo judicium desidero, verùm aliquando etiam fidem.* This is so severe and unjust a Censure of our justly famous Countryman, (a Man of known Probity) that might deserve a better answer; but I have only time to say, that although Dr. *Schelhammer* hath out-done all that wrote before him, in his Book *de Auditu*, and shewed himself a Man of Learning and Industry; yet as our Countryman wrote more than he, (though perhaps not free from Errours too) so he hath manifested himself to have been as curious and sagacious an Anatomist, as great a Philosopher, and as learned and skilful a Physician as any of his Censurers, and his Reputation for Veracity and Integrity, was no less than any of theirs too. But after all this terrible Clamour, Dr. *Schelhammer* prejudicately mistaketh Dr. *Willis*'s meaning, to say no worse. For by *utræque Membranæ refringunt*, Dr. *Willis* plainly enough, I think, means no more than a Restriction of the ingress of too many Rays; as his following explicatory Words manifest, *viz. refringunt, & quasi emolliunt, easque Sensorio non nisi proportionatas tradunt.* But indeed Dr. *Schelhammer* hath shewn himself a too rigid Censor, by making Dr. *Willis* say, the *Ear-drum* had such like Braces as the *War-drum*, viz. *Quod porro de machinis seu tæniis Tympani bellici adducit, dicitque idem in Tympano auditorio conspici, id prorsus falsissimum est.* I wonder Dr. *Schelhammer*, did not also charge Dr. *Willis* with making it a Porter, since he saith in the same Paragraph, *Janitoris officio*, &c. But Dr. *Willis*'s meaning is plain enough, that the little Bones and Muscles of the *Ear-drum* do the same Office in straining and relaxing it, as

the

the Braces of the *War-drum* do in that. And considering how curious and solemn an Apparatus there is of Bones, Muscles, and Joynts, all adapted to a ready Motion; I am clearly of Dr. *Willis*'s Opinion, that the Use of the *Ear-drum* is chiefly for the proportionating Sounds, and that by its Extension and Retraction it corresponds to all Sounds, loud or languid, as the Pupil of the Eye doth to several Degrees of Light: and that they are no other than secondary Uses assigned by Dr. *Schelhammer*, as the principal or sole Uses; of keeping out the external colder Air, Dust, and other Annoyances, but especially that *ob solius aeris interni potissimùm irrumpentis vim, hunc motum Tympani, ac Mallei esse conditum, ut cedere primùm, deinde sibi restitui queat*; as his Words are. *P. ult.* c. 6. §. 13.

It was no improbable thought of *Rohault*, *nos attentos præbere, nil aliud est, nisi* Tympanum, *ubi ita opus est facto, contendere aut laxare, & operam dare ut illud in eâ positione intentum stet, in quâ tremulum aeris externi motum commodissimè excipere possit.* Roh. Phys. p. 1. c. 26. §. 48.

The hearing of deaf Persons more easily by means of loud Noises, is another Argument of the Use of the Straining or Relaxation of the *Tympanum* in Hearing. Thus, Dr. *Willis* (ubi supra) *Accepi olim a viro fide digno, se mulierem noviisse, quæ licèt surda fuerit, quousque tamen intra conclave Tympanum pulsaretur, verba quævis clarè audiebat: quare Maritus ejus Tympanistam pro servo domestico conducebat, ut illius ope, colloquia interdum cum Uxore suâ haberet. Etiam de alio Surdastro mihi narratum est, qui prope Campanile degens, quoties unà plures Campanæ resonarent, vocem quamvis facilè audire, & non aliàs potuit.*

Abscisso Musculo [Processus majoris Mallei] *in recenti aure, relaxatur* [Tympani Membrana.] *Valsalv. de Aur. Hum.* c. 2. §. 5.

Upon considering the great difference in Author's Opinions about the Use of the Parts, and Manner how Hearing is performed, as also what a curious Provision there is made in the Ear, by the four little Bones, the Muscles, Membrane, *&c.* I was minded (since I penned this Note) to make enquiry my self into this Part, and not rely upon Authority. And after a diligent search of various Subjects, I find we may give as rational and easie an Account of Hearing, as of Seeing, or any other Sense; as I have shewn in my last cited *Note* 4. *Book* VII. *Chap.* 2. with relation to Birds. And as to Man and Beasts, the case is the same, but the Apparatus more Complex and Magnificent. For whereas in Birds, the *Auditory Nerve* is affected by the Impressions made on the *Membrane*, by only the intermediacy of the *Columella*; in Man, it is done by the Intervention of the four little Bones, with the Muscles acting upon them, his Hearing being to be adjusted to all kinds of Sounds, or Impressions made upon

to that of the *Labyrinth* (21), and therein ſurvey the curious and admirable Structure of the *Veſtibulum*, the *Semicircular Canals* (22), and *Cochlea*; particularly the artificial Gyrations, and other ſingular Curioſities obſervable in the two latter.

But

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upon the *Membrana Tympani*. Which Impreſſions are imparted to the *Auditory Nerve* in this manner, *viz.* firſt they act upon the *Membrane* and *Malleus*, the *Malleus* upon the *Incus*, and the *Incus* upon the *Os Orbiculare* and *Stapes*; and the *Stapes* upon the *Auditory Nerve*: for the Baſe of the *Stapes* (the ſame as the *Operculum* in Birds) not only covers the *Feneſtra Ovalis*, within which the *Auditory Nerve* lieth, but hath a part of the *Auditory Nerve* ſpread upon it too. It is manifeſt that this is the true Proceſs of Hearing, becauſe, if the *Membrane* be moved, you may ſee all the Bones move at the ſame time, and work the Baſe of the *Stapes* up and down in the *Feneſtra Ovalis*, as I ſhewed in this Chapter, *Note* 4. concerning the *Mole*; and as it may be ſeen in other Ears carefully opened, if the Parts remain *in ſitu*.

(21) I do not confine the *Labyrinth* to the *Canales Semicirculares*, or any other Part, as the elder Anatomiſts ſeem to have done, who by their erroneous and blind Deſcriptions ſeem not well to have underſtood theſe Parts: but with thoſe much more curious and accurate Anatomiſts *Monſieur du Vernay*, and Dr. *Valſalva*, under the *Labyrinth*, I comprehend the *Canales Semicirculares*, and the *Cochlea*, together with the intermediate Cavity, called by them the *Veſtibulum*.

(22) In the *Semicircular Canals*, two things deſerve to be noted. 1. That the three Canals are of three different Sizes, *Major*, *Minor*, and *Minimus*. 2. Although in different Subjects they are frequently different; yet in the ſame Subject they are conſtantly the ſame. The reaſon of all which, together with their Uſes, *Valſalva* ingeniouſly thinks is, that as a part of the tender Auditory Nerve is lodged in theſe Canals, ſo they are of three Sizes, the better to ſuit all the Variety of Tones; ſome of the Canals ſuiting ſome, and other other Tones. And although there be ſome difference as to the Length and Size of theſe Canals in different Perſons; yet, leſt there ſhould be any diſcord in the Auditory Organs of one and the ſame Man, thoſe Canals are always in exact Conformity to one another in one and the ſame Man. *V. Valſal. ubi ſupr.* c. 3. §. 7. and c. 6. §. 4, 9.

(3) *Hit*

But I ſhall not expatiate on theſe recluſe Parts, only there is one ſpecial Contrivance of the Nerves miniſtering to this Senſe of Hearing, which muſt not be paſſed by; and that is the Branches of one of the *Auditory Nerves* (23), ſpread partly to the Muſcles of the Ear, partly to the Eye, partly to the Tongue and Inſtruments of Speech, and inoſculated with the Nerves to go to the Heart and Breaſt. By which means there is an admirable and uſeful conſent between theſe parts of the Body; it being natural for moſt Animals upon the hearing any uncouth Sound, to erect their Ears, and prepare them to catch every Sound; to open their Eyes (thoſe conſtant faithful Sentinels) to ſtand upon their Watch; and to be ready with the Mouth to call out, or utter what the preſent Occaſion ſhall dictate. And accordingly it is very uſual for moſt Animals when ſurprized and terrified with any frightful Noiſe, preſently to ſhriek and cry out.

But there is beſides this, in Man, another great Uſe of this nervous Commerce between the Ear and Mouth: and that is, (as one of the beſt Authors on this Subject expreſſeth it,) (24) "That the Voice "may correſpond with the Hearing, and be a kind "of

(23) *Hic poſterior Nervus extra cranium delatus, in tres ramos dividitur, qui omnes motibus patheticis——inſerviunt. Primus——muſculis Auris impenditur. Proculdubio hujus actione efficitur, ut animalia quævis, a ſubito ſoni impulſu, aures, quaſi ſonum nimis cito tranſeuntem captaturas erigant. Ramus alter ——— verſus utrumque oculi angulum ſurculos emittit: qui muſculis palpebrarum attollentibus inſeruntur; quorum certè munus eſt ad ſubitum ſoni appulſum oculos confeſtim aperire, eoſque velut ad Excubias vocare. ——Tertius ——ramus verſus Linguæ radicem deſcendens, muſculis ejus & oſſis Hyoeideos diſtribuitur, adeoque organa quædam vocis edendæ actuat,* &c. *Willis*'s Cereb. Anat. c. 17.

(24) *Hujuſmodi Nervorum conformatio in Homine uſum alium inſigniorem præſtat, nempe ut Vox.* &c. *Willis Ibid.*

" of Echo thereof, that what is *heard* with *one* of " the two Nerves, may be readily expreſſed with " the Voice, by the help of the *other*.

Thus much ſhall ſuffice to have ſpoken concerning the *Organ*. Let us,

2. Take notice of the *Object* of this admirable Senſe, namely *Sound*, and ſo conclude this Chapter. I ſhall not here enquire into the Nature and Properties of Sound, which is in a great Meaſure intricate, and hath puzzelled the beſt Naturaliſts: Neither ſhall I ſhew how this admirable Effect of the divine Contrivance may be improved to divers Uſes (25), and Purpoſes in humane Life. But my buſineſs will be to ſhew that this thing, of ſo admirable

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(25) Among the Uſes to which the Wit of Man hath employed Sounds, we may reckon the Inſtruments uſeful in convocating Aſſemblies, managing Armies, and many other Occaſions, wherein Bells, Trumpets, Drums, Horns, and other Sounding Inſtruments are uſed; the Particularities of which it would be tedious to recount, as that the biggeſt *Bell* in *Europe* is reckoned to be at *Erfurt* in *Germany*, which they ſay may be heard Twenty Four Miles; with much more to the ſame Purpoſe. I ſhall therefore only for a Sample take notice of the *Speaking-Trumpet*; the Invention of which is commonly aſcribed to our eminent Sir *Samuel Morland*; but was more probably *Ath. Kircher*'s, at leaſt he had contrived ſuch an Inſtrument, before Sir *Samuel* hit upon his. *Kircher* in his *Phonurg.* ſaith, the *Tromba* publiſhed laſt Year in *England*, he had invented Twenty-four Years before, and publiſhed in his *Miſurgia*; that *Jac. Albanus Ghibbeſius*, and *Fr. Eſchinardus* aſcribe it to him; and that *G. Schottus* teſtifieth he had ſuch an Inſtrument in his Chamber in the *Roman College*, with which he could call to, and receive Anſwers from the Porter. And conſidering how famed *Alexander* the *Great*'s Tube was, which is ſaid might be heard 100 *Stadia*, it is ſomewhat ſtrange that no Body ſooner hit upon the Invention. Of this *Stentorophonick Horn* of *Alexander*, there is a Figure preſerved in the *Vatican*; which for Curioſity ſake, I have from *Kircher* repreſented in *Fig.* 3. He ſaith its Diameter was five Cubits, and that it was ſuſpended on a Supporter.

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mirable Uſe in the Animal World, is the Work of God. And this will appear, let the ſubject Matter of Sounds be what it will, either the Atmoſphere (26) in groſs, or the æthereal Part thereof, or ſoniferous Particles of Bodies, as ſome fancy, or whatever

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For the Make of the *Speaking-Trumpet*, and the Reaſon why it magnifies Sounds, I ſhall refer to *Kircher*; eſpecially to Sir *Samuel Morland*'s *Tuba Stentorophonica*, Publiſhed in 1672.

Kircher ſaith, he took one of theſe Trumpets, of Fifteen Palms Length, along with him to the *Mons Euſtachianus*, where he convocated 2200 Perſons to Prayers, by means of the unuſual Sound, at two, three, four, and five *Italian* Miles Diſtance.

With theſe *Bellowing Trumpets*, I ſhall join ſome *Bellowing Caves* for the Reader's Diverſion. *Ol. Magnus* deſcribes a Cave in *Finland*, near *Viburg*, called *Smellen*, into which, if a Dog, or other living Creature be caſt, it ſends forth ſo dreadful a Sound, that knocks down every one near it. For which Reaſon they have guarded the Cave with high Walls, to prevent the Miſchiefs of its Noiſe. *Vid. Ol. Magn. Hiſtor.* l. 11. c. 4. Such another *Peter Martyr* ſaith is in *Hiſpaniola*, which, with a ſmall Weight caſt into it, endangers Deafneſs at Five Miles Diſtance. And in *Switzerland*, *Kircher* ſaith, in the *Cucumer-Mountain* is a Pit that ſends out both a dreadful Noiſe and a great Wind therewith: And that there is a Well in his Country 300 Palms deep, whoſe Sound is equal to that of a great Gun. *Vid. Kirch. Phonurg.*

Ol. Magnus ſpeaking of the vaſt high Mountains of a Northern Province, called *Angermannia*, ſaith, *Ubi baſes eorum in profundiſſimo gurgite ſtantes, caſu aliquo, vel propoſito Nautæ acceſſerint, tantum horrorem ex alta fluctuum colliſione percipiunt, ut niſi præcipiti remigio, aut valido vento evaſerint, ſolo pavore ferè exanimes fiant, multoque dierum curriculo, ob capitis turbationem, priſtinæ mentis, & ſanitatis compotes vix evadant. Habent baſes illorum montium in fluctuum ingreſſu & regreſſu tortuoſas rimas, ſive ſciſſuras, ſatis ſtupendo naturæ opificio fabricatas, in quibus longa voragine formidabilis ille Sonitus quaſi ſubterraneum tonitru generatur.* Ol. Magn. *l.* 2. *c.* 4. See alſo *Chap.* 12.

(25) That the Air is the Subject, or Medium of Sound, is manifeſt from the Experiments in rarefied and condenſed Air. In an unexhauſted Receiver, a ſmall Bell may be heard at the Diſtance of ſome Paces; but when exhauſted, it can ſcarce be heard at the neareſt Diſtance: And if the Air be compreſſed,

whatever elſe the Philoſopher may think it. For who but an intelligent Being, what leſs than an omnipotent, and infinitely wiſe God could contrive, and

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the Sound will be louder, proportionably to the Compreſſion, or Quantity of Air crouded in, as I have often tried my ſelf, and may be farther ſeen in Mr. *Hawksbee*'s curious Experiments, p. 97. Alſo his Experiments in *Phil. Tranſ. Nr.* 321.

Neither doth this ſucceed only in forced Rarefactions and Condenſations of the Air, but in ſuch alſo as are natural; as is evident from *David Frædlichius* in *Varenius*, upon the higheſt Eminencies of *Carpathus*, near *Keſmarckt* in *Hungary*. The Story of *Frædlichius* is this, *Ego Menſe Junii* 1615. *tum adoleſcens, ſublimitatem horum montium, cum duobus comitibus Scholaribus, experiri volens, ubi, cùm in primæ rupis vertice, magno labore, me ſummum terminum aſſecutum eſſe putarem, demum ſeſe obtulit alia multo altior cautes, ubi per vaſta eaque vacillantia ſaxa (quorum unum, ſi loco à viatore dimovetur——aliquot centena——rapit, & quidem tanto cum fragore, ut illi metuendum ſit, ne totus Mons corruat, eumque obruat) enixus eſſem, iterum alia ſublimior prodiit, &c. donec ſummo vitæ periculo ad ſupremum cacumen penetraverim. Ex declivioribas montibus, cùm in ſubjectas valles, ——nil niſi obſcuram noctem, aut cæruleum quid, inſtar profundi aeris, quod vulgo ſudum cælum appellatur, obſervare potui, mihique videbar, ſi de monte caderem, non in terram, ſed rectè in cælum me prolapſurum. Nimiâ enim declivitate, ſpecies viſibiles, extenuatæ & hebetatæ fuerunt. Dum vero altiorem montem peterem, quaſi intra nebulas denſiſſimas hærebam. ——Et cum non procul à ſummo vertice eſſem, de ſublimi quieſcens proſpexi & animadverti iis in locis, ubi mihi antea videbar intra nebulas hæſiſſe, compactas atque albas ſeſe movere nubes, ſupra quas, per aliquot milliaria, & ultra terminos Sepuſi commodus mihi proſpectus patuit. Alias tamen etiam nubes altiores, alias item humiliores, necnon quaſdam æqualiter a terra diſtantes vidi. Atque hinc tria intellexi.* 1. *Me tum tranſiviſſe principium mediæ Aeris regionis.* 2. *Diſtantiam nubium a terra, non eſſe æqualem.* —— 3. *Diſtantiam nubium* —— *non* 72 *Mill. Ger. ut quidam* —— *ſed tantum dimidiatum Mill. Ger. In ſummum montis verticem cùm perveniſſem, adeo tranquillum & ſubtilem aerem ibi offendi, ut ne pili quidem motum ſentirem, cum tamen in depreſſioribus ventum vehementem expertus ſim: unde collegi ſummum cacumen iſtius montis Carpathici ad Mill. Ger. a radicibus ſuis imis exſurgere, & ad ſupremam uſque aeris regionem, ad quam Venti non aſcendunt, pertingere. Exploſi in eâ ſummitate Sclopetum;*

and make such a fine Body, such a Medium, so susceptible of every Impression, that the Sense of Hearing

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tum ; quod non majorem sonitum primo præ se tulit, quam si ligillum vel bacillum confregissem ; post intervallum autem temporis murmur prolixum invaluit, inferioresque montis partes, convalles & sylvas opplevit. Descendendo per nives annosas intra convalles, cum iterum Sclopetum exonerarem, major & horribilior fragor, quàm ex tormento capacissimo inde exoriebatur : hinc verebar ne totus mons concussus mecum corrueret : duravitque hic sonus per semiquadrantem horæ usque dum abstrusissimas cavernas penetrasset, ad quas aer undique multiplicatus resiliit. —— In his celsis montibus, plerumque ningit grandinatve mediâ æstate, quoties nempe in subjectâ & vicinâ planitie pluit, uti hoc ipsum expertus sum. Nives diversorum annorum ex colore & cortice duriore dignosci possunt. Varen Geogr. Gen. l. 1. c. 19. *Prop. ult.*

The Story being diverting, and containing divers Things remarkable, I have chosen to note the whole of it (altho' somewhat long) rather than single out the Passages only, which relate to the diminishing the Sound of his Pistol, by the rarity of the Air, at that great Ascent up into the Atmosphere ; and the magnifying the Sound by the Polyphonisms or Repercussions of the Rocks, Caverns and other phonocaptick Objects below in the Mount.

But 'tis not the Air alone that is capable of the Impressions of Sound, but the Water also, as is manifest by striking a Bell under Water, the Sound of which may plainly enough be heard, but it is much duller, and not so loud : and it is also a Fourth deeper by the Ear of some great Judges in musical Notes, who gave me their Judgments in the matter. But *Mersenne* saith, a Sound made under Water is of the same Tone or Note, if heard under Water ; as are also Sounds made in the Air, when heard under Water. *Vid. Mersen. Hydraul.*

Having mentioned the hearing of Sounds under Water, there is another Curiosity worth mentioning, that also farther proves Water to be susceptible of the Impressions of Sound, *viz. Divers* at the bottom of the Sea, can hear the Noises made above, only confusedly. But, on the contrary, those above cannot hear the Divers below. Of which an Experiment was made, that had like to have been fatal : one of the Divers blew an Horn in his Diving-Bell, at the bottom of the Sea ; the Sound whereof (in that compressed Air) was so very loud and irksome, that it stunned the Diver, and made him so giddy, that he had like to have dropt out of his Bell, and to have been drowned. *Vid. Sturmii Colleg. Cur. Vol. 2. Tentam. 1.*

Hearing hath occaſion for, to empower all Animals to expreſs their Senſe and Meaning to others; to make known their Fears, their Wants, their Pains and Sorrows in melancholick Tones; their Joys and Pleaſures in more harmonious Notes; to ſend their Mind at great Diſtances (27), in a ſhort time (28), in loud Boations; or to expreſs their Thoughts near at Hand with a gentle Voice, or in ſecret

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(27) As to the Diſtance to which Sound may be ſent, having ſome Doubt, whether there was any Difference between the Northern and Southern Parts; by the Favour of my learned and illuſtrious Friend Dr. *Newton*, Her Majeſty's late Envoy at *Florence*, I procured ſome Experiments to be made for me in *Italy*. His moſt Serene Highneſs the *Great Duke*, was pleaſed to order great Guns to be fired, for this Purpoſe, at *Florence*, and Perſons were appointed on Purpoſe to obſerve them at *Leghorne*; which they compute is no leſs than 55 Miles in a ſtraight Line. But notwithſtanding the Country between be ſomewhat hilly and woody, and the Wind alſo was not favouring, only very calm and ſtill, yet the Sound was plainly enough heard. And they tell me, that the *Leghorne* Guns are often heard 60 Miles off, at *Porto Ferraio*; that when the *French* bombarded *Genoa*, they heard it near *Leghorne* 90 Miles diſtant: and in the *Meſſina Inſurrection*, the Guns were heard from thence as far as *Auguſta* and *Syracuſe*, about 100 *Italian* Miles. Theſe Diſtances being ſo conſiderable, give me reaſon to ſuſpect, that Sounds fly as far, or nearly as far in the Southern, as in the Northern Parts of the World, notwithſtanding we have a few Inſtances of Sounds reaching farther Diſtances. As Dr. *Hearn* tells us of Guns fired at *Stockholm* in 1685. that were heard 180 *Engliſh* Miles. And in the *Dutch* War, 1672. the Guns were heard above 200 Miles. *Vid. Phil. Tranſ. Nr.* 113. Alſo there is this farther Reaſon of Suſpicion, that the *Mercury* in the *Barometer* riſeth higher without than within the Tropicks, and the more Northerly, ſtill the higher; which may encreaſe the Strength of Sounds by *Note* 26.

(28) As to the Velocity of Sounds, by reaſon the moſt celebrated Authors differ about it, I made divers nice Experiments my ſelf, with good Inſtruments; by which I found, 1. That there is ſome, although a ſmall Difference in the Velocity of Sounds with or againſt the Wind; which alſo is, 2. Augmented or diminiſhed by the Strength or Weakneſs of the Wind. But that

ſecret Whiſpers! And to ſay no more, who leſs than the ſame moſt wiſe and indulgent Creator, could form ſuch an Oeconomy, as that of Melody and muſick is! That the *Medium* ſhould (as I ſaid) ſo readily receive every Impreſſion of Sound, and convey the melodious Vibration of every muſical String, the harmonious Pulſes of every Animal Voice, and of every muſical Pipe; and the Ear as well adapted and ready to receive all theſe Impreſſions, as the *Medium* to convey them: And laſtly, that by means of the curious Lodgment and Inoſculations of the *Auditory Nerves* before-mentioned, the Orgaſmes of the Spirits ſhould be allayed, and Perturbations of the Mind, in a great Meaſure quieted, aud ſtilled (29): Or to expreſs it in the Words

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that nothing elſe doth accelerate or retard it, not the Differences of Day or Night, Heat or Cold, Summer or Winter, Cloudy or Clear, Barometer high or low, *&c.* 3. That all Kinds of Sounds have the ſame Motion, whether they be loud or languid, of Bells, Guns, great or ſmall, or any other ſonorous Body. 4. That they fly equal Spaces in equal Times. Fifthly and laſtly, That the Mean of their Flight is at the Rate of a Mile in 9 ¼ Half-ſeconds, or 1142 Feet in one Second of time. *Vid. Phil. Tranſ. Ibid.*

(29) *Timothy* a Muſician could excite *Alexander the Great* to Arms with the *Phrygian* Sound, and allay his Fury with another Tone, and excite him to Merriment. So *Ericus* King of *Denmark*, by a certain Muſician could be driven to ſuch a Fury, as to kill ſome of his beſt and moſt truſty Servants. More of this Power of Muſick over the Affections may be ſeen in *Ath. Kirch. Phonurg. L. 2. Sect.* 1. Alſo in *Iſ. Voſſius de Poimatum cantu, & Rythmi viribus.*

And not only upon the Affections, but alſo on the parts of the Body, Muſick is able to exerts its Force, as appears from the *Gaſcoign Knight, Cui Phermingis ſono audito Veſica ſtatim ad Urinam reddendam vellicabatur.* Such another we have in *A°* 1. *Ephem. Nat. Curioſ. Obſerv.* 134. Alſo *Morhoff de Scyph. vitr. per cert. human. vocis ſonum fracto:* where there is not only the Account of the *Dutchman* at *Amſterdam*, one *Nic. Petter*, that brake Romer-Glaſſes with the Sound of his Voice; but alſo di-

vers other Instances of the Power and Effects of Sound. But to the Story of the *Gascoigne Knight*, Mr. *Boyl* from *Scaliger* adds a pleasant Passage, That one he had disobliged, to be even with him, caused at a Feast, a Bag-pipe to be played, when he was hemmed in with the Company; which made the Knight bepiss himself, to the great Diversion of the Company, as well as Confusion of himself. *Boyl's Essay of the Effect of Lang. Motion.* In the same Book are other Matters that may be noted here. One whose Arm was cut off, was exceedingly tormented with the discharge of the great Guns at Sea, although he was at a great Distance on Land. And a great Ship-Commander observed his wounded Men with broken Limbs suffered in like manner at the Enemies Discharges. An ingenious Domestick of his one would have his Gums bleed at the Tearing of Brown-paper. And an ingenious Gentleman of Mr. *Boyl's* acquaintance confessed to him, that he was inclined to the *Knight of Gascoigne's* Distemper upon hearing the Noise of a Tap running. The Dancing to certain Tunes, of Persons bit with the *Tarantula*, he was assured of by an ingenious Acquaintance at *Tarentum*, who saw several among the rest a Physician, affected with that Distemper. And many other Accounts of this kind, seemingly credible, are related in *Morhoff*, *Kircher*, and many others; although Dr. *Cornelio* questions the Matters of Fact, in *Phil. Transf. Nr.* 83. Mr. *Boyl* also saith, a sober Musician told him, he could make a certain Woman weep, by playing one Tune, which others would be little affected at. And he saith, that he himself had a kind of shivering at the repeating two Verses in *Lucan*. And I add, that I very well know one to have a sort of chill about his *Præcordia* and Head, upon reading, or hearing the 53d Chapter of *Isaiah*; as also *David's* Lamentations for *Saul* and *Jonathan*, 1 Sam. 1.

Neither are our Minds and Bodies only affected with Sounds, but also inanimate Bodies: Of which many Stories may be met with in *Kircher*, particularly a large Stone that would tremble at the Sound of one particular Organ-pipe; in *Morhoff* also, who among many other Relations, hath this, *Memini cùm ipsi* [*clarisf. Willisio*] *de experimento Vitri per vocem fracti narrarem, ex eo audivisse, quod in ædibus Musicis sibi vicinis aliquoties collapsum pavimentum fuerit: quod ipse sonis continuis adscribere non dubitavit.* Morhoff. cap. 12. *Mersenne* also among many Relations in his *Harmon*, and other Books, tells a far more probable Story, of a particular part of a Pavement, that would shake as if the Earth would open, when the Organs played, than what he relates about *Antipathy* in his *Quæst. & Comment. in Genes*, viz. That the Sound of a Drum made of Wolf's-Skin, will break another made of Sheep's-Skin: That Hens will fly at the Sound of an Harp strung with Fox-Gut-Strings; and more to the same purpose. Mr. *Boyl* also in his last cited Book tells us, Seats will tremble at the Sound of Organs; and that he hath felt his Hat to do so

too

Words of the laſt-cited famous Author (30), "That Muſick ſhould not only affect the Fancy "with Delight, but alſo give Relief to the Grief "and Sadneſs of the Heart, yea, appeaſe all thoſe "turbulent Paſſions, which are excited in the "Breaſt by an immoderate Ferment, and Fluctua-"tion of the Blood.

And now, who can reflect upon all this curious Apparatus of the *Senſe of Hearing*, and not give the great Creator his due Praiſe! Who can ſurvey all this admirable Work, and not as readily own it to be the Work of an omnipotent, and infinitely wiſe and good God (31), as the moſt artful Melodies we hear, are the Voice or Performances of a living Creature?

CHAP.

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too under his Hand, at certain Notes both of Organs, and in Diſcourſe: that he tried an Arch that would anſwer to C fa-ut, and had done ſo 100 Years; and that an experienced Builder told him any well-built Vault will anſwer ſome determinate Note. And at *Eaſtbury-Houſe* near *Barking*, I my ſelf diſcovered the Porch, (having firm Brick-Walls,) not only to Sound when ſtruck on the Bottom, but alſo to give almoſt as loud a Sound, when I ſounded the ſame Note with my Voice.

(30) *Willis*, ubi ſupr.

(31) *Ille Deus eſt——— qui non calamo tantum cantare, & agreſte, atque inconditum carmen ad aliquam tantum oblectationem modulari docuit, ſed tot artes, tot vocum varietates, tot ſonos, alios ſpiritu noſtro, alios externo cantus adituros commentus eſt.* Senec. de Benef. l. 4. c. 6.

(1) A piece

CHAP. IV.

Of the Senſe of Smelling.

THIS Senſe I ſhall diſpatch in leſs compaſs than the two laſt, becauſe its Apparatus (although ſufficiently grand and admirable, (yet) is not ſo multiplicious as of the Eye and Ear: It being ſufficient in this Senſe, that the odoriferous Effluvia of Bodies (1) can have an eaſie, free Paſſage to the Olfactory Nerves, without the formalities of Refractions, and other Preparations neceſſary to the Perfection of the two former Senſes. Accordingly the All-wiſe Creator hath made ſufficient Proviſion for the reception of Smells, by the Apertures of the Noſtrils (2); made not of Fleſh or Bone, but Cartilaginous, the better to be kept open, and withal to be dilated or contracted, as there is occaſion: For which Service it hath ſeveral proper and curious Muſcles (‖).

And

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(1) A piece of *Ambergreaſe* ſuſpended in a pair of Scales, that would turn with a very ſmall part of a Grain, loſt nothing of its Weight in 3½ Days; neither did *Aſſa-fœtida* in 5½ Days; but an Ounce of *Nutmegs* loſt 5½ Grains in 6 Days; and *Cloves* 7⅝ Grains. *Boyl's Subtil. of Effluv.* c. 5.

(2) *Nares eo quod omnis Odor ad ſuperiora fertur, rectè ſurſùm ſunt: Et quòd Cibi & Potionis judicium magnum earum eſt, non ſine cauſa vicinitatem Oris ſecutæ ſunt.* Cicer. de Nat. Deor. L. 2.

(‖) Had not the Contriver of Animal Bodies been minded his Work ſhould have all the Signatures of Accuracy, this Senſe might have been performed with a bare Aperture of the Noſe; but that nothing might go imperfect out of his Hand, he hath made a part of the Noſe eaſily moveable, and given a Set of Muſcles to lift up, and to open and ſhut the Noſtrils; and ſo adjuſt it to every Occaſion of this Senſe.

(3) *Odorem*

And forasmuch as it is by Breathing (3), that the odorant Particles are drawn in, and conveyed to the Sensory, therefore there is a very wise Provision made in the *Laminæ*, with which the upper part of the Nose is barricaded, which serve to two excellent Uses: partly, to fence out any noxious Substances from entering the breathing Passages in our Sleep, or when we cannot be aware (4); and partly, to receive the Divarications of the *Olfactory Nerves*, which are here thick spread, and which do by these means meet the Smells entering with the Breath, and striking upon them.

And accordingly the more accurate this Sense is in any Animal, the longer we may observe those *Laminæ* are, and more of them in number folded up, and crouded together, to contain the more nervous Filaments, and to detain, and fetter the odoriferous Particles in their Windings and Turnings.

And an admirable Provision this is, which the great Creator hath made for the good of Brute Creatures (5); the chief Acts of many of whose Lives are performed by the Ministry of this Sense.

In

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(3) *Odorem non aliud, quam infectum Aera, intelligi posse.* Plin. Nat. Hist. l. 9. c. 7.

(4) For a farther guard against the Ingress of noxious things the *Vibrissæ*, or Hairs placed at the entrance of the Nostrils serve, which in some measure stop the entrance of things improper, or however give warning of them, but at the same time allow an easie Passage to the Breath and Odours.

(5) *Multò præclarius emicat* [*Olfactus*] *in brutis animalibus, quam in homine: ista namque hoc solo indice, herbarum, aliorumque corporum priùs ignotorum virtutes certissimè dignoscunt, quin & victum suum absentem, vel in abstruso positum, Odoratu venantur, ac facillimè investigant. Quod autem minùs sagaces sunt hominum nares, illud non facultatis hujus abusui* (prout nonnulli volunt) *ascribi debet, verùm in causâ est ipsius Organi defectus; hoc enim circa victûs humani criteria* (*ubi ratio, & intellectus adsunt*) *non*

In Insects, and many other Creatures, it is of great Use in the Propagation of their Kind; as particularly in helping them to safe and convenient Places for the Incubation of their Eggs, and breeding up their Young. Others are by the accuracy of this Sense, of Use to Mankind, which would be otherwise of little or no Use (6). And most of the irrational Animals, Birds, Beasts, and Creeping things, do, by their Smell, find out their Food; some at great distances, and some at hand. With what Sagacity do some discover their Food in the midst of Mud and Dirt (7)? With what Curiosity do the herbaceous Kind pick and chuse such Plants as afford them wholsome Food, or sometimes such as are Medicinal (8), and refuse such as would hurt and destroy them? And all by the help principally, if not only, of the Smell, assisted by its near Ally the Taste. Of which I shall in the next place speak very briefly.

CHAP.

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nonita accuratum requiritur: Propterea enim inferiores potentiæ in homine, a naturâ minus perfectæ existunt, ut superiorum culti, & exercitio, relinqueretur locus. Willis de Anim. Brut. *cap.* 13.

(6) Thus the chief Use of Hounds is to Hunt; and other Dogs to be a Watch and Guard to our Houses by Night. For which Services (particularly in Hounds) their *Olfactory Nerves* are not only remarkably large, (like as they are in other Brutes,) but their Branches, and Filaments are in the *Laminæ* of the Nostrils both more, and larger than I have seen in any other Creature whatsoever. Also there are more Convolutions of the *Laminæ*, than I ever remember to have found in any other Animal.

The Sagacity of Hounds is prodigious, of which see an Instance in *Book* IV. *Chap.* 11. *Note* 56.

(7) See *Book* VII. *Chap.* 2. *Note* 5.

(8) *Vid. Plin. Hist. Nat.* l. 8. c. 27. *Quæ animalia quas herbas ostenderunt.*

(1) Tæ

CHAP. V.

Of the Taſte (1).

IN this, as in the laſt Senſe, we have an Apparatus abundantly ſufficient to the Senſe; Nerves curiouſly divaricated about the Tongue (2), and Mouth, to receive the Impreſſions of every Guſto; and theſe Nerves guarded with a firm and proper Tegument to defend them from Harms; but withal ſo perforated in the papillary Eminences, as to give a free admiſſion to Taſtes.

But

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(1) Τὰ δὲ εἴδη τῶν χυλῶν, &c. *Saporum genera* ——— *dulcis, pinguis, auſterus, acerbus, acris, ſalſus, amarus, acidus.* Theophr. de Cauſ. Plant. l. 6. c. 1. What may be the cauſe of the difference of Taſtes, he ſaith is hard to aſſign, πότερον γὰρ τοῖς παθεσι, &c. *Utrum affectionibus Senſuum,——an figuris, quibus ſinguli conſtant, ut Democritus cenſet.* id. ib. Δημόκριτος δὲ, &c. *Democritus——dulcem eſſe ſaporem qui rotundus: acerbum qui figurâ magnâ; aſperum qui multis angulis,* &c. id. ib. c. 2. But of the Diverſities and Cauſes of Taſtes, ſee Dr. *Grew, Lect.* 6. and Dr. *Willis de Anim. Brut.* c. 12.

(2) *Intellectus Saporum eſt cæteris in primâ linguâ: Homini, & in palato.* Plin. l. 11. 37.

The Opinions of Anatomiſts concerning the Organ of *Taſte* are various. *Bauhin, T. Bartholin, Bartholette, Veſlinge, Deuſinge,* &c. place it in the laxer fleſhy Parts of the Tongue: Our famous *Wharton,* in the Gland at the Root of the Tongue: *Laurentius* in the thin Tunick covering the Tongue: but the Learned *Malpighi* with great probability concludes, becauſe the outward covering of the Tongue is perforated, under which lie papillary Parts, (of which Mr. *Cowper* hath very good Cuts in his *Anat. Tab.* 13.) that in theſe the Taſte lieth. *Malpighi*'s Words are, *Quare cum dictis meatibus inſignibus occurrant papillaria corpora, probabiliùs eſt in his ultimo, ex ſubintranti ſapido humore titillationem, & mordicationem quandam fieri, quæ Guſtum efficiat.* Malpig. Op. Tom. 2. De Linguâ, pag. 18.

Præcipuum

But I ſhall ſay no more of this Senſe, only a word or two of its conſent with the Smell, and the Situation of them both: Their Situation is in the moſt convenient place imaginable, for the diſcharge of their Offices; at the firſt entrance (3), into the way to the grand Receptacle of our Food and Nouriſhment; to Survey what is to be admitted therein; to judge between what is wholſome, and fit for Nouriſhment, and what is unſavoury and pernicious. And for this end, the All-wiſe Creator ſeems to have eſtabliſhed a great conſent between the Eye, the Noſe, and Tongue, by ordering the Branches of the ſame Nerves (4) to each of thoſe three Parts, as alſo indeed to divers other Parts of the Body, which I may have Occaſion to mention in a more proper place (5). By which means

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Præcipuum ac ferè ſolum Guſtatûs organon eſt Lingua; cui aliquatenus ſubobſcurè tamen Palatum, & ſuperior Gulæ pars conſentiunt: in omnibus vero fibræ nervoſæ immediata ſenſionis inſtrumenta ſunt. Quare obſervare eſt, Linguam præ aliâ quâvis parte inſignitèr fibroſam eſſe, etiam texturâ valdè porosâ conſtare, in eum nempe finem, ut particulæ rei ſapidæ copioſius, ac penitiùs intra Senſorii meatus admittantur —— Nervi autem qui fibris Linguæ denſiſſime intertextis famulantur, ac ſaporum impreſſiones τῷ σφόδρα αἰσθητικῷ communicant, ſunt —— Nervi e paribus tum quinto, tum nono; & ubique cum denſâ propaginum ſerie per totam ejus compagem diſtributi. Willis ibid.

(3) *Guſtatus, qui ſentire eorum quibus veſcimur genera debet, habitat in eâ parte Oris, quâ eſculentis, & poculentis ita natura patefecit.* Cicer. de Nat. Deor. L. 2. *Vid. quoque ſupr.* Note 2. Chap. 4.

(4) *Multa hujus* [quinti Paris] *Nervi propagines Maſticationis operi deſtinantur; ideoque quoniam alimenta ingerenda non modo Guſtûs, eſt etiam Olfactûs & Viſûs examen ſubire debent, ab eodem Nervo, cujus rami ad Palatum & Fauces miſſi, Manducationis negotium peragunt, propagines aliæ, velut exploratrices, ad Nares & Oculos ſeruntur, nempe ut iſthæc aliorum ſenſuum organa, etiam ad objecta Guſtûs melius dignoſcenda, probationum auxiliis quibuſdam inſtruantur.* Willis Nerv. Deſor. & Uſus. *cap.* 22.

(5) See *Book* V. *Chap.* 8.

(1) *Malpighi*

means there is all the Guard that can be, againſt pernicious Food; foraſmuch as before it is taken into the Stomach, it is to undergo the trial of three of the Senſes; the Scrutiny of the Eye, that ſtrict Surveyor of its outward Appearance; and the Probation of the Smell and Taſte, the two ſevereſt Judges of its natural Conſtitution and Compoſition.

CHAP. VI.

Of the Senſe of Feeling (1).

HAving ſpent ſo much Time upon the other Senſes, and therein given ſuch ample Proofs of the infinite Creator's Wiſdom, I ſhall but briefly take notice of two things relating to this laſt Senſe.

One

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(1) *Malpighi* is of this Opinion, that as *Taſte* is performed by the *Papillæ* in the Tongue; ſo is *Feeling* by ſuch like *Papillæ* under the Skin. From ſeveral Diſſections, and other Obſervations he thus concludes, *Ex his, & ſimilibus videbatur animus abundè certior redditus, earundem Papillarum pyramidalium copiam, quas aliàs in Linguâ deſcripſi, in locis præcipuè exquiſitiori Tactui dicatis reperiri, eodem progigni nervoſo, & cuticulari corpore, ſimulque circumvolvi reticulari involucro, & extimam cuticulam, veluti ultimum terminum attingere.——Microſcopio quilibet in manûs dorſo pro ſudore orificia quædam miro ordine diſperſa intueri poteſt, circa quæ frequentia quædam capitula aſſurgunt; hæc verò ſunt Papillarum fines, dum a cute aſſurgentes interpoſitum ſuperant rete, ſimulque extimam cuticulam. Hæc repetitis ſectionibus deprehendi: ex quibus non improbabilitèr deducam, ſicuti ex elatioribus —— papillis —— in Linguâ, Guſtûs Organon eliciter, —— ita ex copioſâ harum Papillarum congerie —— in organis, ubi maximè animalia Tactûs motione afficiuntur, —— adæquatum Tactûs organum ſufficientèr haberi.* Malpig. de extern. Tact. Org. p. 26. *Conſul. quoque ejuſd. Vit.* p. 28.

These

One is its Organ, the Nerves. For as all Senſation is performed by the Nerves (2), and indeed the other Senſes (performed by Nerves) are a kind of Feeling; ſo is this Senſe of *Feeling* performed by Nerves likewiſe, ſpread in the moſt incomparable, curious manner throughout the whole Body. But to deſcribe their Origine in the Brain, and Spinal-Marrow, their Ramifications to all the Parts, their Inoſculations with one another, and other Matters, whereby not only the Senſe of *Feeling* is performed, but alſo Animal-Motion, and an admirable Conſent and Harmony of all the Parts of the Body is effected, (to deſcribe, I ſay, theſe things) would take up too much time, and I have already, and ſhall as I go along, give ſome Hints thereof.

The other thing I ſhall take notice of, is the diſperſion of this Senſe throughout the Body, both without, and within. The other Senſes, I have obſerved, are ſeated in the very beſt place for the Relief and Comfort, the Guard and Benefit of the Animal. And foraſmuch as it is neceſſary to the Being, and Well-being of the Body, that every Part ſhould be ſenſible of things ſafe, or things prejudicial to it ſelf, therefore it is an admirable Contrivance of the great Creator, to diſperſe this Senſe of

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Theſe Obſervations of *Malpighi*, our late curious and diligent Mr. *Cowper* hath confirmed, and given us very elegant Cuts both of the Skin, and the *Papillæ*, and the Nerves, Glands, *&c.* under it, from Microſcopical Obſervations. *Vid. Cowper's Anat.* Introd. and Tab 4.

(2) Although the Eye be the uſual Judge of Colours, yet ſome have been able to diſtinguiſh them by their Feeling. *Quidam fuit qui venit ad M. Duc. Hetruriæ aulam qui colores per Tactum cognoſcebat. Pro experimento velum ſericum, uniformiter textum, pluribus coloribus tinctum & offerebatur, & veracitèr de colore in ſingulis partibus judicabat.* Grimald. de Lum. & Col. pr. 43. §. 59.

(3) *Tactus*

of *Feeling* throughout every part (3), to distinguish between Pleasure aud Pain, things Salutary, and things Hurtful to the Body.

Thus in the five Senses of Animals we have an Oeconomy worthy of the Creator, and manifestly demonstrating his Power, Wisdom and Indulgence. For whether we consider the Mechanism of the Organs, or the great Use and Convenience of each Sense, we find it noble and grand, curious and artificial; and every way worthy of its infinite Maker, and beyond the Wit and Power of any thing but a *GOD*. And therefore we must even deny our Senses, by denying them to be God's Handy-work.

And now from those chief Machines of Animal Performances and Enjoyments, the five Senses; let us pass to another thing in common to all the sensitive Creatures, which is Respiration.

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(3) *Tactus autem toto corpore æquabiliter fusus est, ut omnes ictus, omnesque nimios & frigoris, & caloris appulsus sentire possimus.* Cicer. *ubi supr.*

Tactus sensus omnibus est, etiam quibus nullus alius: nam & Ostreis, & terrestribus Vermibus quoque. Existimaverim omnibus sensum & Gustatûs esse. Cur enim alios alia sapores appetunt? in quo vel Naturæ præcipua architectio. Plin. Nat. Hist. l. 10. c. 71.

CHAP. VII.

Of Respiration.

OF all the Acts of Animal Life, this is one of the chief, and most necessary. For whatsoever hath Animal Life, hath also the Faculty of Respiration, or somewhat equivalent thereto (1). Indeed

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(1) The Uses assigned to *Respiration* by all the Anatomists before *Malpighi*'s Discoveries of the Structure of the Lungs, are so various, and many of them so improbable, that it would be frivolous to recount them. But the more eminent modern Anatomists assign these Uses. *Willis* thus Sums up his Opinion, *Præcipua Pulmonum functio & usus sunt sanguinem & aerem per totas partium compages intimosque recessus, atque ductus quosque minutissimos traducere, & ubique invicem committere; in eum nempe finem, ut sanguis venosus a circuitu redux, & chymo recenti dilutus,——tum perfectius misceatur & velut subigatur, tum potissimum ut secundum omnes suas partes ab aere nitroso de novo accendatur.* Pharmaceut. p. 2. S. 1. c. 2. §. 2. *Mayow* saith rightly, that one grand Use of *Expiration* is, *Ut cum aere expulso, etiam vapores e sanguine exhalantes, simul exsufflentur.* And as for *Inspiration*, that it conveyeth a nitro-aerial ferment to the Blood, to which the the Animal Spirits are owing, and all Muscular-Motion. *Mayow de Respir.* p. 22, *&c. meâ Edit.*

Somewhat of the Opinion of these two last-cited, if I mistake not, (it being long since I read their Tracts, and have them not now at Hand,) were *Ent*, *Sylvius*, *Swammerdam*, *Diemerbroeck*, and my Friend Mr. *Ray* in an unpublished Tract of his, and in his Letters now in my Hands.

But our Dr. *Thurston* for good reasons rejects these from being principal Uses of Respiration, and thinks, with great reason, the principal Use to be to move, or pass the Blood from the right to the left Ventricle of the Heart. Upon which account Persons hanged, drowned, or strangled by Catarrhs, so suddenly die, namely, because the Circulation of their Blood is stopped. For the same reason also it is, that Animals die so soon in the Air-Pump. Among other Proofs he instanceth in an Experiment of Dr. *Croon*, (*Profess. Gresh.*) which he made before our *R. S.* by strangling a Pullet, so that not the least sign of Life appeared; but

deed so congenial is this with Life, that *Breath* and *Life* are in Scripture Phrase and Common Speech taken

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but by blowing Wind into the Lungs through the *Trachea*, and so setting the Lungs a playing, he brought the Bird to Life again. Another Experiment was one tryed by Dr. *Walter Needham* before Mr. *Boyl*, and others at *Oxford*, by hanging a Dog, so that the Heart ceased moving. But hastily opening the Dog, and blowing Wind into the *Ductus Pecquetianus*, he put the Blood in Motion, and by that means the Heart, and so recovered the Dog to Life again. *V. Thurston de Respir. Us.* p. 60, and 63. *meâ Edit.*

Such an Experiment as Dr. *Croon*'s, my Friend, the late justly renowned Dr. *Hook* shewed also our *R. S.* He cut away the *Ribs*, *Diaphragm*, and *Pericardium* of a Dog; also the top of the Wind-Pipe, that he might tie it on to the Nose of a pair of Bellows; and by blowing into the Lungs, he restored the Dog to Life; and then ceasing blowing, the Dog would soon fall into dying Fits; but by blowing again, he recovered: and so alternately would die, and recover for a considerable time, as long and often as they pleased. *Philos. Transf. Nr.* 28.

For the farther Confirmation of Dr. *Thurston*'s Opinion, the ingenious Dr. *Musgrave* cut off, and close stopped up the Windpipe of a Dog with a Cork, and then threw open the *Thorax*; where he found the Blood stagnating in the *Lungs*, the *Arteria Pulmonaris*, the *right Ventricle* and *Auricle* of the *Heart*, and the two great Trunks of the *Cava* distended with Blood to an immense degree; but at the same time the *Vena Pulmonaris*, the *left Ventricle* and *Auricle* of the *Heart* in a manner empty, hardly a Spoonful of Blood therein. *Philos. Transf. Nr.* 240. Or both the Experiments may be together met with in *Lowth. Abridg. Vol.* 3. *p.* 66, 67.

This Opinion of our learned *Thurston*, the late learned *Etmuller* espoused, who being particular in reckoning up the Uses of Respiration, I shall therefore the more largely cite him. Respiration, saith he, serves, 1. *Ad Olfactum.* 2. *Ad Screatum & Sputationem.* 3. *Ad Oscitationem, Tussim, Sternutationem, Emunctionemque.* 4. *Ad liquidorum Sorbitionem, Suctionemve.* 5. *Ad Loquelam, Cantum, Clamorem, Risum, Fletum, Flatum,* &c. 6. *Ad fecum Alvi, Urinæ, Fœtus, Molæve, necnon Secundinarum expulsionem.* 7. *Ad promovendi Ventriculi, Intestinorum, Lacteorumque vasorum,* &c. *contenta.* 8. *Ad halitus aqueos Sanguinis e pulmonibus aeris ope exportandos.* 9. *Ad Diapnoen.* 10. *Ad exactiorem Chyli, Lymphæque, necnon Sanguinis*——*mistelam.* 11. *Ad*

taken as ſynonymous Things, or at leaſt neceſſary Con-

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conciliandam ſanguini—coccineam rubedinem, &c. 12. *Nec moroſè negabimus, aerem——pulmones & ſanguinem illos tranſcurrentem, minus calida reddere*, &c. 13. *Quod denique aer ſanguini ſingulis Reſpirationibus aliquantillâ ſui parte, admixtus, pauciſſimas quaſdam in Spirituum animalium elaboratione particulas ſimul contribuat.* All theſe Uſes although of great Conſequence, yet he thinks rather conduce to the *Well-Being*, than the Being of the Animal; becauſe without any one of them, the Animal would not ſo ſpeedily die, as it doth by Strangling, or in the Air-Pump. He therefore aſſigns a 14th, and the principal Uſe of Reſpiration to be, *For the paſſing of the Blood through the Lungs, that is thrown into them by the Heart.* Etmull. Diſſert. 2. c. 10. §. 1, & 16.

But the late Dr. *Drake*, with great Ingenuity and Addreſs, (like a Perſon ſo conſiderable for his Years as he was in his Time,) not only eſtabliſheth this Notion of Reſpiration, but alſo carries it farther, making it the true Cauſe of the *Diaſtole* of the Heart; which neither *Borelli*, *Lower*, or *Cowper*, much leſs any before thoſe great Men, have well accounted for. That the Heart is a Muſcle, is made evident beyond all doubt by Dr. *Lower*. And that the Motion of all Muſcles conſiſts in Conſtriction, is not to be doubted alſo. By which means the *Syſtole* is eaſily accounted for. But foraſmuch as the Heart hath no *Antagoniſt-Muſcle*, the *Diaſtole* hath puzzelled the greateſt Wits. But Dr. *Drake* with great Judgment, and much Probability of Reaſon, maketh the Weight of the incumbent Atmoſphere to be the true *Antagoniſt* to all the Muſcles which ſerve both for ordinary Inſpiration, and the Conſtriction of the Heart. The particulars of his Opinion may be ſeen in his *Anatomy*. L. 2. c. 7. And in *Phil. Tranſ. Nr.* 281.

And I remember when I was at the Univerſity, my moſt ingenious and learned Tutor Dr. *Wills*, when he read Anatomy to us, was of Opinion, that the Lungs were blown up by the Weight of the incumbent Air, and repreſented the manner of Reſpiration in this manner, *viz.* He put a Bladder into a Pair of Bellows, turning back the Neck of the Bladder, and tying it faſt, ſo that no Air might enter in between the Bladder and Bellows. This being done, when the Bellows were opened, the Bladder would be blown up, by the Weight of the incumbent Air; and when ſhut, the Air would be thereby preſſed forcibly out of the Bladder, ſo as to blow the Fire. This Experiment I take notice of here, becauſe, (beſides the Illuſtration it gives to Reſpiration,) that great *Genius* ſeems to have had a truer No-

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Concomitants of one another. *Moſes* (2) (expreſſeth) Animal Life, by [*The Breath of Life.*] Saith he, *Gen.* 7. 21, 22. *All Fleſh that moved on the Earth, Fowl, Cattel, Beaſt, creeping Things, and Man; all in whoſe Noſtrils was the Breath of Life in the dry Land died.* So the Pſalmiſt, *Pſal.* 104. 29. *Thou takeſt away their Breath, they die.* So grand an Act therefore in common to all Animals, may juſtly deſerve a place in this Survey of the Works of God, in the Animal Kingdom.

And here I might launch out into an ample Deſcription of all the Parts miniſtering to this neceſſary Act, and ſhew the curious Contrivance and artificial Structure of them. But a tranſient View ſhall ſuffice. I might begin with the outward Guards, the Noſe and Mouth; but theſe have been already touched upon. But the exquiſite Mechaniſm of the *Larynx*, its Variety of Muſcles, its Cartilages, all ſo exquiſitely made for the purpoſe of Reſpiration, and forming the Voice (3), are very ad-

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tion of this *Phænomenon* than was very common then, *viz.* about the Year 1677 or 78; as alſo, becauſe I have in ſome Authors met with the ſame Experiment, without mention of Dr. *Wills*, whoſe I take it to have been.

Another uſe of great Conſideration the already commended Dr. *Cheyne* aſſigns, namely, to form the elaſtick Globules of which the Blood principally conſiſts, without which there would be a general Obſtruction in all the capillary Arteries. *Cheyne's Phil. Prin. of Nat. Rel.* or *Harris's Lex. Tech. in Lungs.*

(2) *Gen.* 2. 7. 6. 17. & 7. 15.

(3) Becauſe it would be endleſs to ſpecify the curious Mechaniſm of all the Parts, concurring to the Formation of the Voice, I ſhall therefore for a Sample note only two things. 1. There are thirteen Muſcles provided for the Motion of the five Cartilages of the *Larynx*. Gibſ. Anat. *l.* 2. *c.* 14. A Sign of the careful and elaborate Proviſion that is made for the Voice. 2. It is a prodigious Faculty of the *Glottis* in contracting and dilating it ſelf with ſuch Exquiſiteneſs, as to form all Notes. For (as the ingenious Dr. *Keil* ſaith) *ſuppoſing the greateſt Diſtance*

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top, to fence againſt all Annoyances; its cartilaginous Rings (6) nearly environing it, with its membranous Part next the Gullet, to give the freer paſſage to the deſcent of the Food; and laſtly, its inner Tegument of exquiſite Senſe to be readily affected with, and to make efforts againſt every thing that is hurtful or offenſive, theſe, I ſay, do all juſtly deſerve our Admiration.

And no leſs prodigious are the Parts farther within; the *Bronchi*, the *Veſiculæ* (7), with their muſcular

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branous. And in a Pigeon, *which hath a low and ſoft Note 'tis partly Cartilaginous, and partly Membranous. In an* Owl, *which hath a good audible Note, 'tis more Cartilaginous. But that of a* Jay, *hath hard Bones, inſtead of Cartilages: and ſo of a* Linnet, *whereby they have both of them, a louder and ſtronger Note,* &c.

The Rings of the Wind-pipe are fitted for the Modulation of the Voice. For in Dogs *and* Cats, *which in the Expreſſion of divers Paſſions uſe a great many Notes, (as Men do,) they are open and flexible, as in Man. Whereby all, or any of them are dilated, or contracted, more or leſs, as is convenient for a higher or deeper Note,* &c. *whereas in ſome other Animals, as in the* Japan-Peacock, *which uſeth hardly more than one ſingle Note, they are entire,* &c. Grew's Coſmolog. Sacr. *Book* I. *Chap.* 5. §. 9, 10.

(6) It is a farther manifeſt Indication of ſingular Deſign in the cartilaginous Rings of the *Aſpera Arteria*, that all the way where they are Contiguous to the *Oeſophagus*, they are Membranous, to afford an eaſie Paſſage to the Food; but after that, in the *Bronchii*; they are ſome compleatly Annular, ſome Triangular, &c. And another obſervable is, the lower Parts of the ſuperior Cartilages, receive the upper Parts of the inferior, in the *Bronchi*; whereas in the *Aſpera Arteria*, the Cartilages run and remain parallel to one another; which is a noble difference or Mechaniſm in this (in a manner) one and the ſame Part, enabling the Lungs and *Bronchi* to contract themſelves in Expiration, and to extend and dilate themſelves in Inſpiration.

(7) I ſhall not here intrench ſo much upon the Anatomiſt's Province, to give a Deſcription of the *Lungs*, although it be a curious Piece of God's Workmanſhip, but refer to *Seignior Malpighi*, the firſt Diſcoverer of their *Veſiculæ* in 1660, in his two Letters to *Borelli de Pulmon*: alſo to Dr. *Willis*'s *Pharm. rat.*

lar Fibres (†), as some assert they have, together with the Arteries and Veins, which every where accompany the airy Passages, for the Blood to receive there its Impregnations from the Air.

From

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p. 2. S. 1. c. 1. *de Respir. Orig. & Us.* who as he wrote after *Malpighi*, so hath more accurately described those Parts; and to Mr. *Cowper*'s *Anat.* Tab. 24, 25. And if the Reader hath a mind to see what Opposition *Seignior Malpighi*'s Discoveries met with at Home and Abroad, and what Controversies he had on that Account, as also his Censures of Dr. *Willis*'s Descriptions and Figures, he may consult *Malpighi*'s Life written by himself, *pag.* 4. *to* 21.

That the *Lungs* consist of *Vesiculæ*, or *Lobuli* of *Versiculæ* admitting of Air from the *Bronchi* is visible, because they may be blown up, cleansed of Blood, and so dried. But Mr. *Cowper* saith, he could never part the *Lobuli*, (so as to make the Doctor's *Fig.* 1. *Tab.* 3. & 4.) so that probably the *Vesiculæ* are contiguous to one another throughout each Lobe of the Lungs. And not only Air, but *Diemerbroeck* proves, that the *Vesiculæ* admit of Dust also from two Asthmatick Persons he opened; one a Stone-Cutter's Man, the *Vesiculæ* of whose Lungs were so stuffed with Dust, that in cutting, his Knife went as if through an heap of Sand. The other was a Feather-Driver, who had these Bladders filled with the fine Dust or Down of Feathers.

(†) There is a considerable difference between Dr. *Willis*, and *Etmuller*, viz. whether the *Vesiculæ* of the Lungs have any muscular Fibres or not? *Etmuller* expresly saith, *Nullas Fibras musculosas multo minus rubicandam Musculorum compagem (sunt enim Vesiculæ albidæ & fere diaphanæ) in ipsis reperiri.* ubi supr. c. 6. §. 2. And afterwards §. 3. *Pulmones esse molles flexilesque musculosis fibris ceu proprie explicationis organis destitutos.* But Dr. *Willis* as expresly asserts they have musculous Fibres, and assigns an excellent Use of them; *Cellulæ istæ vesiculares, ut nixus pro expiratione contractivos edant, etiam fibras, uti per Microscopium plane conspicere est, musculares obtinent.* ubi supr. §. 16. And in the next §, *Ut pro datâ occasione majorem aeris copiam exsufflent, aut materiam extussiendam ejiciant, fibris muscularibus donatæ, sese arctius contrahunt, contentaque sua penitus exterminant. Etenim ordinariæ pectoris Systolæ, quas musculorum relaxationes ex parte efficiunt, aerem forsan totum a Trachea & Bronchiis, haud tamen a Vesiculis, quaque vice ejiciunt: propter has (quoties opus erit) inaniendas, & totius Pectoris cavitas plurimùm augustatur,*

&

From hence I might proceed to the commodious Form of the Ribs (8), the curious Mechaniſm of the Intercoſtal-muſcles (9), the Diaphragm, and all the other Muſcles (10) miniſtring both to the ordinary, and extraordinary Offices of Reſpiration. But

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& cellulæ ipſe veſiculares a propriis fibris conſtrictis coarctantur.

(8) *Circa hos motus* [*Scil. Pectoris dilatationem*, &c.] *divini Conditoris mechanicen, ad regulas Mathematicas plane adaptatam, ſatis admirari non poſſumus; ſiquidem nullâ aliâ in re manifeſtiùs* Ὁ Θεὸς γεωμετρεῖν *videatur. Quippe cum pectoris tum ampliatio, tum coarctatio a quibuſdam Muſculis (quorum munus unicum eſt contrahere) perfici debeat; res ita inſtituitur, ut Coſtæ, quæ thoracis, velut parallelogrammi oblongi verſus cylindrum incurvati, latera efformant, in figuram modo quadratam, cum angulis rectis, pro pectoris ampliatione; modo in rhomboeidem, cum angulis acutis pro ejuſdem contractione, ducantur*, &c. Willis, *ubi ſupr.* §. 28.

Galen having ſpoken of the Parts miniſtring to Reſpiration concludeth, *Nihil uſquam a Naturâ ullo pacto per incuriam fuiſſe præteritum, quæ cùm omnia præſentiret, & provideret, quæ ſunt neceſſario illa, quæ cauſa alicujus extiterunt, conſecutura, omnibus inſtaurationes parare occupavit, cujus apparatus copioſa facultas admirabilem Sapientiam teſtantur.* De uſ. part. l. 5. c. 15. See alſo *l. 6. c. 1.*

(9) For the Structure of the *Intercoſtals*, *Midriff*, &c. I ſhall refer to Dr. *Willis*, and other Anatomiſts. But Dr. *Drake* taxeth Dr. *Willis* with an Error in fancying there is an oppoſition in the Office of the *Intercoſtals*, by reaſon the Fibres of the *external* and internal *Intercoſtals* decuſſate; that therefore the *External* ſerve to raiſe the Ribs, the *Internal* to draw them down. But Dr. *Drake* is of *Steno*'s, and Dr. *Mayow*'s Opinion, that notwithſtanding the Decuſſation of their Fibres, the Power they exert upon, and the Motion they effect in the Ribs is one aud the ſame. *Drake's Anat.* l. 2. c. 7. and l. 4. c. 5. *Mayow's de Reſpir.* c. 7.

(10) Although Dr. *Drake* and ſome others deny the *Intercoſtals* being Antagoniſt-Muſcles, as in the preceeding Note, yet they, and moſt other Anatomiſts that I have met with, attribute a conſiderable power to them in the act of Reſpiration, as they do alſo to the *Subclavian*, and *Triangular Muſcles*: but the learned *Etmuller* denies it for theſe three Reaſons, 1. *Quia reſpirando nullam in illis contractionem ſentio.* 2. *Quia*——*ſibi invicem*

But passing them by, I shall stop at one prodigious Work of Nature, and manifest Contrivance of the Almighty Creator, which although taken notice of by others (11), yet cannot be easily passed by in the Subject I am upon; and that is the Circulation of the Blood in the *Fœtus in the Womb*, so different from the Method thereof after it is Born. In the Womb, whilst it is as one Body with the Mother, and there is no Occasion, nor place for Respiration, there are two Passages (12) on purpose for the transmission of the Blood without passing it through the Lungs.

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vicem non adducuntur, &c. 3. *Quia Costæ omnes ab aliis modo enarratis musculis moventur, idque simul*, &c. *Intercostales itaque, necnon Subclavios Musculos Costis, parietum instar, ad complenda interstitia intercostalia, pectusque integrandum, ac Costas connectendas, intertextos esse, probabiliter concludo: quo munere Triangulares etiam —— fungi, rationi consentaneum est.* Etmul. Dissert. 2. cap. 4. §. 6.

But as to the Use of the *Triangular-Muscle* in Respiration, we may judge of it, from its remarkable Size, and Use in a Dog; of which Dr. *Willis* gives this Account from *Fallopius*: *In Homine parvus adeo & subtilis iste* [Musculus] *est, ut vix pro Musculo accipi queat: in cane per totum os pectoris protenditur, & cartilagines omnes, etiam verarum Costarum sterno inosculatas, occupat. Cujus discriminis ratio divinam circa Animalium fabricas Providentiam plane indigitat. Quippe cum hoc animal, ad cursus velocissimos & diu continuandos natum, quo sanguis, dum intensius agitatur, ritè accendatur eventileturque, aerem celerrimè & fortiter uti inspirare, ita etiam exspirare debet—idcirco propter hunc actum firmiùs obeundum (cujus in Homine haud magnus est usus) musculus caninus molem ingentem & tanto operi parem sortitur.* Willis *ubi supr.* §. 32.

(11) *Ray*'s Wisdom of God in the Creation, p. 343.

(12) Mr. *Cheselden*, an ingenious and most accurate Anatomist, having somewhat particular in his Observations about the Circulation of the Blood through the Heart of the Fœtus, I shall present the Reader with some of his Observations, which he favoured me with the sight of. *The Blood*, (saith he) *which is brought to the Heart by the ascending* Cava, *passeth out of the right Auricle into the left, through a Passage called* Foramen Ovale, *in the* Septum

Lungs. But as ſoon as the *Fœtus* is Born, and become thereby a perfectly diſtinct Being, and breathes for it ſelf, then theſe two Paſſages are ſhut up: one nearly obliterated, the other becomes only a Ligament, except in ſome Creatures that are Amphibious, or are forced to lie long under Water, in whom theſe Paſſages probably remain open *(13)*.

And now what Action of any rational Creature, what is there in a Man's Life, that doth more plainly

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[Septum common to them both] *without paſſing through the right Ventricle (as after the Birth, while the Blood from the deſcending Cava paſſeth through the right Auricle and Ventricle into the pulmonary Artery, and thence into the Aorta through a Duct, betwixt that and the pulmonary Artery, called* Ductus Arterioſus, *whilſt a ſmall Portion of the Blood, thrown into the pulmonary Artery paſſeth through the Lungs, no more than is ſufficient to keep open the pulmonary Veſſels. Thus both Ventricles are employed in driving the Blood through the Aorta to all Parts of the Fœtus, and to the Mother too. But after the Birth, the Blood being to be driven from the Aorta through the Fœtus alone, and not the Mother too, one Ventricle becomes ſufficient, whilſt the other is employed in driving the Blood through the Lungs, the* Ductus Arterioſus *being ſhut up by means of the Alteration of its Poſition, which happens to it from the raiſing the Aorta by the Lungs when they become inflated. After that the Blood is thus driven into the Lungs, in its return it ſhuts the Valve of the* Foramen Ovale *againſt the* Foramen *it ſelf, to whoſe ſides it ſoon adheres, and ſo ſtops up this Paſſage. The* Ductus Arterioſus, *or* Ductus Arterioſus in Ligamentum verſus, *is ſeldom to be diſcerned in adult Bodies, but the Figure of the* Foramen Ovale *is never obliterated.*

(13) It hath been generally thought to be not improbable, but that on ſome Occaſions the *Foramen Ovale* may remain open in Man. In a Girl of four or five Years of Age, Dr. *Conner* found it but half cloſed, and in the Form of a Creſcent. And he thinks ſomewhat of this kind might be in the Perſon whoſe Skeleton was found to have no Joynts in the Back-bone, Ribs, *&c.* Of which a Deſcription, with Cuts, may be found in *Phil. Tranſ. Nr.* 215. and more largely in his *Diſſert. Med. Phyſ. de Stupendo Oſſium coalitu*, where he adds to the Girl, in whom the *For. Ov.* was not ſhut; a like Obſervation of another Girl he opened at *Oxford* of three Years Old, *in qua Foramen Ovale fere*

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plainly ſhew Deſign, Reaſon, and Contrivance, than this very Act of Nature doth the Contrivance and

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erat occluſum, in medio tamen, exili foramine, per quod Turundam facilè tranſmiſi, erat pervium, pag. 30. So Mr. *Cowper* (than whom none more accurate nor a better Judge) ſaith, *I have often found the* Foramen Ovale *open in the Adult.* Anat. Append. Fig. 3. But Mr. *Cheſelden* is of a different Opinion. Of which in the following Note.

From ſomewhat of this cauſe I am apt to think it was that the *Tronningholm Gardiner* eſcaped drowning, and ſome others mentioned by *Pechlin*. His Stories are, *Hortulanus Tronningholmenſis etiamnum vivens, annos natus* 65, *pro illâ ætate ſatis adhuc valens & vegetus, cum ante* 18 *annos, alii in aquas delapſo opem ferre vellet, ſorte-fortunâ & ipſe per glaciem incautiùs procedens, aquas incidit* 18 *ulnas profundas: ubi ille, corpore erecto quaſi ad perpendiculum, pedibus fundo adhæſit. Conſtitit ſic per* 16 *horas, antequam produceretur in auras. Dixit autem, ſimul ac infra aquarum ſuperficiem fuit demerſus, ſtatim obriguiſſe totum, &, ſi quem tum habuit motum & ſenſum, amiſiſſe, niſi quod ſonantes Stockolmii campanas etiam ſub aquis obſcuriùs percipere ſibi ſit viſus. Senſit etiam, ſtatim ſeſe velut veſiculam ori applicaſſe, adeo ut aqua nulla os penetraverit, in aures vero tranſitum, etiam ſentiente illo, habuerit; atque inde auditum ſuum debilitatum aliquandiu eſſe. Hoc ſtatu dum* 16 *horas permanſit fruſtra quæſitus, tandem repertum, conto in caput infixo, cujus etiam ſenſum ſe habuiſſe dixit, fundo extraxerunt, ſperantes ex more aut perſuaſione gentis revicturum eſſe. Itaque pannis linteiſque productum obvolvunt, ne aer admitti poſſit pernicioſus futurus ſubito illapſu: cuſtoditum ſic ſatis ab aere ſenſim ſenſimque tepidiori loco admovent, mox calidis adoriuntur faſciis, fricant, radunt, & ſufflaminatum tot horis ſanguinis corporiſque motum negotiosâ illâ operâ reducunt: denique antapoplecticis & genialibus liquoribus vitæ reddunt & priſtinæ mobilitati. Retulit is atque oſtendit ſe etiamnum in capite circumferre veſtigia violentiæ a conto illatæ, & cephalalgiis vexari graviſſimis. Et propter hunc ipſum caſum, religiosè a popularibus, & hujuſce rei teſtibus probatum, Sereniſſimæ Reginæ matris munificentiâ & annuo ſtipendio eſt donatus——& Sereniſ. Principi—— oblatus, vivus ſui teſtis.——Conſignatam manu habes Hiſtoriam D. Tilaſii, Biblioth. Reg. Præfecti, qui teſtatus eſt ſe prænoviſſe mulierem, quæ tres ipſos dies ſub aquis hæſit, & ſimilem in modum, quo Hortulanus ille, reſuſcitata, adhuc dum lucis plenâ fruitur uſurâ. Accedit Nob. Burmanni——fides, qui conſeſſus eſt,—— ſe in pago* Boneſs *parochiæ* Pithoviæ *concionem frequentaſſe funebrem,*

and Deſign of the great God of Nature? What is Thought and Contrivance, if this be not? That there ſhould be a temporary Part in the Body, made juſt for the preſent Exigence; to continue whilſt there is occaſion for it, and to ceaſe when there is none; in ſome Creatures to remain always, by reaſon of their amphibious way of living, and in Land-Animals (purely ſuch) to ceaſe?

Another excellent Contrivance, a-kin to the laſt, is for the Preſervation of ſuch Creatures whoſe occaſions

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brem, in quâ, dum acta recenſeret Præco Senis cujuſdam 7agenarii, Laur. Jonæ——*audiverit ex ore Concionatoris, virum eum, adoleſcentem 17 annorum, aquis ſubmerſum, 7 demum hebdomadâ (rem prodigioſam!) extractum ad ſe rediiſſe vivum & incolumem.* Pechlin. de Aer. & Alim. def. c. 10.

Shall we to this Cauſe, or to the Offification, or more than ordinary Strength of the Wind-pipe, attribute the recovery to Life of Perſons hanged? Of which *Pechlin* gives an Inſtance that fell under his own Knowledge, of a Woman hanged, and in all appearance Dead, but recovered by a Phyſician accidentally coming in, with a plentiful Adminiſtration of *Spir. Sal. Armon. Pechl. ib.* c. 7. And the Story of *Ann Green* executed at *Oxford, Dec.* 14, 1650. is ſtill well remembred among us. *She was hanged by the Neck near half an Hour, ſome of her Friends in the mean time thumping her on the Breaſt, others hanging with all their weight upon her Legs, ſometimes lifting her up, and then pulling her down again with a ſudden Jirk, thereby the ſooner to diſpatch her out of her Pain*; as her Printed Account wordeth it. After ſhe was in her Coffin, being obſerved to breath, a luſty Fellow ſtamped with all his force on her Breaſt and Stomach, to put her out of her Pain. But by the aſſiſtance of Dr. *Peity*, Dr. *Willis*, Dr. *Bathurſt*, and Dr. *Clerk*, ſhe was again brought to Life. I my ſelf ſaw her many Years after, after that ſhe had (I heard) born divers Children. The particulars of her Crime, Execution, and Reſtauration, ſee in a little Pamphlet, called *News from the Dead*, written, as I have been informed, by Dr. *Bathurſt*, afterwards the moſt vigilant and learned Preſident of *Trinity-College, Oxon*,) and Publiſhed in 1651. with Verſes upon the Occaſion.

(14) The

ſions frequently neceſſitate them to live without, or with but little Reſpiration. Fiſhes might be named here, whoſe Habitation is always in the Waters. But theſe belong to an Element which I cannot at preſent engage in. But there are many Animals of our own Element, or partly ſo, whoſe Organs of Reſpiration, whoſe Blood, whoſe Heart, and other Inſtruments of Life are admirably accommodated to their method of living. Thus many amphibious Creatures (14), who live in Water as well as Air, many Quadrupeds, Birds, Inſects, and other Animals, who can live ſome Hours, Days, yea, whole Winters with little or no Reſpiration, in a Torpitude, or ſort of Sleep, or middle State between Life and Death. The Proviſion made for theſe peculiar Occaſions of Life, in the Fabrick of the

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(14) The *Sea-Calf* hath the *Foramen Ovale*, by which means it is enabled to ſtay long under Water, as the *Pariſ. Anatomiſts*. Of which ſee in *Book* VI. *Chap.* 5. *Note* 3.

But the fore-commended Mr. *Cheſelden* thinks the *Foramen Ovale* is neither open in amphibious Creatures, nor any adult Land-Animals. *When I firſt* (ſaith he) *applied my ſelf to the Diſſection of Humane Bodies, I had no diſtruſt of the frequent Accounts of the* Foramen Ovale *being open in Adults: but I find ſince, that I miſtook the* Oſtium Venarum Coronariarum *for the* Foramen. *The like I ſuppoſe Authors have done, who aſſert that it is always open in amphibious Animals: for we have made diligent enquiry into thoſe Animals, and never found it open. Neither would that (as they imagine) ſerve thoſe Creatures to live under Water, as the* Fœtus *doth* in Utero, *unleſs the* Ductus Arterioſus *was open alſo.*

This Opinion of Mr. *Cheſelden* hath this to render it probable, that the *Oſtium Venarum Coronariarum* is ſo near the *Foramen Ovale*, that without due regard it may be eaſily miſtaken for it. Such therefore as have opportunity of examining this part in amphibious Animals, or any other Subject, ought to ſeek for the *Oſtium*, whenever they ſuſpect they have met with the *Foramen*.

(15) Of

the Lungs, the Heart, and other Parts of ſuch Creatures (15), is manifeſtly the Work of him, who as St. *Paul* ſaith (16), *giveth to all Breath, and Life, and all things.*

CHAP. VIII.

Of the Motion of Animals.

NEXT to the two grand Acts of Animal Life, their Senſe and Reſpiration, I ſhall conſider their *Motion*, or *Locomotive Faculty*, whereby they convey themſelves from place to place, according to their Occaſions, and way of Life. And the admirable Apparatus to this purpoſe is a plain demonſtration of God's particular Fore-ſight, Care, and eſpecial Providence towards all the Animal World.

And here I might view in the firſt place the Muſcles, their curious Structure (1), the nice tacking them to every Joynt, to pull it this way, and that way, and the other way, according to the ſpecial Purpoſe, Deſign, and Office of every ſuch Joynt: Alſo their various Size and Strength; ſome large

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(15) Of the ſingular Conformation of the Heart and Lungs of the *Tortoiſe*, which is an amphibious Animal, See *Book* VI. *Chap.* 5. *Note* 2.

(16) Act 17. 25.

(1) That the Muſcles are compounded of Fibres is viſible enough. Which Fibres the curious and ingenious *Borelli* ſaith, are cylindraceous: not hollow, but filled with a ſpungy, pithy Subſtance, after the manner of Elder, as he diſcovered by his Microſcopes. *Borel. de Mot. Animal.* Part 1.

Theſe

large and corpulent, others leſs, and ſome ſcarce viſible to the naked Eye; all exactly fitted to every Place, and every Uſe of the Body. And laſtly, I might take notice of the muſcular Motions, both Involuntary, and Spontaneous (2).

Next I might ſurvey the ſpecial Fabrick of the Bones (3) miniſtring to Animal Motion. Next I might

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Theſe Fibres he ſaith are naturally white, but derive their redneſs only from the Blood in them.

Theſe Fibres do in every Muſcle, (in the Belly at leaſt of the Muſcle,) run parallel to one another, in a neat orderly Form. But they do not all tend the ſame way, but ſome run aſlant, ſome longways, *&c.* according to the Action or Poſition of each reſpective Muſcle. The particulars of which, and of divers other obſervables in the Muſcles would, beſides Figures, take up too much room in theſe Notes; and therefore I muſt refer to the Anatomiſts, particularly *Steno*, *Borelli*, *Cowper*, &c.

(2) The infinite Creator hath greatly exerted his Art and Care in the Proviſion made by proper Muſcles and Nerves for all the different Motions in Animal Bodies, both involuntary, and voluntary. It is a noble Providence that moſt of the vital Motions, ſuch as of the Heart, Stomach, Guts, *&c.* are involuntary, the Muſcles acting whether we ſleep or wake, whether we will or no. And it is no leſs providential that ſome even of the vital Motions are partly voluntary, partly involuntary, as that, for inſtance, of Breathing; which is performed both ſleeping and waking; but can be intermitted for a ſhort time on occaſion, as for accurate hearing any thing, *&c.* or can be encreaſed by a ſtronger Blaſt, to make the greater diſcharges of the Blood from the Lungs, when that any thing overcharges them. And as for the other Motions of the Body, as of the Limbs, and ſuch as are voluntary, it is a no leſs Providence that they are abſolutely under the Power of the Will; ſo as that the Animal hath it in its power to command the Muſcles and Spirits of any part of its Body, to perform ſuch Motions and Actions as it hath occaſion for.

(3) *Quid dicam de Oſſibus? quæ ſubjecta corpori mirabiles commiſſuras habent, & ad ſtabilitatem aptas, & ad artus finiendos accommodatas, & ad motum, & ad omnem corporis actionem.* Cicer. de Nat. Deor. l. 2.

By

By reason it would be endless to mention all the Curiosities observeable in the Bones, I shall for a Sample, single out only an instance or two, to manifest that Design was used in the Structure of these Parts in Man.

The first shall be in the *Back-bone*, which (among many others) hath these two things remarkable. 1. Its different Articulations from the other Joynts of the Body. For here most of the Joynts are flat, and withal guarded with Asperities and Hollows, made for catching and holding; so as firmly to lock, and keep the Joynts from Luxations, but withal to afford them such a Motion, as is necessary for the Incurvations of the Body. 2. The difference of its own Joynts in the Neck, Back, and Loins. In the Neck, the *Atlas*, or upper *Vertebra*, as also the *Dentata* are curiously made, and joynted (differently from the rest) for the commodious, and easy bending and turning the Head every way. In the Thorax, or Back, the Joynts are more close and firm: and in the Loins more lax and pliant; as also the Spines are different, and the Knobs and Sockets turned the quite contrary way, to answer the occasions the Body hath to bend more there, than higher in the Back. I shall close this Remark with the ingenious Dr. *Keil*'s Observation.

The Structure of the Spine *is the very best that can be contrived; for had it been all Bone, we could have had no Motion in our Backs: had it been of two or three Bones articulated for Motion, the* Medulla Spinalis *must have been necessarily bruised at every Angle or Joynt; besides, the whole would not have been so pliable for the several Postures we have occasion to put our selves in. If it had been made of several Bones without intervening Cartilages, we should have had no more Use of it, than if it had been but one Bone. If each* Vertebra *had had its own distinct Cartilages, it might have been easily* dislocated. *And lastly, the oblique Processes of each superiour and inferiour* Vertebra, *keep the middle one that it can neither be thrust backwards nor forwards to compress the* Medulla Spinalis. *Keil's Anat.* c. 5. § 8.

Compare here what *Galen* saith of the Articulations, Ligaments, Perforation, *&c.* of the *Spine* to prove the Wisdom and Providence of the Maker of Animal Bodies, against such as found fault with Nature's Works; among which he names *Diagoras*, *Anaxagoras*, *Asclepiades*, and *Epicurus*. *V. Galen de Us. Part. L.* 12. *init.* and *Chap.* 11, &c. also *L.* 13. *init.*

2. The next Instance shall be in one or two things, wherein the Sceletons of Sexes differ. Thus the *Pelvis* made in the Belly by the *Ilium*, *Ossa Coxendicis* and *Pubis*, is larger in a Female than Male-Sceleton, that there may be the more Room for the lying of the Viscera, and Fœtus. So the Cartilage bracing together the two *Ossa Pubis*, or *Sharebones*, *Bartholine* saith is twice thicker and laxer in Women than Men: as also is the Cartilage that tieth the *Os Sacrum* to its *Vertebra*; and all to give way to the passage of the Fœtus.

might take notice of the Joynts (4), their compleat Form adjusted to the Place, and Office they are employed in; their Bandage, keeping them from Luxations; the oily Matter (‖) to lubricate them, and

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Another considerable Difference is in the cartilaginous Productions of the seven long Ribs, whereby they are braced to the Breast-Bone. These are harder and firmer in Women than in Men; the better to support the Weight of the Breasts, the sucking Infant, *&c.*

(4) It is remarkable in the Joynts, and a manifest Act of Caution and Design, 1. That although the Motion of the Limbs be circular, yet the Center of that Motion is not in a Point, but an ample Superficies. In a Point, the Bones would wear, and penetrate one another; the Joynts would be exceedingly weak, *&c.* but the Joynts consisting of two large Superficies, Concave and Convex, some furrowed and ridged, some like a Ball and Socket, and all lubricated with an oily Substance, they are incomparably prepared both for Motion and Strength. 2. That the Bones next the Joynt are not spungy, as their Extremities commonly are, nor hard and brittle; but capped with a strong, tough, smooth cartilaginous Substance, serving both to Strength and Motion.

But let us here take notice of what *Galen* mentions on this Subject. *Articulorum unusquisque Eminentiam Cavitati immissam habet. Veruntamen hoc fortasse non adeo mirabile est, sed si consideratâ omnium totius corporis ossium mutuâ connexione, Eminentias cavitatibus suscipientibus æquales semper inveneris, Hoc mirabile. Si enim justo amplior esset Cavitas, laxus sanè & infirmus fieret Articulus: si strictior, motus difficulter fieret, ut qui nullam versionem haberet, ac periculum esset non parvum, eminentias ossium arctatas frangi: sed horum neutrum factum est.——Sed quoniam ex tam secura constructione periculum erat, ne motiones difficilius fierent, & eminentiæ ossium extererentur, duplex rursus auxilium in id Natura molita est. 1. Cartilagine os utrumque subungens, atque oblinens: alterum, ipsis Cartilaginibus humorem unctuosum, velut oleum superfundens; per quem facilè mobilis, & attritu contumax omnis articulatio Ossium facta est.——Ut undique diligenter Articulus omnis custodiretur, Ligamenta quædam ex utroque osse produxit Natura.* Galen de Us. Part. l. 1. c. 15.

(‖) For the affording this oily or mucilaginous Matter, there are *Glandules* very commodiously placed near the Joynts, so as not too suffer to great Compression by the Motion of the neighbouring

and their own Smoothneſs to facilitate their Motion.

And laſtly, I might trace the various Nerves throughout the Body, ſent about to miniſter to its various Motions (5). I might conſider their Origine (6), their Ramifications to the ſeveral Parts, and their Inoſculations with one another, according to the Harmony and Accord of one part with another, neceſſary for the benefit of the Animal. But ſome of thoſe things I have given ſome touches upon already, and more I ſhall mention hereafter (7), and it would be tedious here to inſiſt upon them all.

I ſhall

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bouring Bones, and yet to receive a due Preſſure, ſo as to cauſe a ſufficient emiſſion of the Mucilage into the Joynts. Alſo another thing conſiderable is, that the excretory Ducts of the *mucilaginous Glands* have ſome length in their Paſſage from the Glands to their Mouths; which is a good Contrivance to prevent their Mouths being oppreſſed by the Mucilage, as alſo to hinder the too plentiful Effuſion thereof, but yet to afford a due expreſſure of it at all times, and on all occaſions, as particularly in violent and long-continued Motions of the Joynts, when there is a greater than ordinary expence of it. See *Cowper's Anat. Tab.* 79

(5) There is no doubt to be made, but that the Muſcles receive their Motion from the Nerves. For if a Nerve be cut, or ſtraightly bound, that goes to any Muſcle, that Muſcle ſhall immediately looſe its Motion. Which is doubtleſs the caſe of Paralyticks; whoſe Nerves are ſome of them by Obſtructions, or ſuch like Means reduced to the ſame State as if cut, or bound.

Neither is this a modern Notion only: for *Galen* ſaith, *Principium Nervorum omnium Cerebrum eſt, & Spinalis Medulla.* —— *Et Nervi a Cerebro animalem vlrtutem accipiunt.* —— *Nervorum utilitas eſt facultatem Senſûs & Motûs a principio in partes diducere.* And this he intimates to have been the Opinion of *Hippocrates* and *Plato.* De Uſ. Part. l. 1. c. 16. *& paſſim.*

(6) Dr. *Willis* thinks, that in the *Brain* the Spirits are elaborated that miniſter to voluntary Motion: but in the *Cerebellum*, ſuch as effect involuntary, or natural Motions; ſuch as that of the Heart, the Lungs, *&c. Cerebri Anat.* c. 15.

(7) See *Book V. Chap.* 8.

I ſhall therefore only ſpeak diſtinctly to the Locomotive Act it ſelf, or what directly relates to it. And here it is admirable to conſider the various Methods of Nature (8), ſuited to the Occaſions of the various Animals. In ſome their Motion is ſwift, in others ſlow. In ſome performed with two, four, or more Legs: in ſome with two or four Wings: in ſome with neither (9).

And firſt for ſwift or ſlow Motion. This we find is proportional to the Occaſions of each reſpective Animal. *Reptiles*, whoſe Food, Habitation, and Neſts, lie in the next Clod, Plant, Tree, or Hole, or can bear long Hunger and Hardſhip, they need neither Legs, nor Wings for their Tranſportation; but their vermicular, or finuous Motion, (performed with no leſs Art, and as curiouſly provided for, as the Legs or Wings of other Creatures; this, I ſay,) is ſufficient for their Conveyance.

Man

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(8) To the foregoing, I ſhall briefly add ſome Examples of the ſpecial Proviſion made for the Motion of ſome Animals by *Temporary Parts*. *Frogs* and *Toads* in their *Tadpole-ſtate* have Tails, which fall off when their Legs are grown out. The *Lacerta aquatica*, or *Water-Newt*, when Young, hath four neat ramified Fins, two on a ſide, growing out a little above its Fore-Legs, to poiſe, and keep its Body upright, (which gives it the reſemblance of a young Fiſh,) which fall off when the Legs are grown. And the *Nymphæ* and *Aureliæ* of all or moſt of the Inſects bred in the Waters, as they have particular Forms, different from the Inſects they produce; ſo have alſo peculiar Parts afforded them for their Motion in the Waters, Oars, Tails, and every Part adapted to the Waters, which are utterly varied in the Inſects themſelves in their *mature State* in the Air.

(9) *Jam vero alia animalia gradiendo, alia ſerpendo ad paſtum accedunt, alia volando, alia nando.* Cicer. de Nat. Deor. l. 2. c. 47.

Compare alſo what *Galen* obſerves concerning the Number of Feet in Man, and in other Animals; and the wiſe Proviſion thereby made for the Uſe and Benefit of the reſpective Animals. *De Uſu Par.* in the beginning of the third Book.

(10) As

Man and *Beasts*, whose Occasions require a large Room, have accordingly a swifter Motion, with proper Engines for that Service; answerable to their range for Food, their Occupation or Business, or their want of Armature, and to secure them against Harms (10).

But for the winged Creatures, (Birds and Insects,) as they are to traverse large Tracts of Land, and Water, for their Food, for their commodious Habitation, or Breeding their Young, to find places of Retreat and Security from Mischiefs; so they have accordingly the Faculty of flying in the Air; and that swiftly or slowly, a long or a short time, according to their Occasions and Way of Life. And accordingly their Wings, and whole Body are curiously prepared for such a Motion; as I intend to shew in proper place (11).

Another remarkable thing in the motive Faculty of all Creatures, is the neat, geometrical Performance of it. The most accurate Mathematician, the most skilful in mechanick Motions, can't prescribe a nicer Motion (than what they perform) to the Legs and Wings of those that walk or fly (12), or to the Bodies of those that creep (13). Neither can the Body be more compleatly poised for the Motion

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(10) As I shall hereafter shew, that the indulgent Creator hath abundantly provided for the safety of Animals by their Cloathing, Habitations, Sagacity and Instruments of Defence; so there appears to be a Contemperament of their *Motion* with these Provisions. They that are well-armed and guarded, have commonly a slower Motion; whereas they that are destitute thereof, are swifter. So also timid helpless Animals are commonly swift; thus Deers and Hares: but Animals endowed with Courage, Craft, Arms, *&c.* commonly have a slower Motion.

(11) See *Book VII. Chap.* 1.

(12) See *Book VII. Chap.* 1. the end.

(13) See *Book IX. Note* 3.

Motion it is to have in every Creature, than it already actually is. From the largeſt Elephant to the ſmalleſt Mite, we find the Body artfully ballanced (14). The Head not too heavy, nor too light for the reſt of the Body, nor the reſt of the Body for it (15). The Viſcera not left looſe, or ſo placed, as to ſwag, over-balance, or over-ſet the Body; but well-braced, and diſtributed to maintain the æquipoiſe of the Body. The motive Parts alſo are admirably well-fixed in reſpect to the Center of Gravity; placed in the very Point, fitteſt to ſupport and convey the Body. Every Leg beareth his true ſhare of the Body's Weight. And the Wings ſo nicely are ſet to the Center of Gravity, as even in that fluid Medium, the Air, the Body is as truly ballanced, as we could have ballanced it with the niceſt Scales.

But among all Creatures, none more elegant than the ſizing the Body of *Man*, the gauging his Body ſo nicely, as to be able to Stand erect, to Stoop,

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(14) *Siquis unquam alius Opifex, æqualitatis & proportionis magnam habuit providentiam, certè Natura habuit in animalium corporibus conformandis; unde Hippocrates eam rectiſſimè juſtam nominat.* Galen de Uſ. Part. l. 2. c. 16.

(15) The Make of the Bodies of ſome Water Fowls, ſeems to contradict what I here ſay, the Heads and long Necks of ſome, as of Swans, Ducks, and Geeſe; and the hinder Parts of others, as of the Doucker and More-Hen, and ſome other kinds, ſeeming to be too heavy for the reſt of their Body. But inſtead of being an Argument againſt, it is a notable Inſtance of the divine Art and Providence, theſe things being nice Accommodations to their way of Life. Of ſuch as have long Necks, ſee *Book VII. Chap.* 3. *Note* 9.

And as for ſuch whoſe hinder Parts ſeem to over-balance their foremoſt Parts, whereby they fly with their Bodies in a manner erect, this alſo is an excellent Accommodation to their way of Life, which is Diving, rather than Flying. *Vid. Book VII. Chap.* 4. *Note* 9.

(16) See

Stoop, to Sit, and indeed to Move any way, only with the help of ſo ſmall a Stay as the Feet (16): whoſe Mechaniſm of Bones, Tendons and Muſcles to this purpoſe, is very curious, and admirable.

CHAP. IX.

Of the Place allotted to the ſeveral Tribes of Animals.

HAving diſpatched the Motion of Animals, let us in the next place conſider the *Place* which the infinitely wiſe Creator hath appointed them to Move and Act, and Perform the Offices of the Creation in. And here we find every Particular well ordered. All Parts of our Terraqueous Globe fit for an Animal to live and act in, are ſufficiently ſtocked with proper Inhabitants: The watery Element (unfit one would think for Reſpiration and Life) abounding with Creatures fitted for it: its Bowels abundantly ſtored, and its Surface well beſpread. The Earth alſo is plentifully ſtocked in all its Parts, where Animals can be of any Uſe: not probably the deepeſt Bowels thereof indeed, being Parts in all likelihood unfit for Habitation and Action, and where a living Creature would be uſeleſs in the World; but the Surface every where abundantly ſtored.

But that which is moſt conſiderable in this Matter, and plainly ſheweth the divine Management in the Caſe, is, that thoſe Creatures are manifeſtly deſigned for the Place in which they are, and the Uſe

(16) See *Book V. Chap.* 2. *Note* 8.

Uſe and Services they perform therein. If all the Animals of our Globe had been made by Chance, or placed by Chance, or without the divine Providence, their Organs would have been otherwiſe than they are, and their Place and Reſidence confuſed and jumbled. Their Organs (for Inſtance) of Reſpiration, of Viſion, and of Motion would have fitted any Medium, or have needed none; their Stomachs would have ſerved any Food, and their Blood, and Covering of their Bodies been made for any Clime, or only one Clime. Conſequently all the Animal World would have been in a confuſed, inconvenient, and diſorderly Commixture. One Animal would have wanted Food, another Habitation, and moſt of them Safety. They would have all flocked to one, or a few Places, taken up their Reſt in the Temperate Zones only, and coveted one Food, the eaſieſt to be come at, and moſt ſpecious in ſhew; and ſo would have poiſoned, ſtarved, or greatly incommoded one another. But as the matter is now ordered, the Globe is equally beſpread, ſo that no place wanteth proper Inhabitants, nor any Creature is deſtitute of a proper place, and all things neceſſary to its Life, Health, and Pleaſure. As the Surface of the Terraqueous Globe is beſpread with different Soils, with Hills, and Vales, with Seas, Rivers, Lakes, and Ponds, with divers Trees and Plants, in the ſeveral Places; ſo all theſe have their Animal Inhabitants, whoſe Organs of Life and Action are manifeſtly adapted to ſuch and ſuch Places and Things; whoſe Food and Phyſick, and every other Convenience of Life, is to be met with in that very Place appointed it. The Watery, the Amphibious (†), the airy Inhabitants, and thoſe on the

(†) *Eſt etiam admiratio nonnulla in Beſtiis aquatilibus iis, quæ gignuntur in terrâ: veluti Crocodili, fluviatileſque Teſtudines, quædamque*

the Dry-land Surface, and the Subterraneous under it, they all Live and Act with Pleasure, they are gay, and flourish in their proper Element, and allotted Place, they want neither for Food, Cloathing, or Retreat; which would dwindle and die, destroy, or poison one another, if all coveted the same Element, Place, or Food.

Nay, and as the Matter is admirably well ordered, yet considering the World's encrease, there would not be sufficient Room, Food, and other Necessaries for all the living Creatures, without another grand Act of the divine Wisdom and Providence, which is the *Ballancing the Number of Individuals* of each Species of Creatures in that place appointed thereto: Of which in the next Chapter.

CHAP. X.

Of the Balance of Animals, or their due Proportion wherewith the World is stocked.

THE whole Surface of our Globe can afford Room, and Support only to such a number of all sorts of Creatures. And if by their doubling, trebling, or any other Multiplication of their Kind, they should encrease to double or treble that number, they must starve, or devour one another. The keeping

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damque Serpentes ortæ extra aquam, simul ac primùm niti possunt, aquam persequuntur. Quin etiam Anatum ova Gallinis sæpe supponimus — [Pulli] *deinde eas* [matres] *relinquunt* — *& effugiunt, cùm primùm aquam, quasi naturalem domum, videre potuerunt.* Cicer. de Nat. Deor. l. 2. c. 48.

(1) *Be-*

keeping therefore the Balance even is manifeſtly a Work of the Divine Wiſdom and Providence. To which end, the great Author of Life hath determined the Life of all Creatures to ſuch a Length, and their Increaſe to ſuch a Number, proportional to their Uſe in the World. The Life of ſome Creatures is long, and their Increaſe but ſmall, and by that means they do not over-ſtock the World. And the ſame Benefit is effected, where the Increaſe is great, by the Brevity of ſuch Creature's Lives, by their great Uſe, and the frequent Occaſions there are of them for Food to Man, or other Animals. It is a very remarkable Act of the Divine Providence, that uſeful Creatures are produced in great plenty (1), and others in leſs. The prodigious and frequent Increaſe of Inſects, both in and out of the Waters, may exemplify the one: and 'tis obſervable in the other, that Creatures leſs uſeful, or by their voracity pernicious, have commonly fewer Young, or do ſeldomer bring forth. Of which many inſtances might be given in the voracious Beaſts and Birds. But there is one ſo peculiar an Animal, as if made for a particular inſtance in our preſent caſe, and that is the *Cuntur* of *Peru* (2); a Fowl of that Magnitude, Strength, and Appetite, as to ſeize not only on the Sheep, and leſſer Cattel, but even the

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(1) *Benigna circa hoc Natura, innocua & eſculenta animalia fœcunda generavit.* Plin. Nat. Hiſt. l. 8. c. 55.

(2) *Captain* J. Strong, *gave me this Account, together with a Quill-Feather of the* [Cuntur *or* Condore *of* Peru] *on the Coaſt of* Chili, *they met with this Bird in about* 33° *S. Lat. not far from* Mocha, *an Iſland in the South-Seas,——they ſhot it ſitting on a Cliff, by the Sea-ſide; that it was* 16 *Feet from Wing to Wing extended: that the* Spaniſh *Inhabitants told them they were afraid of theſe Birds, leſt they ſhould prey upon their Children. And the Feather he gave me* (ſaith the Doctor) *is* 2 *Foot,* 4 *Inches long; the Quill part* 5¾ *Inches long, and* 1½ *Inch about in the largeſt*

the larger Beasts, yea, the very Children too. Now these as they are the most pernicious of Birds, so are the most rare, being seldom seen, or only one, or a few in large Countries; enough to keep up the Species, but not to over-charge the World.

Thus the Balance of the Animal World is throughout all Ages kept even, and by a curious Harmony, and just Proportion between the increase of all Animals, and the length of their Lives, the World is through all Ages well, but not over-stored. *One Generation passeth away, and another Generation cometh* (3), so equally in it's Room, to balance the Stock of the Terraqueous Globe in all Ages, and Places, and among all Creatures, that it is an actual Demonstration of our Saviour's Assertion, *Matt.* 10. 29. that the most inconsiderable, common Creature,

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largest Part. It weighed 3 *dr.* 17½ *gr. and is of a dark brown Colour.* Dr. *Sloane* in Phil. Trans. Nr. 208.

To this Account the Doctor (in a Letter to Mr. *Ray*, *Mar.* 31. 1694. with other Papers of Mr. *Ray's* in my Hands) adds the Testimony of *Jos. Acosta*, l. 4. c. 37. and *Garcilasso de la Vega*, who l. 8. c. 19. saith, *There are other Fowls, called* Cuntur, *and by the* Spaniards *corruptly* Condor. *Many of these Fowls having been killed by the* Spaniards, *had their Proportion taken, and from end to end of their Wings measured* 15 *or* 16 *Feet.*——— *Nature to temper and allay their Fierceness, denied them the Talons, which are given to the* Eagle; *their Feet being tipt with Claws like an* Hen. *However their Beak is strong enough to tear off the Hide, and rip up the Bowels of an* Ox. *Two of them will attempt a* Cow or Bull, *and devour him. And it hath often happened, that one of them alone hath assaulted Boys of ten or twelve Years of Age, and eaten them. Their Colour is black and white like a* Magpie. *It is well there are but few of them, for if they were many, they would very much destroy the Cattle. They have on the forepart of their Heads a Comb, not pointed like that of a* Cock, *but rather even in the form of a Razour. When they come to alight from the Air, they make such an humming Noise with the fluttering of their Wings, as is enough to astonish, or make a Man deaf.*

(3) Eccles. 1. 4.

(4) The

Creature, *even a Sparrow (two of which are ſold for a Farthing) doth not fall on the Ground without our Heavenly Father.*

This Providence of God is remarkable in every Species of living Creatures: but that eſpecial Management of the Recruits and Decays of Mankind, ſo equally all the World over, deſerves our eſpecial Obſervation. In the beginning of the World, and ſo after *Noah*'s Flood, the Longævity of Men, as it was of abſolute Neceſſity to the more ſpeedy peopling of the new World, ſo is a ſpecial Inſtance of the Divine Providence in this Matter (4). And the ſame Providence appears in the following Ages, when

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(4) The Divine Providence doth not only appear in the Longævity of Man immediately after the Creation and Flood; but alſo in their different Longævity at thoſe two times. Immediately after the Creation, when the World was to be peopled by one Man, and one Woman, the Age of the greateſt part of thoſe on Record was 900 Years and upwards. But after the Flood, when there were three Perſons by whom the World was to be peopled, none of thoſe Patriarchs, except *Shem*, arrived to the Age of 500; and only the three firſt of *Shem*'s Line, *viz. Arphaxad*, *Salah*, and *Eber*, came near that Age; which was in the firſt Century after the Flood. But in the ſecond Century, we do not find any reached the Age of 240. And in the third Century, (about the latter end of which *Abraham* was born,) none, except *Terah*, arrived to 200 Years. By which time the World was ſo well peopled, (that part of it at leaſt where *Abraham* dwelt,) that they had built Cities, and began to be cantoned into diſtinct Nations, and Societies, under their reſpective Kings; ſo that they were able to wage War, four Kings againſt five, *Gen.* 14. Nay, if the Accounts of *Anian*, *Beroſus*, *Manetho*, and others, yea *Africanus* be to be credited, the World was ſo well peopled even before the times we ſpeak of, as to afford ſufficient Numbers for the great Kingdoms of *Aſſyria*, *Ægypt*, *Perſia*, &c. But learned Men generally, with great reaſon, reject theſe as legendary Accounts.

If the Reader hath a mind to ſee a Computation of the increaſe of Mankind in the three firſt Centuries after the Flood, he may find two different ones of the moſt learned Archbiſhop *Uſher*,

when the World was pretty well peopled, in reducing the common Age of Man then to 120 Years, (*Gen.* 6. 3.) in proportion to the Occasions of the World at that time. And lastly, when the World was fully peopled after the Flood, (as it was in the Age of *Moses*, and so down to our present time,) the lessening the common Age of Man to 70 or 80 Years (5), (the Age mentioned by *Moses*, Psal. 90. 10; this, I say,) is manifestly an appointment of the

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Usher, and *Petavius*, together with a Refutation of the so early beginning of the *Assyrian Monarchy*, as also Reasons for placing *Abraham* near 1000 Years after the Flood in our most learned Bishop *Stillingfleet's Orig. Sacr.* Book III. Chap. 4. §. 9.

(5) That the common Age of Man hath been the same in all Ages since the World was peopled, is manifest from prophane, as well as sacred History. To pass by others, *Plato* lived to the Age of 81, and was accounted an old Man. And those which *Pliny* reckons up, *l.* 7. *c.* 48. as rare Examples of long Life, may for the most part be matched by our modern Histories, especially such as *Pliny* himself gave credit unto. Dr. *Plot* hath given us divers Instances in his History of *Oxon. C.* 2. §. 3. and *Chap.* 8. §. 54. and History of *Staffordshire*, c. 8. §. 91, *&c.* Among others, one is of twelve Tenants of Mr. *Biddulphs*, that together made 1000 Years of Age. But the most considerable Examples of aged Persons among us, is of old *Parre* of *Shropshire*, who lived 152 Years 9 Months, according to the learned Dr. *Harvey*'s Account; and *Henry Jenkins* of *Yorkshire*, who lived 169 Years, according to the Account of my learned and ingenious Friend Dr. *Tancred Robinson*: of both which, with others, see *Lowth. Abridg. Phil. Transf. V.* 3. *p.* 306. The great Age of *Parre* of *Shropshire*, minds me of an Observation of the Reverend Mr. *Plaxton*, that in his two Parishes of *Kinardsey* and *Donington* in *Shropshire* likewise, every sixth Soul was 60 Years of Age or upwards. *Phil. Transf. Nr.* 310.

And if we step farther North into *Scotland*, we shall find divers recorded for their great Age. Of which I shall present the Reader with only one modern Example of one *Laurence*, who married a Wife after he was 100 Years of Age, and would go out to Sea a Fishing in his little Boat, when he was 140 Years old; and is lately dead of no other Distemper, but meer old Age, saith Sir *Rob. Sibbald Prodr. Hist. Nat. Scot.* p. 44, and l. 3. p. 4.

As

the ſame infinite Lord that ruleth the World. For, by this means the peopled World is kept at a convenient Stay, neither too full, nor too empty. For if Men (the generality of them I mean) were to live now to *Methuſalah*'s Age of 969 Years, or only to *Abraham*'s, long after the Flood, of 175 Years, the World would be too much over-run. Or if the Age of Man was limited to that of divers other Animals, to ten, twenty, or thirty Years only, the decays then of Mankind would be too faſt. But at the middle Rate mentioned, the Balance is nearly even, and Life and Death keep an equal pace. Which equality is ſo great and harmonious, and ſo

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As for Foreigners, the Examples would be endleſs, and therefore that of *Joh. Ottele* ſhall ſuffice, who was as famous for his Beard, as for being 115 Years of Age. He was but two Brabant Ells $\frac{3}{4}$ high; and his long grey Beard was $1\frac{1}{4}$ Ell long. His Picture and Account may be ſeen in *Ephem. Germ. T.* 3. *Obſ.* 163.

As for the Story *Roger Bacon* tells of one that lived 900 Years by the help of a certain Medicine; and many other ſuch Stories, I look upon them as fabulous. And no better is that of the *Wandering-Jew*, named *Joh. Buttadeus*, ſaid to have been preſent at our Saviour's Crucifixion; although very ſerious Stories are told of his being ſeen at *Antwerp*, and in *France*, about the middle of the laſt Century but one; and before in A° 1542. converſed with by *Paul* of *Eitſen*, Biſhop of *Sleſwick*; and before that, *viz.* in 1228, ſeen and converſed with by an *Armenian Archbiſhop's Gentleman*; and by others at other times.

If the Reader hath a mind to ſee more Examples, he may meet with ſome of all Ages in the learned *Hakewill's Apol.* p. 181. where he will alſo find that learned Author's Opinion of the Cauſes of the Brevity and Length of Humane Life. The Brevity thereof he attributeth to a too tender Education, ſucking ſtrange Nurſes, too haſty Marriages, but above all to Luxury, high Sauces, ſtrong Liquors, *&c.* The Longævity of the Ancients he aſcribes to Temperance in Meat and Drink, anointing the Body, the uſe of Saffron and Honey, warm Cloths, leſſer Doors and Windows, leſs Phyſick, and more Exerciſe.

(6) The

ſo manifeſt an Inſtance of the Divine Management, that I ſhall ſpend ſome Remarks upon it.

It appears from our beſt Accounts of theſe matters, that in our *European* Parts (6), (and I believe the ſame is throughout the World; that, I ſay,) there is a certain Rate or Proportion in the Propagation of Mankind. Such a number Marry (7), ſo many are Born, ſuch a number Die; in proportion

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(6) The Proportions which *Marriages* bear to *Births*, and *Births* to *Burials* in divers parts of *Europe*, may be ſeen at an eaſy View in this Table: which

Names of the Places.	Marriages to Births: As	Births to Burials: As
England in general.	1 to 4'63	1'12 to 1
London.	1 to 4'	1 to 1'1
Hantſhire, from 1569 to 1658.	1 to 4'	1'2 to 1
Tiverton in *Devonſhire*, 1560 to 1664.	1 to 3'7	1'26 to 1
Cranbrook in *Kent*, 1560 to 1649.	1 to 3'9	1'6 to 1
Aynho in *Northamptonſhire*, for 118 Years.	1 to 6	1'6 to 1
Upminſter in *Eſſex*, for 100 Years	1 to 4'6	1'08 to 1
Frankfort on the *Main* in 1695.	1 to 3'7	1'2 to 1
Old, Middle, and Lower *March* in 1698	1 to 3'7	1'9 to 1
Dominions of *E.* of *Brandenburgh* in 1698.	1 to 3'7	1'5 to 1
Breſlaw in *Sileſia*, from 1687 to 91.		1'6 to 1
Paris in 1670, 1671, and 1672.	1 to 4'7	1'6 to 1

Table I made from Major *Graunt*'s Obſervations on the Bills of Mortality, Mr. *King*'s Obſervations in the firſt of Dr. *Davenant's Eſſays*, and what I find put together by my ingenious Friend Mr. *Lowthorp*, in his *Abridgment*, *Vol.* 3. *p.* 668. and my own Regiſter of *Upminſter*. That from *Aynho* Regiſter in *Northamptonſhire*, I had from the preſent Rector, the learned and ingenious Mr. *Waſſe*: and I was promiſed ſome Accounts from the North, and divers other Parts of this Kingdom, but have not yet received them.

(7) The preceding Table ſhews, that Marriages, one with another, do each of them produce about four Births, not only in *England*, but in other Parts of *Europe* alſo.

And

tion to the number of Perſons in every Nation, County, or Pariſh. And as to Births, two things are very conſiderable: One is the proportion of Males and Females (8), not in a wide Proportion, not

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And by Mr. *King*'s Eſtimate, (the beſt Computations I imagine of any, being derived from the beſt Accounts, ſuch as the Marriage, Birth, and Burial Act, the Poll-Books, *&c* by his eſtimate, I ſay,) about 1 in 104 marry. For he judgeth the number of the People in *England*, to be about five Millions and an half; of which about 41000 annually marry.

As to what might be farther remarked concerning Marriages, in regard of the Rights and Cuſtoms of ſeveral Nations, the Age to which divers Nations limited Marriage, *&c.* it would be endleſs, and too much out of the way to mention them. I ſhall only therefore, for the Reader's Diverſion, take notice of the Jeer of *Lactantius*, *Quare apud Poetas ſalaciſſimus Jupiter deſiit liberos tollere? Utrum ſexagenarius factus & ei Lex Papia fibulam impoſuit?* Lactant. Inſtit. l. 1. c. 16. By which *Lex Papia* Men were prohibited to marry after 60, and Women after 50 Years of Age.

(8) Major *Graunt*, (whoſe Concluſions ſeem to be well-grounded,) and Mr. *King*, diſagree in the Proportions they aſſign to Males and Females. This latter makes in *London*, 10 Males to be to 13 Females; in other Cities and Market-Towns, 8 to 9; and in the Villages and Hamlets 100 Males to 99 Females. But Major *Graunt*, both from the *London* and Country Bills ſaith, there are 14 Males to 13 Females. From whence he juſtly infers, *That Chriſtian Religion, prohibiting Polygamy, is more agreeable to the Law of Nature, than Mahumetiſm, and others, that allow it.* Chap. 8.

This Proportion of 14 to 13, I imagine is nearly juſt, it being agreeable to the Bills I have met with, as well as thoſe in Mr. *Graunt*. In the 100 Years, for example, of my own Pariſh-Regiſter, although the Burials of Males and Females were nearly equal, being 633 Males, and 623 Females in all that time; yet there were baptized 709 Males, and but 6[illegible]5 Females, which is 13 Females to 13'7 Males. Which inequality ſhews, not only, that one Man ought to have but one Wife, but alſo that every Woman may, without Polygamy, have an Husband, if ſhe doth not bar her ſelf by the want of Vertue, by Denial, *&c.* Alſo this Surpluſage of Males is very uſeful for the Supplies of War, the Seas, and other ſuch expences of the Men above the Women.

That

not an uncertain, accidental Number at all Adventures, but nearly equal. Another thing is, that a few more are Born than appear to Die, in any certain place (9). Which is an admirable Provision for the extraordinary Emergencies and Occasions of the World; to supply unhealthful Places, where Death out-runs Life; to make up the Ravages of great Plagues, and Disease, and the Depredations of War, and the Seas; and to afford a sufficient Number for Colonies in the unpeopled Parts of the

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That this is a Work of the Divine Providence, and not a Matter of Chance, is well made out by the very Laws of Chance, by a Person able to do it, the ingenious and learned Dr. *Arbuthnot*. He supposeth *Thomas* to lay against *John* that, for eighty-two Years running, more Males shall be born than Females: and giving all Allowances in the Computation to *Thomas*'s side, he makes the odds against *Thomas*, that it doth not happen so, to be near five Millions of Millions, of Millions, of Millions to one: but for Ages of Ages, (according to the World's Age,) to be near an infinite Number to one against *Thomas*. *Vid. Philos. Transf. Nr.* 328.

(9) The foregoing Table shews that, in *England* in general, fewer Die than are Born, there being but 1 Death to $1\frac{12}{100}$ Births. But in *London* more Die than are Born. So by Dr. *Davenant*'s Tables, the Cities likewise and Market-Towns bury $1\frac{7}{100}$ to one Birth. But in *Paris* they out-do *London*, their Deaths being $1\frac{1}{4}$ to one Birth: the reason of which I conceive is, because their Houses are more crouded than in *London*. But in the Villages of *England*, there are fewer Die than are Born, there being but 1 Death to $1\frac{17}{100}$ Births. And yet Major *Graunt*, and Dr. *Davenant* both observe, that there are more Breeders in *London*, and the Cities and Market-Towns, than are in the Country, notwithstanding the *London* Births are fewer than the Country; the reason of which see in *Graunt*, *Chap.* 7. and *Davenant ubi supr.* p. 21.

The last Remark I shall make from the foregoing Table shall be, that we may from thence judge of the healthfulness of the places there mentioned. If the Year 1698 was the mean Account of the three *Marcks*, those places bid the fairest for being most healthful; and next to them *Aynho* and *Cranbrook* for *English* Towns.

Earth. Or on the other hand we may ſay, that ſometimes thoſe extraordinary Expences of Mankind may be not only a juſt Puniſhment of the Sins of Men, but alſo a wiſe Means to keep the Balance of Mankind even; as one would be ready to conclude by conſidering the *Aſiatick*, and other the more fertile Countries, where prodigious Multitudes are yearly ſwept away with great Plagues and ſometimes War, and yet thoſe Countries ſo far from being waſted, that they remain full of People.

And now upon the whole Matter, what is all this but admirable and plain Management? What can the maintaining throughout all Ages and Places theſe Proportions of Mankind, and all other Creatures, this Harmony in the Generations of Men, be but the Work of one that ruleth the World! Is it poſſible that every Species of Animals ſhould ſo evenly be preſerved, proportionate to the Occaſions of the World? That they ſhould be ſo well balanced in all Ages and Places, without the help of Almighty Wiſdom and Power! How is it poſſible by the bare Rules, and blind Acts of Nature, that there ſhould be any tolerable Proportion; for Inſtance, between Males and Females, either of Mankind, or of any other Creature (10), eſpecially ſuch as are of a Ferine, not a Domeſtick Nature, and conſequently out of the command and management of Man! How could Life and Death keep ſuch an even pace through all the Animal World! If we ſhould take it for granted, that, according to the Scripture-Hiſtory, the World had a Be-

(10) *Quid loquar, quanta ratio in beſtiis ad perpetuam conſervationem earum generis appareat? Nam primùm aliæ Mares, aliæ Fœminæ ſunt, quod perpetuitatis causâ machinata natura eſt.* Cicer. de Nat. Deor. L. 2.

(11) Although

a Beginning, (as who can deny it) (11), or if we ſhould ſuppoſe the Deſtruction thereof by *Noah's Flood*: How is it poſſible, (after the World was repleniſhed,) that in a certain Number of Years, by the greater Increaſes and Doublings of each Species of Animals; that (I ſay) this Rate of *Doubling* (12) ſhould ceaſe; or that it ſhould be compenſated by ſome other means! That the World ſhould be as well,

(11) Although *Ariſtotle* held the Eternity of the World, yet he ſeems to have retracted that Opinion, or to have had a different Opinion when he wrote his *Metaphyſicks*; for in his firſt Book, he affirms, that *God is the Cauſe and Beginning of all things*: and in his Book *de Mundo*, he ſaith, *There is no doubt but God is the Maker and Conſervator of all things in the World*. And the *Stoicks* Opinion is well known, who ſtoutly aſcribed the Contrivance and Beauty of the Heavens, and Earth, and all Creatures to a wiſe intelligent Agent. Of which *Tully* gives a large Account in his ſecond Book *De Nat. Deor.* in the Perſon of *Balbus*.

(12) I have before in *Note* 7. obſerved, that the ordinary Rate of the Doubling or Increaſe of Mankind is, that every Marriage one with another produces about four Births; but ſome have much exceeded that. *Babo*, Earl of *Abenſperg*, had thirty-two Sons and eight Daughters, and being invited to Hunt with the Emperor, *Henry* II. and bring but few Servants, brought only one Servant, and his thirty-two Sons. To theſe many others might be added; but one of the moſt remarkable Inſtances I have any where met with, is that of Mrs. *Honywood*, mentioned by *Hakewil*, *Cambden*, and other Authors; but having now before me the Names, with ſome Remarks, (which I received from a pious neighbouring Deſcendant from the ſame Mrs. *Honywood*,) I ſhall give a more particular Account than they. Mrs. *Mary Honywood*, was Daughter, and one of the Co-Heireſſes of *Robert Atwaters*, Eſq; of *Lenham* in *Kent*. She was Born in 1527; Married in *February* 1543. at ſixteen Years of Age, to her only Husband *Robert Honywood*, of *Charing* in *Kent*, Eſquire. She Died in the ninety-third Year of her Age, in *May* 1620. She had ſixteen Children of her own Body, ſeven Sons, and nine Daughters; of which one had no Iſſue, three died young, and the youngeſt was Slain at *Newport-Battle*, *June* 20. 1600. Her Grand-Children in the ſecond Generation were One Hundred and Fourteen; in the

well, or better ſtocked than now it is, in 1656 Years, (the time between the Creation and the Flood, this) we will ſuppoſe may be done by the natural Methods of each Species Doubling or Increaſe: But in double that number of Years, or at this Diſtance from the Flood, of 4000 Years, that the World ſhould not be over-ſtocked, can never be made out, without allowing an infinite Providence.

I conclude then this Obſervation with the Pſalmiſts Words, *Pſal.* 104. 29, 30. *Thou hideſt thy Face, all Creatures are troubled, thou takeſt away their Breath, they Die, and return to their Duſt. Thou ſendeſt forth thy Spirit, they are Created, and thou reneweſt the Face of the Earth.*

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third Two Hundred and Twenty-eight; and Nine in the fourth Generation. So that ſhe could ſay the ſame that the Diſtick doth, made of one of the *Dalburg*'s Family of *Baſil.*

1 2 3 4
Mater ait Natæ, die Natæ, filia Natam
5 6
Ut moneat, Natæ plangere Filiolam.

1 2 3 4
Riſe up Daughter, and go to thy Daughter, for her Daughters
5 6
Daughter hath a Daughter. Mrs. *Honywood* was a very pious Woman, afflicted in her declining Age with Deſpair, in ſome meaſure; concerning which, ſome Divines once diſcourſing with her, ſhe in a Paſſion ſaid, *She was as certainly damned as this Glaſs is broken*, throwing a *Venice*-Glaſs againſt the Ground, which ſhe had then in her Hand. But the Glaſs eſcaped breaking, as credible Witneſſes atteſted.

CHAP.

CHAP. XI.

Of the Food of Animals.

THE preceding Reflection of the Pſalmiſt mindeth me of another thing in common to Animals, that pertinently falleth next under Conſideration, which is the *Appointment of Food*, mentioned in ver. 27, 28, of the laſt cited 104 *Pſalm. Theſe* [Creatures] *wait all upon thee: that thou mayſt give them their Meat in due Seaſon. That thou giveſt them, they gather: thou openeſt thy hand, they are filled with good.* The ſame is again aſſerted in *Pſal.* 145. 15, 16. *The Eyes of all wait upon thee, and thou giveſt them their Meat in due Seaſon. Thou openeſt thy hand; and ſatisfyeſt the deſire of every living thing.*

What the Pſalmiſt here aſſerts, affords us a glorious Scene of the Divine Providence and Management. Which, (as I have ſhewed it to concern it ſelf in leſſer things,) ſo we may preſume doth exert it ſelf particularly in ſo grand an Affair as that of Food, whereby the Animal World ſubſiſts. And this will be manifeſted, and the *Pſalmiſt*'s Obſervations exemplified from theſe ſix following Particulars.

1. From the ſubſiſting and maintaining ſuch a large Number of Animals throughout all Parts of the World.

2. From the proportionate Quantity of Food to the Eaters.

3. From the variety of Food ſuited to the variety of Animals: or the delight which various Animals have in different Food.

4. From the peculiar Food which peculiar Places afford to the Creatures ſuited to thoſe Places.

5. From the admirable and curious Apparatus made for the gathering, preparing, and digeſtion of the Food. And,

6. and laſtly, From the great Sagacity of all Animals in finding out, and providing their Food.

1. It is a great Act of the Divine Power and Wiſdom, as well as Goodneſs, to provide Food for ſuch a World of Animals (1), as every where poſſeſs the Terraqueous Globe; on the Dry-land, and in the Seas and Waters; in the Torrid and Frozen Zones, as well as the Temperate. That the Temperate Climates, or at leaſt the fertile Valleys, and rich and plentiful Regions of the Earth ſhould afford Subſiſtence to many Animals may appear leſs wonderful perhaps. But that in all other the moſt unlikely places for Supplies, ſufficient Food ſhould be afforded to ſuch a prodigious Number, and ſo great variety of Beaſts, Birds, Fiſhes, and Inſects, is owing to that Being, who hath as wiſely adapted their Bodies to their Place and Food, as well as provided Food for their Subſiſtence there.

But I ſhall leave this Conſideration, becauſe it will be illuſtrated under the following Points; and proceed,

2. To conſider the adjuſtment of the quantity of Food in proportion to the Eaters. In all places generally enough, or ſuch a ſufficiency, as may be ſtiled a Plenty; but not ſuch a Superfluity, as to waſt, and corrupt, and thereby annoy the World. But that which is particularly remarkable here is, that among the great variety of Foods, the moſt uſeful

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(1) *Paſtum animantibus largè & copiosè natura eum, qui cuique aptus erat, comparavit.* Cicer. de Nat. Deor. L. 2.

Ille Deus eſt, —— qui per totum orbem armenta dimiſit, qui gregibus ubique paſſim vagantibus pabulum præſtat. Senec. de Benef. l. 4 c. 6.

(2) *Tritico*

uſeful is the moſt plentiful, moſt univerſal, eaſieſt propagated, and moſt patient of Weather, and other Injuries. As the herbaceous Eaters (for Inſtance) are many, and devour much; ſo the Dry-land Surface we find naturally every where almoſt carpeted over with Graſs, and other agreeable wholſome Plants; propagating themſelves in a manner every where, and ſcarcely deſtroyable by the Weather, the Plough, or any Art. So likewiſe for Grain, eſpecially ſuch as is moſt uſeful, how eaſily is it cultivated, and what encreaſe doth it produce? *Pliny*'s example of *Wheat* (2) is a ſufficient Inſtance in this matter; which, (as that curious Heathen obſerves,) being principally uſeful to the ſupport of Man, is eaſily propagated, and in great plenty. And an happy Faculty that is of it, that it can bear either extreams of Heat or Cold, ſo as ſcarce to refuſe any Clime.

3. Another wiſe Proviſion the Creator hath made relating to the Food of Animals is, that various Animals delight in various Food (3); ſome in Graſs and Herbs; ſome in Grain and Seeds; ſome in Fleſh; ſome in Inſects; ſome in this (4), ſome in that; ſome more delicate and nice, ſome voracious

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(2) *Tritico nihil eſt fertilius; hoc ei Natura tribuit, quoniam eo maximè alat hominem: utpote cum e modio, ſi ſit aptum ſolum —— 150 modii reddantur. Miſit D. Auguſto procurator —— ex uno grano (vix credibile dictu) 400 paucis minus germina. Miſit & Neroni ſimilitèr 340 ſtipulas ex uno grano.* Plin. Nat. Hiſt. l. 18. c. 10.

(3) *Sed illa quanta benignitas Naturæ, quòd tam multa ad veſcendum, tam varia, tamque jucunda gignit; neque ea uno tempore anni, ut ſemper & novitate delectemur & copiâ.* Cic. de Nat. Deor. l. 2.

(4) *Swammerdam* obſerves of the *Ephemeron-Worms*, that their Food is Clay, and that they make their Cells of the ſame. Upon which occaſion he ſaith of *Moths*, that eat Wool and Furr, *There*

cious and catching at any thing. If all delighted in, or ſubſiſted only with one ſort of Food, there would not be ſufficient for all; but every variety chuſing various Food, and perhaps abhorring that of others, is a great and wiſe means that every Kind hath enough, and oftentimes ſomewhat to ſpare.

It deſerves to be reckoned as an Act of the Divine Appointment, that what is wholſome Food to one, is nauſeous, and as a Poyſon to another; what is a ſweet and delicate Smell and Taſte to one, is fœtid and loathſome to another. By which means all the Proviſions the Globe affords are well diſpoſed of. Not only every Creature is well provided for, but a due Conſumption is made of thoſe things that otherwiſe would encumber the World, lie in the way, corrupt, rot, ſtink, and annoy, inſtead of cheriſh and refreſh. For our moſt uſeful Plants, Grain, and Fruits, would mould and rot; thoſe Beaſts, Fowls, and Fiſhes, which are reckoned among the greateſt Dainties, would turn to Carrion, and Poyſon us: Nay, thoſe Animals, which are become Carrion, and many other things that are noyſome, both on the Dry-land, and in the Waters, would be more grievous Annoyances, and breed Diſeaſes, was it not for the Proviſion which the infinite Orderer of the World hath made, by cauſing theſe things to be ſweet, pleaſant, and wholſome Food to ſome Creature or other, in the place

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There are two things very conſiderable, 1. *That the Cells they make to themſelves, wherein they live, and with which as their Houſe, Tortoiſe-like, they move from place to place, they make of the Matter next at hand.* 2. *That they feed alſo on the ſame, therefore when you find their Cells, or rather Coats or Caſes to be made of Yellow, Green, Blew, or Black-Cloth, you will alſo find their Dung of the ſame Colour.* Swammerd. Ephem. vita. Publiſhed by Dr. *Tyſon, Chap.* 3.

(5) *Job*

place where those things fall: to Dogs, Ravens, and other voracious Animals, for Instance, on the Earth; and to rapacious Fishes, and other Creatures inhabiting the Waters.

Thus is the World in some measure kept sweet and clean, and at the same time divers Species of Animals supplied with convenient Food. Which Providence of God, particularly in the Supplies afforded the *Ravens*, is divers times taken notice of in the Scriptures (5); but whether for the Reasons now hinted, or any other special Reasons I shall not enquire. Thus our Saviour, *Luke* 12. 24. *Consider the Ravens; for they neither sow, nor reap, which neither have Store-house, nor Barn, and God feedeth them.* It is a manifest Argument of the Divine Care and Providence in supplying the World with Food and Necessaries, that the *Ravens* accounted as unclean, and little regarded by Man, destitute of Stores, and that live by Accidents, by what falleth here and there; that such a Bird, I say, should be provided with sufficient Food; especially if that be true, which *Aristotle* (6), *Pliny* (7), and *Ælian* (8) report of their unnatural Affection and Cruelty to their young, "That they expell them their Nests "as soon as they can Fly, and then drive them out "of the Country.

Thus having considered the wise Appointment of the Creator in suiting variety of Food to variety of Animals: Let us in the

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(5) *Job* 38. 41. *Psal.* 147. 9.

(6) *Aristot. l.* 9. *c.* 31. Hist. Animal.

(7) *Pliny* affirms this of the *Crow* as well as *Raven*, *Cæteræ omnes* [i. e. Cornices] *ex eodem genere pellunt nidis pullos, ac volare cogunt, sicut & Corvi, qui——robustos suos fœtus fugant longiùs.* Nat. Hist. l. 10. c. 12.

(8) *Var. Hist.*

(9) *Chap.*

4th place Take a View of the peculiar Food which particular Places afford to the Creatures inhabiting therein.

It hath been already obſerved (9), that every place on the Surface of the Terraqueous Globe is ſtocked with proper Animals, whoſe Organs of Life and Action are curiouſly adapted to each reſpective place. Now it is an admirable Act of the Divine Providence, that every place affords a proper Food to all the living Creatures therein. All the various Regions of the World, the different Climates (10), the various Soils, the Seas, the Waters, nay our very Putrefactions, and moſt naſty Places about the Globe, as they are inhabited by ſome or other Animal, ſo they produce ſome proper Food or other, affording a comfortable Subſiſtence to the Creatures living there. I might for Inſtances (11) of this bring the great variety of Herbs, Fruits, and Grains on

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(9) *Chap.* 9.

(10) *Admiranda Naturæ diſpenſatio eſt, ut aliter, alioque modo, tempore, & induſtria colatur terra Septentrionalis, aliter Æthiopia,* &c. *Quoad Aquilonares, hoc certum eſt, in pleriſque agris Veſtrogothorum, parte objecta Meridionali plagæ, Hordeum ſpatio* 36 *dierum a ſemine projecto maturum colligi, hoc eſt, a fine Junii uſque medium Auguſti, aliquando celerius. Ea namque maturitas ex ſoli natura, aeriſque clementia, ac humore lapillorum fovente radices, Soleque torrente, neceſſario provenit, ut ita naſcatur, ac maturetur, taleſque ſpicæ ſex ordines in numero ariſtæ habent.* Ol. Mag. Hiſt. l. 13. c. 8. *Prata & paſcua tantâ luxuriant graminum ubertate, ac diverſitate, ut neceſſum ſit inde arcere jumenta, ne nimio herbarum eſu crepent,* &c. Id. ib. l. 19. c. 36.

(11) Among the many noble Contrivances of Food, that univerſal Aliment, *Bread*, I cannot but attribute to the Revelation, or at leaſt the Inſpiration of the Creator and Conſervator of Mankind; not only becauſe it is a Food uſed in all or moſt Parts of the World; but eſpecially becauſe it is of incomparable Uſe in the great Work of Digeſtion, greatly aſſiſting the Ferment or whatever cauſes the Digeſtion of the Stomach. Of which take this Example from the noble Mr. *Boyl.* "He extracted a Menſtruum

on the Earth, the large Swarms of Insects in the Air, with every other Food of the Creatures residing in the Earth, or flying in the Air. But I shall stop at the *Waters*, because the *Psalmist*, in the forecited 104 *Psalm*, speaks with Relation to the especial Provision for the Inhabitants of the Waters; and also by reason that many Land-Animals have their chief Maintenance from thence.

Now one would think, that the Waters were a very unlikely Element to produce Food for so great a Number of Creatures as have their Subsistence from thence. But yet how rich a Promptuary is it, not only to large Multitudes of Fishes, but also to many amphibious Quadrupeds, Insects, Reptiles, and Birds! From the largest *Leviathan*, which the Psalmist saith (12), *playeth in the Seas*, to the smallest Mite in the Lakes and Ponds, all are plentifully provided for; as is manifest from the Fatness of their Bodies, and the Gayety of their Aspect and Actions.

And the Provision which the Creator hath made for this Service in the Waters is very observable; not only by the Germination of divers aquatick Plants there, but particularly by appointing the Waters to be the Matrix of many Animals, particularly of many of the Insect-kind, not only of such as are peculiar to the Waters, but also of many appertaining to the Air and the Land, who, by their near Alliance to the Waters, delight to be about

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" struum from Bread alone, that would work on Bodies more " Compact than many hard Minerals, nay even on Glass it self, " and do many things that *Aqua-fortis* could not do.——Yet " by no means was this so corrosive a Liquor as A. F. or as the " other *acid Menstruums*". *Vid.* the ingenious and learned Dr. *Harris Lex. Tech. verbo Menstruum*, where the way of preparing it may be met with.

(12) Psal. 104. 26.

(13) The

about them, and by that means become a Prey, and plentiful Food to the Inhabitants of the Waters. And beſides theſe, what prodigious Sholes do we find of minute Animals, even ſometimes diſcolouring the Waters (13)! Of theſe, (not only in the Water, but in the Air and on Land,) I have always thought there was ſome more than ordinary Uſe, intended by the All-wiſe Creator. And having bent many of my Obſervations that way, I have evidently found it accordingly to be. For be they never ſo numberleſs, or minute, thoſe Animals ſerve

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(13) The Inſects that for the moſt part diſcolour the Waters, are the ſmall Inſects of the *Shrimp-kind*, called by *Swammerdam*, *Pulex aquaticus arboreſcens*. Theſe I have often ſeen ſo numerous in ſtagnating Waters in the Summer Months, that they have changed the Colour of the Waters to a pale or deep Red, ſometimes a Yellow, according to the Colour they were of. Of this *Swammerdam* hath a pretty Story, told him by Dr. *Florence Schuyl*, viz. *Se aliquando Studiis intentum, magno quodam & horrificio rumore fuiſſe turbatum, & ſimul ad cauſam ejus inquirendam excitatum; verum ſe vix eum in finem ſurrexiſſe, cum Ancilla ejus pænè exanimis adcurreret, & multo cum ſingultu referret, omnem Lugduni* [Batavorum] *aquam eſſe mutatam in ſanguinem.* The cauſe of which upon Examination he found to be only from the numerous Swarms of thoſe *Pulices*. V. Swam. Hiſt. Inſect. *p.* 70.

The cauſe of this great Concourſe and Appearance of thoſe little Inſects I have frequently obſerved to be to perform their Coit; which is commonly about the latter end of *May*, and in *June*. At that time they are very venereous, friſking, and catching at one another; and many of them conjoined Tail to Tail, with their Bellies inclined one towards another.

At this time alſo they change their Skin or *Slough*; which I conceive their rubbing againſt one another mightily promoteth. And what if at this time they change their Quarters? *V. Book VIII. Chap.* 4. *Note* 6.

Theſe ſmall Inſects, as they are very numerous, ſo are Food to many Water-Animals. I have ſeen not only *Ducks* ſhovel them up as they ſwim along the Waters, but divers Inſects alſo devour them, particularly ſome of the middle-ſized *Squillæ aquaticæ*; which are very voracious Inſects.

(14) Beſides

ſerve for Food to ſome Creatures or other. Even thoſe Animalcules in the Waters, diſcoverable only with good Microſcopes, are a Repaſt to others there, as I have often with no leſs admiration than pleaſure ſeen (14).

But now the uſual Objection is, that Neceſſity maketh Uſe (15). Animals muſt be fed, and they make uſe of what they find: In the deſolate Regions, and in the Waters, for Inſtance, they feed upon what they can come at; but in greater plenty, pick and chuſe.

But this Objection hath been already in ſome meaſure anſwered by what hath been ſaid; which plainly

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(14) Beſides the *Pulices* laſt mentioned, there are in the Waters other Animalcules very numerous, which are ſcarce viſible without a Microſcope. In *May*, and the Summer Months, the green Scum on the top of ſtagnating Waters is nothing elſe but theſe Animalcules: So is likewiſe the green Colour in them, when all the Water ſeems Green. Which Animalcules, in all probability, ſerve for Food to the *Pulices aquatici*, and other the minuter Animals of the Waters. Of which I gave a pregnant Inſtance in one of the *Nymphæ* of *Gnats*, to my Friend the late admirable Mr. *Ray*, which he was pleaſed to publiſh in the laſt Edition of his *Wiſdom of God in the Creation*, pag. 430.

(15) *Nil adeo quoniam natum'ſt in Corpore, ut uti*
Poſſemus, ſed quod natum'ſt, id procreat uſum.
And afterwards,
Propterea capitur Cibus, ut ſuffulciat artus,
Et recreet vireis interdatus, atque patentem
Per membra ac venas ut amorem obturet edendi.
And after the ſame manner he diſcourſeth of Thirſt, and divers other things. *Vid. Lucret. l.* 4. *v.* 821, &c.

Againſt this Opinion of the *Epicureans*, *Galen* ingeniouſly argues in his Diſcourſe about the Hand. *Non enim Manus ipſæ* (ſaith he) *hominem artes docuerunt, ſed Ratio. Manus autem ipſæ ſunt artium organa; ſicut Lyra muſici.—Lyra muſicum non docuit, ſed eſt ipſius artifex per eam, qua præditus eſt, Rationem: agere autem non poteſt ex arte abſque organis, ita & unaquælibet anima facultates quaſdam a ſua ipſius ſubſtantia obtinet.—Quod autem corporis particulæ animam non impellunt,—manifeſtè videre licet, ſi animalia recens nata conſideres, quæ quidem priùs*

agere

plainly argues Design, and a super-intending Wisdom, Power, and Providence in this special business of Food. Particularly the different delight of divers Animals in different Food, so that what is Nauseous to one, should be Dainties to another, is a manifest Argument, that the allotment of Food is not a matter of mere Chance, but entailed to the very Constitution and Nature of Animals; that they chuse this, and refuse that, not by Accident, or Necessity, but because the one is a proper Food, agreeable to their Constitution, and so appointed by the infinite Contriver of their Bodies; and the other is disagreeable and injurious to them.

But all this Objection will be found frivolous, and the Wisdom and Design of the great Creator will demonstratively appear, if we take a Survey,

5*thly*. Of the admirable and curious Apparatus in all Animals made for the Gathering, Preparing, and Digestion of their Food. From the very first Entrance to the utmost Exit of the Food, we find every

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agere conantur, quam perfectas habeant particulas. Ego namque Bovis vitulum cornibus petere conantem sæpenumero vidi, antequam ei nata essent cornua: Et pullum Equi calcitrantem, &c. Omne enim animal suæ ipsius Animæ facultates, ac in quos usus partes suæ polleant maximè, nullo doctore, præsentit. ——— *Quâ igitur ratione dici potest, animalia partium usus a partibus doceri, cum & antequam illas habeant, hoc cognoscere videantur? Si igitur Ova tria acceperis, unum Aquilæ, alterum Anatis, reliquum Serpentis, & calore modico foveris, animaliaque excluseris; illa quidem alis volare conantia, antequam volare possint; hoc autem revolvi videbis, & serpere affectans, quamvis molle adhuc & invalidum fuerit. Et si, dum perfecta erunt, in una eademque domo nutriveris; deinde ad locum subdialem ducta emiseris, Aquila quidem ad sublime; Anas autem in paludem;* ——*Serpens verò sub terrâ irrepet.* — *Animalia quidem mihi videntur Naturâ magis quam Ratione artem aliquam* [τεχνικὰ artificiosa] *exercere: Apes fingere alveolos*, &c. Galen de usu Part. l. c. 3.

(16) *Alia*

ry thing contrived, made, and disposed with the utmost Dexterity and Art, and curiously adapted to the place the Animal liveth in, and the Food it is to be nourished with.

Let us begin with the *Mouth*. And this we find, in every Species of Animals, nicely conformable to the Use of such a part; neatly sized and shaped for the catching of Prey, for the gathering or receiving Food (16), for the formation of Speech, and every other such like Use (17). In some Creatures it is wide and large, in some little and narrow: in some with a deep Incisure up into the Head (18), for the better

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(16) *Alia dentibus prædantur, alia unguibus, alia rostri adunci-tate carpunt, alia latitudine* [ejusdem] *ruunt, alia acumine excavant, alia sugunt, alia lambunt, sorbent, mandunt, vorant. Nec minor varietas in Pedum ministerio, ut rapiant, distrahant, teneant, premant, pendeant, tellurem scabere non cessent.* Plin. Nat. Hist. l. 10. c. 71.

(17) Because it would be tedious to reckon up the Bones, Glands, Muscles, and other Parts belonging to the Mouth, it shall suffice to observe that, for the various Services of Man's Mouth, besides the Muscles in common with other Parts, there are five Pair, and one single one proper to the Lips only, as Dr. *Gibson* reckons them: but my most diligent and curious Friend Mr. *Cowper* discovered a sixth Pair. And accordingly Dr. *Drake* reckons six Pair, and one single one proper to the Lips. *L.* 3. *c.* 13.

(18) *Galen* deserves to be here consulted, who excellently argues against the casual Concourse of the Atoms of *Epicurus* and *Asclepiades*, from the provident and wise Formation of the Mouths of Animals, and their Teeth answerable thereto. In Man, his Mouth without a deep Incisure, with only one canine Tooth on a Side, and flat Nails, because, saith he, *Hic Natura certò sciebat se animal mansuetum ac civile effingere, cui robur & vires essent ex sapientiâ, non ex corporis fortitudine.* But for *Lions*, *Wolfs*, and *Dogs*, and all such as are called Καρχαρόδοντες, (or having sharp, serrated Teeth,) their Mouths are large, and deep cut; Teeth strong and sharp; and their Nails sharp, large, strong and round, accommodated to holding and tearing. *V. Galen de Us. Part. l.* 11. *c.* 9.

(19) Among

better catching and holding of Prey, and more eaſy Comminution of hard, large, and troubleſome Food; in others with a much ſhorter Inciſure, for the gathering and holding of herbaceous Food.

In *Inſects* it is very notable. In ſome forcipated; to catch, hold, and tear their Prey (19). In ſome aculeated; to pierce and wound Animals (20), and ſuck their Blood. And in others ſtrongly rigged with Jaws and Teeth; to gnaw, and ſcrape out their

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(19) Among Inſects the *Squillæ aquaticæ*, as they are very rapacious, ſo are accordingly provided for it. Particularly the *Squilla aquatica maxima recurva*, (as I call it,) who hath ſomewhat terrible in its very Aſpect, and in its Poſture in the Water, eſpecially its Mouth, which is armed with long ſharp Hooks; with which it boldly and greedily catcheth any thing in the Waters, even one's Fingers. When they have ſeized their Prey, they will ſo tenaciouſly hold it with their forcipated Mouth, that they will not part therewith, even when they are taken out of the Waters, and jumbled about in one's Hand. I have admired at their peculiar way of taking in their Food; which is done by piercing their Prey with their *Forcipes*, (which are hollow,) and ſucking the Juice thereof through them.

The *Squilla* here mentioned, is the firſt and ſecond in *Mouffet's Theat. Inſect. l.* 2. *c.* 37.

(20) For an Inſtance of Inſects endued with a Spear, I ſhall for its peculiarity pitch upon one of the ſmalleſt, if not the very ſmalleſt of all the *Gnat* kind, which, I call, *Culex minimus nigricans maculatus ſanguiſuga*. Among us in *Eſſex*, they are called *Nidiots*, by *Mouffet*, *Midges*. It is about $\frac{1}{10}$ of an Inch, or ſomewhat more long: with ſhort *Antennæ*; plain in the Female, in the Male feathered, ſomewhat like a Bottle-bruſh. It is ſpotted with blackiſh Spots, eſpecially on the Wings, which extend a little beyond the Body. It comes from a little ſlender Eel-like Worm, of a dirty white Colour, ſwimming in ſtagnating Waters by a wrigling Motion: as in *Fig.* 5.

Its *Aurelia* is ſmall with a black Head, little ſhort Horns, a ſpotted, ſlender, rough Belly. *Vid. Fig.* 6. It lies quietly on the top of the Water, now and then gently wagging it ſelf this way, and that.

Theſe *Gnats* are greedy Blood-ſuckers, and very troubleſome where numerous, as they are in ſome places near the *Thames*, parti-

their Food, to carry Burdens (21), to perforate the Earth, yea the hardeſt Wood, yea even Stones themſelves, for Houſes (22) to themſelves, and Neſts for their Young.

And laſtly in *Birds* it is no leſs remarkable. In the firſt place it is neatly ſhaped for piercing the Air, and making way for the Body through the airy Regions. In the next place it is hard and horny, which is a good Supplement for the want of Teeth, and cauſeth the Bill to have the Uſe and Service of the Hand. It's hooked Form is of great Uſe to the rapacious Kind (23), in catching and holding their Prey, and in the Comminution thereof by tearing; to others it is no leſs ſerviceable to their climbing, as well as neat and nice Comminu-

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particularly in the Breach-waters that have lately befallen, near us, in the Pariſh of *Dagenham*; where I found them ſo vexatious, that I was glad to get out of thoſe Marſhes. Yea, I have ſeen Horſes ſo ſtung with them, that they have had drops of Blood all over their Bodies, where they were wounded by them.

I have given a Figure (in *Fig.* 7.) and more particular Deſcription of this *Gnat*, becauſe, although it be common, it is no where taken notice of by any Author I know, except *Mouffet*, who I ſuppoſe means theſe *Gnats*, which he calls *Midges*, c. 13. p. 82.

(21) *Hornets* and *Waſps* have ſtrong Jaws, Toothed, wherewith they can dig into Fruits, for their Food; as alſo gnaw and ſcrape Wood, whole Mouthfuls of which they carry away to make their Combs. *Vid. infr. Chap.* 13. *Note* 2.

(22) *Monſieur de la Voye* tells of an ancient Wall of Free-Stone in the *Benedictines-Abbey* at *Caen* in *Normandy*, ſo eaten with Worms, that one may run ones Hand into moſt of the Cavities: that theſe Worms are ſmall and black, lodging in a greyiſh Shell; that they have large flattiſh Heads, a large Mouth, with four black Jaws, *&c. Phil. Tranſact. Nr.* 18

(23) *Pro iis* [Labris] *cornea & acuta Volucribus Roſtra. Eadem rapto vivendibus adunca: collecto recta: herbas ruentibus limumque lata, ut Suum generi. Jumentis vice manûs ad colligenda pabula: ora apertiora laniatu viventibus.* Plin. Nat. Hiſt. l. 11. c. 37.

tion of their Food (24). Its extraordinary Length and Slenderneſs is very uſeful to ſome, to ſearch and grope for their Food in mooriſh places (25); as its Length and Breadth is to others, to hunt and ſearch in muddy places (26): and the contrary Form, namely, a thick, ſhort, and ſharp-edged Bill is as uſeful to other Birds, who have occaſion to huſk and flay the Grains they ſwallow. But it would be endleſs and tedious to reckon up all the various Shapes, and commodious Mechaniſm of all; the Sharpneſs and Strength of thoſe who have occaſion to perforate Wood, and Shells (27); the Slenderneſs and Neatneſs of ſuch as pick up ſmall Inſects; the Croſs-form of ſuch as break up Fruits (28); the

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(24) *Parrots* have their Bills nicely adapted to theſe Services, being hooked for climbing, reaching for what they have occaſion for; and the lower Jaw being compleatly fitted to the Hooks of the upper, they can as minutely break their Food, as other Animals do with their Teeth.

(25) Thus in *Woodcocks*, *Snipes*, &c. who hunt for Worms in mooriſh Ground, and, as Mr. *Willughby* ſaith, live alſo on the fatty unctuous Humour they ſuck out of the Earth. So alſo the Bills of *Curlews*, and many other Sea-Fowl, are very long to enable them to hunt for the Worms, *&c.* in the Sands on the Sea-ſhore, which they frequent.

(26) *Ducks*, *Geeſe*, and divers others, have ſuch long broad Bills to quaffer and hunt in Waters, and Mud; to which we may reckon the uncouth Bill of the *Spoon-bill*: but that which deſerves particular Obſervation in the Birds named in theſe two laſt Notes is, the Nerves going to the end of their Bills, enabling them to diſcover their Food out of ſight, of which ſee *Book VII. Chap.* 2. *Note* 5.

(27) The *Picus viridis*, or *Green-Woodſpite*, and all the *Wood-Peckers* have Bills, curiouſly made for digging Wood, ſtrong, hard, and ſharp. A neat Ridge runs along the top of the Green-Wood-*Pecker*'s Bill, as if an Artiſt had deſigned it for Strength and Neatneſs.

(28) The *Loxia*, or *Croſs Bill*, whoſe Bill is thick and ſtrong, with the Tips croſſing one another, with great readineſs breaks open Fir-cones, Apples, and other Fruit to come at their Kernels,

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fartheſt from the Center, as being only Preparers to the reſt; the others, being to grind and mince, are accordingly made ſtronger, and placed nearer the Center of Motion and Strength. Likewiſe their various Form (34) in various Animals is conſiderable, being all curiouſly adapted to the peculiar Food (35) and Occaſions of the ſeveral Species of Animals.

Atoms. For the Confirmation of which he puts the caſe, that ſuppoſe the order of the Teeth ſhould have been inverted, the *Grinders* ſet in the room of the *Inciſors*, &c. (which might as well have been, had not the Teeth been placed by a wiſe Agent,) in this caſe, what Uſe would the Teeth have been of? What Confuſion by ſuch a ſlight Errour in their diſpoſal only? Upon which he argues, *At ſiquis choream hominum* 32 (the number of the Teeth) *ordine diſpoſuit, eum ut hominem induſtrium laudaremus: cùm verò Dentium choream Natura tam bellè exornarit, nonne ipſam quoque laudabimus?* And then he goes on with the Argument from the Sockets of the Teeth, and their nice fitting in them, which being no leſs accurately done, than what is done by a Carpenter or Stone-cutter in fitting a Tenon into a Mortice, doth as well infer the Art and Act of the wiſe *Maker* of Animal Bodies, as the other doth the Act and Art of Man. And ſo he goes on with other Arguments to the ſame Effect. *V. Galen de Uſ. Part. l.* 11. *c.* 8.

(34) A curious Account of this may be found in an *Extract of a Letter concerning the Teeth of divers Animals.* Printed at *Paris*, in *M. Vauguion*'s Compleat Body of Chirurg. Oper. *Chap.* 53.

(35) As it hath been taken notice of, that various Animals delight in various Food; ſo it conſtantly falls out, that their Teeth are accordingly fitted to their Food; the Rapacious to catching, holding and tearing their Prey; the Herbacious to gathering and comminution of Vegetables: and ſuch as have no Teeth, as Birds, their Bill, Craw, and Gizard, aſſiſted with Stones ſupply the defect of Teeth. But the moſt conſiderable Example of this kind is in ſome Families of the Inſect-Tribes, as the *Papilio-kind*, &c. who have Teeth, and are voracious, and live on tender Vegetables in their *Nympha* or *Caterpillar-ſtate*, when they can only creep; but in their mature, *Papilio-ſtate*, they have no Teeth, but a *Proboſcis* or *Trunk* to ſuck up Honey, *&c.* their parts for gathering Food, as well as their Food being changed, as ſoon as hey have Wings to enable them to fly to it.

(36) It

Animals (36). And laſtly, the temporary Defect of them (37) is no leſs obſervable in Children, and ſuch young Creatures, where there is no occaſion for them, but they would be rather an Annoyance to the tender Nipples and Breaſts.

From the Teeth, the grand Inſtruments of Maſtication, let us proceed to the other miniſterial Parts. And here the *Parotid*, *Sublingual*, and *Maxillary Glands*, together with thoſe of the Cheeks and Lips are conſiderable, all lodged in the moſt convenient Places about the Mouth and Throat, to afford that noble digeſtive ſalival Liquor to be mixed with the Food in Maſtication, and to moiſten and lubricate the Paſſages, to give an eaſy deſcent to the Food. The commodious Form alſo of the Jaws deſerves our notice, together with the ſtrong Articulation of the lowermoſt, and its Motion. And laſtly, the curious Form, the great Strength, the convenient Lodgment and Situation of the ſeveral

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(36) It is remarkable in the Teeth of Fiſhes, that in ſome they are ſharp, as alſo jointed, ſo as to fall back, the better to catch and hold their Prey, and to facilitate its Paſſage into the Stomach: So in others they are broad and flat, made to break the Shells of Snailes and Shell-fiſh devoured by them. Theſe *Teeth* or *Breakers* are placed, in ſome, in the Mouth; in ſome, in the Throat; and in *Lobſters*, &c. in the Stomach it ſelf; in the bottom of whoſe Stomachs are three of thoſe *Grinders*, with peculiar Muſcles to move them.

(37) What is there in the World can be called an Act of Providence and Deſign, if this temporary Defect of Teeth be not ſuch; that Children, for Inſtance, ſhould have none whilſt they are not able to uſe them, but to hurt themſelves, or the Mother; and that at the very Age when they can take in more ſubſtantial Food, and live without the Breaſt, and begin to need Teeth for the ſake of Speech; that then, I ſay, their Teeth ſhould begin to appear, and gradually grow, as they more and more ſtand in need of them.

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And now we are arrived to the grand Receptacle of the Food, the *Stomach*; for the moſt part as various, as the Food to be conveyed therein. And here I might deſcribe the admirable Mechaniſm of its Tunicks, Muſcles, Glands, Nerves, Arteries, and Veins (41), all manifeſting the ſuper-eminent Contrivance and Art of the infinite Workman (42); they being all nicely adjuſted to their reſpective Place, Occaſion and Service. I might alſo inſiſt upon that moſt neceſſary Office of *Digeſtion*; and here conſider that wonderful Faculty of the Stomachs of all Creatures, to diſſolve (43) all the ſeveral ſorts of Food appropriated to their Species; even ſometimes things of that conſiſtency as ſeem inſoluble (44), eſpecially by ſuch ſeemingly ſimple and weak *Menſtruums*, as we find in their Stomach;

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is to promote Deglutition; of which the Longitudinal,——ſhorten the Oeſophagus, and ſo make its Capacity larger, to admit of the Matter to be ſwallowed. The Annular, on the contrary, contract the Capacity, and cloſing behind the deſcending Aliment, preſs it downwards. Drake's Anat. v. 1. l. 1. c. 9.

(41) See *Willis*, ibid. *Cowper's Anat. Tab.* 35. and many other Authors.

(42) *Proptuarium autem hoc, alimentum univerſum excipiens, ceu Divinum, non Humanum ſit opificium.* Galen de Uſ. Part. l. 4. c. 1.

(43) *How great a Comprehenſion of the Nature of things, did it require, to make a Menſtruum, that ſhould corrode all ſorts of Fleſh coming into the Stomach, and yet not, the Stomach it ſelf, which is alſo Fleſh?* Dr. *Grew's* Coſmol. Sacr. c. 4.

(44) The Food of the *Caſtor* being oftentimes, if not always dry things, and hard of Digeſtion, ſuch as the Roots and Bark of Trees, 'tis a wonderful Proviſion made in that Creature's Stomach, by the digeſtive Juice lodged in the curious little Cells there. A Deſcription of whoſe admirable Structure and Order may be found in *Blaſius* from *Wepfer*; concerning which he ſaith, *In quibus Mucus reconditus, non ſecus ac Mel in Favis.——Nimirum, quia Caſtoris alimentum exſuccum & coctu difficillimum eſt, ſapientiſſimus & ſummè admirandus in ſuis operibus rerum Conditor. D. O. M. ipſi pulcherrimâ iſtâ & affabrè factâ ſtructurâ be-*

mach: But I ſhall only give theſe things a bare mention, and take a more peculiar Notice of the ſpecial Proviſion made in the particular Species of Animals, for the Digeſtion of that ſpecial Food appointed them.

And in the firſt place it is obſervable, that, in every Species of Animals, the Strength and Size of their Stomach (45) is comformable to their Food. Such whoſe Food is more delicate, tender, and nutritive, have commonly this Part thinner, weaker, and leſs bulky: whereas ſuch whoſe Aliment is leſs nutritive, or whoſe Bodies require larger Supplies to their Bulk, their Labours, and waſt of Strength and Spirits, in them it is large and ſtrong.

Another very remarkable thing in this Part is the number of Ventricles in divers Creatures. In many but one; in ſome two or more (46). In ſuch as

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nigriſſimè proſpexit, ut nunquam deeſſet Fermentum, quod ad ſolvendum & comminuendum alimentum durum & aſperum par foret. Vid. Blaſ. Anat. Animal. c. 10. *Confer etiam Act. Erud. Lips.* Ann. 1684. p. 360.

Moſt of our Modern Anatomiſts and Phyſicians attribute Digeſtion to a diſſolving *Menſtruum*; but Dr. *Drake* takes it to be rather from fermentative diſſolving Principles in the Aliment it ſelf, with the Concurrence of the Air and Heat of the Body; as in Dr. *Papin's Digeſter. V. Dr. Anat. v.* 1. *c.* 14.

(45) *All carnivorous Quadrupeds have the ſmal'eſt Ventricles, Fleſh going fartheſt. Thoſe that feed on Fruits and Roots have them of a middle Size. Yet the* Mole, *becauſe it feeds unclean, hath a very great one.* Sheep *and* Oxen, *which feed on Graſs, have the greateſt. Yet the* Horſe, (*and for the ſame reaſon the* Coney *and* Hare,) *though Graminivorous, yet comparatively have but little ones. For that a* Horſe *is made for Labour, and both this and the* Hare *for quick and continued Motion: for which, the moſt eaſy Reſpiration, and ſo the freeſt Motion of the Diaphragme is very requiſite; which yet could not be, ſhould the Stomach lie big and cumberſome upon it, as in* Sheep *and* Oxen *it doth.* Grew. ib. Chap. 6.

(46) The *Dromedary* hath four Stomachs, one whereof is peculiarly endowed with about twenty Cavities, like Sacks in all probability

as make a ſufficient Comminution of the Food in the Mouth, one ſuffices. But where Teeth are wanting, and the Food dry and hard, (as in granivorous Birds,) there the Defect is abundantly ſupplied by one thin membranaceous Ventricle, to receive and moiſten the Food, and another thick, ſtrong, muſcular one, to grind and tear (47) it. But in Birds, and other Creatures, whoſe Food is not Grain, but Fleſh, Fruits, Inſects, or partly one, partly the other, there their Stomachs are accordingly comformable to their Food (48), ſtronger or weaker, membranous or muſcular.

But as remarkable a thing as any in this part of Animals is the curious Contrivance and Fabrick of the ſeveral Ventricles of ruminating Creatures. The very Act it ſelf of *Rumination* is an excellent Proviſion for the compleat Maſtication of the Food, at the reſting, leiſure times of the Animal. But the Apparatus for this Service, of divers Ventricles for its various Uſes and Purpoſes, together with their curious Mechaniſm, deſerves great Admiration (49).

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probability for the holding of Water. Concerning which, ſee *Book VI. Chap.* 4. *Note* 1.

(47) To aſſiſt in which Office they ſwallow ſmall angular Stones, which are to be met with in the Gizards of all granivorous Birds: but in the Gizard of the *Jynx*, or *Wryneck*, which was full only of *Ants*, I found not one Stone. So in that of the *Green Wood-pecker*, (full of *Ants* and Tree-maggots,) there were but few Stones.

(48) *In moſt carnivorous Birds, the third Ventricle is Membranous; where the Meat is concocted, as in a Man: Or ſomewhat Tendinous, as in an* Owl; *as if it were made indifferently for Fleſh, or other Meat, as he could meet with either. Or moſt thick and tendinous, called the Gizard; wherein the Meat, as in a Mill is ground to pieces.* Grew, *ubi ſupra.* Chap. 9.

(49) It would be much too long a Task to inſiſt upon it here as it deſerves, and therefore concerning the whole Buſineſs of Rumination,

Having thus far purſued the Food to the place, where, by its Reduction into Chyle, it becomes a proper Aliment for the Body; I might next trace it through the ſeveral Meanders of the *Guts*, the *Lacteals*, and ſo into the *Blood* (50), and afterwards into the very Habit of the Body; I might alſo take notice

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Rumination, I ſhall refer to *J. Cour. Peyeri Merycolog. ſeu de Ruminantibus & Ruminatione commentar*; where he largely treateth of the ſeveral Ruminating-Animals, of the Parts miniſtring to this Act, and the great Uſe and Benefit thereof unto them.

(50) There are too many Particulars to be inſiſted on obſervable in the Paſſages of the *Chyle*, from the Guts to the *Left Subclavian Vein*, where it enters into the Blood; and therefore I ſhall only for a Sample of this admirable Oeconomy take notice of ſome of the main and more general Matters. And,

1. After the Food is become Chyle, and gotten into the Guts, it is an excellent Proviſion made not only for its Paſſage through the Guts, but alſo for its Protruſion into the *Lacteals*, by the *Periſtaltick* Motion and *Valvulæ conniventes* of the Guts. 2. It is an admirable Proviſion that the Mouths of the *Lacteals*, and indeed the *Lacteals primi generis* themſelves are ſmall and fine, not wider than the *Capillary Arteries* are, leſt by admitting Particles of the Nouriſhment groſſer than the *Capillaries*, dangerous Obſtructions might be thereby produced. 3. After the reception of the Aliment into the *Lacteals primi generis*, it is a noble Proviſion for the advancement of its Motion, that in the *Meſenterick Glands* it meets with ſome of the *Lymphæ Ducts*, and receives the Impregnations of the *Lymphæ*. And paſſing on from thence, it is a no leſs Advantage. 4. That the *Lacteals* and *Lymphæ Ducts* meet in the *Receptaculum Chyli*, where the Aliment meeting with more of the *Lympha* is made of a due Conſiſtence and Temperament for its farther Advancement through the *Thoracick Duct*, and ſo into the *Left Subclavian Vein* and Blood. Laſtly, This *Thoracick Duct* it ſelf is a part of great Conſideration. For, (as Mr. *Cowper* ſaith,) *If we conſider in this Duct its ſeveral Diviſions and Inoſculations, its numerous Valves looking from below upwards, its advantageous Situation between the great Artery and Vertebræ of the Back, together with the Ducts diſcharging their refluent Lympha from the Lungs and other neighbouring Parts, we ſhall find all conduce to demonſtrate the utmoſt Art of Nature uſed in furthering the ſteep and perpendicular Aſcent of the Chyle.* Anat. Introduct.

(51) Theſe

notice of the Separation made in the *Inteſtines*, of what is nutritive, (which is received,) and what is feculent, (being ejected,) and the Impregnations there from the *Pancreas* and the *Gall*: and after it hath been ſtrained through thoſe curious Colanders, the *Lacteal Veins*, I might alſo obſerve its Impregnations from the *Glands* and *Lymphæducts*: and to name no more, I might farther view the exquiſite Structure of the Parts miniſtring to all theſe delicate Offices of Nature; particularly the artificial Conformation of the Inteſtines might deſerve a ſpecial enquiry, their Tunicks, Glands, Fibres traverſing one another (51), and periſtaltick Motion in all Creatures; and their cochleous Paſſage (52) to retard the Motion of the Chyle, and to make amends for the ſhortneſs of the Inteſtines, in ſuch Creatures who have but one Gut; together with many other Accommodations of Nature in particular Animals that might be mentioned. But it ſhall ſuffice to have given only a general Hint of thoſe curious and admirable Works of God. From whence it is abundantly manifeſt how little weight there is in the former Atheiſtical Objection. Which will receive a farther Confutation from the

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(51) Theſe, although noble Contrivances and Works of God, are too many to be inſiſted on, and therefore I ſhall refer to the Anatomiſts, particularly Dr. *Willis Pharmaceut*, Dr. *Cole* in *Phil. Tranſ. Nr.* 125. and Mr. *Cowper*'s elegant Cuts in his *Anat. Tab.* 34. 35. and *Append. Fig.* 39, 40.

(52) In the *Thornback*, and ſome other Fiſhes it is a very curious Proviſion that is made to ſupply the Paucity and Brevity of the Guts; by the Perforation of their ſingle Gut going not ſtraight along, but round round like a pair of Winding-Stairs; ſo that their Gut, which ſeems to be but a few Inches long, hath really a Bore of many Inches. But of theſe, and many other noble Curioſities and Diſcoveries in Anatomy, the Reader will, I hope, have a better and larger Account from the curious and ingenious Dr. *Dowglas*.

(53) *Quibus*

6. and laſt thing relating to Food, that I ſhall ſpeak of, namely, *The great Sagacity of all Animals in finding out, and providing their Food.* In Man perhaps we may not find any thing very admirable, or remarkable in this kind, by means of his Reaſon and Underſtanding, and his Supremacy over the inferiour Creatures; which anſwereth all his Occaſions relating to this Matter. But then even here the Creator hath ſhewed his Skill, in not overdoing the Matter, in not providing Man with an unneceſſary Apparatus to effect over and over again what is feaſible by the reach of his Underſtanding, and the power of his Authority.

But for the inferiour Creatures, who want Reaſon, the power of that natural Inſtinct, that Sagacity (53) which the Creator hath imprinted upon them, do amply compenſate that Defect. And here we ſhall find a glorious Scene of the Divine Wiſdom, Power, Providence, and Care, if we view the various Inſtincts of Beaſts, great and ſmall, of Birds, Inſects, and Reptiles (54). For among every Species of them we may find notable Acts of Sagacity, or Inſtinct, proportional to their Occaſi-

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(53) *Quibus beſtiis erat is cibus, ut alius generis beſtiis veſcerentur, aut vires natura dedit, aut celeritatem: data eſt quibuſdam etiam machinatio quædam, atque ſolertia,* &c. Cicer. de Nat. Deor. L. 2.

(54) Among Reptiles that have a ſtrange Faculty to ſhift for Food, *&c.* may be reckoned *Eels*, which, although belonging to the Waters, can creep on the Land from Pond to Pond, *&c.* Mr. *Moſeley* of *Moſeley*, ſaw them creep over the Meadows, like ſo many Snakes from Ditch to Ditch; which he thought was not only for bettering their Habitation, but alſo to catch Snailes in the Graſs. *Plot's Hiſt. Stafford.* c. 7. §. 32.

And as early as the Year 1125, the Froſt was ſo very Intenſe, that the *Eels* were forced to leave the Waters, and were frozen to Death in the Meadows. *Vid. Hakewil's Apol. L.* 2. *Chap.* 7. *S.* 2.

(55) *Enumerare*

ons for Food. Even among thoſe whoſe Food is near at hand, and eaſily come at, as Graſs and Herbs, and conſequently have no great need of Art to diſcover it; yet, that faculty of their accurate Smell and Taſte, ſo ready at every turn to diſtinguiſh between what is ſalutary, and what pernicious (55), doth juſtly deſerve Praiſe. But for ſuch Animals, whoſe Food is not ſo eaſily come at, a variety of wonderful Inſtinct may be met with, ſufficient to entertain the moſt curious Obſerver. With what entertaining Power and Artifice do ſome Creatures hunt (56) and purſue their Game and Prey! And others watch and way-lay theirs

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(55) *Enumerare poſſum, ad paſtum capeſſendum conficiendumque, quæ ſit in figuris animantium & quam ſolers, ſubtiliſque deſcriptio partium, quamque admirabilis fabrica membrorum. Omnia enim quæ intus incluſa ſunt, ita nata, atque ita locata ſunt, ut nihil eorum ſupervacaneum ſit, nihil ad vitam retinendam non neceſſarium. Dedit autem eadem Natura belluis & ſenſum, & appetitum, ut altero conatum haberent ad naturales paſtus capeſſendos; altero ſecernerent peſtifera a ſalutaribus.* Cicer. de Nat. Deor. L. 2. See *Book IV. Chap.* 4.

(56) It would be endleſs to give Inſtances of my own and others Obſervations of the prodigious Sagacity of divers Animals in Hunting, particularly Hounds, Setting-Dogs, *&c.* one therefore ſhall ſuffice of Mr. *Boyl*'s, viz. *A Perſon of Quality —— to make a tryal, whether a young Blood-Hound was well inſtructed, —— cauſed one of his Servants —— to walk to a Town four Miles off, and then to a Market-Town three Miles from thence. —— The Dog, without ſeeing the Man he was to purſue, followed him by the Scent to the above-mentioned Places, notwithſtanding the Multitude of Market-People that went along in the ſame way, and of Travellers that had occaſion to croſs it. And when the Blood-Hound came to the chief Market-Town, he paſſed through the Streets, without taking Notice of any of the People there, and left not till he had gone to the Houſe, where the Man he ſought, reſted himſelf, and found him in an Upper-Room, to the wonder of thoſe that followed him.* Boyl determ. Nat. of Effluv. Chap. 4.

(57) There

theirs (57)! With what prodigious Sagacity do others grope for it under Ground, out of Sight, in mooriſh Places, in Mud and Dirt (58); and others dig and delve for it both above (59) and under the Surface of the drier Lands (60)! And how curious, and well-deſigned a Proviſion is it of particular large

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(57) There are many Stories told of the Craft of the *Fox* to compaſs his Prey; of which *Ol. Magnus* hath many ſuch, as feigning the barking of a *Dog*, to catch Prey near Houſes; feigning himſelf Dead, to catch ſuch Animals as come to feed upon him; laying his Tail on a Waſp-Neſt, and then rubbing it hard againſt a Tree, and then eating the *Waſps* ſo killed: ridding himſelf of *Fleas*, by gradually going into Water, with a Lock of Wool in his Mouth, and ſo driving the *Fleas* up into it, and then leaving it in the Water: by catching *Crab*-Fiſh with his Tail, which he ſaith he himſelf was an Eye-witneſs of; *Vidi & ego in Scopulis Norvegiæ Vulpem, interrupes immiſſâ caudâ in aquas, plures educere Cancros, ac demum devorare.* Vid. Ol. Mag. Hiſt. l. 18. c. 39, 40.

But *Pliny*'s fabulous Story of the *Hyæna* out-does theſe Relations of the *Fox*, *Sermonem humanum inter paſtorum ſtabula aſſimulare, nomenque alicujus addiſcere, quem evocatum foràs laceret. Item Vomitionem hominis imitari ad ſollicitandos Canes quos invadat.* Plin. Nat. Hiſt. l. 8 c. 30.

(58) This do *Ducks*, *Woodcocks*, and many other Fowls which ſeek their Food in dirty, mooriſh Places. For which Service they have very remarkable Nerves reaching to the end of their Bills. Of which ſee *Book VII. Chap.* 2. *Note* 5.

(59) *Swine*, and other Animals that dig, have their Noſes made more tendinous, callous, and ſtrong for this Service, than others that do not dig. They are alſo edged with a proper Border for penetrating and lifting up the Earth; and their Noſtrils are placed well, and their Smell is very accurate to diſcover whatſoever they purſue by digging.

(60) The *Mole*, as its Habitation is different from that of other Animals, ſo hath its Organs in every reſpect curiouſly adapted to that way of Life; particularly its Noſe made ſharp, and ſlender, but withal tendinous and ſtrong, *&c.* But what is very remarkable, it hath ſuch Nerves reaching to the end of its Noſe and Lips, as *Ducks*, &c. have, mentioned above in *Note* 58. Which pair of Nerves I obſerved to be much larger than any other Nerves proceeding out of the Brain.

(61) Predacious

large Nerves in ſuch Creatures, adapted to that eſpecial Service!

What an admirable Faculty is that of many Animals to diſcover their Prey at vaſt Diſtances; ſome by their Smell ſome Miles off (61); and ſome by their ſharp and piercing Sight, aloft in the Air, or at other great Diſtances (62)! An inſtance of the latter of which *GOD* himſelf giveth, (*Job* 39. 27, 28, 29.) in the Inſtinct of the *Eagle*. *Doth the Eagle mount up at thy command? and make her Neſt on high? She dwelleth and abideth on the Rock, upon the crag of the Rock, and the ſtrong Place* (63). *From thence ſhe ſeeketh her Prey, and her Eyes behold afar off.* What a commodious Proviſion

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(61) Predacious Creatures, as *Wolfs*, *Foxes*, &c. will diſcover Prey at great Diſtances; ſo will *Dogs* and *Ravens* diſcover Carrion a great way off by their Smell. And if (as the Superſtitious imagine) the latter flying over and haunting Houſes be a ſign of Death, it is no doubt from ſome cadaverous Smell thoſe *Ravens* diſcover in the Air by their accurate Smell, which is emitted from thoſe diſeaſed Bodies, which have in them the Principles of a ſpeedy Death.

(62) Thus *Hawkes* and *Kites* on Land, and *Gulls* and other Birds that prey upon the Waters, can at a great Height in the Air ſee *Mice*, little Birds and Inſects on the Earth, and ſmall Fiſhes, *Shrimps*, &c. in the Waters; which they will dart down upon and take.

(63) Mr. *Ray* gives a good Account of the Nidification of the *Chryſaetos caudâ annulo albo cinctâ. Hujus Nidus A°. 1668. in ſylvoſis prope Derwentiam*, &c. *inventus eſt e bacillis ſeu virgis ligneis grandioribus compoſitus, quorum altera extremitas rupis cujuſdam eminentiæ, altera duabus Betulis innitebatur — Erat Nidus quadratus, duas ulnas latus —— In eo pullus, unicus, adjacentibus cadaveribus unius agni, unius leporis, & trium Grygallorum pullorum.* Synop's Method. Avium. p. 6. And not only *Lambs*, *Hares*, and *Grygalli*, but Sir *Robert Sibbald* tells us they will ſeize *Kids* and *Fawns*, yea, and Children too: Of which he hath this Story of an *Eagle* in one of the *Orcades* Iſlands, *Quæ Infantulum unius anni pannis involutum arripuit (quem Mater teſſellas uſtibiles pro igne allatura momento temporis depoſuerat in loco*

Houton-

on hath the Contriver of Nature made for Animals that are neceſſitated to climb for their Food; not only in the Structure of their Legs and Feet, and in the Strength of their Tendons and Muſcles acting in that particular Office (64), but alſo in the peculiar Structure of the principal Parts acting in the acqueſt of their Food (65)! What a Proviſion alſo is that in nocturnal Birds and Beaſts, in the peculiar Structure of their Eye (66), (and we may perhaps add the accuracy of their Smell too,) whereby they are enabled to diſcover their Food in the dark? But among all the Inſtances we have of natural Inſtinct, thoſe Inſtincts and eſpecial Proviſions made to ſupply the Neceſſities of helpleſs Animals, do in a particular manner demonſtrate the

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Houton-Head *dicto*) *eumque deportaſſe per* 4 *milliaria paſſuum ad* Hoiam; *quâ re ex matris ejulatibus cognitâ, quatuor viri illuc in naviculâ profecti ſunt, & ſcientes ubi Nidus eſſet, Infantulum illæſum & intactum deprehenderunt.* Prod. Nat. Hiſt. Scot. l. 3. p. 2. p. 14.

(64) See in *Book VII. Chap.* 1. *Note* 11. the Characteriſticks of the *Wood-pecker-kind.*

(65) *The contrivance of the Legs, Feet, and Nails* [*of the* Opoſſum] *ſeems very advantageous to this Animal in climbing Trees, (which it doth very nimbly,) for preying upon Birds.* But that which is moſt ſingular in this Animal is the Structure of its Tail to enable it to hang on Boughs. *The Spines, or Hooks —— in the middle of the under Side of the* Vertebræ *of the Tail, are a wonderful piece of Nature's Mechaniſm. The firſt three* Vertebræ *had none of theſe Spines, but in all the reſt they were to be obſerved. —— They were placed juſt at the Articulation of each Joynt, and in the middle from the Sides. —— For the performing this Office* [of hanging by the Tail] *nothing, I think, could be more advantageouſly contrived. For when the Tail is twirled or wound about a Stick, this hook of the Spine eaſily ſuſtains the Weight, and there is but little Labour of the Muſcles required, only enough for bowing or crooking the Tail.* This and more to the ſame purpoſe, ſee in Dr. *Tyſon's Anat. of the Opoſſ.* in *Phil. Tranſ. Nr.* 239.

(66) See before *Chap.* 2. *Notes* 24, 25, 26.

67 *Quid*

the great Creator's Care. Of which I ſhall give two Inſtances.

1. The Proviſion made for young Creatures. That Στοργὴ, that natural Affection, ſo connatural to all, or moſt Creatures towards their Young (67), what an admirable, noble Principle is it, implanted in them by the wiſe Creator! By means of which, with what Alacrity do they tranſact their Parental Miniſtry? With what Care do they nurſe up their Young? think no Pains too great to be

(67) *Quid dicam quantus amor beſtiarum ſit in educandis cuſtodiendiſque iis, quæ procreaverint, uſque ad eum finem, dum poſſint ſe ipſa defendere?* And having inſtanced in ſome Animals, where this Care is not neceſſary, and accordingly is not employed, he goes on, *Jam Gallinæ, aveſque reliquæ & quietum requirunt ad pariendum locum, & cubilia ſibi, nidoſque conſtruunt, eoſque quam poſſunt molliſſimè ſubſternunt, ut quàm facillimè ova ſerventur. Ex quibus pullos cum excluſerint, ita tuentur, ut & pennis foveant, ne frigore lædantur, & ſi eſt calor, a ſole ſe opponant.* Cicer. de Nat. Deor. L. 2.

To this natural Care of Parent-Animals to their Young, we may add returns made by the Young of ſome towards the Old ones. *Pliny* ſaith of *Rats*, *Genitores ſuos feſſos ſenectâ, alunt inſigni pietatè.* Nat. Hiſt. l. 8. c. 57. So *Cranes*, he ſaith, *Genetricum ſenectam invicem educant.* l. 10. c. 23. This St. *Ambroſe* takes Notice of in his *Hexameron*, and *Ol. Magnus* after him, *Depoſiti patris artus, per longævum ſenectutis plumis nudatos, circumſtans ſoboles pennis propriis fovet,* ——*collatitio cibo paſcit, quando etiam ipſa naturæ reparatdiſpendia, ut hinc inde ſenem ſublevantes, fulcro alarum ſuarum ad volandum exerceant, & in priſtinos uſus deſueta membra reducant.* For which Reaſon this Bird is denominated *Pia. Vid. Ol. Mag. Hiſt.* l. 19. c. 14.

Hereto may be added alſo the conjugal Στοργὴ of the little green *Æthiopian Parrot*, which Mr. *Ray* deſcribes from *Cluſius*. *Fœmellæ ſeneſcentes (quod valdè notabile) vix edere volebant, niſi cibum jam a mare carptum, & aliquandiu in prolobo retentum, & quaſi coctum roſtro ſuo exciperent, & Columbarum pulli a matre ali ſolent.* Synop. Method. Av. p. 32.

taken for them, no Dangers (68) too great to be ventured upon for their Guard and Security. How carefully will they lead them about in places of Safety? carry them into places of Retreat and Security, yea, ſome of them admit them into their own Bowels (69)? How will they careſs them with their affectionate Notes? lull and quiet them with their tender parental Voice? put Food into their Mouths? ſuckle them? cheriſh and keep them warm? teach them to pick, and eat, and gather Food for themſelves? And in a word, perform the whole Part of thoſe deputed by the ſovereign Lord and Preſerver of the World, to help ſuch young and ſhiftleſs Creatures, till they are come to that Maturity as to be able to ſhift for themſelves?

And as for other Animals, (particularly Inſects, whoſe Sire is partly the Sun, and) whoſe numerous Off-ſpring would be too great for their Parent-Animal's Care and Proviſion, theſe are ſo generated as to need none of their Care; by reaſon they arrive immedi-

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(68) The moſt timid Animals, that at other times abſcond, or haſtily fly from the Face of Man, Dogs, &c. will, for the ſake of their Young, expoſe themſelves. Thus among Fowls, *Hens* will aſſault, inſtead of fly from ſuch as meddle with their Brood. So *Partridges*, before their Young can fly, will drop frequently down, firſt at leſſer, and then at greater Diſtances to dodge and draw off *Dogs* from purſuing their Young.

(69) The *Opoſſum* hath a curious Bag on purpoſe for the ſecuring and carrying about her Young. There are belonging to this Bag two Bones, (not to be met with in any other Sceleton,) and four pair of Muſcles; and ſome ſay the Teats lie therein alſo. Dr. *Tyſon's Anat. of the Opoſſ.* in *Phil. Tranſact. Nr.* 239. where he alſo, from *Oppian*, mentions the *Dog-Fiſh* that upon any Storm, or Danger receives the young Ones into her Belly, which come out again when the fright is over. So alſo the *Squatina* and *Glaucus*, the ſame Author ſaith have the ſame Care for their Young, but receive them into different Receptacles.

(70) See

immediately to their Ἡλικία, their perfect, adult State, and are able to ſhift for themſelves. But yet, thus far their parental Inſtinct (equivalent to the moſt rational Care and Fore-ſight) doth extend, that they do not wildly drop their Eggs and Sperm any where, at all Adventures, but ſo cautiouſly repoſite it in ſuch commodious Places, ſome in the Waters, ſome on Fleſh, ſome on Plants proper and agreeable to their Species (70), and ſome ſhut up agreeable Food in their Neſts, partly for Incubation, partly for Food (71), that their Young in their *Aurelia*, or *Nympha State*, may find ſufficient and agreeable Food to bring them up, till they arrive to their Maturity.

Thus far the parental Inſtinct and Care.

Next we may obſerve no leſs in the Young themſelves, eſpecially in thoſe of the irrational Animals. Foraſmuch as the Parent-Animal is not able to bear them about, to cloth them, and to dandle them, as Man doth; how admirably hath the Creator contrived their State, that thoſe poor young Creatures can ſoon walk about, and with the little helps of their Dam, ſhift for, and help themſelves? How naturally do they hunt for their Teat, ſuck, pick (72), and take in their proper Food?

But

(70) See *Book VIII. Chap. 6.*

(71) See *Chap.* 13. *Note* 2.

(72) There is manifeſtly a ſuperintending Providence in this Caſe, that ſome Animals are able to ſuck as ſoon as ever they are born, and that they will naturally hunt for the Teat before they are quite gotten out of the Secundines, and parted from the Navel-String, as I have ſeen. But for *Chickens*, and other young Birds, they not being able immediately to pick till they are ſtronger, have a notable Proviſion made for ſuch a time, by a part of the yolk of the Egg being incloſed in their Belly a lit-

But for the young of Man, their Parent's Reaſon, joined with Natural Affection, being ſufficient to Help, to Nurſe, to Feed, and to Cloth them; therefore they are Born helpleſs, and are more abſolutely, than other Creatures, caſt upon their Parent's Care (73). A manifeſt Act and Deſignation of the Divine Providence.

2. The other Inſtance I promiſed, is the Proviſion made for the Preſervation of ſuch Animals as are ſometimes deſtitute of Food, or in danger of being ſo. The Winter is a very inconvenient, improper Seaſon, to afford either Food or Exerciſe to Inſects, and many other Animals. When the flowry Fields are diveſted of their Gayety; when the fertile Trees and Plants are ſtript of their Fruits, and the Air inſtead of being warmed with the cheriſhing Beams of the Sun, is chilled with rigid Froſt; what would become of ſuch Animals as are impatient of Cold? What Food could be found by ſuch as are ſubſiſted by the Summer-Fruits? But to obviate all this Evil, to ſtave off the Deſtruction and Extirpation of divers Species of Animals, the infinitely wiſe Preſerver of the World hath as wiſely ordered the matter; that, in the firſt place, ſuch as are impatient of Cold, ſhould have ſuch a ſpecial Structure of their Body, particularly of their Heart, and Circulation of their Blood,

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tle before their Excluſion or Hatching, which ſerves for their Nouriſhment till they are grown ſtrong enough to pick up Meat. *Vid. Book VII. Chap.* 4. *Note* 1.

(73) *Qui* [Infantes] *de ope noſtrâ ac de divinâ miſericordiâ plus merentur, qui in primo ſtatim nativitatis ſuæ ortu plorantes ac flentes, nil aliud faciunt quam deprecantur.* Cyprian. Ep. ad Fid.

(74) I might

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particularly we may at the proper Seaſon, obſerve not only the little Treaſures and Holes well ſtocked with timely Proviſions, but large Fields (77) here and there throughout beſpread with conſiderable Numbers of the Fruits of the neighbouring Trees, laid carefully up in the Earth, and covered ſafe by the provident little Animals inhabiting thereabouts. And not without Pleaſure have I ſeen and admired the Sagacity of other Animals hunting out thoſe ſubterraneous Fruits, and pilaging the Treaſures of thoſe little provident Creatures.

And

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in Summer. —— *Thoſe that are lazy among them, they lay on their Backs, then lay a great handful of dry Herbage upon their Bellies,* &c. *then others drag thoſe Drones to the Mouths of their Burroughs, and ſo thoſe Creatures ſerve inſtead of Barrows,* &c. *I have often ſeen them practiſe this, and have had the Curioſity to obſerve them whole Days together.* —— *Their Holes are parted like Chambers; ſome ſerve for Store-houſes, others for Burying-places,* &c. *Their Government is nothing inferiour to that of* Bees, *&c. They never go abroad without poſting a Centinel, upon ſome high Ground, to give notice to the others whilſt they are feeding. As ſoon as the Centinel ſees any Body, it ſtands upon his Hind-legs, and Whiſtles.* Beauplau's *Deſcription of* Ukraine, in *Vol. I.* of the Collection of Voyages, *&c*

A like Inſtance of the Northern *Galli Sylveſtres*, ſee in *Chap.* 13. *Note* 6.

As for the Scriptural Inſtance of the *Ant*, ſee hereafter *Book VIII. Chap.* 5. *Note* 4.

(77) I have in *Autumn*, not without Pleaſure obſerved, not only the great Sagacity and Diligence of *Swine* in hunting out the Stores of the *Field-Mice*; but the wonderful Precaution alſo of thoſe little Animals in hiding their Food before-hand againſt Winter. In the time of Acorns falling, I have, by means of the *Hogs*, diſcovered, that the *Mice* had, all over the neighbouring Fields, treaſured up ſingle Acorns in little Holes they had ſcratched, and in which they had carefully covered up the Acorn. Theſe the *Hogs* would Day after Day hunt out by their ſmell.

(1) Concerning

And now from this bare tranſient View of this Branch of the great Creator's Providence and Government, relating to the *Food* of his Creatures, we can conclude no leſs, than that ſince this grand Affair hath ſo manifeſt Strokes of admirable and wiſe Management, that ſince this is demonſtrated throughout all Ages, and Places, that therefore it is God's Handy-work. For how is it poſſible that ſo vaſt a World of Animals ſhould be ſupported, ſuch a great Variety equally and well ſupplied with proper Food in every place fit for Habitation, without an eſpecial Super-intendency and Management, equal to, at leaſt, that of the moſt prudent Steward and Houſholder? How ſhould the Creatures be able to find out their Food when laid up in ſecret Places? and how ſhould they be able to gather even a great deal of the common Food, and at laſt to macerate and digeſt it, without peculiar Organs adapted to the Service? And what leſs than an infinitely wiſe God could form ſuch a Set of curious Organs, as we find every Species endowed with for this very Uſe? Organs ſo artificially made, ſo exquiſitely fitted up, that the more ſtrictly we ſurvey them, the more accurately we view them, (even the meaneſt of them with our beſt Glaſſes,) the leſs fault we find in them, and the more we admire them: whereas the beſt poliſh'd, and moſt exquiſite Works made by Humane Art, appear through our Glaſſes, as rude and bungling, deformed and monſtrous; and yet we admire them, and call them Works of Art and Reaſon. And laſtly, what leſs than Rational and Wiſe could endow irrational Animals with various Inſtincts, equivalent in their ſpecial way to Reaſon it ſelf? Inſomuch that ſome from thence have abſolutely concluded that thoſe Creatures had ſome glimmerings of Reaſon. But it is manifeſtly Inſtinct, not Reaſon they Act by, becauſe we find no varying,

but that every Species doth naturally pursue at all times the same way, without any Tutorage or Learning: whereas *Reason*, without Instruction, would often vary, and do that by many Methods, which *Instinct* doth by one alone. But of this probably more hereafter.

CHAP. XII.

Of the Clothing of Animals.

HAving in the foregoing Chapter somewhat largely taken a View of the infinite Creator's Wisdom and Goodness towards his Creatures in ordering their Food, I shall be more brief in this Chapter in my View of their *Clothing* (1); another necessary Appendage of Life, and in which we have plain Tokens of the Creator's Art, manifested in these two particulars; the *Suitableness of Animal's Clothing to their Place and Occasions:* and the *Garniture and Beauty thereof.*

1. The Clothing of Animals is suited to their place of Abode, and Occasions there; a manifest Act of Design and Skill. For if there was a possibility that Animals could have been accoutered any other way, than by God that made them, it must needs have come to pass, that their Clothing would have been at all Adventures, or all made the

(1) Concerning the *Clothing* of Animals, *Aristotle* observes, *That such Animals have Hair, as go on Feet, and are viviparous; and that such are covered with a Shell, as go on Feet, and are oviparous.* Hist. Anim. l. 3. c. 10.

(2) *Cujus*

the ſame mode and way, or, ſome of it at leaſt, inconvenient and unſuitable. But on the contrary we find all is curious and compleat, nothing too much, nothing too little, nothing bungling, nothing but what will bear the Scrutiny of the moſt exquiſite Artiſt, yea, and ſo far out-do his beſt Skill, that his moſt exquiſite Imitations even of the meaneſt Hair, Feather, Scale, or Shell, will be found only as ſo many ugly, ill-made Blunders and Botches, when ſtrictly brought to the Teſt of good Glaſſes. But we ſhall find an Example remarkable enough in the preſent Caſe, if we only compare the beſt of Clothing which Man makes for himſelf, with that given by the Creator for the covering of the irrational Creatures. Of which it may be ſaid, as our *Saviour* doth of the Flowers of the Field, *Mat.* 6. 29. *That even Solomon in all his Glory was not arrayed like one of theſe.*

But let us come to Particulars, and conſider the ſuitableneſs of the different Method the Creator hath taken in the Clothing of Man, and of the Irrational Animals. This *Pliny* (2) pathetically laments, and ſays, *It is hard to judge whether Nature hath beeu a kinder Parent, or more cruel Stepmother to Man.* For, ſays he, *Of all Creatures, he alone is covered with other's Riches, whereas Nature hath given*

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(2) *Cujus* [Hominis] *causâ videtur cuncta alia genuiſſe Natura, magnâ & ſæva mercede contra tanta ſua munera: ut non ſit ſatis æſtimare, Parens melior homini, an triſtior Noverca fuerit. Ante omnia unum Animantium cunctorum alienis velat opibus: cæteris variè tegumenta tribuit, teſtas, cortices, coria, ſpinas, villos, ſetas, pilos, plumam, pennas, ſquamas, vellera. Truncos etiam arboreſque cortice, interdum gemino, a frigoribus & calore tutata eſt. Hominem tantùm nudum, & in nuda humo, natali die abjicit ad vagitus ſtatim & ploratum, nullumque tot animalium aliud ad lachrymas, & has protinus vitæ principio.* Plin. Nat. Hiſt. L. 7. *Proem.*

Let

given various Clothing to other Animals, Shells, Hides, Prickles, Shag, Briſtles, Hair, Down, Quills, Scales, Fleeces; and Trees ſhe hath fenced with a Bark or two againſt the injuries of Cold and Heat. Only poor naked Man, he ſays, *is in the day of his Birth caſt into the wide World, to immediate crying and ſqualling; and none of all Creatures beſides, ſo ſoon to Tears in the very begiming of their Life.*

But here we have a manifeſt Demonſtration of the Care and Wiſdom of God towards his Creatures; that ſuch ſhould come into the World with their Bodies ready furniſhed and accommodated, who had neither Reaſon nor Forecaſt to contrive, nor Parts adapted to the Artifices and Workmanſhip of Clothing; but for Man, he being endowed with the tranſcending Faculty of Reaſon, and thereby made able to help himſelf, by having Thought to contrive, and withal Hands to effect, and ſufficient Materials (3) afforded him from the Skins and Fleeces of Animals, and from various Trees and

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Let *Seneca* anſwer this complaint of *Pliny*, although perhaps what he ſaith might be more properly noted in another place: *Quiſquis es iniquus æſtimator ſortis humanæ, cogita quanta nobis tribuerit Parens noſter, quanto valentiora animalia ſub jugum miſerimus, quanto velociora aſſequamur, quam nihil ſit mortale non ſub ictu noſtro poſitum. Tot virtutes accepimus, tot artes, animum denique cui nihil non eodem quo intendit momento pervium eſt, Syderibus velociorem,* &c. Senec. de Benef. l. 2. c. 29.

(3) *Mirantur plurimi quomodo tutè & ſanè vivant homines in horrendis frigoribus plagæ Septentrionalis; hancque levem quæſtionem ultra 30 annos audieram in Italiâ, præſertim ab Æthiopibus, & Indis, quibus onerojus videtur veſtitus ſub Zonâ torridâ.*——— *Quibus reſpondetur,* — *Gaudet Indus multiplici plumarum genere, magis forſan pro tegumento, quam neceſſitate: rurſus Scytha villoſo veſtitu.*—— *Ita ſub polo Arctico adverſus aſperrimas hyemes*—— *opportuna remedia facilitèr adminiſtrat* [Natura] *Ligna videlicet in maxima copia, & leviſſimo pretio, & demum Pelles diverſorum animalium, tam Sylveſtrium quam domeſticorum.* Then he gives a Catalogue

and Plants: Man, I say, having all this Provision made for him, therefore the Creator hath wisely made him naked, and left him to shift for himself, being so well able to help himself.

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Catalogue of them, and saith, *Quarum omnium experti pellifices ita ingeniosè noverunt mixturas componere, ut pulcherrimum decorem ostendat varietas, & calidissimum fomentum adjuncta mollities.* Ol. Mag. Hist. l. 6. c. 20.

To this guard against the Cold, namely, of Fire and Clothing, I hope the Reader will excuse me, if I take this opportunity of adding some other Defensatives Nature, (or rather the great Author of Nature,) hath afforded these Northern Regions: Such are their high Mountains, abounding, as *Ol. Magnus* saith, through all parts; also their numerous Woods, which besides their Fire, do with the Mountains serve as excellent Screens against the cold piercing Air and Winds. Their vast Quantities of Minerals and Metals also afford Heat, and warm Vapours, *Mineræ Septentrionalium regionum satis multæ, magnæ, diversæ, & opulentæ sunt*, saith the same curious and (for his time) learned Arch-bishop, *l. 6. c.* 1. and in other places. And for the warmth they afford, the *Vulcano*'s of those Parts are an evidence; as are also their terrible Thunder and Lightening, which are observed to be the most severe and mischievous in their Metalline Mountains, in which large Herds of Cattle are sometimes destroyed; the Rocks so rent and shattered, that new Veins of Silver are thereby discovered; and a troublesome kind of Quinsey is produced in their Throats, by the stench and poisonous Nature of the sulphureous Vapours; which they dissolve by drinking warm Beer and Butter together, as *Olaus* tells us in the same Book, *Chap.* 11.

To all which Defensatives, I shall in the last place add the warm Vapours of their Lakes; some of which are prodigiously large, of 130 *Italian* Miles in Length, and not much less in Breadth; also of their Rivers, especially the Vapours arising from the Sea. Of which guard against severe Cold, we have lately had a convincing Proof in the *great Frost* in 1708. wherein when *England*, *Germany*, *France*, *Denmark*, yea the more Southerly Regions of *Italy*, *Switzerland*, and other Parts suffered severely, *Ireland* and *Scotland* felt very little of it, hardly more than in other Winters; of the Particulars of which having given an Account in the *Philos. Transact. Nr.* 324. I shall thither refer

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And a notable Act this is of the Wiſdom of God, not only as the more ſetting forth his Care and Kindneſs to them that moſt needed his Help, the helpleſs irrational Animals, and in his not over-doing his Work; but alſo as it is moſt agreeable to the Nature and State of Man (4), both on natural and political Accounts. That Man ſhould cloth himſelf is moſt agreeable to his Nature, particularly (among other things) as being moſt ſalutary, and moſt ſuitable to his Affairs. For by this means, Man can adapt his Clothing to all Seaſons, to all Climates, to this, or to any Buſineſs. He can hereby keep himſelf ſweet and clean, fence off many Injuries; but above all, by this Method of Cloathing, with the natural Texture of his Skin adapted to it, it is that that grand means of Health, namely,

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the Reader. But it ſeems this is what doth ordinarily befall thoſe Northern Parts, particularly the *Iſlands of Orkney*, of which the learned Dr. *Wallace* gives this Account: *Here the Winters are generally more ſubject to Rain than Snow; nor doth the Froſt and Snow continue ſo long here as in other Parts of* Scotland, *but the Wind in the mean time will often blow very boiſterouſly, and it Rains ſometimes, not by Drops, but by Spouts of Water, as if whole Clouds fell down at once. In the Year* 1680, *in the Month of* June, *after great Thunder, there fell Flakes of Ice near a Foot thick.* Wall. Account of *Ork. Chap.* 1. *p.* 4. From which laſt Paſſage I obſerve, that although, in thoſe Parts, the Atmoſphere near the Earth be warm, it is exceſſively cold above, ſo as to freeze ſome of thoſe Spouts of Water in their deſcent, into ſuch great, and almoſt incredible Maſſes of Hail. And whence can this Warmth proceed, but from the Earth or Sea emitting Heat ſufficient to ſtave off the Cold above? Conſult *Book II. Chap.* 5. *Note* 3.

(4) *Sicut enim ſi innata ſibi* [i. e. Homini] *aliqua haberet arma, illa ei ſola ſemper adeſſent, ita & ſi artem aliquam Naturæ ſortitus eſſet, reliquas ſanè non haberet. Quia vero ei melius erat omnibus armis, omnibuſque artibus uti, neutrum eorum a naturâ ipſi propterea datum eſt.* Galen de Uſ. Part. l. 1. c. 4.

(5) Concern-

ly, *Inſenſible Perſpiration* (5) is performed, at leaſt greatly promoted, without which an humane Body would be ſoon over-run with Diſeaſe.

In the next place there are good political Reaſons for Man's clothing himſelf, inaſmuch as his Induſtry is hereby employed in the Exerciſes of his Art and Ingenuity; his Diligence and Care are exerted in keeping himſelf ſweet, cleanly, and neat; many Callings and Ways of Life ariſe from thence; and (to name no more) the Ranks and Degrees of Men are hereby in ſome meaſure rendered viſible to others, in the ſeveral Nations of the Earth.

Thus it is manifeſtly beſt for Man that he ſhould clothe himſelf.

But for the poor ſhiftleſs Irrationals, it is a prodigious Act of the great Creator's Indulgence, that they are all ready furniſhed with ſuch Clothing, as is proper to their Place and Buſineſs (6). Some covered

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(5) Concerning *Inſenſible Perſpiration*, *Sanctorius* obſerves, that it much exceeds all the Senſible put together. *De Stat. Med. Aph.* 4. That as much is evacuated by *Inſenſ. Perſpiration* in one Day, as is by *Stool* in fourteen Days. Particularly that, in a Night's time, about ſixteen Ounces is commonly ſent out by *Urine*, four Ounces by *Stool*; but above forty Ounces by *Inſenſible Perſpiration*. Aphor. 59, 60. That if a Man eats and drinks 8 *l.* in a Day, 5 *l.* of it is ſpent in *Inſenſible Perſpiration*. Sect. 1. Aph. 6. And as to the times, he ſaith, *Ab aſſumpto cibo* 5 *horis* 1 *l. circiter perſpirabilis —— exhalare ſolet; a* 5*a ad* 12*am* 3 *l. circiter; a* 12*a ad* 16*am vix ſelibram.* Aph. 56.

And as to the wonderful Benefits of *Inſenſible Perſpiration* they are abundantly demonſtrated by the ſame learned Perſon, *ubi ſupra*; as alſo by *Borelli* in his ſecond *Part. de Mot. Animal. Prop.* 188. who ſaith, *Neceſſaria eſt inſenſibilis Tranſpiratio, ut vita Animalis conſervetur.*

(6) *Animantium vero quanta varietas eſt? quanta ad eam rem vis, ut in ſuo quæque genere permaneant? quarum aliæ coriis tectæ ſunt, aliæ villis veſtitæ, aliæ ſpinis hirſutæ: plumâ alias, alias ſquammâ*

covered with Hair (7), ſome with Feathers (8), ſome

ſquammâ videmus obductas, alias eſſe cornibus armatas, alias habere effugia pennarum. Cicer. de Nat. Deor. L. 2.

(7) From *Malpighi*'s curious Obſervations of the *Hair*, I ſhall note three things. 1. Their Structure is fiſtulous, or tubular; which hath long been a Doubt among the curious. *Fiſtuloſum* [eſſe Pilum] *demonſtrat luſtratio pilorum a caudâ & collo Equorum*; &c. ——— *præcipuè ſetarum Apri, quæ patentiorem ex fiſtulis compoſitionem exhibent. Eſt autem dictus Apri pilus cylindricum corpus quaſi diaphanum*——*fiſtularum aggerie conflatum, & ſpeciem columnæ ſtriatæ præ ſe fert. Componentes fiſtulæ in gyrum ſituatæ in apice patentiores redduntur; nam hians pilus in geminas dividitur partes, & componentes minimæ fiſtulæ* ——— *liberiores redditæ manifeſtantur, ita ut enumerari poſſunt; has autem 20, & ultra numeravi.* ——— *Expoſitæ fiſtulæ* ——— *tubuloſæ ſunt, & frequentibus tunicis tranſverſalitèr ſituatis, veluti valvulis pollent. Et quoniam Spinæ, in Erinaceis præcipui*, &c. *nil aliud ſunt, quam duri, & rigidi pili, ideo*, &c. And then he deſcribes the *Hedge-hog*'s Spines, in which thoſe Tubes manifeſtly appear, together with medullary Valves and Cells, not inelegant, which he hath figured in *Tab.* 16, at the end of his Works.

That which this ſagacious, and not enough to be commended Obſerver took notice of in the Structure of Hair, and its parity to the Spines, I have my ſelf obſerved in ſome meaſure to be true in the Hair of *Cats*, *Rats*, *Mice*, and divers other Animals; which look very prettily when viewed with a good Microſcope. The Hair of a *Mouſe*, (the moſt tranſparent of any I have viewed,) ſeems to be one ſingle tranſparent Tube, with a Pith made up of a fibrous Subſtance running in dark Lines, in ſome Hairs tranſverſly, in others ſpirally, as in *Fig.* 14, 15, 16, 17. Theſe darker medullary Parts, or Lines I have obſerved, are no other than ſmall Fibres convolved round round, and lying cloſer together than in other Parts of the Hair. They run from the bottom to the top of the Hair, and I imagine ſerve to the gentle Evacuation of ſome Humour out of the Body; perhaps the Hair ſerves as well for the *Inſenſible Perſpiration* of hairy Animals, as to fence againſt Cold, and Wet. In *Fig.* 14, 16, is repreſented the Hair of a *Mouſe*, as it appears through a ſmall Magnifier; and in *Fig.* 15, 17, as it appears when viewed with a large Magnifier.

Upon another Review, I imagine, that although in *Fig.* 14, 15, the dark Parts of the Pith ſeem to be tranſverſe, that they as well as in the two other Figures, run round in a ſcrew-like Faſhion.

(8) See *Book VIII. Chap.* 1. *Note* 4, 5. (9) See

ſome with Scales, ſome with Shells (9), ſome only with Skin, and ſome with firm and ſtout Armature; all nicely accommodated to the Element in which the Creature liveth, and its Occaſions there (10). To *Quadrupeds* Hair is a commodious Clothing; which, together with the apt Texture of their Skin, fitteth them for all Weathers, to lie on the Ground, and to do the Offices of Man: and the thick and warm Furrs and Fleeces of others, are not only a good Defenſative againſt the Cold and Wet, but alſo a ſoft Bed to repoſe themſelves in, and to many of them a comfortable covering to nurſe and cheriſh their tender Young.

And as Hair to Quadrupeds, ſo Feathers are as commodious a dreſs to ſuch as fly in the Air, to Birds, and ſome Inſects; not only a good guard againſt Wet and Cold, and a comfortable Covering to ſuch as hatch and brood their Young; but alſo moſt commodious for their Flight. To which purpoſe they are nicely and neatly placed every where on the Body, to give them an eaſy Paſſage through the Air (11), and to aſſiſt in the watting their Body through that thin Medium. For which Service,

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(9) See *Chap.* 14. *Note* 3.

(10) It is a ſign ſome wiſe Artiſt was the Contriver of the Clothing of Animals, not only as their Clothing varies as their Way of living doth; but alſo, becauſe every part of their Bodies is furniſhed with proper ſuitable Clothing. Thus divers Animals that have their Bodies covered for the moſt part with ſhort, ſmooth Hair, have ſome Parts left naked, where Hair would be an Annoyance; and ſome Parts beſet with long Hair, as the Mane and Tail; and ſome with ſtiff, ſtrong Briſtles, as about the Noſe, and ſometimes within the Noſtrils, to guard off, or give warning of Annoyances.

(11) The Feathers being placed from the Head towards the Tail, in cloſe and neat Order, and withal preened and dreſſed from the Oil-bag, afford as eaſy a Paſſage through the Air,

vice, how curious is their Texture for Lightneſs, and withal for Strength? hollow and thin for Lightneſs, but withal context and firm, for Strength. And where 'tis neceſſary they ſhould be filled, what a light and ſtrong medullary Subſtance is it they are filled with? By which curious Contrivances, even the very heavieſt Parts made for Strength, are ſo far from being a load to the Body, that they rather aſſiſt in making it light and boyant, and capacitate it for Flight. But for the Vanes, the lighteſt part of the Feather, how curiouſly are they wrought with capillary Filaments, neatly interwoven together (12), whereby they are not only light, but alſo ſufficiently cloſe and ſtrong to keep the Body warm, and guard it againſt the Injuries of Weather, and withal to impower the Wings, like ſo many Sails, to make ſtrong Impulſes upon the Air in their Flight (13). Thus curious, thus artificial, thus commodious is the Clothing of Beaſts and Birds: Concerning which, more in proper place.

And no leſs might I ſhew that of Reptiles and Fiſhes (14) to be, if it was convenient to enlarge upon this Branch of the Creator's Works. How well

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Air, as a Boat new cleaned and dreſſed finds in its Paſſage through the Waters. Whereas, were the Feathers placed the contrary, or any other way, (as they would have been, had they been placed by Chance, or without Art,) they would then have gathered Air, and been a great Encumbrance to the Paſſage of the Body through the Air. See *Book VII. Chap.* 1. *Note* 2.

(12) In *Book VII. Chap.* 1. *Note* 5. There is a particular Account of the Mechaniſm of their Vanes, from ſome nice Microſcopical Obſervations, and therefore I ſhall take no farther Notice of it here.

(13) *Vid. Borel. de Mot. Animal.* Prop. 182. Vol. 1.

(14) See *Book IX.*

(15) For

well adapted are the *Annuli* of ſome Reptiles, and the Contortions of the Skin of others, not only to fence the Body ſufficiently againſt outward Injuries; but to enable them to creep, to perforate the Earth (15), and in a word, to perform all the Offices of their Reptile State, much better than any other Tegument of the Body would do? And the ſame might be ſaid of the covering of the Inhabitants of the Waters, particularly the Shells of ſome, which are a ſtrong guard to the tender Body that is within, and conſiſtent enough with their ſlower Motion; and the Scales and Skins of others, affording them an eaſy and ſwift Paſſage through the Waters. But it may be ſufficient to give only a hint of theſe things, which more properly belong to another place.

Thus hath the indulgent Creator furniſhed the whole Animal World with convenient, ſuitable Clothing.

(15) For a Sample of this Branch of my Survey, let us chuſe the Tegument of *Earth-Worms*, which we ſhall find compleatly adapted to their way of Life and Motion, being made in the moſt compleat manner poſſible for terebrating the Earth, and creeping where their Occaſions lead them. For their Body is made throughout of ſmall Rings, and theſe Rings have a curious Apparatus of Muſcles, enabling thoſe Creatures with great Strength to dilate, extend, or contract their *Annuli*, and whole Body; thoſe *Annuli* alſo are each of them armed with ſmall, ſtiff, ſharp *Beards*, or *Prickles*, which they can open, to lay hold on; or ſhut up cloſe to their Body: And laſtly, under the Skin there lies a *ſlimy Juyce*, that they emit, as occaſion is, at certain Perforations between the *Annuli*, to lubricate the Body, and facilitate its Paſſage into the Earth. By all which means they are enabled with great ſpeed, eaſe, and ſafety to thruſt, and wedge themſelves into the Earth; which they could not do, had their Bodies been covered with Hair, Feathers, Scales, or ſuch like Clothing of the other Creatures. See more concerning this Animal, *Book IX. Chap. I. Note* 1.

2. Let us in the next place take a ſhort View of the *Garniture* (16) and *Beauty* thereof. And here we ſhall thus far at leaſt deſcry it to be beautiful, that it is Compleat and Workman-like. Even the Clothing of the moſt ſordid Animal, thoſe that are the leaſt beautified with Colours, or rather whoſe Clothing may regrate the Eye (17); yet when we come ſtrictly to view them, and ſeriouſly conſider the nice Mechaniſm of one Part, the admirable Texture of another, and the exact Symmetry of the whole, we diſcern ſuch Strokes of inimitable Skill, ſuch incomparable Curioſity, that we may ſay with *Solomon*, Eccleſ. 3. 11. [God] *hath made every thing beautiful in his time.*

But for a farther Demonſtration of the ſuper-eminent Dexterity of his Almighty Hand, he hath been pleaſed as it were on purpoſe to give ſurprizing Beauties to divers Kinds of Animals. What radiant Colours are many of them, particularly ſome Birds and Inſects (18), bedecked with! What a prodigious Combination is there often of theſe, yea, how nice an Air frequently of meaner Colours,

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(16) *Ariſtotle* in his *Hiſt. Anim. l.* 3. *c.* 12. names ſeveral Rivers that by being drank of, change the Colour of the Hair.

(17) For an example, let us take the Clothing of the *Tortoiſe* and *Viper*, becauſe by an incurious View it rather regrateth than pleaſeth the Eye: but yet by an accurate Survey, we find the Shells of the former, and the Scales of the latter to be a curious piece of Mechaniſm, neatly made, and ſo compleatly and well put and tacked together, as to exceed any humane Compoſures. Of the latter, ſee more in *Book IX. Chap.* 1. *Note* 3.

(18) It would be endleſs to enter into the Particulars of the beautiful *Birds* and *Inſects* of our *European* Parts; but eſpecially thoſe inhabiting the Countries between the Tropicks, which are obſerved as much to exceed our Birds in their Colours, as ours do theirs in their Singing.

(19) The

lours (19), as to captivate the Eye of all Beholders, and exceed the Dexterity of the moſt exquiſite Pencil to Copy?

And now, when we thus find a whole World of Animals clothed in the wiſeſt Manner, the moſt ſuitable to the Element in which they live, the Place in which they reſide, and their State and Occaſions there; when thoſe that are able to ſhift for themſelves are left to their own Diſcretion and Diligence; but the Helpleſs well accoutered and provided for; when ſuch incomparable Strokes of Art and Workmanſhip appear in all, and ſuch inimitable Glories and Beauties in the Clothing of others; who can without the greateſt Obſtinacy and Prejudice deny this to be *GOD*'s Handy-work? The gaudy, or even the meaneſt Apparel which Man provideth for himſelf, we readily enough own to be the Contrivance, the Work of Man: and ſhall we deny the Clothing of all the Animal World beſides, (which infinitely ſurpaſſeth all the Robes of earthly Majeſty; ſhall we, dare we deny that) to be the Work of any thing leſs than of an infinite, intelligent Being, whoſe Art and Power are equal to ſuch glorious Work!

(19) The *Wryneck* at a diſtance is a Bird of mean Colour; neither are indeed its Colours radiant, or beautiful ſingly conſidered: but in the Hand, we ſee its light and darker Colours ſo curiouſly mixed together, as to give the Bird a ſurprizing Beauty. The ſame is alſo obſervable in many Inſects, particularly of the *Phalæna-kind*.

CHAP. XIII.

Of the Houſes, and Habitations of Animals.

HAving in the laſt Chapter as briefly as well I could, ſurveyed the *Clothing* of Animals, I ſhall in this take a view of their *Houſes*, *Neſts*, their *Cells*, and *Habitations*: another thing no leſs neceſſary to their Well-being than the laſt; and in which the great Creator hath likewiſe ſignalized his Care and Skill, by giving Animals an architectonick Faculty, to build themſelves convenient places of Retirement, in which to repoſe and ſecure themſelves, and to nurſe up their Young.

And here, as before, we may conſider the caſe of Man, and that of the Irrational Animals. Man having (as I ſaid) the Gift of Reaſon and Underſtanding, is able to ſhift for himſelf, to contrive and build, as his Pleaſure leads him, and his Abilities will admit of. From the meaneſt Huts and Cottages, he can erect himſelf ſtately Buildings, bedeck them with exquiſite Arts of Architecture, Painting, and other Garniture, enoble them, and render them delightful with pleaſant Gardens, Fountains, Avenues, and what not? For Man therefore the Creator hath abundantly provided in this reſpect, by giving him an Ability to help himſelf. And a wiſe Proviſion this is, inaſmuch as it is an excellent Exerciſe of the Wit, the Ingenuity, the Induſtry and Care of Man.

But ſince Ingenuity without Materials would be fruitleſs, the Materials therefore which the Creator hath provided the World with for this very ſervice of Building, deſerves our notice. The great va-

rieties

rieties of Trees (1), Earth, Stones, and Plants anſwering every Occaſion and Purpoſe of Man for this Uſe, in all Ages, and Places, all the World over, is a great Act of the Creator's Goodneſs, as manifeſting, that ſince he has left Man to ſhift for himſelf, it ſhould not be without ſufficient Helps to enable him to do ſo, if he would but make uſe of them, and the Senſe and Reaſon which God had given him.

Thus ſufficient Proviſion is made for the Habitation of Man.

And no leſs ſhall we find is made for the reſt of the Creatures; who although they want the power of Reaſon to vary their Methods, and cannot add to, or diminiſh from, or any way make Improvements upon their natural way; yet we find that natural Inſtinct, which the Creator's infinite Underſtanding hath imprinted in them, to be abundantly ſufficient, nay, in all probability the very beſt or only Method they can take, or that can be invented for the reſpective Uſe and Purpoſe of each peculiar Species of Animals (†). If ſome Creatures make their Neſts in Houſes, ſome in Trees, ſome

(1) —*Dant utile lignum*
Navigiis Pinos, domibus Cedroſque, Cupreſſoſque:
Hinc radios trivêre Rotis, hinc tympana plauſtris
Agricolæ, & pandas ratibus poſuêre carinas.
Viminibus Salices fœcundæ, frondibus Ulmi;
At Myrtus validis haſtilibus, & bona bello
Cornus; Ityreos Taxi torquentur in arcus.
Nec Tiliæ leves, aut torno raſile Buxum,
Non formam accipiunt, ferroque cavantur acuto;
Necnon & torrentem undam levis innatat Alnus
Miſſa Pado: necnon & apes examina condunt
Corticibuſque cavis, vitioſæque Ilicis alvo.
Virgil. Georg. L. 2.

(†) See *Chap.* 15. and *Book VIII. Chap.* 6.

ſome in Shrubs, ſome in the Earth (2), ſome in Stone, ſome in the Waters, ſome here, and ſome there, or have none at all; yet we find, that that Place, that Method of Nidification doth abundantly anſwer the Creature's Uſe and Occaſions. They can there ſufficiently and well repoſe, and ſecure themſelves, lay, and breed up their Young. We are ſo far from diſcerning any Inconvenience in any of their reſpective Ways, from perceiving any Loſs befall the Species, any decay, any periſhing of their Young; that in all probability, on the contrary,

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(2) Many of the *Veſpæ-Ichneumones* are remarkable enough for their Nidification and Proviſion for their Young. Thoſe in Earth, who commonly have golden and black Rings round their *Alvi*, having lined the little Cells they have perforated in the Earth, lay therein their Eggs, and then carry in to them Maggots from the Leaves of Trees, and ſeal them up cloſe and neatly. And another *Ichneumon*, more of the *Veſpa* than *Muſca-Ichneumon* Kind, (having a little Sting in its Tail, of a black Colour,) gave me the Pleaſure one Summer of ſeeing it build its Neſt in a little Hole in my Study-Window. This it coated about with an odoriferous reſinous Gum, collected, I ſuppoſe, from ſome Fir-Trees near: after which it laid two Eggs, (I think the Number was,) and then carried in divers Maggots, ſome bigger than it ſelf. Theſe it very ſagaciouſly ſealed cloſe up into the Neſt, leaving them there doubtleſs partly to aſſiſt the Incubation; and eſpecially for Food to the future Young, when hatched.

Of this Artifice of theſe *Ichneumons*, *Ariſtotle* himſelf takes notice, Οἱ δὲ Σφῆκες Ἰχνεύμονες καλούμενοι, &c. *As to the* Veſpæ *called* Ichneumones, *(leſs than others,) they kill* Spiders, *and carry them into their Holes, and having ſealed them up with Dirt, they therein hatch, and produce thoſe of the ſame Kind.* Hiſt. An. l. 5. c. 20.

To what hath been ſaid about theſe *Ichneumon-Waſps*, I ſhall add one Obſervation more concerning the providential Structure of their Mouth in every of their Tribes, *viz.* Their Jaws are not only very ſtrong, but nicely ſized, curved, and ſet for gnawing and ſcraping thoſe compleat little Holes they perforate in Earth, Wood, yea Stone it ſelf.

(3) *Tully*

contrary, in that particular way they better thrive, are more ſecure, and better able to ſhift for, and help themſelves. If, for Inſtance, ſome Beaſts make to themſelves no Habitations, but lie abroad in the open Air, and there produce their Young; in this caſe we find there is no need it ſhould be otherwiſe, by reaſon they are either taken care of by Man (3), or in no Danger, as other Creatures, from abroad. If others repoſite their Young in Holes (4) and Dens, and ſecure themſelves alſo therein, it is, becauſe ſuch Guard, ſuch Security is wanting, their Lives being ſought either by the Hoſtility of Man, or to ſatisfy the Appetite of rapacious Creatures (5). If among Birds, ſome build their Neſts cloſe, ſome open, ſome with this, ſome with another Material, ſome in Houſes, ſome in Trees, ſome on the Ground (6), ſome on Rocks and Crags on high, (of which God himſelf hath given

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(3) *Tully* having ſpoken of the Care of ſome Animals towards their Young, by which they are nurſed, and brought up, ſaith, *Accedit etiam ad nonnullorum animantium, & earum rerum quas terra gignit, conſervationem, & ſalutem, hominum etiam ſolertia & diligentia. Nam multæ & pecudes, & ſtirpes ſunt, quæ ſine procuratione hominum ſalvæ eſſe non poſſunt.* Cicer. de Nat. Deor. L. 2.

(4) Prov. 30. 26. *The Conies are but a feeble Folk, yet make they their Houſes in the Rocks.*

(5) See *Note* 10.

(6) It is a notable Inſtinct which *Ol. Magnus* tells of the *Galli Sylveſtres* in his Northern Country, to ſecure themſelves againſt the Cold and Storms of the Winter. *Cum nives inſtar collium terræ ſuperficiem ubique cooperiunt, ramoſque arborum diutius deprimunt, & condenſant, certos fructus Betulæ arboris —— in forma longi Piperis vorant, & glutiunt indigeſtos; idque tanta aviditate, ac quantitate, ut repletum guttur toto corpore majus appareat. Deinde partitis agminibus ſeſe inter medios nivium colles immergunt, præſertim in Jan. Febr. Martio, quando nives ut turbines, typhones, vel tempeſtates graviſſimæ e nubibus deſcendunt. Cumque cooperta ſunt, —— certis hebdomadis cibo in gutture collecto,*

given an Inſtance in the *Eagle*, Job 39. 27, 28.) And ſo among the Inſect and Reptile Kinds, if ſome repoſite their Eggs or Young in the Earth, ſome in Wood, ſome in Stone, ſome on one kind of Plant, ſome on another, ſome in warm and dry Places, ſome in the Waters and moiſt Places, and ſome in their own Bodies only, as ſhall be ſhewn in proper place; in all theſe Caſes, it is in all probability the beſt or only Method the Animal can take for the Hatching and Production of its Young, for their Supplies, Safety, or ſome other main point of their Being, or Well-being. This is manifeſt enough in many Caſes, and therefore probable in all. It is manifeſt that ſuch Animals, for inſtance, as breed in the Waters, (as not only Fiſh, but divers Inſects, and other Land-Animals do,) that their Young cannot be hatched, fed, or nurſed up in any other Element. It is manifeſt alſo, that Inſects which lay their Eggs on this, and that, and the other agreeable Tree, or Plant, or in Fleſh, *&c.* that it is by that means their Young are fed, and nurſed up. And it is little to be doubted alſo, but that theſe Matrixes may much conduce to the Maturation and Production of the Young. And ſo in all other the like caſes of Nidification, of Heat or Cold, Wet or Dry, Expoſed or Open, in all probability this is the beſt Method for the Animal's Good, moſt ſalutary and agreeable to its Nature, moſt for it Fecundity, and the Continuance and Increaſe of its Species; to which every Species of Animals is naturally prompt and inclined.

Thus

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lecto, egeſto, & reſumpto vivunt. Venatorum canibus non produntur. —— Quod ſi præſentiunt nivem imminere majorem, prædicto fructu, iterum devorato, aliud domicilium captant, in eoque manent uſque ad finem Martii, &c. Ol. Mag. Hiſt. *l.* 19. *c.* 33.

(7) It

Thus admirable is the natural Sagacity and Inſtinct (7) of the irrational Animals in the Convenience and Method of their Habitations. And no leſs is it in the Fabrick of them. Their architectonick Skill, exerted in the Curioſity and Dexterity of their Works, and exceeding the Skill of Man to imitate; this, I ſay, deſerves as much or more Admiration and Praiſe, than that of the moſt exquiſite Artiſt among Men. For with what inimitable Art (8) do theſe poor untaught Creatures lay a parcel of rude and ugly Sticks and Straws, Moſs and Dirt together, and form them into commodious Neſts? With what Curioſity do they line them within, wind and place every Hair, Feather, or Lock of Wool, to guard the tender Bodies of themſelves and their Young, and to keep them warm? And with what Art and Craft do many of them thatch and coat their Neſts without, to dodge and deceive the Eye of Spectators, as well as to guard and fence againſt the Injuries of Weather (9)? With what prodigious Subtilty do ſome

(7) It is a very odd Story, (which I rather mention for the Reader's Diverſion, than for its Truth,) which Dr. *Lud de Beaufort* relates, *Vir fide dignus narravit mihi, quod cum ſemel, animi gratia, nidum aviculæ ligno obturaſſet, ſeque occultaſſet, cupidus videndi quid in tali occaſione præſtaret; illa cùm fruſtra ſæpius tentaſſet roſtro illud auferre, caſus admodum impatiens, abiit, & poſt aliquod temporis ſpatium reverſa eſt, roſtro gerens plantulam, quâ obturamento applicatâ, paulo poſt, illud veluti telum erupit tanta vi, ut diſperſa impetu herbula ac occaſionem ipſi ab avicula ejus virtutem diſcendi, præripuerit.* Coſmop. divina. Sect. 5. C. 1. Had he told us what the Plant was, we might have given better Credit to his Story.

(8) Of the Subtilty of Birds in Nidification, ſee *Pliny's Nat. Hiſt. l.* 10. *c.* 33.

(9) Among many Inſtances that might be given of this Subtilty of Birds, and other Creatures, that of the *long-tailed Titmouſe* deſerves Obſervation, who with great Art builds her Neſt with Moſſes, Hair, and the Webs of *Spiders*, caſt out from them when

ſome foreign Birds (10), not only plat and weave the fibrous Parts of Vegetables together, and curiouſly tunnel them, and commodiouſly form them into Neſts; but alſo artificially ſuſpend them on the tender Twigs of Trees to keep them out of the reach of rapacious Animals?

And ſo for *Inſects*, thoſe little, weak, thoſe tender Creatures; yet, what admirable Artifts are they in this buſineſs of Nidification! With what great Diligence doth the little *Bee* gather its Combs from various Trees (11) and Flowers, the *Waſp* from ſolid

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when they take their Flight, (ſee *Book VIII. Chap.* 4. *Note* 5.) with which the other Materials are ſtrongly tied together. Having neatly built, and covered her Neſt with theſe Materials; without, ſhe thatcheth it on the top with the *Muſcus arboreus ramoſus*, or ſuch like broad, whitiſh Moſs, to keep out Rain, and to dodge the Spectator's Eye: and within, ſhe lineth it with a great Number of ſoft Feathers; ſo many, that I confeſs I could not but admire how ſo ſmall a Room could hold them, eſpecially that they could be laid ſo cloſe and handſomly together to afford ſufficient Room for a Bird with ſo long a Tail, and ſo numerous an Iſſue as this Bird commonly hath, which Mr. *Ray* ſaith, (*Synopſ. Method. Avium*, p. 74.) *Ova inter omnes aviculas numeroſiſſima ponit.* See more of the Neſt of this Bird from *Aldrovand*, in *Willugh. Ornith.* p. 243.

(10) The Neſt of the *Guira tangeima*, the *Icterus minor*, and the *Jupujuba*, or whatever other Name the *American Hang-Neſts* may be called by, are of this Kind. Of which ſee *Willughby's Ornith. Lib.* 2. *Chap.* 5. §. 12, 13. Alſo Dr. *Grew's Muſæum Reg. Soc. Part* 1. *Sect.* 4. *Chap.* 4. Theſe Neſts I have divers times ſeen, particularly in great Perfection in our *R. S.* Repoſitory, and in the noble and well-furniſhed *Muſæum* of my often-commended Friend Dr. *Sloane*; and at the ſame time I could not but admire at the neat Mechaniſm of them, and the Sagacity of the Bird, in hanging them on the Twigs of Trees, to ſecure their Eggs and Young from the *Apes*.

(11) I mention Trees, becauſe I have ſeen *Bees* gather the Gum of Fir-Trees, which at the ſame time gave me the Pleaſure of ſeeing their way of loading their Thighs therewith.

(12) *Waſps*

ſolid (12) Timber; and with what prodigious Geometrical Subtilty do thoſe little Animals work their deep hexagonal Cells, the only proper Figure that the beſt Mathematician could chuſe for ſuch a Combination of Houſes (13)! With what Accuracy do other Inſects perforate the Earth (14), Wood, yea Stone it ſelf (15)! For which Service the compleat Apparatus of their Mouths (16) and Feet (17), deſerves

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(12) *Waſps* at their firſt coming may be obſerved to frequent Poſts, Boards, and other Wood that is dry and ſound, but never any that is rotten. Theſe they may be heard to ſcrape and gnaw; and what they ſo gnaw off, they heap cloſe together between their Chin and Fore-Legs, until they have gotten enough for a Burden, which they then carry away in their Mouths, to make their Cells with.

(13) Circular Cells would have been the moſt capacious, but this would by no means have been a convenient Figure, by reaſon much of the Room would have been taken up by Vacancies between the Circles: therefore it was neceſſary to make Uſe of ſome of the rectilinear Figures. Among which only three could be of uſe; of which *Pappus Alexandrin.* thus diſcourſeth, *Cum igitur tres figuræ ſunt, quæ per ſeipſas locum circa idem punctum conſiſtentem replere poſſunt, Triangulum ſcil. Quadratum & Hexagonum, Apes illam quæ ex pluribus angulis conſtat ſapienter delegerunt, utpote ſuſpicantes eam plus mellis capere quam utramvis reliquarum: Et Apes quidem illud tantum quod ipſis utile eſt cognoſcunt,* viz. *Hexagonum Quadrato & Triangulo eſſe majus & plus Mellis capere poſſe, nimirum æquali materiâ in conſtructionem uniuſcujuſque conſumptâ. Nos vero qui plus ſapientiæ quam Apes habere profitemur, aliquid etiam magis inſigne inveſtigabimus.* Collect. Math. L. 5.

(14) See before, *Note* 2.

(15) See *Chap.* 11. *Note* 22.

(16) See *Chap.* 11. *Note* 21.

(17) Among many Examples, the Legs and Feet of the *Mole-Cricket*, (*Gryllotalpa*,) are very remarkable. The Fore-Legs are very brawny and ſtrong; and the Feet armed each with four flat ſtrong Claws, together with a ſmall Lamina with two larger Claws, and a third with two little Claws: which Lamina is joynted to the bottom of the Foot, to be extended, to make the Foot wider, or withdrawn within the Foot. Theſe Feet are placed to ſcratch ſomewhat ſideways, as well as downward after the

deſerves particular Obſervation, as hath been, and will be hereafter obſerved. And further yet, with what Care and Neatneſs do moſt of thoſe little ſagacious Animals line thoſe their Houſes within, and ſeal them up, and fence them without (18)! How artificially will others fold up the Leaves of Trees and Plants (19), others houſe themſelves in Sticks and Straws, others glew light and floating Bodies together (20), and by that Artifice make themſelves floating Houſes in the Waters, to tranſport

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the manner of *Moles* Feet, and they are very like them alſo in Figure.

Somewhat of this nature *Swammerdam* obſerves of the Worms of the *Ephemeron*. *To this purpoſe* [to dig their Cells] *the wiſe Creator hath furniſhed them* (ſaith he) *with fit Members. For, beſides that their two Fore-Legs are formed ſomewhat like thoſe of the ordinary* Moles, *or* Gryllotalpa, *he hath alſo furniſhed them with two toothy Cheeks, ſomewhat like the Sheers of* Lobſters, *which ſerve them more readily to bore the Clay.* Swammerdam's Ephem. Vit. publiſhed by Dr. *Tyſon*, *Chap.* 3.

(18) See the before-cited *Note* 2.

(19) They are for the moſt part ſome of the *Phalænæ* Tribe which inhabit the tunnelled, convolved Leaves that we meet with on Vegetables in the Spring and Summer. And it is a ſomewhat wonderful Artifice, how ſo ſmall and weak a Creature, as one of thoſe newly hatched Maggots, (for doubtleſs it is they, not the Parent-Animal, that emits no Web, nor hath any textrine Art,) can be able to convolve the ſtubborn Leaf, and then bind it, in that neat round Form, with the Thread or Web it weaves from its own Body; with which it commonly lines the convolved Leaf, and ſtops up the two Ends, to prevent its own falling out, and *Ear-wigs*, and other noxious Animals getting in.

(20) The ſeveral ſorts of *Phryganea*, or *Cadews* in their Nympha, or Maggot-ſtate, thus houſe themſelves; one ſort in Straws, called from thence *Straw-Worms*; others in two or more Sticks laid parallel to one another, creeping at the bottom of Brooks; others with a ſmall bundle of pieces of Ruſhes, Duck-weed, Sticks, *&c.* glewed together, wherewith they float on the Top, and can row themſelves about the Waters. Both theſe are called *Cod-bait*. Divers other ſorts there are, which the Reader may

ſport themſelves at Pleaſure after their Food, or other neceſſary occaſions of Life? And for a Cloſe, let us take the Scriptural Inſtance of the *Spider*, Prov. 30. 28. which is one of the four little things which *v.* 24. *Agur* ſays, is *exceeding Wiſe. The Spider taketh hold with her Hands, and is in Kings Palaces* (21). I will not diſpute the Truth of our *Engliſh* Tranſlation of this Text, but ſuppoſing the Animal mentioned to be that which is meant; it is manifeſt, that the Art of that Species of Creatures in ſpinning their various Webs, and the Furniture their Bodies afford to that purpoſe, are an excellent Inſtinct and Proviſion of Nature, ſetting forth its glorious Author.

And

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may ſee a Summary of, from Mr. *Willughby*, in *Raii Method. Inſect.* p. 12. together with a good, though very brief Deſcription of the *Papilionaceous* Fly, that comes from the *Cod-bait Cadew*. It is a notable architectonick Faculty theſe Animals have, to gather ſuch Bodies, and then to glue them together; ſome to be heavier than Water, that the Animal may remain at the bottom, where its Food is, for which purpoſe they uſe Stones, as well as Sticks, Ruſhes, *&c.* and ſome to be lighter than Water, to float on the Top, and gather its Food from thence. Theſe little Houſes look coarſe, and ſhew no great Artifice outwardly; but are well tunnelled and made within with a hard tough Paſte; into which the hind part of the Maggot is ſo fixed, that it can draw its Cell after it any where, without danger of leaving it behind; as alſo thruſt its Body out, to reach what it wanteth; or withdraw it into its Cell, to guard it againſt Harms.

(21) Having mentioned the *Spider*, I ſhall take this Occaſion (although it be out of the way) to give an Inſtance of the Poyſon of ſome of them, *Scaliger Exerc.* 186. *relates, that in* Gaſcony, *his Country, there are* Spiders *of that virulency, that if a Man treads upon them, to cruſh them, their Poyſon will paſs through the very Soles of his Shooes.* Boyl Subtil. of Effluv. c. 4.

Mr. *Leenwenhoek* put a *Frog* and *Spider* together into a Glaſs, and having made the *Spider* ſting the *Frog* divers times, the *Frog* died in about an Hour's time. *Philoſ. Tranſact. Nr.* 272.

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And now from this ſhort and tranſient View of the architectonick Faculty of Animals, eſpecially the Irrationals, we may eaſily perceive ſome ſuperiour and wiſe Being was certainly concerned in their Creation or Original. For how is it poſſible that an irrational Creature ſhould with ordinary and coarſe, or indeed any Materials, be ever able to perform ſuch Works, as exceed even the Imitation

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In the ſame *Tranſaction* is a curious Account of the manner how *Spiders* lay, and guard their Eggs, *viz.* they emit them not out of the hindmoſt part of the Body, but under the upper part of her Belly near the hind Legs, *&c.* Alſo there is an Account of the Parts from which they emit their Webs, and divers other things worth Obſervation, with Cuts illuſtrating the whole.

But in *Philoſ. Tranſ. Nr.* 22. Dr. *Nath. Fairfax* from *S. Redi*, and his own Obſervations thinks *Spiders* not Venemous, ſeveral Perſons, as well as Birds ſwallowing them without hurt; which I my ſelf have known in a Perſon of Learning, who was adviſed to take them medicinally at firſt, and would at any time ſwallow them, affirming them to be ſweet, and well taſted. And not only Innocuous, but they are very Salutiferous too in ſome of the moſt ſtubborn Diſeaſes, if the pleaſant Story in *Mouſet* be true, of a rich *London* Matron, cured of a deſperate *Tympany* by a certain Debauchee, that hearing of her Caſe, and that ſhe was given over by the Doctors, went to her, pretending to be a Phyſician, and confidently affirming he could cure her; which ſhe being willing to believe, agrees with him for ſo much Money, one half to be paid down, the other upon Cure. Upon which he gives her a *Spider*, promiſing her Cure in three Days. Upon which, (not doubting but he had poyſoned her, and fearing he might be called to Account for it,) he gets out of Town as faſt as he could. But inſtead of being poyſoned, ſhe ſoon recovered. After ſome Months the Quack gets privately to Town, when he thought the Buſtle might be over; and enquiring how his Patient did, was informed of her Cure; and thereupon viſiting her, and making an excuſe for his Abſence, he received his Pay with great Applauſe and Thanks. *Mouf. Inſect. l.* 2. *c.* 15.

Having ſaid ſo much of *Spiders*, I might here add their Flight: But of this, ſee *Book VIII. Chap.* 4. *Note* 5.

(1) *Callent*

tion of a rational Creature? How could the Bodies of many of them (particularly the laſt mentioned) be furniſhed with architective Materials? How could they ever diſcover them in their Bodies, or know what Uſe to make of them? We muſt therefore neceſſarily conclude, that the Irrationals either have Reaſon and Judgment, not only Glimmerings thereof, but ſome of its ſuperiour Acts, as Wiſdom and Foreſight, Diſcretion, Art, and Care; or elſe, that they are only paſſive in the Caſe, and act by Inſtinct, or by the Reaſon of ſome ſuperiour Being imprinted in their Nature, or ſome way or other (be it how it will) congenial with them. That they are Rational, or excell Man in Art and Wiſdom, none ſurely will be ſo fooliſh as to ſay. And therefore we muſt conclude, that thoſe excellent Ends they purſue, and that admirable Art they exert, is none of their own, but owing to that infinitely wiſe and excellent Being, of whom it may be ſaid with reference to the Irrational, as well as Rational Creatures, as it is, *Prov.* 2. 6. *The Lord giveth Wiſdom; out of his Mouth cometh Knowledge and Underſtanding.*

CHAP.

CHAP. XIV.

Of Animal's Self-Preservation.

HAving thus considered the Food, Clothing, and Houses of Animals; let us in this Chapter take a Glance of another excellent Provision the wise Creator hath made for the good of the Animal World, and that is the Methods which all Animals naturally take for their *Self-Preservation* and *Safety*. And here it is remarkable, (as in the Cases before,) that *Man*, who is endowed with Reason, is born without Armature, and is destitute of many Powers which irrational Creatures have in a much higher Degree than he, by reason he can make himself Arms to defend himself, can contrive Methods for his own Guard and Safety, can many ways annoy his Enemy, and stave off the Harms of noxious Creatures.

But for others, who are destitute of this supereminent Faculty, they are some way or other provided with sufficient Guard (1), proportionate to their place of Abode, the Dangers they are like to incur

(1) *Callent in hoc cuncta animalia, sciuntque non sua modo commoda, verum & hostium adversa; norunt sua tela, norunt occasiones, partesque dissidentium imbelles. In ventre mollis est tenuisque cutis Crocodilo: ideoque se, ut territi, mergunt Delphini, subeunteque alvum illa secant spina.* Plin. Nat. Hist. l. 8. c. 25.

(2) *Omnibus*

incur there (2); and in a word, to their greateſt occaſions and need of Security. Accordingly ſome are ſufficiently guarded againſt all common Dangers by their natural Clothing, by their Armature of Shells, or ſuch like hard and impregnable Covering of their Body (3). Others deſtitute of this

(2) *Omnibus aptum eſt Corpus Animæ moribus & facultatibus: Equo fortibus ungulis & juba eſt ornatum (etenim velox & ſuperbum & generoſum eſt animal.) Leoni autem, utpote animoſo & feroci, dentibus & unguibus validum. Ita autem & Tauro & Apro; illi enim Cornua, huic exerti Dentes.* —— *Cervo autem & Lepori (timida enim ſunt animalia) velox corpus, ſed inerme. Timidis enim velocitas, arma audacibus conveniebant.* —— *Homini autem (ſapiens enim eſt* ——*) manus dedit, inſtrumentum ad omnes artes neceſſarium, paci non minus quam bello idoneum. Non igitur indiguit Cornu ſibi innato, cum meliora Cornibus arma manibus, quandocunque volet, poſſit accipere: etenim Enſis & Haſta majora ſunt Arma, & ad incidendum promptiora.* —— *Neque Cornu, neque Ungula quicquam niſi cominus agere poſſunt; Hominum vero arma eminus juxta ac cominus agunt: telum quidem & ſagitta magis quam cornua.* —— *Non igitur eſt nudus, neque inermis,* —— *ſed ipſi eſt Thorax ferreus, quandocunque libet omnibus Coriis difficilius ſauciatu organum.* —— *Nec Thorax ſolùm ſed & Domus, & Murus, & Turris,* &c. Galen de Uſu. Part. l. 1. c. 2.

(3) Shells deſerve a place in this Survey, upon the Account of their great Variety, the curious and uncouth Make of ſome, and the beautiful Colours and pretty Ornaments of others; but it would be endleſs to deſcend to Particulars. Omitting others, I ſhall therefore only take Notice of the *Tortoiſe Shell*, by reaſon a great deal of Dexterity, appears even in the ſimplicity of that Animal's Skeleton. For, beſides, that the Shell is a ſtout guard to the Body, and affords a ſafe Retreat to the Head, Legs, and Tail, which it withdraws within the Shell upon any Danger, beſides this, I ſay, the Shell ſupplieth the place of all the Bones in the Body, except thoſe of the extreme Parts, the Head, and Neck, and the four Legs, and Tail. So that at firſt ſight, it is ſomewhat ſurprizing to ſee a compleat Skeleton conſiſting of ſo ſmall a number of Bones, and they abundantly ſufficient for the Creature's uſe.

Guard, are armed, ſome with Horns (4), ſome with ſharp Quills and Prickles (5), ſome with Claws, ſome with Stings (‖); ſome can ſhift and change

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(4) *Dente timentur Apri; defendunt cornua Tauros:*
Imbelles Damæ quid niſi præda ſumus? Mart. l. 13. Epig. 94.

(5) The *Hedghog* being an helpleſs, ſlow, and patient Animal, is accordingly guarded with Prickles, and a Power of rolling it ſelf in them. *Clavis terebrari ſibi pedes, & diſcindi viſcera patientiſſimè ferebat, omnes cultri ictus ſine gemitu pluſquam Sartanâ nobilitate concoquens.* Borrichius in Blaſ. de Echino. *Panniculum carnoſum amplexabatur Muſculus pænè circularis, admirandæ fabricæ, lacinias ſuas ad pedes, caudam, caput, variè exporrigens, cujus miniſterio Echinus ſe ad arbitrium in orbem contrahit.* Act. Dan. in Blaſio.

Iſte licet digitos teſtudine pungat acuta,
Cortice depoſito mollis Echinus erit. Martial. L. 13. Epigr 86.

(‖) The *Sting* of a *Waſp*, or *Bee*, &c is ſo pretty a piece of Work, that it is worth taking Notice of, ſo far as I have not found others to have ſpoken of it. Others have obſerved the Sting to be an hollow Tube, with a bag of ſharp penetrating Juice (its Poiſon) joined to the end of it within the Body of the *Waſp*, which is, in Stinging, injected into the Fleſh through the Tube. But there are beſides this, two ſmall, ſharp, bearded Spears, lying within this Tube or Sting, as in a Sheath. In a *Waſp*'s Sting I counted eight Beards on the ſide of each Spear, ſomewhat like the Beards of Fiſh-hooks. Theſe Spears in the Sting, or Sheath, lie one with its Point a little before that of the other; as is repreſented in *Fig.* 21. to be ready (I conceive) to be firſt darted into the Fleſh; which being once fixed, by means of its foremoſt Beard, the other then ſtrikes in too, and ſo they alternately pierce deeper and deeper, their Beards taking more and more hold in the Fleſh; after which the Sheath or Sting follows, to convey the Poyſon into the wound. Which that it may pierce the better, it is drawn into a Point, with a ſmall ſlit a little below that Point, for the two Spears to come out at. By means of this pretty Mechaniſm in the Sting it is, that the Sting when out of the Body, and parted from it, is able to pierce and ſting us: and by means of the Beards being lodged deep in the Fleſh, it comes to paſs that *Bees* leave their Stings behind them, when they are diſturbed before they have time to withdraw their Spears into their Scabbard. In *Fig.* 21. is repreſented

change their Colours (6), some can make their escape by the help of their Wings, and others by the swiftness of their Feet, some can screen themselves by diving in the Waters, others by tinging and disordering the Waters (7) can make their escape; and some can guard their Bodies even in the very Flames, by the Ejection of the Juyce of their

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represented the two Spears as they lie in the Sting. In *Fig.* 22. the two Spears are represented when squeezed out of their Scabbard, the Sting; in which latter, *Fig. A c b* is the Sting, *c d*, and *b e* the two-bearded Spears thrust out.

(6) The *Chameleon* is sufficiently famed on this Account. Besides which, *Pliny* tells us of a Beast as big as an *Ox*, called the *Tarandus*, that when he pleaseth assumes the Colour of an *Asse*, and *Colorem omnium fruticum, arborum, florum, locorumque reddit in quibus latet metuens, ideoque raro capitur.* Plin. l. 8. c. 34.

How true this is there may be some Reason to doubt; but if any Truth be in the Story, it may be from the Animals chusing such Company, or Places, as are agreeable to its Colour: as I have seen in divers *Caterpillars*, and other Insects, who I believe were not able to change their Colour, from one Colour to another, yet I have constantly observed to fix themselves to such things as were of the same Colour; by which means they dodge the Spectator's Eye. Thus the *Caterpillar* that feeds on *Elder*, I have more than once seen so cunningly adhering to the small Branches of the same Colour, that it might be easily mistaken for a small Stick, even by a careful View. So a large green *Caterpillar* that feeds on *Buckthorn*, and divers others. To which I may add the prodigious Sagacity of the *Ichneumon-Flies* that make the *Kermes*, (for of that Tribe all I ever saw, are,) how artificially they not only include their Eggs within that gummy Skin or Shell, but also so well humour the Colour of the Wood they adhere to by various Streaks and Colours, that it is not easy to distinguish them from the Wood it self.

(7) *Contrà metum & vim, suis se armis quæque defendit. Cornibus Tauri, Apri dentibus, morsu Leones, aliæ fugâ se, aliæ occultatione tutantur: atramenti effusione Sepiæ, torpore Torpedines. Multa etiam infectantes odoris intollerabili fœditate depellunt.* Cicero de Nat. Deor. L. 2.

their Bodies (8), some by their accurate Smell, Sight, or Hearing, can foresee Dangers (9); others by their natural Craft can prevent or escape them (10); others by their uncouth Noise (11), by the horrid Aspect, and ugly Gesticulations of their Body (12); and some even by the Power of their Excrements, and their Stink (13) can annoy their Enemy, and secure

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(8) A Knight called *Corvini* at *Rome*, cast a *Salamander* into the Fire, which presently swelled, and then vomited store of thick slimy Matter, which put out the Coals, to which the *Salamander* presently retired, putting them out again in the same manner, as soon as they rekindled, and by this means saved it self from the force of the Fire for the space of two Hours. After which it lived nine Months. *Vid. Philos. Transact. Nr.* 21. in *Lowth. Abridg. Vol.* 2. *p.* 816.

(9) *Pliny* gives an Instance in each *l.* 10. *c.* 69. *Aquilæ clariùs cernunt*, [quam homines;] *Vultures sagaciùs odorantur: liquidiùs audiunt Talpæ obrutæ terrâ, tam denso atque surdo naturæ elemento.*

(10) The *Doubling* of the *Hare* before she goes to Form, thereby to dodge and deceive *Dogs*, although a vulgar Observation, is a notable Instinct, for an Animal less famed for cunning than the *Fox*, and some others.

(11) It is natural for many Quadrupeds, Birds, and *Serpents*, not only to put on a torvous angry Aspect, when in Danger; but also to snarl, hiss, or by some other Noise deter their Adversary.

(12) The *Jynx* or *Wryneck*, although a Bird of very beautiful Feathers, and consequently far enough from being any way terrible; yet being in Danger, hath such odd Contortions of its Neck, and Motions of its Head, that I remember have scared me, when I was a Boy, from taking their Nests, or touching the Bird; daring no more to venture my Hand into their Holes, than if a *Serpent* had lodged in it.

(13) *Bonasus tuetur se calcibus & stercore, quod ab se quaternis passibus* [trium jugerum longitudine, *Plin. Nat. Hist. l.* 8. *c.* 15.] *ejaculatur, quod sæpe comburit adeo ut deglabrentur canes.* Ray Synopf. Quadr. *p.* 71.

Camelus

ſecure themſelves: And againſt ſome (14) the Divine Providence it ſelf hath provided a Guard.

By ſuch Shifts and Means as theſe, a ſufficient Guard is miniſtered to every Species of Animals, in its proper reſpective Place; abundantly enough to ſecure the Species from Deſtruction, and to keep up that Balance, which I have formerly ſhewed, is in the World among every, and all the Species of Animals; but yet not enough to ſecure Individuals from becoming a Prey to Man, or to other Creatures,

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Camelus Peruvianus Glama dictus neminem offendit, ſed miro admodum ingenio ſe ab illatâ vindicat injuriâ, nimirum vomitu vel cibi, vel humoris in vexantem retrorſum cum impetu ejaculato, ob protenſam colli longitudinem. Id. ib. p. 146.

Yzquiepatl, (Anglicè *Squnck* Præf.] and one that I ſaw they called a *Stonck*) *cum quis eam inſectatur, fundit cum ventris crepitu halitum fœtidiſſimum: quin ipſa tota teterrimum exhalat odorem, & urina ſtercuſque eſt fœtidiſſimum, atque adeo peſtilens, ut nihil ſit reperire in noſtro orbe, cui in hâc re poſſit comparari: quo fit, ut in periculo conſtituta, urinam & fæces ad 8 plurimùm paſſuum intervallum ejiciat, hoc modo ſe ab omnibus vindicans injuriis, ac veſtes inficiens maculis luteis indelebilibus, & nunquam ſatis perſpirante odore: aliàs innoxium Animal eduleque, hâc ſolâ ratione horrendiſſimum.* Id. ib. p. 182.

Si Accipitur Ardeam in ſublimi moleſtat, ſtercore immiſſo in pennas ejus, eas putreſcere facit: uti Solinus ſcribit de Bonaſo, &c. Ita & Lupus urinam ſpargit in perſequentem. Olaus Mag. Hiſt. l. 19. c 14.

(14) Thus againſt the *Crocodile*, which can catch its Prey only before it, not on one ſide. So the *Shark*, of which take my often-commended Friend Dr. *Sloane*'s Obſervation: *It hath this particular to it, with ſome others of its own Tribe, that the Mouth is in its under Part, ſo that it muſt turn the Belly upwards to prey. And was it not for that time that it is in turning, in which the purſued Fiſhes eſcape, there would be nothing that could avoid it; for it is very quick in Swimming, and hath a vaſt Strength, with the largeſt Swallow of any Fiſh, and is very devouring.* Sloane's *Voyage to* Jamaica, *pag.* 23.

Creatures, as their Neceſſities of Life require. To which purpoſe the natural Sagacity and Craft of the one in intrapping (15) and captivating, being in ſome Meaſure equivalent to that of the other in evading, is as excellent a means for the maintaining the one, as preſerving the other; and if well conſidered, argues the Contrivance of the infinitely wiſe Creator and Preſerver of the World.

CHAP. XV.

Of the Generation of Animals.

THERE is now only one thing more of the ten Things in common to Animals, and that is what relates to their Generation (1), and Conſervation

(15) See *Chap.* 11 *Note* 57.

(1) *Spontaneous Generation* is a Doctrine ſo generally explod-ed, that I ſhall not undertake the diſproof of it. It is ſo evident, that all Animals, yea and Vegetables too, owe their Production to Parent-Animals and Vegetables, that I have often admired at the Sloth and Prejudices of the ancient Philoſophers, in ſo eaſily taking upon truſt the *Ariſtotelian*, or rather the *Ægyptian* Doctrine of *Æquivocal Generation*; that when they ſaw *Flies*, *Frogs*, and *Lice*, for inſtance, to be Male and Female, and accordingly to engender, lay Eggs, *&c.* they could ever imagine any of theſe Creatures ſhould be ſpontaneouſly produced, eſpecially in ſo Romantick a manner, as in the Clouds; as they particularly thought *Frogs* were, and that they dropped down in Showers of Rain. For an anſwer to this caſe of *Frogs*, I ſhall refer to a Relation of my own, which my late moſt ingenious and learned Friend, the great Mr. *Ray* requeſted of me, and was pleaſed to publiſh in his laſt Edition of his *Wiſdom of God manifeſted*, &c. p. 365.

But

But some will yet assert the Raining of *Frogs*; among which the curious Dr. *Plot* is somewhat of this Opinion; telling us of *Frogs* found on the Leads of the Ld *Aston*'s Gatehouse at *Tixal* in *Staffordshire*, which he thinks by some such means came there, as also on the Bowling-Green frequently after a Shower of Rain. *Plot's Hist. Staff.* c. 1. §. 47.

But we may take a Judgment of this, and an Hundred such like Reports, to be met with in considerable Authors, from other the like Reports that have been better inquired into. In a Scarcity in *Silesia*, a mighty Rumour was spread of its *raining Millet-Seed*. But the Matter being inquired into, 'twas found to be only the Seeds of the *Ivy-leaved Speedwel*, or *small Henbit* growing in the place in great plenty. *Ephe. Germ. An.* 3. *Obser.* 40. So in the *Archipelago* it was thought Ashes were rained, Ships being covered therewith at One Hundred Leagues distance. But in all probability it was from an Eruption of *Vesuvius*, that then happened. About *Warmister* in *Wilts*, 'twas reported it *rained Wheat*. But an ingenious Observer, Mr. *Cole*, found it to be only *Ivy-Berries* blown thither in a considerable Quantity by a Tempest. In the Year 1696. at *Cranstead* near *Wrotham* in *Kent*, a Pasture-Field was over-spread with little young *Whitings*, supposed to fall from the Clouds in a Tempest of Thunder and Rain. But doubtless they were brought thither with Waters from the Sea, by the Tempest. *Vid.* the fore-commended Mr. *Lowth. Abridg. Phil. Trans V.* 2. *p.* 143, 144.

Neither needeth it to seem strange, that Ashes, *Ivy-Berries*, small Fishes, or young *Frogs*, (which yet may have some other Conveyance,) should be thus transported by tempestuous Winds, considering to what Distance, and in what Quantities the Sea-Waters were carried by the *Great Storm*, Nov. 26. 1703. of which an ingenious Friend sent me these Accounts from *Lewes* in *Sussex*, viz. *That a Physician travelling soon after the Storm, to* Tisehurst, *twenty Miles from the Sea, as he rode along pluckt some Tops of Hedges, and chawing them, found them Salt: that some* Grapes *hanging on the Vines at* Lewes, *were so too; that Mr.* Williamson, *Rector of* Ripe, *found the Twigs in his Garden Salt the* Monday *after the Storm, and others observed the same a Week after: that the Grass of the Downs about* Lewes, *was so Salt, that the* Sheep *would not feed till Hunger compelled them: and that the* Miller *of* Berwick, *(three Miles from the Sea,) attempting, with his Man, to secure his Mill, were so washed with Flashes of Sea-water, like the Breakings of Waves against the Rocks, that they were almost strangled therewith, and forced to give over their Attempt.*

vation of their Species (2) by that means. It would not be ſeemly to advance far in this admirable Work of God; neither ſhall I at all inſiſt upon that of Man for the ſame reaſon. And as for the Irrationals (3), I ſhall confine my ſelf to theſe five Matters.

1. Their

I called this Doctrine of *Æquivocal Generation*, an *Egyptian Doctrine*, becauſe probably it had its Riſe in *Ægypt*, to ſalve the Hypotheſis of the Production of Men and other Animals out of the Earth, by the help of the Sun's Heat. To prove which, the *Egyptians*, (as *Diodor. Sicul.* ſaith,) *produce this Obſervation, That about* Thebes, *when the Earth is moiſtened by the* Nile, *by the intenſe Heat of the Sun, an innumerable multitude of* Mice, *do ſpring out.* From whence he infers, that all kind of Animals might as well at firſt come likewiſe out of the Earth And from theſe the learned Biſhop *Stillingfleet* thinks other Writers, as *Ovid*, *Mela*, *Pliny*, &c. have, without examining its Truth, taken up the ſame Hypotheſis. *V. Stillingfleet's Orig. Sacr.* Part 2. Book I. Chap. 1.

The before-commended Dr. *Harris*, from the Obſervations of Dr. *Harvey*, Sr. *Malpighi*, Dr. *de Graaf*, and Mr. *Leewenhoeck* infers three Things concerning *Generation* as highly probable. 1. *That Animals are ex Animalculo.* 2. *That the Animalcules are originally in ſemine Marium, & non in Fœminis.* 3. *That they can never come forward, or be formed into Animals of the reſpective Kind, without the Ova in Fœminis.* His Proofs and Illuſtrations, ſee under the word *Generation* in his *Lex. Techn. Vol.* 2.

(2) *At certè Natura, ſi fieri potuiſſet, maximè optaſſet ſuum opificium eſſe immortale: quod cùm per materiam non liceret (nam quod* ——— *ex carne eſt compoſitum, incorruptibile eſſe non poteſt) ſubſidium quod potuit ipſi ad immortalitatem eſt fabricata, ſapientis cujuſdam urbis conditoris exemplo,* &c. *Nam mirabilem quandam rationem invenit, quo modo in demortui animalis locum, novum aliud ſufficiat.* Galen de Uſ. Part. l. 14. c. 2.

(3) *Animantia Bruta Obſtetricibus non indigent in edendo Partu, cùm inditâ Naturæ vi Umbilicus ſeipſum occludat.* Ol. Rudbeck in Blaſii Anat. Felis.

(4) Chap.

1. Their natural Sagacity in chuſing the fitteſt Places to repoſite their Eggs and Young.

2. The fitteſt Times and Seaſons they make Uſe of for their Generation.

3. The due and ſtated Number of their Young.

4. Their Diligence and earneſt Concern in their Breeding up.

5. Their Faculty of feeding them, and their Art and Sagacity exerted therein.

1. The natural Sagacity of irrational Animals in chuſing the fitteſt Places to repoſite their Eggs and Young. Of this I have given larger Hints already than I needed to have done, when I ſpake of the Architecture (4) of Animals, intending then to have wholly paſſed by this Buſineſs of Generation. I ſhall therefore now only ſuperadd a few other Inſtances, the more to illuſtrate this matter.

It hath been already ſhewn, and will hereafter (5) further appear, that the Places in which the ſeveral Species of Animals lay up their Eggs and Young are the beſt for that purpoſe; Waters (6) for

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(4) *Chap.* 13.

(5) *Book VIII. Chap.* 6.

(6) The *Ephemeron*, as it is an unuſual and ſpecial Inſtance of the Brevity of Life, ſo I take to be a wonderful Inſtance of the ſpecial Care and Providence of God in the Conſervation of the Species of that Animal. For, 1. As an Animal, whoſe Life is determined in about five or ſix Hours time, (*viz.* from about ſix in the Evening, till about eleven a Clock at Night,) needs no Food; ſo neither doth the *Ephemeron* eat, after it is become a *Fly*. 2. As to its Generation. In thoſe five Hours of its Life, it performs that, and all other neceſſary Offices of its Life. For in the beginning of its Life, it ſheds its Coat; and that being done, and the poor little Animal thereby rendered Light and Agile, it ſpends the reſt of its ſhort time in friſking over the Waters,

for one, Fleſh for another, Holes in Wood (7), Earth, or Stone (8) for others, and Neſts for others; and we ſhall find, that ſo ardent is the Propenſity of all Animals, even of the meaneſt Inſects to get a fit place for the Propagation of their Young, that, as will hereafter appear, there is ſcarce any thing that eſcapeth the Inqueſt of thoſe little ſubtile Creatures. But beſides all this, there are two or three things more obſervable, which plainly argue the Inſtinct of ſome ſuperiour rational Being. As,

1. The compleat and neat Order which many Creatures obſerve in laying up their Seed or Eggs in proper Repoſitories. Of which I ſhall ſpeak in another place (9).

2. The ſuitable Apparatus in every Creature's Body for the laying up its Eggs, Seed, or Young in their proper place. It would be as endleſs as needleſs to name all Particulars, and therefore an Inſtance or two of the Inſect Tribe may ſerve for a Specimen in this place, 'till I come to other Particulars. Thus Inſects, who have neither Feet adapted to ſcratch, nor Noſes to dig, nor can make artificial

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Waters, and at the ſame time the Female droppeth her Eggs on the Waters, and the Male his Sperm on them to impregnate them. Theſe Eggs are ſpread about by the Waters, deſcend to the bottom by their own Gravity, and are hatched by the warmth of the Sun into little Worms, which make themſelves Caſes in the Clay, and feed on the ſame without any need of parental Care. *Vid. Ephem. vitæ*, tranſlated by Dr. *Tyſon* from *Swammerdam*. See alſo *Book VIII. Chap. 6. Note* 17.

(7) V. *Chap.* 13. *Note* 2. and *Book VIII. Chap. 6.*

(8) The Worms in *Chap.* 11. *Note* 22. breed in the Holes, they gnaw in Stone, as is manifeſt from their Eggs found therein.

(9) See *Book VIII. Chap. 6. Note* 16.

(10) Many

artificial Nests to lay up their Young; yet what abundant amends is there made them, in the power they have either to extend the *Abdomen* (10), and

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(10) Many, if not most Flies, especially those of the *Flesh-Fly*-kind, have a Faculty of extending their *Uropygia*, and thereby are enabled to thrust their Eggs into convenient Holes, and Receptacles for their Young, in Flesh, and whatever else they Fly-blow. But none more remarkable than the *Horse Fly*, called by *Pennius* in *Mouffet*, (p. 62.) Σκολιόῤῥ, i. e. *Curvicauda*, and the *Whame* or *Burrel-Fly*, which is vexatious to Horses in Summer, not by stinging them, but only by their bombylious Noise, or tickling them in laying their Nits, or Eggs on their Hair; which they do in a very dextrous manner, by thrusting out their *Uropygia*, bending them up, and by gentle, slight Touches, sticking the Eggs to the Hair of the Legs, Shoulders, and Necks, commonly of Horses; so that Horses which go abroad, and are seldom dressed, are somewhat discoloured by the numerous Nits adhering to their Hair.

Having mentioned so much of the Generation of this Insect, although it be a little out of the way, I hope I shall be excused for taking Notice of the long-tailed Maggot, which is the Product of these Nits or Eggs, called by Dr. *Plot. Eruca glabra*, [or rather *Eula Scabra*, it should be] *caudata aquatico-arborea*, it being found in the Water of an hollow Tree. This I mention, as being a singular and remarkable Work of God, not so much for its being utterly unlike to its Parent *Bee*-like-Fly, as for the wise Provision made for it by its long Tail: which is so joynted at certain distances from the Body, as that it can be withdrawn, or sheathed one Part within another to what length the Maggot pleaseth, so as to enable it to reach the bottom of very shallow, or deeper Waters, for the gathering of Food. At the end of this tapering Tail is a Ramification of Fibrillæ, or small Hairs, representing (when spread) a Star; with the help of which spread out on the top of the Waters, it is enabled to Hang, making by that means a small Depression or Concavity on the Surface of the Water. In the midst of this Star, I imagine the Maggot takes in Air, there being a Perforation, which with a Microscope I could perceive to be open, and by the Star to be guarded against the Incursion of the Water.

(11) The

and thereby reach the commodious Places they could not otherwiſe come at; or elſe they have ſome aculeous Part or Inſtrument to terebrate, and make way for their Eggs into the Root (11), Trunk (12), Fruit (13), Leaves (14), and the tender

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(11) The Excreſcences on the Roots of *Cabbages*, *Turneps*, and divers other Plants have always a Maggot in them: but what the Animal is that thus makes its way to the Root under Ground, whether *Ichneumon*, *Phalæna*, or rather *Scarab*, (which I moſt ſuſpect) I could never diſcover, being not able to bring them to any thing in Boxes.

(12) I preſume they are only of the *Ichneumon-Fly-kind*, that have their Generation in the Trunks of Vegetables. In *Malpighi de Gallis*, *Fig.* 61. is a good Cut of the gouty Excreſcences, or rather Tumors of the *Briar-ſtalk*: from which proceeds a ſmall black *Ichneumon-Fly*, with red *Legs*; black ſmooth, joynted *Antennæ*; pretty large *Thorax*; and ſhort, round *Belly*, of the ſhape of an Heart. It leapeth as a *Flea*. The *Male*, (as in other Inſects,) is leſſer than the *Female*, and very venerous; in ſpite of Danger, getting upon the Female, whom they beat and tickle with their Breeches and Horns, to excite them to a *Coit*.

Another example of Generation in the Trunks of Vegetables, ſhall be from the Papers of my often-commended Friend Mr. *Ray*, which are in my Hands, and that is an Obſervation of the ingenious Dr. *Nath. Wood*: *I have* (ſaith he) *lately obſerved many Eggs in the common Ruſh. One ſort are little tranſparent Eggs, in ſhape ſomewhat like a Pear, or Retort, lying within the Skin, upon, or in the Medulla, juſt againſt a browniſh Spot on the out-ſide of the Ruſh; which is apparently the Cicatrix of the wound made by the Fly, when ſhe puts her Eggs there. Another kind is much longer, and not ſo tranſparent, of a long oval, or rather cylindrical Form: ſix, eight, or more, lie commonly together, acroſs the Ruſh, parallel to each other like the Teeth of a Comb, and are as long as the Breadth of the Ruſh.* Letter from *Kilkenny* in *Ireland*, Apr. 28. 1697.

(13) See *Book VIII. Chap.* 6. *Note* 4.

(14) I have in *Chap.* 13. *Note* 19, and *Book VIII. Chap.* 6. *Notes* 5, 6, taken notice of the Nidification and Generation of ſome Inſects on the Leaves of Vegetables, and ſhall therefore for

der Buds of Vegetables (15), or some other such curious and secure Method they are never destitute of. To which we may add,

3. The natural Poyson (‖), (or what can I call it,) which many or most of the Creatures, last intended, have to cause the Germination of such Balls, Cases, and other commodious Repositories as are an admirable Lodgment to the Eggs and Young, that particularly assist in the Incubation and Hatching the Young, and then afford them sufficient Food and Nourishment in all their *Nympha-State*, in which they need Food; and are afterwards commodious

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for the Illustration of this place, chuse an uncommon Example out of the *Scarab-kind*, (the Generation of which Tribe hath not been as yet mentioned,) and that is of a small *Scarab* bred in the very Tips of *Elm leaves*. These Leaves in Summer may be observed to be, many of them, dry and dead, as also turgid: in which lieth a dirty, whitish, rough Maggot. From which proceeds a *Beetle* of the smallest kind, of a light *Weesle* colour, that leapeth like a *Grashopper*, although its Legs are but short. Its Eyes are blackish, Vaginæ thin, and prettily furrowed, with many Concavities in them; small club-headed Antennæ, and a long Rostrum like a Proboscis.

The same, or much like this, I have met with on the Tips of *Oaken* and *Holly-leaves*. How the *Scarab* lays its Eggs in the Leaf, whether by terrebrating the Leaf, or whether the *Maggot*, when hatched, doth it, I could never see. But with great Dexterity it makes its way between the upper and under Membranes of the Leaf, feeding upon the parenchymous Part thereof. Its Head is slenderer and sharper than of most *Maggots*, as if made on purpose for this Work; but yet I have often wondered at their Artifice in so nicely separating the Membranes of the *Elm*-leaf, without breaking them, and endangering their own tumbling out of them, considering how thin and very tender the Skins of that Leaf (particularly) are.

(15) See *Book VIII. Chap. 6. Note* 24.

(‖) See *Book VIII. Chap.* 8. to *Note* 26, &c.

(16) Πολλὰ

commodious Houſes and Beds for them in their *Aurelia-State*, till they are able to break Priſon, fly abroad, and ſhift for themſelves. But this ſhall be taken Notice of, when I come to treat of Inſects.

8. As irrational Animals chuſe the fitteſt Place, ſo alſo the fitteſt Times and Seaſons for their Generation. Some indeed are indifferent to all Times, but others make uſe of peculiar Seaſons (16). Thoſe, for inſtance, whoſe Proviſions are ready at all Seaſons, or who are under the Tuition of Man, produce their Young without any great regard to Heat or Cold, Wet or Dry, Summer or Winter. But others, whoſe Proviſions are peculiar, and only to be met with at certain Seaſons of the Year, or who, by their Migration and Change of Place, are tied up to certain Seaſons; theſe (as if endowed with a natural Care and Foreſight of what ſhall happen) do accordingly lay, hatch, and nurſe up their Young in the moſt proper Seaſons of all the Year for their purpoſe: as in Spring, or Summer, the times of plenty of Proviſions, the times of warmth for Incubation, and the moſt proper Seaſons to breed up their Young, till they are able to ſhift for themſelves, and can range about for Food, and ſeek places of Retreat and Safety, by flying long Flights as well as their Progenitors, and paſſing into far diſtant Regions, which (when others fail) afford thoſe helpleſs Creatures the Neceſſaries of Life.

3. To

(16) Πολλὰ δὲ κ) πρὸς τὰς ἐπτροφὰς τ τέκνων ςοχαζόμενα, ποιῦνται τ σωδυασμὸν ἐν τῇ ἀπαρτίσει ὥρα. Ariſt. Hiſt. An. l. 5. c. 8. *ubi plura.*

Chap.

3. To the ſpecial Seaſons, I may add the peculiar Number of Young produced by the Irrational Creatures. Of which I have already taken ſome notice, when I ſpake of the Balance of Animals (17). Now, if there was not a great deal more than Chance in this Matter, even a wiſe Government of the Creation, it could never happen that every Species of Animals ſhould be tied up to a certain Rate and Proportion of its Increaſe; the moſt uſeful, would not be the moſt fruitful, and the moſt pernicious produce the feweſt Young, as I have obſerved it commonly is. Neither would every Species produce ſuch a certain Rate as it is only able to breed up. But all would be in a confuſed, huddled State. Inſtead of which, on the contrary, we find every thing in compleat Order; the Balance of Genera, Species and Individuals always proportionate and even; the Balance of Sexes the ſame; moſt Creatures tied up to their due Stint and Number of Young, without their own Power and Choice, and others (particularly of the winged Kind (18)) producing their due Number at their Choice and Pleaſure;

(17) *Chap.* 10.

(18) Mr. *Ray* alledges good Reaſons to conclude, that although Birds have not an exact Power of numbering, yet, that they have of diſtinguiſhing many from few, and knowing when they come near to a certain Number; and that they have it in their Power to lay many or few Eggs. All which he manifeſteth from *Hens*, and other domeſtick Fowls, laying many more Eggs when they are withdrawn, than when not. Which holds in wild as well as domeſtick Birds, as appears from Dr. *Liſter*'s Experiment in withdrawing a *Swallow*'s Eggs, which by that means laid nineteen Eggs ſucceſſively before ſhe gave over. *V. Ray's Wiſdom of God*, &c. p. 137.

(19) *Palumbes*

Pleasure; some large Numbers, but not more than they can cover, feed, and foster; others fewer, but as many as they can well nurse and breed up. Which minds me,

4*thly*. Of the Diligence and earnest Concern which irrational Animals have of the Production, and Breeding up their Young. And here I have already taken notice of their Στοργὴ, or natural Affection, and with what Zeal they feed and defend their Young. To which may be added these two things.

1. The wonderful Instinct of Incubation. It is utterly impossible, that ever unthinking untaught Animals should take to that only Method of hatching their Young, was it not implanted in their Nature by the infinitely wise Creator. But so ardent is their Desire, so unwearied is their Patience when they are engaged in that Business, that they will abide their Nests for several Weeks, deny themselves the Pleasures, and even the Necessaries of Life; some of them even starving themselves almost, rather than hazard their Eggs, to get Food, and others either performing the Office by turns (19), or else the one kindly seeking out, and carrying Food to the other (20), engaged in the Office of Incubation.

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(19) *Palumbes incubat fœmina post meridiana in matutinum, cætero mas. Columbæ incubant ambo, interdiu Mas, noctu Fœmina.* Plin. Nat. Hist l. 10. c. 58.

(20) Of the common *Crow*, Mr. *Willughby* saith, *The Females only sit, and that diligently, the Males in the mean time bring them Victuals, as* Aristotle *saith. In most other Birds, which pair together, the Male and Female sit by turns.* Ornithol. L. 2. Sect. 1. C. 2. §. 2. And I have observed the Females to be much fatter than the Males.

(21) See

cubation. But of these Matters in a more proper place (21).

2. When the young ones are produced, not only with what Care do they feed and nurse them, but with what surprizing Courage do all or most Creatures defend them! It is somewhat strange to see timid Creatures (22), who at other times are cowardly, to be full of Courage, and undaunted at that time; to see them furiously and boldly encounter their Enemy, instead of fly from him; and expose themselves to every Danger, rather than hazard, and forsake their Young.

With this earnest Concern of the irrational Animals for their Young, we may join in the

5th and last Place, Their Faculty and Sagacity of feeding them. Of which I shall take notice of three things.

1. The Faculty of suckling the Young, is an excellent Provision the Creator hath made for those helpless Creatures. And here the agreeableness and suitableness of that Food to young Creatures deserves particular Observation, as also their delight in it, and desire and endeavours after it, even as soon as born (23), together with the willingness of all, even the most savage and fierce Animals

(21) See *Book VII. Chap.* 4.

(22) *Volucribus Natura novam quandam Pullos educandi, rationem excogitavit: ipsis enim præcipuum quendam amorem in ea quæ procrearunt, ingeneravit, quo impulsa bellum pro pullis cum ferocibus animalibus, quæ antè declinarunt, intrepidè suscipiunt, victumque ipsis convenientem suppeditant.* Galen de Us. Part. l. 14. c. 4.

(23) *In iis animantibus quæ lacte aluntur, omnis ferè cibus matrum lactescere incipit: eaque quæ paulo ante nata sunt sine magistro, duce naturâ, mammas appetunt, earumque ubertate saturan-*

to part with it, and to administer it to their Young, yea, to teach and institute them in the Art of taking it.

And lastly, To name no more, the curious Apparatus which is made for this Service in the divers Species of Animals by a due number of Breasts proportionable to the Occasions of each Animal, by curious Glands in those Breasts to separate that nutritive Juyce, the Milk, by Arteries and Veins to convey it to them, and proper Rivulets and Channels to convey it from them, with Duggs and Nipples placed in the most convenient part of the Body (24) of each Animal to administer it to their Young; all these things, I say, do manifestly proclaim the Care and Wisdom of the great Creator.

2. As

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tur. Atque ut intelligamus nihil horum esse fortuitum, & hæc omnia esse provida, solertisque naturæ, quæ multiplices fœtus procreant, ut Sues, ut Canes, his Mammarum data est multitudo; quas easdem paucas habent eæ bestiæ, quæ pauca gignunt. Cicer. de Nat. Deor. L. 2. *Consule quoque.* Galen de Us. Part. l. 14. c. 4. and l. 15. c. 7.

(24) *Animalia solidipeda & ruminantia vel cornigera inter femora Mammas habent, quorum Fœtus statim a partu pedibus insistunt, quòd matres inter lactandum non decumbant, ut Equa Asina,* &c. *Animalia digitata & multipara in medio ventre, scil. spatio ab inguine ad pectus (in Cuniculo usque ad jugulum) duplicem mammarum seriem sortita sunt, quæ omnia decumbentia ubera fœtibus admovent, ut Ursa, Leæna,* &c. *Si vero hæc in solo inguine Mammas gererent, propria crura inter decumbendum fœtûs accessum ad mammas nonnihil præpedirent. Mulieribus Mammæ binæ sunt, ut & Papillæ, nimirum ut latus lateri conformiter respondeat, & ut alternatim infans à latere in latus inter sugendum transferatur, ne corpus ejus uni lateri nimis assuescens quoquo modo incurvetur. Simia, homo Sylvestris,* &c. Blas. Anat. Animal. Par. I.

2. As for ſuch Animals as do in another manner breed up their Young, by finding out Food, and putting it into their Mouths, the Proviſion made in them for this Service to ſtrike, catch, to pouch, and convey their Prey and Food to their Young (25), is very conſiderable. And ſo is alſo their

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1, Cap. 6. *de Cane ex Whartono.* See here what *Pliny* hath alſo, *L.* 11. *Chap.* 40.

In the *Elephant*, the Nipples are near the Breaſt, by reaſon the old one is forced to ſuck her ſelf, and by the help of her Trunk conveys the Milk into the Mouth of her Young. *Vid. Phil. Tranſact. Nr.* 336.

(25) For an Exemplification I might name many Animals, particularly Birds, whoſe Parts are compleatly ſuited to this Service. They are Characteriſticks of Rapacious Birds, to have aduncous Bills and Talons to hold and tear, and ſtrong brawny Thighs to ſtrike and carry their Prey, as well as a ſharp piercing Sight to ſpy it afar of. *Ray Synopſ. Method. Av.* p. 1. The *Pelecane* alſo might be here named for its prodigious Bag under its Bill and Throat, big enough to contain thirty Pints. *Id. ibid.* p. 122. And to name no more, the common *Heron* hath its moſt remarkable Parts adapted to this Service; long Legs for wading, and a long Neck anſwerable thereto to reach Prey, a wide extenſive Throat to pouch it; long Toes, with ſtrong hooked Talons, one of which is remarkably ſerrate on the Edge, the better to hold their Prey: a long ſharp Bill to ſtrike their Prey, and ſerrate towards the Point, with ſharp hooked Beards ſtanding backward, to hold their Prey faſt when ſtruck; and laſtly, large, broad, concave Wings (in appearance much too large, heavy, and cumberſome for ſo ſmall a Body, but) of greateſt Uſe to enable them to carry the greater Loads to their Neſts at ſeveral Miles Diſtance: as I have ſeen them do from ſeveral Miles beyond me, to a large Heronry above three Miles diſtant from me. In which I have ſeen *Plaiſe*, and other Fiſh, ſome Inches long, lying under the high Trees in which they build: and the curious and ingenious Owner thereof hath ſeen a large *Eel* conveyed by them, notwithſtanding the great Annoyance it gave them in their Flight, by its twiſting this way, and that way about their Bodies.

their Sagacity in equally distributing it among them, that among many, all shall be duly, equally, and in good Order, fed.

3. There is yet another Instinct remaining, of such Animals as can neither administer Suck to their Young, neither lay them in places affording Food, nor can convey and bring them Food, but do with their Eggs lay up Provisions for their future Young. Somewhat of this is reported of some Birds (26); but I have my self with Pleasure frequently seen some of the Species of Insects to carry ample Provisions into their dry and barren Cells, where they have sealed them carefully and cautiously up with their Eggs, partly, 'tis like, for Incubation sake, and partly as an easy Bed to lodge their Young; but chiefly for future Provision for their Young, in their Nympha-state, when they stand in need of Food (27).

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(26) This is reported of the *American Ostrich*, mentioned by *Acarette*, in *Philos. Transact. Nr.* 89. Of which see, *Book VII. Chap.* 4. *Note* 4.

(27) *Hornets*, *Wasps*, and all the kinds of *Bees* provide Honey; and many of the *Pseudosphecæ*, and *Ichneumon-Wasps* and *Flies* carry in *Maggots*, *Spiders*, &c. into their Nests; of which see above, *Note* 2. *Chap.* 13.

CHAP.

CHAP. XVI.

The Concluſion.

THUS I have as briefly as well I could, (and much more briefly than the Matters deſerved,) diſpatched the Decad of things I propoſed in common to the ſenſitive Creatures. And now let us pauſe a little, and reflect. And upon the whole Matter, what leſs can be concluded than that there is a Being infinitely Wiſe, Potent, and Kind, able to Contrive and Make this glorious Scene of things, which I have given only a Glance of? For what leſs than Infinite, could ſtock ſo vaſt a Globe with ſuch a noble Set of Animals? all ſo contrived, as to miniſter to one another's Help ſome way or other, and moſt of them ſerviceable to Man peculiarly, the Top of this lower World; made as 'twere on purpoſe to obſerve, and ſurvey, and ſet forth the Glory of the infinite *Creator*, manifeſted in his Works! Who! What but the great *GOD* could ſo admirably provide for the whole Animal World every thing ſerviceable to it, or that can be wiſhed for, either to conſerve its Species, or to miniſter to the Being or Well-being of Individuals! Particularly, who could *Feed* ſo ſpacious a World, who could pleaſe ſo large a number of Palates, or ſuit ſo many Palates to ſo great a variety of Food, but the infinite Conſervator of the World! And who but the ſame great *HE*, could provide ſuch commodious *Clothing* for every Animal; ſuch proper *Houſes*, *Neſts*, and *Habitations*; ſuch ſuitable *Armature* and *Weapons*;

Weapons; ſuch *Subtilty*, *Artifice*, and *Sagacity*, as every Creature is more or leſs armed and furniſhed with, to fence off the Injuries of the Weather, to reſcue it ſelf from Dangers, to preſerve it ſelf from the Annoyances of its Enemies; and, in a word, to conſerve its Self, and its Species! What but an infinite ſuperintending Power could ſo equally *balance* the ſeveral Species of Animals, and conſerve the *Numbers* of the Individuals of every Species ſo even, as not to over or under people the Terraqueous Globe! Who but the infinite wiſe Lord of the World could allot every Creature its moſt ſuitable *Place* to live in, the moſt ſuitable Element to *breathe*, and *move*, and *act* in! And who but *HE* could make ſo admirable a Set of Organs, as thoſe of Reſpiration are, both in Land and Water-Animals! Who could contrive ſo curious a Set of Limbs, Joynts, Bones, Muſcles, and Nerves, to give to every Animal the moſt commodious *Motion* to its State and Occaſions! And to name no more, what Anatomiſt, Mathematician, Workman, yea Angel could contrive, and make ſo curious, ſo commodious, and every way ſo exquiſite a Set of Senſes, as the *five Senſes* of Animals are; whoſe Organs are ſo dexterouſly contrived, ſo conveniently placed in the Body, ſo neatly adjuſted, ſo firmly guarded, and ſo compleatly ſuited to every Occaſion, that they plainly ſet forth the Agency of the infinite Creator and Conſervator of the World!

So that here upon a tranſient View of the Animal World in general only, we have ſuch a throng of Glories, ſuch an enraviſhing Scene of things, as may excite us to admire, praiſe, and adore the infinitely wiſe, powerful, and kind CREATOR; to condemn all atheiſtical Principles;

ples; and with holy *David*, *Pſal.* 14. 1. to conclude that he is in good earneſt a *Fool*, that dares to ſay, *There is no God*, when we are every where ſurrounded with ſuch manifeſt Characters, and plain Demonſtrations of that infinite Being.

But in the next Book we ſhall ſtill find greater Tokens, if poſſible, in my View of Animals in particular.

A SURVEY

A

SURVEY

Of the Particular

Tribes of *ANIMALS.*

IN the foregoing Book, having taken a View of the things in common to Animals, my Buſineſs in the next, will be to inſpect the particular Tribes, in order to give further Manifeſtations of the Infinite Creator's Wiſdom, Power and Goodneſs, towards the Animal World.

BOOK V.

A SURVEY *of* MAN.

THE firſt *Genus* of Animals that I ſhall take Notice of, ſhall be *Man*, who may juſtly claim the Precedence in our Diſcourſe, inaſmuch as God hath given him Superiority in the Animal World; *Gen.* 1. 26. *And God ſaid, Let us make Man in our Image, after our Likeneſs: and let them have Dominion over the Fiſh of the Sea, and over the*

Fowl of the Air, and over the Cattel, and over all the Earth, and over every creeping thing that creepeth upon the Earth.

And as to Man, we have ſo excellent a Piece of Workmanſhip, ſuch a Microcoſm, ſuch an Abridgment of the Creator's Art in him, as is alone ſufficient to demonſtrate the Being and Attributes of God. Which will appear by conſidering the *Soul*, and the *Body* of Man.

CHAP. I.

Of the SOUL *of Man.*

MY Survey of Man, I ſhall begin with the Soul of Man, by reaſon it is his moſt noble Part (1), the Copy of the Divine Image in us (2); in which we have enough to fill us with Admiration of the Munificence, Power, and Wiſdom of the Infinite Creator (3), when we contemplate

(1) *Jam vero Animum ipſum, Mentemque hominis, Rationem, Conſilium, Prudentiam, qui non divina cura perfectæ eſſe perſpicit, is his ipſis rebus mihi videtur carere.* Cicer. de Nat. Deor. L. 2.

(2) *Senſum a Cœleſti demiſſum traximus arce,*
Cujus egent prona, & terram ſpectantia: mundi
Principio indulſit communis Conditor; illis
Tantum Animas; nobis quoque Animum.
Juven. Sat. 15.

Et cum non aliter poſſent mortalia fingi,
Adjunxit geminas, illæ cum corpore lapſæ
Intereunt: hæc ſola manet, buſtoque ſuperſtes
Evolat. Claudian. de 4. Conſul. Honor.

(3) *Nam ſiquis nulli ſectæ addictus, ſed libera ſententia rerum conſiderationem inierit, conſpicatus in tanta carnium ac ſuccorum colluvie tantam Mentem habitare: conſpicatus item & cujuſvis animalis conſtructionem (omnia enim declarant Opifi-*

template the noble Faculties of this our ſuperior part, the vaſt Reach and Compaſs of it's *Underſtanding*, the prodigious Quickneſs and Piercingneſs of it's *Thought*, the admirable Subtilty of it's *Invention*, the commanding Power of it's *Wiſdom*, the great Depth of it's *Memory* (4), and in a Word, it's Divine Nature and Operations.

But I ſhall not dwell on this, tho' the ſuperiour part of Man, becauſe it is the leaſt known. Only there are two things I can't eaſily paſs by, becauſe they manifeſt the eſpecial Concurrence and Deſign of the Infinitely wiſe Creator, as having a

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Opificis Sapientiam) *Mentis, quæ homini ineſt, excellentiam intelliget, tum opus de partium utilitate, quod prius exiguum eſſe ſibi videbatur, perfectiſſimæ Theologiæ verum principium conſtituet: quæ Theologia multo eſt major atque præſtantior tota Medicina.* Galen. de uſu Part. L. 17. c. 1.

(4) Among many Examples that I conld give of Perſons famous for *Memory*, *Seneca*'s Account of himſelf may be one, *Hanc* [*Memoriam*] *aliquando in me floruiſſe, ut non tantum ad uſum ſufficeret, ſed in miraculum uſque procederet, non nego. Nam & 2000 nominum recitata, quo ordine erant dicta, reddebam: & ab his qui ad audiendum præceptorem noſtrum convenierunt, ſingulos verſus a ſingulis datos, cum plures quam 200 efficerentur, ab ultimo incipiens uſque ad primum recitabam.* After which, mention is made of the great Memory of *Latro Porcius* (*chariſſimi mihi ſodalis*, *Seneca* calls him who retained in his Memory all the Declamations he had ever ſpoken, and never had his Memory fail him, not ſo much as in one ſingle Word. Alſo he takes notice of *Cyneas*, Ambaſſador to the *Romans* from King *Pyrrhus*, who in one Day had ſo well learnt the Names of his Spectators, that *poſtero die novus homo & Senatum, & omnem urbanam circumjuſam Senatui plebem, nominibus ſuis perſalutavit.* Senec. controverſ. L. 1. init. Vid. quoque Plin. L. 7. c. 24. where he alſo adds other Examples, viz. *Cyrus rex omnibus in exercitu ſuo militibus nomina reddidit; L. Scipio populo Rom. Mithridates 22 gentium rex, totidem linguis jura dedit, pro concione ſingulas ſine interprete affatus. Charmidas* (*ſeu potius Carneades*) ——— *quæ quis exegerat volumina in bibliothecis, legentis modo repreſentavit.*

a particular and neceſſary Tendency to the Management and good Order of the World's Affairs. The

1. Of which is the various *Genii*, or *Inclinations of Men's Minds* to this, and that, and the other Buſineſs (5). We ſee how naturally Men betake themſelves to this and that Employment: ſome delight moſt in Learning and Books, ſome in Divinity, ſome in Phyſick, Anatomy and Botany, ſome in Critical Learning and Philology, ſome in Mathematicks, ſome in Metaphyſicks, and deep Reſearches; and ſome have their Delight chiefly in Mechanicks, Architecture, War, Navigation, Commerce, Agriculture; and ſome have their Inclinations lie even to the ſervile Offices of the World, and an hundred things beſides.

Now all this is an admirably wiſe, as well as moſt neceſſary Proviſion for the eaſy, and ſure tranſacting the World's Affairs; to anſwer every End and Occaſion of Man, yea, to make Man helpful to the poor helpleſs Beaſts, as far as his Help is needful to them; and all, without any great Trouble, Fatigue or great Inconvenience to Man; rather as a Pleaſure, and Diverſion to him. For ſo far is it from being a Toyl, that the greateſt

(5) *Diverſis etenim gaudet natura miniſtris,*
Ut fieri diverſa queant ornantia terras.
Nec patitur cunctos ad eandem currere metam,
Sed varias jubet ire vias, varioſque labores
Suſcipere, ut vario cultu ſit pulchrior orbis.
Paling. in Scorp.

Οὔτως ὁ πάντεσσι θεὸς χαρίεντα δίδωσι
Ἀνδράσιν, &c. *Ita non omnibus hominibus ſua dona dat Deus, neque bonam indolem, neque prudentiam, nec eloquentiam: alius namque vultum habet deformem; ſed Deus formam eloquentia ornat, &c.* Homer. Odyſ. 8. The like alſo in Iliad. L. 13.

(6) Al-

greateſt Labours (6), Cares, yea and Dangers too, become pleaſant to him who is purſuing his *Genius*, and whoſe Ardour of Inclination eggs him forward, and buoys him up under all Oppoſition, and carrieth him through every Obſtacle to the End of his Deſigns and Deſires.

2. The next is the *Inventive* Power of the Soul (7). Under which I might ſpeak of many things, but I ſhall take Notice only of two, becauſe they manifeſt the particular Concern and Agency of the infinitely wiſe Creator. The

1. Is that *Man's Invention* ſhould reach to ſuch a great Variety of Matters; that it ſhould hit upon every thing, that may be of any Uſe, either to himſelf, or to human Society, or that may any ways promote (what in him lies) the Benefit of this lower part of the Creation.

For the Illuſtration of this, I might take a View of all the Arts and Sciences, the Trades, yea the very Tools they perform their Labours and Contrivances with, as numerous as their Occaſions and Contrivances are various. Indeed what is there that falleth under the Reach of Man's Sen-

(6) Although *Solomon* declares, Eccleſ. 12. 12. *that much Study is a wearineſs to the Fleſh*, yet we ſee with what Pleaſure and Aſſiduity many apply themſelves to it. Thus *Cicero* tells of *Cato*, whom he caſually found in *Lucullus's* Library, *M. Catonem vidi in Bibliotheca ſedentem, multis circumfuſum Stoicorum libris. Erat enim, ut ſcis, in eo inexhauſta aviditas legendi, nec ſatiari poterat: quippe ne reprehenſionem quidem vulgi inanem reformidans, in ipſa curia ſoleret legere ſæpe, dum ſenatus cogeretur —— ut Heluo librorum —— videbatur.* Cicer. de finib. L. 3. non longe ab initio.

(7) *Mentem hominis, quamvis eam non videas, ut Deum non vides, tamen ut Deum agnoſcis ex operibus ejus, ſic ex memoria rerum, & Inventione, & celeritat motus, omnique pulchritudine virtutis vim divinam mentis agnoſcito.* Cicer. Tuſc. quæſt. L. 1.

Senſes, that he doth not employ to ſome Uſe and Purpoſe for the World's Good? The Celeſtial Bodies, the Sun, the Moon, with the other Planets, and the fixt Stars, he employs to the noble Uſes of Aſtronomy, Navigation and Geography. And what a noble Acumen, what a vaſt Reach muſt the Soul be endowed with, to invent thoſe curious Sciences of Geometry and Arithmetick, both Specious and in Numbers; and thoſe nice and various Inſtruments made uſe of by the Geometrician, Aſtronomer, Geographer, and Sailor? And laſtly, what a wonderful Sagacity is ſhewn in the Buſineſs of Opticks, and particularly in the late Invention of the Teleſcope? wherewith new Wonders are diſcovered among God's Works in the Heavens, as there are here on Earth with the Microſcope, and other Glaſſes.

And as for this lower World, what Material is there to be found, what Kind of Earth, or Stone, or Metal, what Animal, Tree, or Plant, yea even the very Shrubs of the Field; in a Word, what of all the excellent Variety the Creator has furniſh'd the World with, for all it's Uſes and Occaſions, in all Ages; What, I ſay, that Man's Contrivance doth not extend unto, and make ſome way or other advantageous to himſelf, and uſeful for Building, Cloathing, Food, Phyſick, or for Tools and Utenſils, or for even only Pleaſure and Diverſion?

But now conſidering the great Power and Extent of human Invention.

2. There is another thing that doth farther demonſtrate the Super-intendence of the great Creator and Conſervator of the World, and that is, that things of great, and abſolutely neceſſary Uſe, have ſoon, and eaſily occurred to the Invention of Man; but things of little Uſe, or very dangerous Uſe, are rarely and ſlowly diſcovered,

or

or ſtill utterly undiſcover'd. We have as early as the Moſaick Hiſtory, an account of the Inventions of the more uſeful Crafts and Occupations. Thus *Gen.* 3, 23. Adam *was ſent forth from the Garden of* Eden, *by God himſelf to till the Ground.* And in the next Chapter, his two Sons *Cain* and *Abel*, the one was of the ſame Occupation, a Tiller of the Ground; the other a Keeper of Sheep (8). And the Poſterity of theſe are in the later End of this *Gen.* 4. recorded, Jabal *to have been the Father of ſuch as dwell in Tents* (9); *i. e.* He was the *Inventer of Tents*, and pitching thoſe moveable Houſes in the Fields, for looking after, and depaſturing their Cattel in the Deſarts and uncultivated World: Tubal-Cain *was an Inſtructer of every Artificer in Braſs and Iron*, or the firſt that found the Art of *Melting and Malleating* (11) *Metals*, and making them uſeful for Tools, and other neceſſary Implements. And his Siſter *Naamah*, whoſe Name is only mention'd, is by ſome thought to have been the Inventor of *Spinning* and *Cloathing*. Yea the very Art of *Muſick* is thus early aſcribed to *Jubal*; ſo indulgent was the Creator to find a means to divert Melancholy, to cheer the Spirits, and to entertain and pleaſe Mankind. But for things of no uſe, or but little Uſe, or of pernicious Conſequence, either they have been much later thought of, and with great Difficulty, and perhaps Danger too, brought to paſs, or elſe they ſtill are, and perhaps will always remain, Exerciſes of the Wit and Invention of Men. Of

(8) Gen. IV. 2. (9) v. 20. (10) v. 22.

(11) Σφυροκόπος the LXX call him, *i. e.* A Worker with an Hammer.

(12) v. 21.

Of this we might give divers Inſtances: in Mathematicks, about ſquaring the Circle (13); in Mechanicks, (14) about the Art of Flying; and in Navigation, about finding the Longitude. Theſe things,

(13) Altho' the *Quadrature of the Circle* hath in former Ages exerciſed ſome of the greateſt Mathematical Wits, yet nothing hath been done therein ſo conſiderable, as in, and ſince the middle of the laſt Century; when in the Year 1657, thoſe very ingenious and great Men, Mr. *William Neile*, and My Lord *Brounker* and Sir *Chriſtopher Wren* afterwards, in the ſame Year, geometrically demonſtrated the Equality of ſome Curves to a ſtrait Line. Soon after which, others at home and abroad did the like in other Curves. And not long afterwards this was brought under an *Analytical Calculus*: the firſt Specimen whereof, that was ever publiſh'd, Mr. *Mercator* gave in 1668, in a Demonſtration of my Lord *Brounker*'s Quadrature of the *Hyperbola* by Dr. *Wallis*'s Infinite Series. But the penetrating Genius of Sir *Iſaac Newton*, had diſcovered a Way of attaining the Quantity of all quadrible Curves analytically by his Method of *Fluxions*, ſome time before the Year 1668, as I find very probable from an hiſtorical Account in a long Letter of Mr. *Collins*, written in his own Hand, and ſent to *Richard Townley*, Eſq; of *Lancaſhire*, whoſe Papers are in my Hands. In that Letter, Mr. *Collins* ſaith, that *in* September 1668, *Mr.* Mercator *publiſh'd his* Logarithmotechnia, *one of which he ſoon ſent to* Dr. Barrow, *who thereupon ſent him up ſome Papers of Mr.* Newton's (now Sir *Iſaac*) *by which, and former Communications made thereof by the Author, to the Doctor, it appears that the ſaid Method was invented ſome Years before by the ſaid Mr.* Newton, *and generally applied.* And then he goes on to give ſome Account of the Method, what it performs in the Circle, &c. what Mr. *Gregory* had done in that kind, *who intended to publiſh ſomewhat in Latin about it, but would not anticipate Mr.* Newton, *the firſt Inventer thereof*, with much more of this Nature. The Deſign I find of that indefatigable Promoter of Mathematicks, Mr. *Collins*, was to acquaint Mr. *Towneley* in his Letter with what had been done, and to get the Aſſiſtance of that ingenious Gentleman, towards the compleating a Body of *Algebra*.

(14) I do not mention here the *perpetual Motion*, which hath exercifed the Mechanical Wits for many Ages, becauſe it is a thing impoſſible, if not a Contradiction; as the before-commended Dr. *Clarke* aſſerts in *Rohaul. Phyſ.* p. 133.

(15) *Grews*

things, altho' ſome of them in Appearance innocent, yea perhaps very uſeful, yet remain for the moſt part ſecret, not becauſe the Diſcovery of moſt of them is more impoſſible or difficult than of many other things which have met with a Diſcovery, nor is it for want of Man's Diligence therein, or his careful Purſuit and Enquiry after them (for perhaps nothing already diſcovered hath been more eagerly ſought after) but with much better Reaſon (I am ſure with greater Humility and Modeſty) we may conclude it is, becauſe the infinitely wiſe Creator and Ruler of the World hath been pleaſed to lock up theſe things from Man's Underſtanding and Invention, for ſome Reaſons beſt known to himſelf, or becauſe they might be of ill Conſequence, and dangerous amongſt Men. As in all probability the Art of Flying would particularly be: an Art which in ſome Caſes might be of good Uſe, as to the Geographer, and Philoſopher; but in other Reſpects might prove of dangerous and fatal Conſequence; as for Inſtance, by putting it in Man's Power to diſcover the Secrets of Nations and Families, more than is conſiſtent with the Peace of the World for Man to know; by giving ill Men greater Opportunities to do Miſchief, which it would not lie in the Power of others to prevent; and as one (15) obſerves, by making Man leſs ſociable. "For upon every true or falſe Ground of Fear, "or Diſcontent, and other Occaſions, he would "have been fluttering away to ſome other Place: "and Mankind, inſtead of cohabiting in Cities, "would, like the Eagle, have built their Neſts "upon Rocks.

That

(15) *Grews Coſmol. Sacr.* L. 1. ch. 5. § 25.

(16) *Nemo*

That this is the true reaſon of theſe Matters, is manifeſt enough from holy Scripture, and Reaſon (16) alſo gives it's Suffrage thereto. The *Scriptures* expreſly tell us that *Every good Gift, and every perfect Gift is from above, and cometh down from the Father of Lights.* S. James 1. 17. *Solomon,* Prov. 2. 6. ſaith, *The Lord giveth Wiſdom: out of his Mouth cometh Knowledge and Underſtanding.* And *Elihu* is very expreſs, Job. 32. 8. *But there is a Spirit in Man: and the Inſpiration of the Almighty giveth them Underſtanding* Πνοὴ παντοκράτορός ἐστιν ἡ διδάσκουσα, as the LXX render it, *The Inſpiratus, the Afflatus of the Almighty, is their Inſtructor, Miſtreſs or Teacher.* And in Scripture not only the more noble Superiour Acts of Wiſdom or Science, but much Inferiour alſo, bear the Name of Wiſdom, Knowledge and Underſtanding, and are aſcribed unto GOD. 'Tis well known that *Solomon*'s Wiſdom is wholly aſcribed unto GOD: and the Wiſdom, and Underſtanding which GOD is ſaid to have given him, 1 *King.* 4, 29. is particularly ſet forth in the following Verſes, by his great Skill in moral and natural Philoſophy, in Poetry, and probably in Aſtronomy, Geometry, and ſuch other of the politer-Sciences; for which *Egypt*, and the *Eaſtern Nations* were celebrated of old (17): *And* Solomon's *Wiſdom excelled the Wiſdom of all the Children of the Eaſt-Countrey, and all the Wiſdom of* Egypt. *For he was wiſer than all Men: than* Ethan, *&c. And he ſpake*

3000

(16) *Nemo igitur vir magnus ſine aliquo afflatu divino unquam fuit.* Cicer. de nat. Deor. L. 2.

(17) *Egypt* and ſome of the Eaſtern Nations are celebrated for their Skill in polite Literature, both in Scripture and prophane Story. *Job* was of thoſe Parts: ſo were the Σοφοὶ and Μάγοι, the *Brachmans*, and *Gymnoſophiſts*. *Moſes* and *Daniel* had their Education in theſe Parts, and *Pythagoras*, *Democritus*, and others, travelled into theſe Parts for the ſake of their Learning.

3000 *Proverbs: and his Songs were* 1005. *And he ſpake of Trees from the Cedar to the Hyſſop of the Wall,* (*i. e.* of all ſorts of Plants) *alſo of Beaſts, Fowl, Creeping things, and Fiſhes.* So likewiſe the Wiſdom of *Daniel* and his three Companions is aſcribed unto GOD, Dan. 1, 17. *As for theſe four Children, God gave them Knowledge, and Skill in all Learning and Wiſdom, and* Daniel *had Underſtanding in all Viſions and Dreams.* And accordingly in the next Chapter, *Daniel* acknowledgeth and praiſeth God, v. 20. 21. Daniel *anſwered and ſaid, Bleſſed be the Name of God for ever and ever, for Wiſdom and Might are his.* ——— *He giveth Wiſdom unto the Wiſe, and Knowledge to them that know Underſtanding.* But not only Skill in the ſuperiour Arts and Sciences, but even in the more inferiour Mechanick Arts, is called by the ſame Names, and aſcribed unto GOD. Thus for the Workmanſhip of the Tabernacle. Exod. 31. 2. to 6. v. *See, I have called by Name* Bezaleel. *And I have filled him with the Spirit of God, in Wiſdom, and in Underſtanding, and in Knowledge, and in all manner of Workmanſhip. To deviſe cunning Works, to work in Gold, Silver, and Braſs; and in cutting of Stones, to ſet them, and in carving of Timber, to work in all manner of Workmanſhip.* So the Spinſters, Weavers, and other Crafts-people, are called Wiſe-hearted, *Exod.* 35. 10. 25. and other places. And in *Exod.* 36, 1. &c. the LORD is ſaid to have put this Wiſdom in them, and Underſtanding to know how to work all theſe manner of Works for the Service of the Sanctuary. And laſtly, to name no more Inſtances, *Hiram* the chief Architect of *Solomon's Temple,* is in 1. King. 7, 14. and 2. Chron. 2. 14. *called a cunning Man filled with Wiſdom and Underſtanding, to work in Gold, Silver, Braſs, Iron, Stone, Timber, Purple, Blue, fine Linnen, and Crimſon; alſo to grave, and find out every Device which ſhould be put to him.*

Thus

Thus doth the Word of *God* aſcribe the Contrivances and Crafts of Men, to the Agency or Influence of the *Spirit* of *God* upon that of Man. And there is the ſame Reaſon for the Variety of *Genii* or *Inclinations* of Men alſo; which from the ſame Scriptures may be concluded to be a Deſignation, and Tranſaction of the ſame Almighty Governour of the World's Affairs. And who indeed but He could make ſuch a divine Subſtance, endowed with thoſe admirable Faculties, and Powers as the Rational Soul hath? a Being to bear the great Creator's Vice-gerency in this lower World; to employ the ſeveral Creatures; to make uſe of the various Materials; to manage the grand Buſineſſes; and to ſurvey the Glories of all the viſible Works of God! a Creature, without which this lower World would have been a dull, uncouth and deſolate kind of Globe! who I ſay, or what leſs than the *Infinite GOD* could make ſuch a Rational Creature, ſuch a divine Subſtance as the Soul! For if we ſhould allow the Atheiſt any of his nonſenſical Schemes, the *Epicurean* his Fortuitous Concourſe of Atoms, or the *Carteſian* (18) his created Matter put in Motion, yet with what

(18) As we are not to *accuſe any falſly*, ſo far be it from me to detract from ſo great a Man as *Monſieur Cartes* was; whoſe Principles, although many have perverted to Atheiſtical Purpoſes, and whoſe Notions gave ſome of them but an ill Aſpect; yet I am unwilling to believe he was an Atheiſt, ſince in his *Principia Philoſophiæ*, and other of his Works, he vindicates himſelf from this Charge, and frequently ſhews a great Reſpect for Religion: beſides, that many of his ſuſpicious Opinions are capable of a favourable Interpretation, which will make them appear in a better Form. Thus when he diſcardeth *Final Cauſes* from his Philoſophy, it is not a Denial of them, but only excluding the Conſideration of them, for the ſake of free Philoſophiſing;

what tolerable Senſe could he, in his Way, produce ſuch a divine, thinking, ſpeaking, contriving Subſtance as the Soul is; endowed exactly with ſuch Faculties, Powers, and Diſpoſitions as the various Neceſſities and Occaſions of the World require from ſuch a Creature? Why ſhould not rather all the Acts, the Diſpoſitions, and Contrivances of ſuch a Creature as Man (if made in a mechanical Way, and not contrived by God) have been the ſame? Particularly why ſhould he not have hit upon all Contrivances of equal Uſe early as well as many Ages ſince? Why not that Man have effected it, as well as this, ſome thouſands of Years after? Why alſo ſhould not all Nations, and all Ages (19) improve in every thing as well as

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ſing; it being the buſineſs of a Divine, rather than a Philoſopher, to treat of them.

(19) For Ages of *Learning* and *Ignorance* we may compare the preſent, and ſome of the Ages before the Reformation. The laſt Century, and the few Years of this, have had the Happineſs to be able to vie with any Age for the Number of Learned Men of all Profeſſions, and the Improvements made in all Arts and Sciences; too many, and too well known to need a Specification.

But for Ignorance we may take the 9th Age, and ſo down to the Reformation. Even as low as Q. *Elizabeth*, although Learning began to flouriſh, yet we may gueſs how Matters ſtood, even among the Clergy, by her 53 *Injunct.* No. 1559. *Such as are but mean Readers, ſhall peruſe over before, once or twice, the Chapters and Homilies, to the intent they may read to the better Underſtanding of the People, the more Encouragement to Godlineſs.* Spar. Collect. pag. 82. But this is nothing in Compariſon to the Ages before, when the Monk ſaid, *Græcum non eſt legi*, or as *Eſpencæus* more elegantly hath it, *Græce noſſe ſuſpectum, Hebraice prope Hæreticum.* Which Suſpicion (ſaid the learned *Hakewill*) *Rhemigius* ſurely was not guilty of, in commenting upon *diffamatus*, 1 *Theſ.* 1. 8. who ſaith that St. *Paul* ſomewhat improperly put that for *divulgatus*, not being aware that St. *Paul* wrote in

as this or that Age or Nation (20) only? Why ſhould the *Greeks*, the *Arabians*, the *Perſians*, or the *Egyptians* of old, ſo far exceed thoſe of the ſame Nations now? Why the *Africans* and *Americans* ſo generally ignorant and barbarous, and the *Europeans*, for the moſt part, polite and cultivated, addicted to Arts and Learning? How could

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in Greek, and not in Latin. Nay, ſo great was their Ignorance, not only of Greek, but of Latin too, that a Prieſt baptized *in nomine Patria, & Filia, & Spiritua ſancta.* Another ſuing his Pariſhioners for not paving his Church, proved it from Jer. 17. *Paveant illi, non paveam ego.* Some Divines in *Eraſmus*'s time, undertook to prove Hereticks ought to be burnt, becauſe the Apoſtle ſaid *Hæreticum devita.* Two Fryars diſputing about a Plurality of Worlds, one proved it from *Annon decem ſunt facti mundi?* The other replied, *Sed ubi ſunt novem?* And notwithſtanding their Service was read in Latin, yet ſo little was that underſtood, that an old Prieſt in *Hen.* VIII. read *Mumpſimus Domine*, for *Sumpſimus:* and being admoniſhed of it, he ſaid, he had done ſo for Thirty Years, and would not leave his old *Mumpſimus* for their new *Sumpſimus. Vid. Hakew. Apol.* L. 3. c. 7. Sect. 2.

(20) *There is* (*it ſeems*) *in Wits and Arts, as in all things beſides, a kind of circular Progreſs: they have their Birth, their Growth, their Flouriſhing, their Failing, their Fading; and within a while after, their Reſurrection, and Reflouriſhing again. The Arts flouriſhed for a long time among the* Perſians, *the* Chaldeans, *the* Egyptians. ——— *But afterwards the* Grecians *got the ſtart of them*, and are now become as barbarous themſelves, as formerly they eſteemed all beſides themſelves to be. About the Birth of *Chriſt*, Learning began to flouriſh in *Italy*, and ſpread all over *Chriſtendom*; till the *Goths*, *Hunns* and *Vandals* ranſacked the Libraries, and defaced almoſt all the Monuments of Antiquity; ſo that the Lamp of Learning ſeemed to be put out for near the Space of 1000 Years, till the firſt *Manſor* King of *Africa* and *Spain* raiſed up, and ſpurred forward the *Arabian* Wits, by great Rewards and Encouragements. Afterwards *Petrarch* opened ſuch Libraries as were undemoliſhed. He was ſeconded by *Boccace*, and *John* of *Ravenna*, and ſoon after by *Aretine*, *Philelphus*, *Valla*, &c. And thoſe were followed by *Æneas Sylvius*, *Angelus Politanus*, *Hermolaus Barbarus*, *Marſilius Ficinus*, and *Joh. Picus* of *Mirandula.* Theſe were backed by *Rud. Agricola*, *Reu-*

could it come to pass that the Use of the Magnet (21); Printing (22), Clocks (23), Telescopes (24), and

Reucline, *Melancthon*, *Joach. Camerarius*, *Wolphlazius*, *Beat. Rheanus*, Almaines: by *Erasmus* of *Rotterdam*; *Vives*, a Spaniard; *Bembus*, *Sadoletus*, *Eugubinus*, Italians; *Turnebus*, *Muretus*, *Ramus*, *Pithæus*, *Budæus*, *Amiot*, *Scaliger*, Frenchmen: Sir *Tho. More* and *Linaker*, Englishmen. And about this time, even those Northern Nations yielded their great Men; *Denmark* yielded *Olaus Magnus*, *Holster*, *Tycho Brahe*, and *Hemingius*; and *Poland*, *Hosius*, *Frixius*, and *Crumerus*. But to name the Worthies that followed these, down to the present time, would be endless, and next to impossible. See therefore *Hakewill's Apolog.* L. 3. c. 6. §. 2.

(21) Dr. *Gilbert*, the most learned and accurate Writer on the *Magnet*, shews that it's *Attractive* Vertue was known as early as *Plato* and *Aristotle*: but it's *Direction* was a discovery of later Ages. He saith, *Superiori ævo* 300 *aut* 400 *labentibus annis*, *Motus Magneticus in Boream & Austrum repertus*, *aut ab hominibus rursus recognitus fuit*. De Mag. L. 1. c. 1. But who the happy Inventer of this lucky Discovery was, is not known. There is some, not inconsiderable, Reason, to think our famous Country-man, *Rog. Bacon* either discovered, or at least knew of it. But for it's Use in Navigation, Dr. *Gilbert* saith, *In regno Neapolitano Melphitani omnium primi* (*uti ferunt*) *pyxidem instruebant nauticam*, ——— *edocti a cive quodam Jol. Goia* A. D. 1300. ibid. If the Reader hath a mind to see the Arguments for the Invention, being as old as *Solomon's* or *Plautus's* time, or of much younger date, he may consult *Hakewill.* ib. c. 10. §. 4. or *Purchas Pilgr.* L. 1. c. 1. §. 1.

As to the Magnetick Variation, Dr. *Gilbert* attributes the Discovery of it to *Sebastian Cabott*. And the Inclination, or Dipping of the Needle, was the Discovery of our ingenious *Rob. Norman*. And lastly, the Variation of the Variation was first found out by the ingenious Mr. *H. Gellibrand*, Astron. Prof. of *Gresham-Col.* about 1634. *Vid. Gellibr. Disc. Math. on the Variat. of the Magn. Need. and its Variat.* Anno 1635.

But since, Dr. *Halley*, having formerly in *Philos. Transf.* No. 148. and 195. given a probable Hypothesis of the Variation of the Compass, did in the Year 1700 undertake a long and hazardous Voyage, as far as the Ice near the South Pole, in order to examine his said Hypothesis, and to make a System of the Magnetical Variations: which being soon after published, has been since abundantly confirmed by the French, as may be seen in several of the late *Memoirs de Physique & de Mathematique*, published by the French *Academie des Sciences*.

To

To these Discoveries, I hope the Reader will excuse me, if I add one of my own, which I deduced some Years ago, from some magnetical Experiments and Observations I made; which Discovery I also acquainted our Royal Society with some time since, viz. That as the common, horizontal Needle is continually varying towards the E. and W. so is the Dipping-Needle varying up and down, towards or fromwards the Zenith, with the magnetick Tendency describing indeed a Circle round the Pole of the World, as I conceive, or some other point. So that if we could procure a Needle so nicely made, as to point exactly according to it's magnetick Direction, it would, in some certain Number of Years, describe a Circle of about 13 *gr.* Radius round the magnetick Poles Northerly and Southerly. This I have for several Years suspected, and have had some Reason for it too, and three or four Years ago mentioning it at a Meeting of our Royal-Society, they were pleased to cause it to be enter'd in the Journals: but I have not yet been so happy to procure a tolerable good Dipping-Needle, or other proper one to my Mind, to bring the thing to sufficient Test of Experience; as in a short time I hope to do, having lately hit upon a Contrivance that may do the thing.

(22) It is uncertain who was the Inventer of the Art of *Printing*, every Historian ascribing the Honour thereof to his own City or Country. Accordingly some ascribe the Invention of it to *John Guttenberg*, a Knight of *Argentine*, about 1440, and say that *Faustus* was only his Assistant. *Bertius* ascribes it to *Laurence John* of *Haerlem*, and saith *Fust* or *Faust* stole from him both his Art and Tools. And to name no more, some attribute it to *John Fust* or *Faust*, and *Peter Schoeffer* (called by *Fust* in some of his *Imprimaturs*, *Pet. de Gerneshem puer meus.*) But there is now to be seen at *Haerlem*, a Book or two printed by *Laur. Kofter*, before any of these, *viz.* in 1430 and 1432 (*See Mr.* Ellis's *Letter to Dr.* Tyson, *in Phil. Trans.* No. 286.) But be the first Inventer who it will, there is however great Reason to believe, that the Art received great Improvements from *Faust* and his Son in Law *Schoeffer*, the latter being the Inventer of metalline Types, which were cut in Wood before, first in whole Blocks, and afterwards in single Types or Letters. See my learned Friend Mr. *Wanley's* Observations in *Philos. Trans.* No. 288 and 310.

(23) Concerning the Antiquity and Invention of *Clocks* and *Clock-work*, I refer the Reader to a little Book, called the *Artificial Clock-maker*, Ch. 6. Where there is some Account of the Ancients Inventions in Clock-work, as *Archimedes's Sphere*, *Ctesibius's Clock*, &c.

(24) The Invention of *Telescopes*. *Hieron. Syrturus* gives this Account of, *Prodiit* Anno 1609, *seu Genius, seu alter*

vir

and an hundred things beſides ſhould eſcape the Diſcovery of *Archimedes*, *Anaximander*, *Anaximenes*, *Poſidonius*, or other great Virtuoſo's of the early Ages, whoſe Contrivances of various Engines, Spheres, Clepſydræ and other curious Inſtruments are recorded (25)? And why cannot the

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vir adhuc incognitus, Hollandi ſpecie, qui Middleburgi in Zelandia convenit Joh. Lipperſein ——— Juſſit perſpicilla plura tam cava quam convexa, confici. Condicto die rediit, abſolutum opus cupiens, atque ut ſtatim habuit præ manibus, bina ſuſcipiens, cavum ſcil. & convexum, unum & alterum oculo admovebat, & ſenſim dimovebat, ſive ut punctum concurſus, ſive ut artificis opus probaret, poſtea abiit. Artifex, ingenii minime expers, & novitatis curioſus, cœpit idem facere & imitari, &c. Vid. Muſ. Worm. L. 4. c. 7.

(25) Among the curious Inventions of the Antients, *Archytas's Dove* was much famed: of which *Aul. Gellius* gives this Account, *Scripſerunt Simulachrum Columbæ e ligno ab Archyta ratione quadam diſciplinaque mechanica factum, volaſſe. Ita erat ſcilicet libramentis ſuſpenſum, & aura ſpiritus incluſa atque occulta concitum.* Noct. Attic. L. 10. c. 12. The ſame eminent Pythagorean Philoſopher (as *Favorinus* in *Gellius* calls him) is by *Horace* accounted a notable Geometrician too, *Te maris & terræ, numeroque carentis arenæ Menſorem Archyta.* Among the reſt of his Inventions, *Children's Rattles* are aſcribed to him. *Ariſtotle* calls them Ἄρχυτα πλατάγη, *Polit.* 8. i. e. *Archytas's Rattle.* And *Diogenianus* the Grammarian gives the Reaſon of his Invention, Ἄρχυτα πλατάγη ἐπὶ παιδί, &c. *That* Archytas's Rattle *was to quiet Children; for he having Children contrived the Rattle, which he gave them to prevent their* [*tumbling,* ἀσταλίευτοι] *other things about the Houſe.*

To theſe Contrivances of *Archytas* we may add *Regiomontanus's Wooden Eagle, which flew forth of the City aloft in the Air, met the Emperor a good way off, coming towards it, and having ſaluted him, return'd again, waiting on him to the City Gates.* Alſo his *Iron-fly*, which at a Feaſt *flew forth of his Hands, and taking a Round, returned thither again.* Vid. Hakewill ub. ſupr. c. 10. §. 1.

As to other Inventions of the Antients, ſuch as of Letters, Bricks and Tiles, and building Houſes, with the Saw Rule and Plumbet, the Lath, Augre, Clue, &c. alſo the making

the preſent or paſt Age, ſo eminent for polite Literature, for Diſcoveries and Improvements in all curious Arts and Buſineſſes (perhaps beyond any known Age of the World, why cannot it, I ſay) diſcover thoſe hidden *Quæſita*, which may probably be reſerved for the Diſcovery of future, and leſs learned Generations?

Of theſe Matters, no ſatisfactory Account can be given by any mechanical Hypotheſis, or any other way, without taking in the Superintendence

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Braſs, Gold, and other Metals; the uſe of Shields, Swords, Bows and Arrows, Boots, and other Inſtruments of War; the Pipe, Harp, and other muſical Inſtruments; the building of Ships, and Navigation, and many other things beſides; the Inventers of theſe (as reported by ancient Heathen Authors) may be plentifully met with in *Plin. Nat. Hiſt.* L. 7. c. 56.

But in this Account of *Pliny*, we may obſerve whence the Ancients (even the *Romans* themſelves in ſome meaſure) had their Accounts of theſe Matters, *viz.* from the fabulous *Greeks*, who were fond of aſcribing every thing to themſelves. *The Truth is* (ſaith the moſt learned Biſhop *Stillingfleet*) *there is nothing in the World uſeful or beneficial to Mankind, but they have made a Shift to find the Author of it among themſelves. If we enquire after the Original of Agriculture, we are told of* Ceres *and* Triptolemus; *if of Paſturage, we are told of an* Arcadian Pan; *if of Wine, we preſently hear of a* Liber Pater; *if of Iron Inſtruments, then who but* Vulcan? *if of Muſick, none like to* Apollo. *If we preſs them then with the Hiſtory of other Nations, they are as well provided here: if we enquire an account of* Europe, Aſia, *or* Libya; *for the firſt we are told a fine Story of* Cadmus's *Siſter; for the ſecond of* Prometheus's *Mother of that Name; and for the third of a Daughter of* Epaphus. And ſo the learned Author goes on with other particular Nations, which they boaſted themſelves to be the Founders of. *Only the grave* Athenians *thought Scorn to have any Father aſſigned them, their only Ambition was to be accounted Aborigines & genuini Terræ.* But the Ignorance and Vanity of the Greek Hiſtory, that learned Author hath ſufficiently refuted. *Vid. Stilling. Orig. Sacr.* Part 1. B. 1. Ch. 4.

dence of the great Creator and Ruler of the World: who oftentimes doth manifeſt himſelf in ſome of the moſt conſiderable of thoſe Works of Men, by ſome remarkable Tranſactions of his Providence, or by ſome great Revolution or other happening in the World thereupon. Of this I might inſtance in the Invention of Printing (26), ſucceeded firſt by a Train of Learned Men, and the Revival of Learning, and ſoon after that by the Reformation, and the much greater Improvements of Learning at this Day. But the moſt conſiderable Inſtance I can give is, the Progreſs of Chriſtianity by means of the civilized Diſpoſition, and large Extent of the *Roman Empire*. The later of which, as it made way for human Power; ſo the former made way for our moſt excellent Religion into the Minds of Men. And ſo I hope, and earneſtly pray, that the Omnipotent and Allwiſe Ruler of the World will tranſact the Affairs of our moſt holy Religion e're it be long in the Heathen World; that the great Improvements made in the laſt, and preſent Age, in Arts and Sciences, in Navigation and Commerce, may be a means to tranſport our Religion as well as Name, through all the Nations of the Earth. For we find that our Culture of the more polite and curious Sciences, and our great Improvements in even the mechanick Arts, have already made

(26) Whether Printing was invented in 1440, as many imagine, or was ſooner practiſed, in 1430 or 1432, as Mr. *Ellis*'s Account of the Dutch Inſcription in *Phil. Tranſ.* No. 286. doth import; it is however manifeſt, how great an Influence (as it was natural) this Invention had in the promoting of Learning ſoon afterwards, mentioned before in Note 20. After which followed the Reformation about the Year 1517.

made a Way for us into ſome of the largeſt and fartheſt diſtant Nations of the Earth; particularly into the great Empire of *China* (27).

And now before I quit this Subject, I cannot but make one Remark, by way of practical Inference from what has been laſt ſaid; and that is, Since it appears that the Souls of Men are ordered, diſpoſed and actuated by God, even in ſecular, as well as ſpiritual, Chriſtian Acts; a Duty ariſeth therefrom on every Man, to purſue the Ends, and anſwer all the Deſign of the divine Providence in beſtowing his Gifts and Graces upon him. Men are ready to imagine their Wit, Learning, Genius, Riches, Authority, and ſuch like, to be Works of Nature, things of Courſe, or owing to their own Diligence, Subtilty, or Secondary Cauſes; that they are Maſters of them, and at Liberty to uſe them as they pleaſe, to gratify their Luſt or Humor, and ſatisfy their depraved Appetites. But it is evident, that theſe things

(27) The *Chineſe* being much addicted to Judicial Aſtrology, are great Obſervers of the Heavens, and the Appearances in them. For which Purpoſe they have an *Obſervatory* at *Pekin*, and Five Mathematicians appointed to watch every Night; Four towards the four Quarters of the World, and One towards the Zenith, that nothing may eſcape their Obſervation. Which Obſervations are the next Morning brought to an Office to be regiſtred. But notwithſtanding this their Diligence for many Ages and that the Emperor hath kept in his Service above 100 Perſons to regulate the Kalendar, yet are they ſuch mean Aſtronomers, that they owe the Regulation of their Kalendar, the Exactneſs in calculating Eclipſes, &c. to the *Europeans*; which renders the *European* Mathematicians ſo acceptable to the Emperor that *Father Verbieſt*, and divers others, were not only made Principals in the Obſervatory, but put into Places of great Truſt in the Empire, and had the greateſt Honours paid them at their Deaths. Vid. *La Comte Mem. of China.* Letter 2d. &c.

(28)

things are the Gifts of God, they are so many Talents entrusted with us by the infinite Lord of the World, a Stewardship, a Trust reposed in us; for which we must give an Account at the Day when our Lord shall call: according to that parabolical Representation of this Matter by our Blessed Saviour. *Matt.* 25. 14.

Our Duty then is not to abuse these Gifts of God, *not to neglect the Gift that is in us*, not to *hide our Talent in the Earth*; but as St. *Paul* exhorteth *Timothy*, 2. Tim. 1. 6. we must *stir up the Gift of God which is in us*, not let it lie idle, conceal'd or dead; but we must ἀναζωπυρεῖν τὸ χάρισμα, *blow it up, and enkindle it*, as the Original imports; we must improve and employ our Gift to the Glory of the Giver; or in that Ministration, that Use of the World, for which he gave it. Our Stewardship, our Craft, our Calling, be it that of the Ambassadors of Heaven, committed to us, as 'twas to *Timothy*, by the laying on of Hands; or be it the more secular Business of the Gentleman, Tradesman, Mechanick, or only Servant; nay our good Genius, our Propensity to any Good, as suppose to History, Mathematicks, Botany, Natural Philosophy, Mechanicks, *&c.* I say all these Occupations, in which the Providence of God hath engaged Men, all these Inclinations to which his Spirit hath disposed them, ought to be discharged with that Diligence, that Care, and Fidelity, that our great Lord and Master may not say to us, as was said to the unfaithful Steward, Luk. 16. 2. *Give an Account of thy Stewardship, for thou mayest be no longer Steward*: but that he may say, as 'tis in the Parable before cited

(28) 1. Tim. 4. 14.

cited, Matt. 25, 21. *Well done thou good and faithful Servant, thou hast been faithful over a few things, I will make thee Ruler over many things, enter thou into the Joy of thy Lord.* Since now the Case is thus, let us be perſuaded to follow *Solomon*'s Advice, Eccleſ. 9. 10. *Whatſoever thy Hand findeth to do, do it with thy Might* (29): "lay hold on every Oc-
"caſion that preſents itſelf, and improve it with
"the utmoſt Diligence; becauſe now is the time
"of Action, both in the Employments of the
"Body, and of the Mind: now is the Seaſon
"of ſtudying either Arts and Sciences, or Wiſ-
"dom and Vertue, for which thou wilt have no
"Opportunities in the Place whither thou art
"going in the other World. *For there is no Work*
"*nor Device, nor Knowledge, nor Wiſdom in the Grave*
"*whither thou goeſt.*

CHAP. II.

Of Man's BODY, *particularly it's* POSTURE.

HAving thus, as briefly as well I could, ſurveyed the *Soul*, let us next take a View of *Man's Body*. Now here we have ſuch a Multiplicity of the moſt exquiſite Workmanſhip, and of the beſt Contrivance, that if we ſhould ſtrictly ſurvey the Body from Head to Foot, and ſearch only into the known Parts, (and many more lie undiſcovered) we ſhould find too large and tedious a Task to be diſpatched. I ſhall therefore have time only to take a Tranſient, and general kind

(29) *Biſhop Patrick* in loc.

kind of View of this admirable Machine, and that somewhat briefly too, being prevented by others, particularly two excellent Authors of our own (1), who have done it on the same Account as my self. And the

1. Thing that presents itself to our View, is the *Erect Posture* (2) of Man's Body: which is far the most, if not the only commodious Posture for a Rational Creature, for him that hath Dominion over the other Creatures, for one that can invent useful things, and practice curious Arts. For without this Erect Posture, he could not have readily turned himself to every Business, and on every Occasion. His Hand (3 particularly could not

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(1) *Mr.* Ray *in his Wisdom of God manifested in the Works of Creation*, Part 2d. and *Dr.* Cockburn *Essays on Faith*, Part 1. Essay 5.

(2) *Ad hanc providentiam Naturæ tam diligentem* [of which he had been before speaking] *tamque solerter adjungi multa possunt, e quibus intelligatur, quantæ res hominibus a Deo, quamque eximiæ tributæ sunt: qui primum eos humo excitatos, celsos & erectos constituit, ut Deorum cognitionem, cœlum intuentes, capere possent. Sunt enim e terra homines non ut incolæ, atque habitatores, sed quasi spectatores superarum rerum, atque cœlestium, quarum spectaculum ad nullum aliud genus animantium pertinet.* Cic. de Nat. Deor. L. 2.

(3) *Ut autem sapientissimum animalium est Homo, sic & Manus sunt organa sapienti animali convenientia. Non enim quia Manus habuit, propterea est sapientissimum, ut Anaxagoras dicebat; sed quia sapientissimum erat, propter hoc Manus habuit, ut rectissime censuit Aristoteles. Non enim Manus ipsæ hominem artes docuerunt, sed Ratio. Manus autem ipsæ sunt artium organa*, &c. Galen. de Us. Part. L. 1. c. 3. After which in the rest of this first Book and part of the second, he considers the Particulars of the *Hand*, in order to enquire, as he saith, ch. 5. *Num eam omnino Constitutionem habeat* [manus] *qua meliorem aliam habere non potuit.*

Of this Part, (and indeed of the other Parts of human Bodies) he gives so good an Account, that I confess I could not but admire the Skill of that ingenious and famed Hea-

not have been in ſo great Readineſs to execute the Commands of the Will, and Dictates of the Soul. His Eyes would have been the moſt prone, and incommodiouſly ſituated of all Animals; but by this Situation, he can caſt his Eyes upwards, downwards, and round about him; he hath a glorious Hemiſphere of the Heavens (4), and an ample Horizon on Earth (5) to entertain his Eye.

And

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then. For an Example, (becauſe it is a little out of the Way) I ſhall pitch upon his Account of the different Length of the Fingers, L. 1. c. 24. The Reaſon of this Mechaniſm, he ſaith, is, That the Tops of the Fingers may come to an Equality, *cum magnas aliquas moles in circuitu comprehendunt, & cum in ſeipſis humidum vel parvum corpus continere conantur.* —— *Apparent vero in unam circuli circumferentiam convenire Digiti quinque in actionibus hujuſmodi, maxime quando exquiſite ſphæricum corpus comprehendunt.* And this Evenneſs of the Fingers Ends, in graſping Sphærical, and other round Bodies, he truly enough ſaith, makes the Hold the firmer. And it ſeems a noble and pious Deſign he had in ſo ſtrictly ſurveying the Parts of Man's Body, which take in his own tranſlated Words, *Cum multa namque eſſet apud veteres, tam Medicos, quam Philoſophos de utilitate particularum diſſentio (quidam enim corpora noſtra nullius gratia eſſe facta exiſtimant, nullaque omnino arte; alii autem & alicujus gratia, & artificioſe,* ———) *primum quidem tantæ hujus diſſentionis* κεφάλαιον *invenire ſtudui: deinde vero & unam aliquam univerſalem methodum conſtituere, qua ſingularum partium corporis, & eorum quæ illis accidunt, utilitatem invenire poſſemus.* Ibid. cap. 8.

(4) *Pronaque cum ſpectant animalia cætera terram*
Os Homini ſublime dedit, cœlumque tueri
Juſſit, & erectos ad ſidera tollere vultus.
Ovid. Metam. L. 1. car. 84.

(5) If any ſhould be ſo curious to deſire to know how far a Man's Proſpect reacheth by means of the Height of his Eye, ſuppoſing the Earth was an uninterrupted Globe, the Method is a common Caſe of Right angled plain Triangles; where two Sides, and an oppoſite Angle are given. Thus in Fig. 4. *A H B* is the Surface, or a great Circle of the terraqueous Globe: *C* the Center, *H C* it's Semidiameter; *E* the Height of the Eye, and foraſmuch as *H E* is a Tangent, therefore the Angle at *H* is a Right-angle. So

that

that there are given *HC* 3967,737 Miles, or 20949655 English Feet (according to B. II. Ch. 2. Note 1.) *CE* the same Length with the Height of the Eye on the Mast of a Ship, or at only a Man's Height, &c. added to it; and *EHC* the opposite Right-Angle. By which three Parts given, it is easy to find all the other Parts of the Triangle. And first the Angle at *C*, in order to find the Side *HE*, the Proportion is, as the Side *CE*, to the Angle at *H* :: So the Side *HC*, to the Angle at *E*, which being substracted out of 90 *gr.* the Remainder is the Angle at *C*. And then, as the Angle at *E* is to it's opposite Side *HC*, or else, as the Angle at *H* is to it's opposite Side *CE* :: So the Angle at *C* to it's opposite Side *EH*, the visible Horizon. Or the Labour may be shortned, by adding together the Logarithm of the Sum of the two given Sides, and the Logarithm of their Difference: the half of which two Logarithms, is the Logarithm of the Side required, nearly. For an Example we will take the two Sides in Yards, by reason scarce any Tables of Logarithms will serve us farther. The Semidiameter of the Earth is 6983218: the Height of the Eye is 2 Yards more, the Sum of both 13966438.

Logar. of which Sum is	7,1450856
Logar. of 2 Yards (the Differ.) is	0,3010300
Sum of both Logar.	7.4461156
The Half Sum	3.7230578

is the Logar. of 5285 Yards = 3 Miles, which is the Length of the Line *EH*, or Distance the Eye can reach at 6 Feet Height.

This would be the Distance, on a perfect Globe, did the visual Rays come to the Eye in a strait Line. But by means of the Refractions of the Atmosphere, distant Objects on the Horizon appear higher than really they are, and may be seen at a greater Distance, especially on the Sea; which is a Matter of great Use, especially to discover at Sea the Land, Rocks, &c. and it is a great Act of the divine Providence in the Contrivance and Convenience of the Atmosphere, which by this means enlargeth the visible Horizon, and is all one as if the terraqueous Globe was much larger than really it is. As to the Height of the Apparent above the true Level, or how much distant Objects are raised by the Refractions, the ingenious and accurate Gentlemen of the *French Academy-Royal*, have given us a Table in their *Measure of the Earth*; Art. 12.

(6)

And as this Erection of Man's Body is the most compleat Posture; so if we survey the Provision made for it, we find all done with manifest Design, the utmost Art and Skill being employed therein. To pass by the particular Conformation of many of the Parts, the Ligaments and Fastnings to answer this Posture, as the Fastning, for instance, of the *Pericardium* to the *Diaphragm* (which is peculiar to Man (6), I say passing by a deal of this Nature, manifesting this Posture to be an Act of Design) let us stop a little at the curious Fabrick of the Bones, those Pillars of the Body. And how artificially do we find them made, how curiously placed from the Head to Foot! The *Vertebræ* of the Neck and Back Bone (7) made short and complanated, and firmly braced with Muscles and Tendons, for easy Incurvations of the Body, but withal for greater Strength, to support the Body's own Weight, together with other additional Weights it may have Occasion to bear. The *Thigh-Bones* and Legs long, and strong, and every way well fitted for the Motion of the Body. The *Feet* accommodated with a great Number of Bones, curiously and firmly tacked together (to which must be added the ministry of the Muscles (8) to answer all the Motions

(6) See Book 6. Ch. 5. Note 7.

(7) See Book 4. Ch. 8. Note 2.

(8) The Mechanism of the Foot would appear to be wonderful, if I should descend to a Description of all parts: but that would be too long for these Notes: therefore a brief Account (most of which I owe to the before commended Mr. *Cheselden*) may serve for a Sample. In the first Place, it is necessary the Foot should be concave, to enable us to stand firm, and that the Nerves and Blood-Vessels may be free from Compression when we stand or walk. In order hereunto the long *Flexors* of the Toes cross one another at the

tions of the Legs and Thighs, and at the same time to keep the Body upright, and prevent it's falling, by readily assisting against every Vacillation thereof, and with easy and ready Touches keeping the *Line of Innixion*, and *Center* of *Gravity* in due Place and Posture (9).

And as the Bones are admirably adapted to prop, so all the Parts of the Body are as incomparably placed to poise it. Not one Side too heavy for the other, but all in nice Æquipoise: the Shoulders, Arms, and Sides æquilibrated on one Part; on the other Part the *Viscera* of the Belly counterpoised with the Weight of the Scapular part, and that useful Cushion of Flesh behind.

And lastly, to all this we may add the wonderful Concurrence, and ministry of the prodigious Number and Variety of Muscles, placed throughout the Body for this Service: that they should so readily answer to every Posture, and comply with every Motion thereof, without any previous Thought

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the Bottom of the Foot, in the Form of a St. *Andrew*'s Cross, to incline the lesser Toes towards the great One, and the great One towards the lesser. The *short Flexors* are chiefly concerned in drawing the Toes towards the Heel. The *Transversalis Pedis* draws the Outsides of the Foot towards each other; and by being inserted into one of the *Sesamoid* Bones of the great Toe, diverts the Power of the *Abductor Muscle* (falsly so called) and makes it become a *Flexor*. And lastly, the *Peronæus longus* runs round the outer Ankle, and obliquely forwards cross the bottom of the Foot, and at once helps to extend the *Tarsus*, to constrict the Foot, and to direct the Power of the other *Extensors* towards the Ball of the great Toe. Hence the Loss of the *Great Toe*, is more than of all the other Toes. See also Mr. *Cowper*'s *Anat.* Tab. 28. *&c.*

(9) It is very well worth while to compare here what *Borelli* saith *de motu Animal.* Par. 1. cap. 18. *de statione Animal.* Prop. 132, *&c.* to which I refer the Reader, it being too long to recite here.

(10)

Thought or Reflext act, ſo that (as the excellent *Borelli* (10) ſaith) " It is worthy of Admiration, " that in ſo great a Variety of Motions, as run- " ning, leaping, and dancing, Nature's Laws " of Æquilibration ſhould always be obſerved ; " and when neglected, or wilfully tranſgreſſed, " that the Body muſt neceſſarily and immediate- " ly tumble down.

CHAP. III.

Of the FIGURE *and* SHAPE *of Man's* BODY.

THE Figure and Shape of Man's Body is the moſt commodious that could poſſibly be invented for ſuch an Animal ; the moſt agreeable to his Motion, to his Labours, and all his Occaſions. For had he been a Rational Reptile he could not have moved from Place to Place faſt enough for his Buſineſs, nor indeed have done any almoſt. Had he been a Rational Quadrupede, among other things, he had loſt the Benefit of his Hands, thoſe noble Inſtruments of the moſt uſeful Performances of the Body. Had he been made a Bird, beſides many other great Inconveniences, thoſe before mentioned of his Flying, would have been ſome. In a Word, any other Shape of Body, but that which the Allwiſe Creator hath given Man, would have been as incommodious, as any Poſture but that of Erect : it would have rendered him more helpleſs, or have put in his Power to have been more pernicious, or deprived him of ten thouſand Benefits, or Plea-

(10) Borel. ibid. Prop. 142.

Pleaſures, or Conveniences, which his preſent Figure capacitates him for.

CHAP. IV.

Of the STATURE *and* SIZE *of Man's* BODY.

AS in the Figure, ſo in the Stature and Size of Man's Body, we have another manifeſt Indication of excellent Deſign. Not too Pygmean (1), nor too Gigantick (2), either of which Sizes would in ſome particular or other, have been incommodious to Himſelf, or to his Buſineſs, or to the reſt of his fellow Creatures. Too Pygmean would have rendered him too puny a Lord of the Creation, too impotent and unfit to manage the inferiour Creatures, would have expoſed him to the Aſſaults of the weakeſt Animals, to the ravening Appetite of voracious Birds, and have put him in the Way, and endangered his being trodden in the Dirt by the larger Animals. He would have been alſo too weak for his Buſineſs, unable to carry Burdens, and in a Word, to tranſact the greater Part of his Labours and Concerns.

And on the other Hand, had Man's Body been made too monſtrouſly ſtrong, too enormouſly Gigan-

(1) What is here urged about the Size of Man's Body, may anſwer one of *Lucretius*'s Reaſons why *Nil ex nihilo gignitur*. His Argument is

Denique cur Homines tantos natura parare
Non potuit, pedibus qui pontum per vada poſſent
Tranſire, & magnos manibus divellere monteis?
Lucret. L. 1. Car. 200.

(2) *Haud facile ſit ut quiſquam & ingentes corporis vires, & ingenium ſubtile habeat.* Diodor. Sic. L. 17.

(3)

Gigantick (3), it would have rendred him a dan-

(3) Altho' we read of *Giants* before *Noah's* Flood, *Gen.* 6. 4. and more plainly afterwards in *Num.* 13. 33. Yet there is great reason to think the size of Man was always the same from the Creation. For as for the *Nephilim* or *Giants*, in *Gen.* 6. the Ancients vary about them: some taking them for great Atheists, and Monsters of Impiety, Rapine, Tyranny, and all Wickedness, as well as of monstrous Stature, according as indeed the Hebrew Signification allows.

And as for the *Nephilim* in *Num.* 13. which were evidently Men of a Gigantick Size, it must be considered, that it is very probable, the Fears and Discontent of the Spies, might add somewhat thereunto.

But be the Matter as it will, it is very manifest, that in both these Places, *Giants* are spoken of as Rarities, and Wonders of the Age, not of the common Stature. And such Instances we have had in all Ages; excepting some fabulous Relations: such as I take to be that of *Theutobocchus*, who is said to have been dug up, *Anno* 1613. and to have been higher than the Trophies, and 26 feet long; and no better I suppose the Giants to have been, that *Ol. Magnus* gives an account of in his 5th Book, such as *Harthen*, and *Starchater*, among the Men; and among the Women, *reperta est* (saith he) *puella* —— *in capite vulnerata, ac mortua, induta chlamyde purpurea, longitudinis cubitorum* 50, *latitudinis inter humeros quatuor*. Ol. Mag. Hist. L. 5. c. 2.

But as for the more credible Relations of *Goliath* (*whose height was 6 Cubits and a Span*, 1 Sam. 17. 4. which according to the present curious and learned *Lord Bishop of Peterborough*, is somewhat above 11 feet English, *vid.* Bishop *Cumberland of Jewish Weights and Measures*) of *Maximinus* the Emperor, who was 9 feet high, and others in *Augustus*, and other Reigns, of about the same height; to which we may add the Dimensions of a *Skeleton*, dug up lately in the place of a *Roman* Camp near St. *Albans*, by an Urn inscribed, *Marcus Antoninus*; of which an account is given by Mr. *Cheselden*, who judgeth by the Dimensions of the Bones, that the Person was 8 foot high, *vid. Philos. Transact.* No. 333. these antique Examples and Relations, I say, we can match, yea out-do, with modern Examples; of which we have divers in *J. Ludolph. Comment. in Hist. Æthiop.* L. 1. c. 2. §. 22. *Magus*, *Conringius*, Dr. *Hakewill*, and others. Which latter relates, from *Nannez*, of Porters and Archers belonging to the Emperor of *China*, of 15 feet high; and others from

Purchas

Purchas of 10 and 12 feet high, and more; see in the learned Author's Apolog. p. 208.

These indeed exceed what I have seen in *England*; but in 1684, I measur'd an *Irish* Youth, said to be not 19 Years old, who was 7 feet near 8 Inches, and in 1697, a Woman who was 7 feet 3 Inches in height,

But for the ordinary Size of Mankind, in all probability, it was always (as I said) the same, as may appear from the Monuments, Mummies, and other ancient Evidences to be seen at this day. The most ancient Monument at this day, I presume is that of *Cheops*, in the first and faireſt Pyramid of *Egypt*; which was, no doubt, made of capacity every way sufficient to hold the Body intended to be laid up in it. But this we find, by the nice Measures of our curious Mr. *Greaves*, hardly to exceed our common Coffins. *The hollow part within* (saith he) *is in length* only 6,488 *feet*, and *in breadth*, but 2,218 *feet: The depth*, 2,860 feet. *A narrow space, yet large enough to contain a most potent and dreadful Monarch, being dead; to whom living, all* Egypt *was too streight and narrow a Circuit. By these Dimensions, and by such other Observations, as have been taken by me from several embalmed Bodies in* Egypt, *we may conclude there is no decay in Nature* (*though the Question is as old as* Homer) *but that the Men of this Age are of the same Stature they were near* 3000 *Years ago*, vid. *Greaves* of the Pyr. in 1638. in *Rays* Collect. of *Trav.* Tom. 1. pag, 118.

To this more Ancient, we may add others of a later date. Of which take these, among others, from the curious and learned *Hakewill*. The Tombs at *Pisa*, that are some thousand Years old, are not longer than ours: so is *Athelstane*'s in *Malmesbury* Church; so *Sebba*'s in St. *Paul*'s, of the Year 693; so King *Etheldred*'s, &c. Apol. p. 219, *&c.*

The same evidence we have also from the Armour, Shields, Vessels, and other Utensils dug up at this day. The brass Helmet dug up at *Metaurum*, which was not doubted to have been left there at the *overthrow of Asdrubal*, will fit one of our Men at this day.

Nay, besides all this probable, we have some more certain Evidence, *Augustus* was 5 Foot 9 Inches high, which was the just Measure of our famous Queen *Elizabeth*, who exceeded his Height 2 Inches, if proper Allowance be made for the Difference between the Roman and our Foot. *Vid. Hake. ib. p.* 215.

dangerous Tyrant in the World, too ſtrong (4) in ſome Reſpects, even for his own kind, as well as the other Creatures. Locks and Doors might per-

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(4) To the Stature of Men in the foregoing Note, we may add ſome Remarks about their unuſual *Strength*. That of *Sampſon* (who is not ſaid to have exceeded other Men in Stature as he did in Strength) is well known. So of old, *Hector*, *Diomedes*, *Hercules*, and *Ajax* are famed; and ſince them many others: for which I ſhall ſeek no farther than the before commended *Hakewill*, who by his great and curious Learning, hath often moſt of the Examples that are to be met with on all his Subjects he undertakes. Of the After-ages he names *C. Marius*, *Maximinus*, *Aurelian*, *Scanderberge*, *Bardeſin*, *Tamerlane*, *Ziska*, and *Hunniades*. Anno 1529. *Klunber*, Provoſt of the great Church at *Miſnia*, carried a Pipe of Wine out of the Cellar, and laid it in the Cart. *Mayolus* ſaw one hold a Marble Pillar in his Hand 3 Foot long, and one Foot diameter, which he toſs'd up in the Air, and catched again, as if 'twas a Ball. Another of *Mantua*, and a little Man, named *Rodamas*, could break a Cable, &c. *Fernando Burg* fetched up Stairs an Aſs laden with Wood, and threw both on the Fire. At *Conſtantinople*, Anno 1582. one lifted a piece of Wood, that twelve Men could ſcarce raiſe; then lying along, he bare a Stone that ten Men could but juſt roll to him. *G.* of *Fronsberge*, *Baron Mindlehaim*, could raiſe a Man off his Seat, with only his middle Finger; ſtop an Horſe in his full Career; and ſhove a Cannon out of it's Place. *Cardan* ſaw a Man dance with two Men in his Arms, two on his Shoulders, and one on his Neck. *Patacona*, Captain of the *Coſſacks*, could tear an Horſe-ſhoe (and if I miſtake not, the ſame is reported of the preſent King *Auguſtus* of *Poland*.) A Gigantick Woman of the *Netherlands* could lift a Barrel of *Hamburg* Beer. Mr. *Carew* had a Tenant that could carry a But's length, 6 Buſhel of wheaten Meal (of 15 Gallon Meaſure) with the Lubber, the Miller, of 24 Years of Age, on the Top of it. And *J. Roman*, of the ſame County, could carry the Carcaſs of an Ox. Vid. *Hakewill*, ib. p. 238.

Viros aliquot moderna memoria tam a mineralibus, quam aliis Suethiæ, & Gothiæ provinciis adducere congruit, tanta fortitudine præditos, ut quiſque eorum in humeros ſublevatum Equum, vel Bovem maximum, imo vas ferri 600, 800, *aut* 1000 *librarum* (*quale & aliquæ Puellæ levare poſſunt*) *ad plura ſtadia portaret.* Ol. Mag. ubi ſupr.

(5)

perhaps have been made of ſufficient Strength to have barricaded our Houſes; and Walls, and Ramparts might perhaps have been made ſtrong to have fenced our Cities. But theſe things could not have been without a great and Inconvenient Expence of Room, Materials, and ſuch Neceſſaries, that ſuch vaſt Structures and Uſes would have occaſioned, more perhaps than the World could have afforded to all Ages and Places. But let us take the Deſcant of a good Naturaliſt and Phyſician on the Caſe (5). Had Man been "a Dwarf (ſaith he) he had ſcarce been a Rea-"ſonable Creature. For he muſt then have had "a Jolt Head; ſo there would not have been "Body and Blood enough to ſupply his Brain "with Spirits; or he muſt have had a ſmall "Head, anſwerable to his Body, and ſo there "would not have been Brain enough for his Bu-"ſineſs — Or had the Species of Mankind been "Gigantick, he could not have been ſo commo-"diouſly ſupplied with Food. For there would "not have been Fleſh enough of the beſt edible "Beaſts, to ſerve his Turn. And if Beaſts had "been made anſwerably bigger, there would "not have been Graſs enough. And ſo he goeth on. And a little after, "There would not have "been the ſame Uſe and Diſcovery of his Rea-"ſon; in that he would have done many things "by meer Strength, for which he is now put to "invent innumerable Engines. —— Neither "could he have uſed an Horſe, nor divers other "Creatures. But being of a middle Bulk, he "is fitted to manage and uſe them all. For (ſaith "he) no other Cauſe can be aſſigned why a Man "was

(5) *Grews Coſmol. Sacr.* B. 1. ch. 5. §. 25.

" was not made five or ten times bigger, but his " Relation to the reſt of the Univerſe. Thus far our curious Author.

CHAP. V.

Of the STRUCTURE *of the* PARTS *of Man's Body.*

HAving thus taken a View of the Poſture, Shape, and Size of Man's Body, let us in this Chapter ſurvey the Structure of it's Parts. But here we have ſo large a Proſpect, that it would be endleſs to proceed upon Particulars. It muſt ſuffice therefore to take Notice, in general only, how artificially every Part of our Body is made. No Botch, no Blunder, no unneceſſary *Apparatus* (or in other Words) no Signs of Chance (1); but every thing curious, orderly, and performed in the ſhorteſt and beſt Method, and adapted to the moſt compendious Uſe. What one Part is there throughout the whole Body, but what is compoſed of the fitteſt Matter for that Part;

(1) It is manifeſtly an argument of Deſign, that in the Bodies of different Animals, there is an Agreement of the Parts, ſo far as the Occaſions and Offices agree, but a difference of thoſe where there is a difference of theſe. In an humane Body are many Parts agreeing with thoſe of a Dog for inſtance; but in his Forehead, Fingers, Hand Inſtruments of Speech, and many other Parts, there are Muſcles, and other Members which are not in a Dog. And ſo contrariwiſe in a Dog, which is not in Man. If the Reader is minded to ſee what particular Muſcles are in a Man, that are not in a Dog; or in a Dog that are not in an humane Body, let him conſult the curious and accurate Anatomiſt, Dr. *Douglaſs's Myogr. compar.*

(2)

Part; made of the moſt proper Strength and Texture; ſhaped in the compleateſt Form; and in a Word, accouter'd with every thing neceſſary for it's Motion, Office, Nouriſhment, Guard, and what not! What ſo commodious a Structure and Texture could have been given to the Bones, for Inſtance, to make them firm and ſtrong, and withal light, as that which every Bone in the Body hath? Who could have ſhaped them ſo nicely to every Uſe, and adapted them to every Part, made them of ſuch juſt Lengths, given them ſuch due Sizes and Shapes, channelled, hollowed, headed, lubricated, and every other thing miniſtring in the beſt and moſt compendious manner to their ſeveral Places and Uſes? What a glorious Collection and Combination have we alſo of the moſt exquiſite Workmanſhip and Contrivance in the Eye, in the Ear, in the Hand (2), in the Foot (3), in the Lungs, and other Parts already mentioned? What an Abridgment of Art, what

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(2) *Galen* having deſcribed the Muſcles, Tendons, and other parts of the Fingers, and their Motions, cries out, *Conſidera igitur etiam hic mirabilem* CREATORIS *ſapientiam.* De Uſ. Part. L. 1. c. 18.

(3) And not only in the Hand, but in his account of the Foot (*L.* 3.) he frequently takes notice of what he calls *Artem, Providentiam & Sapientiam Conditoris.* As Ch. 13. *An igitur non æquum eſt hic quoque admirari Providentiam Conditoris, qui ad utrumque uſum, etſi certe contrarium, exacte convenientes & conſentientes invicem fabricatus eſt totius membri* [tibiæ] *particulas?* And at the end of the Chap. *Quod ſi omnia quæ ipſarum ſunt partium mente immutaverimus, neque invenerimus poſitionem aliam meliorem ea, quam nunc ſortita ſunt, neque figuram, neque magnitudinem, neque connexionem, neque (ut paucis omnia complectar) aliud quidquam eorum, quæ corporibus neceſſario inſunt, perfectiſſimam pronunciare oportet, & undiquee rectè conſtitutam præſentem ejus conſtructionem.* The like alſo concludes, Ch. 15.

a Variety of Uſes (4) hath Nature laid upon that one Member the Tongue, the grand Inſtrument of Taſt, the faithful Judge, the Centinel, the Watchman of all our Nouriſhment, the artful Modulator of our Voice, the neceſſary Servant of Maſtication, Swallowing, Sucking, and a great deal beſides? But I muſt deſiſt from proceeding upon Particulars, finding I am fallen upon what I propoſed to avoid.

And therefore for a Cloſe of this Chapter, I ſhall only add part of a Letter I received from the before commended very learned and ingenious Phyſician Dr. *Tancred Robinſon*, *What* (ſaith he) *can poſſibly be better contrived for Animal Motion and Life, than the quick Circulation of the Blood and Fluids, which run out of Sight in Capillary Veſſels, and very minute Ducts without Impediment (except in ſome Diſeaſes) being all directed to their peculiar Glands and Channels for the different Secretions, Senſible and Inſenſible; whereof the laſt is far the greateſt in Quantity and Effects, as to Health and Sickneſs, acute Diſtempers frequently ariſing from a Diminution of Tranſpiration through the cutaneous Chimneys, and ſome Chronical ones from an Augmentation: whereas Obſtructions in the Liver, Pancreas and other Glands may only cauſe a Schirrus, a Jaundice, an Ague, a Dropſy, or other ſlow Diſeaſes. So an increaſe of their Secretions may accompany the general Colliquations, as in Fluxes, Hectick Sweats and Coughs, Diabetes, and other Conſumptions. What a mighty Contrivance is there to preſerve theſe due Secretions from the Blood (on which Life ſo much depends) by frequent Attritions and Comminutions of the Fluids in their paſſage through the Heart, the Lungs, and the whole Syſtem of the Muſcles? What Meanders and Contortions of*

(4) *At enim Opificis induſtriæ maximum eſt indicium (quemadmodum ante ſæpenumero jam diximus) iis quæ ad alium uſum fuerunt comparata, ad alias quoque utilitates abuti, neque laborare ut ſingulis utilitatibus ſingulas faciat ac propriæs particulas.* Galen. ub. ſupr. L. 9. c. 5.

(1)

of Veſſels in the Organs of Separation? And what a Concourſe of Elaſtick Bodies from the Air, to ſupply the Springs and continual Motions of ſome Parts, not only in Sleep and Reſt, but in long violent Exerciſes of the Muſcles? whoſe force drive the Fluids round in a wonderful rapid Circulation through the minuteſt Tubes, aſſiſted by the conſtant Pabulum of the Atmoſphere, and their own Elaſtick Fibres, which impreſs that Velocity on the Fluids.

Now I have mentioned ſome Uſes of the Air in carrying on ſeveral Functions in Animal Bodies, I may add the Share it hath in all the Digeſtions of the Solid and Fluid Parts. For when this Syſtem of Air comes, by divine Permittance, to be corrupted with poyſoncus, acrimonious Steams, either from the Earth, from Merchandiſe, or infected Bodies, what Havock is made in all the Operations of living Creatures? The Parts gangrene, and mortify under Carbuncles, and other Tokens: indeed the whole Animal Oeconomy is ruined: of ſuch Importance is the Air to all the Parts of it.

CHAP. VI.

Of the PLACING *the* PARTS *of Man's Body.*

IN this Chapter, I propoſe to conſider the Lodgment of the curious Parts of Man's Body, which is no leſs admirable than the Parts themſelves, all placed in the moſt convenient Parts of the Body, to miniſter to their own ſeveral Uſes and Purpoſes, and to aſſiſt, and mutually to help one another. Where could thoſe faithful Watchmen the Eye, the Ear, the Tongue be ſo commodiouſly placed, as in the upper Part of the Building? where could we throughout the Body find ſo proper a Part to lodge four of the five Senſes, as in the Head (1), near the Brain

(1) *Senſus, interpretes ac nuntii rerum, in capite, tanquam in arce, mirifice ad uſus neceſſarios & facti, & collocati ſunt. Nam oculi tanquam ſpeculatores, altiſſimum locum obtinent: ex quo plurima conſpicientes, fungantur ſuo munere. Et Aures*

Brain (2), the common Senſory, a Place well guarded, and of little other Uſe than to be a Seat to thoſe Senſes? And how could we lodge the Fifth Senſe, that of *Touching* otherwiſe (3), than to diſperſe it to all Parts of the Body? Where could we plant the Hand (4), but juſt where it is, to be ready at every Turn, on all Occaſions of Help and Defence, of Motion, Action, and every of its uſeful Services? Where could we ſet the Legs and Feet, but where they are, to bear up, and handſomely to carry about the Body? Where could we lodge the Heart, to labour about the whole Maſs of Blood, but in, or near the Center of the Body (5)? Where could we find Room for that noble Engine to play freely in, where could we ſo well guard it againſt external Harms, as it is in that very place in which it is lodged and ſecured? Where could we more commodiouſly place, than in the Thorax and Belly, the uſeful *Viſcera* of thoſe Parts, ſo as not to ſwagg, and jogg, and overſet the Body, and yet to miniſter ſo harmoniouſly, as they do, to all the ſeveral Uſes of Concoction, Sanguification, the Separation of various Ferments from the Blood, for the great Uſes of Nature, and to make Diſcharges

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cium ſonum recipere debeant, qui natura in ſublime fertur; recte in illis corporum partibus collocata ſunt. Cicer. de Nat. Deor. L. 2. ubi plura de cæteris Senſibus.

(2) *Galen* well obſerves, that the Nerves miniſtring to Motion, are hard and firm, to be leſs ſubject to Injury: but thoſe miniſtring to Senſe, are ſoft and tender: and that for this Reaſon it is, that Four of the Five Senſes are lodged ſo near the Brain, *viz.* partly to partake of the Brain's ſoftneſs and tenderneſs, and partly for the ſake of the ſtrong guard of the Skull, vid. *Gal. de Uſ. Part.* L. 8. c. 5, 6.

(3) See Book 4. Ch. 6. Note 3.

(4) *Quam vero aptas, quamque multarum artium miniſtras Manus natura homini dedit?* The particulars of which, enumerated by him, ſee in *Cic. ubi ſupr.*

(5) See Book 6. Ch. 5. (6)

charges of what is uſeleſs, or would be burdenſome or pernicious to the Body (6)? How could we plant the curious and great Variety of Bones and of Muſcles of all Sorts and Sizes, neceſſary as I have ſaid to the Support, and every Motion of the Body? where could we lodge all the Arteries and Veins to convey Nouriſhment; and the Nerves Senſation throughout the Body? where, I ſay, could we lodge all theſe Implements of the Body, to perform their ſeveral Offices? how could we ſecure and guard them ſo well, as in the very Places, and in the ſelf ſame manner in which they are already placed in the Body? And laſtly, to name no more, what Covering, what Fence could we find out for the whole Body, better than that of Nature's own providing, the Skin (7)? how could we ſhape it to, or brace it about every part better, either for Convenience or Ornament? What better Texture could we give it, which altho' leſs obdurate and firm, than that of ſome other Animals, yet is ſo much the more ſenſible of every Touch, and more compliant with every Motion? and being eaſily defendible by the Power of Man's Reaſon and Art, is therefore much the propereſt Tegument for a Reaſonable Creature.

CHAP.

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(6) *Ut in ædificiis Architecti avertunt ab oculis & naribus dominorum ea, qua profluentia neceſſario tetri eſſent aliquid habitura; ſic natura res ſimiles (ſcil. excrementa) procul amandavit a ſenſibus.* Cicer. de Nat. Deor. L. 2.

(7) Compare here *Galen*'s Obſervations *de Uſ. Part.* L. 11. c. 15. Alſo *L. 2. c. 6.* See alſo *Cowper*'s *Anat.* where in Tab. 4. are very elegant Cuts of the Skin in divers parts of the Body, drawn from Microſcopical Views, as alſo of the *Papillæ pyramidales*, the *Sudoriferous Glands* and Veſſels, the *Hairs*, &c.

CHAP. VII.

Of the PROVISION *in Man's Body againſt* EVILS.

HAving taken a tranſient View of the Structure and Lodgment of the Parts of human Bodies, let us next conſider the admirable Proviſion that is made throughout Man's Body to ſtave off Evils, and to diſcharge (1) them when befallen. For the Prevention of Evils, we may take the Inſtances already given, of the Situation of thoſe faithful Sentinels, the Eye, the Ear, and Tongue in the ſuperiour Part of the Body, the better to deſcry Dangers at a Diſtance, and to call out preſently for Help. And how well ſituated is the Hand, to be a ſure and ready Guard to the Body, as well as the faithful Performer of moſt of it's Services? The Brain, the Nerves, the Arteries, the Heart (2), the Lungs, and in a Word, all the

(1) One of Nature's moſt conſtant Methods here, is by the *Glands*, and the Secretions made by them: the particulars of which being too long for theſe Notes, I ſhall refer to the modern Anatomiſts who have written on theſe Subjects, and indeed, who are the only Men that have done it tolerably: particularly, our learned Drs. *Cockburn*, *Keil*, *Morland*, and others at home and abroad: an Abridgment of whoſe Opinions and Obſervations, may be met with in Dr. *Harris's Lex. Tech.* Vol. 2. under the words *Glands*, and *Animal Secretion*.

(2) In Man, and moſt other Animals, the Heart hath the guard of Bones. But in the *Lamprey* which hath no Bones, (no not ſo much as a Back-bone) *the Heart is very ſtrangely ſecured, and lies immured or capſulated in a Cartilage, or griſly Subſtance, which includes the Heart, and its Auricle, as the Skull* ——— *doth the Brain in other Animals.* Powers Microſ. Obſer. 22.

(3)

the principal Parts, how well are they barricaded either with ſtrong Bones, or deep Lodgments in the Fleſh, or ſome ſuch the wiſeſt, and fitteſt Method, moſt agreeable to the Office and Action of the Part? Beſides which, for greater Precaution, and a farther Security, what an incomparable Proviſion hath the infinite Contriver of Man's Body made for the Loſs of, or any Defect in ſome of the Parts we can leaſt ſpare, by doubling them? by giving us two Eyes, two Ears, two Hands, two Kidneys, two Lobes of the Lungs, Pairs of the Nerves, and many Ramifications of the Arteries and Veins in the fleſhy Parts, that there may not be a Defect of Nouriſhment of the Parts, in Caſes of Amputation, or Wounds, or Ruptures of any of the Veſſels.

And as Man's Body is admirably contrived and made to prevent Evils: ſo no leſs Art and Caution hath been uſed to get rid of them, when they do happen. When by any Misfortune, Wounds or Hurts do befal, or when by our own wicked Fooleries and Vices, we pull down Diſeaſes and Miſchiefs upon ourſelves, what Emunctories (3), what admirable Paſſages (4), are diſperſed throughout

(3) *Here* [from the Puſtules he obſerved in Monomotapa] *were grounds to admire the contrivance of our Blood, which on ſome Occaſions, ſo ſoon as any thing deſtructive to the conſtitution of it, comes into it, immediately by an inteſtine Commotion endeavoureth to thruſt it forth, and is not only freed from the new Gueſt, but ſometimes what likewiſe may have lain lurking therein —— for a great while. And from hence it comes to paſs, that moſt part of Medicines, when duly adminiſtred, are not only ſent out of the Body themſelves, but likewiſe great quantities of morbifick Matter; as in Salivation*, &c. Dr. *Sloane*'s Voy. to *Jamaica*, p. 25.

(4) *Valſalva* diſcovered ſome Paſſages into the Region of the *Ear-drum*, of mighty uſe (among others) to make Diſcharges

out the Body, what incomparable Methods doth Nature take (5), what vigorous Efforts is ſhe enabled

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charges of Bruiſes, Impoſthumes, or any purulent, or morbifick Matter from the Brain, and parts of the Head. Of which he gives two Examples: one, a Perſon, who from a Blow on his Head, had diſmal Pains therein, grew Speechleſs, and lay under an abſolute Suppreſſion and Decay of his Strength: but found certain Relief, whenever he had a Flux of Blood, or purulent Matter out of his Ear: which after his Death, *Valſalva* diſcovered, was through thoſe Paſſages.

The other was an *Apoplectical Caſe*, wherein he found a large quantity of extravaſated Blood, making way from the Ventricles of the Brain, through thoſe ſame Paſſages. *Valſal. de Aure hum.* c. 2. §. 14. and c. 5. §. 8.

(5) *Hippocrates Lib. de Alimentis*, takes notice of the Sagacity of Nature, in finding out Methods and Paſſages for the diſcharging Things offenſive to the Body, of which the preſent learned and ingenious Biſhop of *Clogher*, in *Ireland* (*Boyle*) gave this remarkable Inſtance to my very curious and ingenious Neighbour and Friend, *D'Acre Barret*, Eſq; *viz.* That in the Plague-Year, a Gentleman at the Univerſity, had a large Plague-Sore gathered under his Arm, which when they expected it would have broken, diſcharged it ſelf by a more than ordinary large and fœtid Stool; the Sore having no other Vent for it, and immediately becoming ſound and well thereupon.

Like to which, is the Story of *Joſ. Lanzonius*, of a Soldier of 35 Years of Age, who had a Swelling in his right Hip, accompanied with great Pain, *&c.* By the uſe of emollient Medicines having ripened the Sore, the Surgeon intended the next Day to have opened it; but about Midnight, the Patient having great provocations to Stool, disburthened himſelf three times; immediately upon which, both the Tumour and Pain ceaſed, and thereby diſappointed the Surgeons Intention. *Ephem. Germ.* Anno 1690. Obſ. 49. More ſuch Inſtances we find of Mr. *Yonges* in *Philoſ. Tranſact.* No. 323. But indeed there are ſo many Examples in our *Philoſ. Tranſact.* in the *Ephem. German. Tho. Bartholine, Rhodius, Sennertus, Hildanus*, &c. that it would be endleſs to recount them. Some have ſwallowed Knives, Bodkins, Needles and Pins, Bullets, Pebbles, and 20 other ſuch things as could not find a Paſſage the ordinary Way, but have met with an *Exit* through the Bladder, or ſome other way of Natures

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bled to make, to diſcharge the Peccant Humours, to correct the morbifick Matter, and in a Word, to ſet all things right again ? But here we had beſt take the Advice of a learned Phyſician in the Caſe : " The Body (ſaith he) is ſo contrived, as " to be well enough ſecured againſt the Mutati- " ons in the Air, and the leſſer Errors we daily " run upon; did we not in our Exceſſes of Eating, " Drinking, Thinking, Loving, Hating, or ſome " other Folly, let in the Enemy, or lay violent " Hands upon our ſelves. Nor is the Body fitted " only to prevent, but alſo to cure, or mitigate " Diſeaſes, when by theſe Follies brought upon " us. In moſt Wounds, if kept clean, and from " the Air, — the Fleſh will glew together, " with it's own Native Balm. Broken Bones are " cemented with the *Callus*, which themſelves " help to make. And ſo he goes on with ample Inſtances in this Matter, too many to be here ſpecified (6). Among which he inſtanceth in the Diſtempers of our Bodies, ſhewing that even many of them are highly ſerviceable to the Diſcharge of malignant Humours, and preventing greater Evils.

And no leſs kind than admirable is this Contrivance of Man's Body, that even it's Diſtempers ſhould many times be it's Cure (7), that when the

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own providing. But paſſing over many Particulars, I ſhall only give one Inſtance more, becauſe it may be a good Caution to ſome Perſons, that theſe Papers may probably fall into the hands of, and that is the danger of ſwallowing *Plum*, *Prune-ſtones*, &c. Sir *Francis Butler*'s Lady had many Prune-ſtones that made way through an Abſceſs near her Navel. *Philoſ. Tranſ.* No. 265. where are other ſuch like Examples. More alſo may be found in No. 282, 304, &c.

(6) *Grew's Coſmol.* §. 28, 29.

(7) *Nor are Diſeaſes themſelves uſeleſs. For the Blood in a Feaver, if well governed, like Wine upon the fret, diſchargeth*

it

the Enemy lies lurking within to destroy us, there should be such a reluctancy, and all Nature excited with it's utmost Vigour to expel him thence. To which purpose, even Pain it self is of great and excellent Use, not only in giving us Notice of the Presence of the Enemy, but by exciting us to use our utmost Diligence and Skill to root out so troublesome and destructive a Companion.

CHAP. VIII.

Of the CONSENT *between the* PARTS *of Man's Body.*

IT is an admirable Provision the merciful Creator hath made for the good of Man's Body, by

it self of all heterogeneous Mixtures: and Nature, the Disease, and Remedies clean all the rooms of the House; whereby that which threatens Death, tends, in conclusion, to the prolonging of Life. Grew ubi sup. §. 52.

And as Diseases minister sometimes to Health, so to other good Uses in the Body, such as quickning the Senses: of which take these Instances relating to the Hearing and Sight. *A very ingenious Physician falling into an odd kind of Feaver, had his sense of Hearing thereby made so very nice and tender, that he very plainly heard soft Whispers, that were made at a considerable distance off, and which were not in the least perceived by the By-standers, nor would have been by him before his Sickness.*

A Gentleman of eminent Parts and Note, during a Distemper he had in his Eyes, had his Organs of Sight brought to be so tender, that both his Friends and himself have assured me, that when he waked in the Night, he could for a while plainly see and distinguish Colours, as well as other Objects, discernable by the Eye, as was more than once tryed. Boyl deter. nat. of Effluv. ch. 4.

Daniel Fraser —— *continued Deaf and Dumb from his Birth, till the* 17*th Year of his Age.* —— *After his recovery from a Feaver, he perceived a Motion in his Brain, which was very uneasy to him; and afterwards he began to hear, and in process of time, to understand Speech,* &c. Vid. Philos. Trans. No. 312.

(i)

by the Harmony between the Parts thereof. Of which let us take St. *Paul*'s Deſcription in 1. *Cor.* 12. 8. *But now hath God ſet the Members every one of them in the body, as it hath pleaſed him.* And (v. 21.) *the Eye cannot ſay unto the Hand I have no need of thee: nor again, the Head to the Feet, I have no need of you.* But ſuch is the conſent of all the Parts, or as the Apoſtle wordeth it, *God hath ſo tempered the Body together, that the Members ſhould have the ſame Care one for another*, v. 25. So that *whether one Member ſuffer, all the Members ſuffer with it: or one Member be honoured*, (or affected with any Good) *all the Members rejoyce* [and ſympathize] *with it*; v. 26.

This mutual Accord, Conſent and Sympathy of the Members, there is no Reaſon to doubt (1), is made by the Commerce of the Nerves (2), and their artificial Poſitions, and curious Ramifications throughout the whole Body, which is admirable and incomparable, and might deſerve a place in this Survey, as greatly and manifeſtly ſetting forth the Wiſdom and Benignity of the great Creator: but that to give a Deſcription thereof from the Origin of the Nerves in the *Brain*, the *Cerebellum*, and *Spine*, and ſo through every Part of the Body, would be tedious, and in-

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(1) See Book 4. Ch. 8.

(2) *Tria propoſita ipſi Naturæ in Nervorum diſtributione fuerunt.* 1. *Ut Senſoriis inſtrumentis Senſum impertiret.* 2. *Ut motoriis Motum:* 3. *Ut omnibus aliis* [partibus] *daret, ut quæ ſi dolorem adferrent, dignoſcerent.* And afterwards, *Si quis in diſſectionibus ſpectavit, conſideravitque juſtene, an ſecus Natura Nervos non eadem menſura omnibus partibus diſtribuerit, ſed aliis quidem liberalius, aliis vero parcius, eadem cum Hippocrate, velit nolit, de Natura omnino pronunciabit, quod ea ſcilicet ſagax, juſta, artificioſa, animaliumque provida eſt.* Galen. de uſ. part. L. 5. c. 9.

(3)

intrench too much upon the Anatomist's Province: and therefore one Instance shall suffice for a Sample of the whole; and that shall be (what was promised before (3) the great Sympathy occasioned by the *Fifth Pair* of Nerves, which I chuse to instance in, rather than the *Par vagum*, or any other of the Nerves; because although we may have less Variety of noble Contrivance and Art than in that Pair, yet we shall find enough for our Purpose, and which may be dispatched in fewer Words. Now this *Fifth Conjugation* of *Nerves* is branched to the Ball, the Muscles and Glands of the Eye; to the Ear; to the Jaws, the Gums, and Teeth; to the Muscles of the Lips (4); to the Tonsils, the Palate, the Tongue, and the parts of the Mouth; to the *Præcordia* also, in some Measure, by inosculating with one of it's Nerves; and lastly, to the Muscles of the Face, particularly the Cheeks, whose sanguiferous Vessels it twists about.

From hence it comes to pass that there is a great Consent and Sympathy (5) between these Parts; so that a Gustable thing seen or smelt, excites the Appetite, and affects the Glands and Parts of the Mouth; that a thing seen or heard, that

(3) Book 4. Ch. 5.

(4) Dr. *Willis* gives the reason *cur mutua Amasiorum oscula labiis impressa, tum præcordia, tum genitalia afficiendo, amorem ac libidinem tam facile irritant*, to be from the consent of those Parts, by the Branches of this 5th Pair. *Nerv. Descr.* c. 22.

And Dr. *Sachs* judges it to be from the consent of the *Labia Oris cum Labiis Uteri*, that in *April*, 1669, a certain breeding Lady, being affrighted with seeing one that had scabby Lips, which they told her were occasioned by a Pestilential Fever, had such like Pustules brake out in the *Labia Uteri*. Ephem. Germ. T. 1. Obs. 20.

(5) Consult *Willis ubi supra*.

(6)

that is ſhameful, affects the Cheeks with modeſt Bluſhes; but on the contrary, if it pleaſes and tickles the Phancy, that it affects the *Præcordia* and Muſcles of the Mouth and Face with Laughter; but a thing cauſing Sadneſs and Melancholy, doth accordingly exert itſelf upon the *Præcordia*, and demonſtrate itſelf by cauſing the Glands of the Eyes to emit Tears (6), and the Muſcles of the Face to put on the ſorrowful Aſpect of Crying. Hence alſo that torvous ſour Look produced by Anger and Hatred: and that gay and pleaſing Countenance accompanying Love and Hope. And in ſhort, it is by means of this Communication of the Nerves, that whatever affects the Soul, is demonſtrated (whether we will or no) by a Conſentaneous Diſpoſition of the *Præcordia* within, and ſuitable Configuration of the Muſcles and Parts of the Face without. By which means (as *Pliny* ſaith) (7) "the Face in Man alone is the "Index of Sorrow or Joy, of Pity or Severity. "In it's aſcending Part, the Brow, is a part of "the Mind ſeated. Therewith we deny, there-"with we aſſent, therewith we ſhew Diſdain "and Pride. Pride hath (ſaith he) "its Con-"ception, it's Riſe in another place; but here "it's Seat. In the Heart it is born and begun, "but here it abides and dwells; and that becauſe, "ſaith he, it could find no other part of the "Body higher or more craggy (8) where it "might reſide alone. Thus

(6) Tears ſerve not only to moiſten the Eye, to clean and brighten the *Cornea*, and to expreſs our Grief; but alſo to alleviate it, according to that of *Ulyſſes* to *Andromache*, in *Seneca's Troas*, v. 762.

Tempus moramque dabimus; arbitrio tuo
Implere lachrymis: Fletus ærumnas levat.

(7) Plin. Nat. Hiſt. L. 11. c. 37.

(8) *Nihil altius ſimul abruptiuſque invenit.*

Thus I have dispatched what I shall remark concerning the Soul and Body of Man. There are divers other things which well deserve a place in this Survey; and these that I have taken notice of deserved to have been enlarged upon: But what hath been said, may suffice for a taste and sample of this admirable Piece of God's Handy-work; at least serve as a Supplement to what others have said before me. For which reason I have endeavoured to say as little wittingly as I could of what they have taken notice of, except where the Thread of my Discourse laid a necessity upon me.

CHAP. IX.

Of the Variety of Men's FACES, VOICES, *and* HAND-WRITING.

HEre I would have put an End to my Observations relating to Man; but that there are three things so expresly declaring the divine Management and Concurrence, that I shall just mention them, although taken notice of more amply by others; and that is, the great Variety throughout the World of Men's Faces (1), Voices (2), and Hand-writing. Had Man's Body been

(1) If the Reader hath a mind to see Examples of Men's likeness, he may consult *Valer. Maximus*, (L. 9. c. 14.) concerning the Likeness of *Pompey* the Great, and *Vibius* and *Publicius Libertinus*; as also of *Pompey* the Father, who got the Name of *Coquus*, he being like *Menogenes* the Cook; with divers others.

(2) As the difference of Tone makes a difference between every Man's Voice, of the same Country, yea Family; So

been made according to any of the Atheiſtical Schemes, or any other Method than that of the infinite Lord of the World, this wiſe Variety would never have been: but Men's Faces would have been caſt in the ſame, or not a very different Mould, their Organs of Speech would have ſounded the ſame or not ſo great a Variety of Notes; and the ſame Structure of Muſcles and Nerves would have given the Hand the ſame Direction in Writing. And in this Caſe, what Confuſion, what Diſturbance, what Miſchiefs would the World eternally have lain under? No Security could have been to our Perſons; no Certainty, no Enjoyment of our Poſſeſſions (3); no Juſtice between Man and Man; no Diſtinction between Good and Bad, between Friends and Foes, between Father and Child, Husband and Wife, Male

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a different Dialect and Pronunciation, differs Perſons of divers Countries; yea Perſons of one and the ſame Country, ſpeaking the ſame Language. Thus in *Greece*, there were the *Ionick*, *Dorick*, *Attick*, and *Æolick* Dialects: So in *Great-Britain*, beſides the grand diverſity of *Engliſh* and *Scotch*, the different Counties vary much in their Pronunciation, Accent and Tone, although all one and the ſame Language. And the way of the *Gileadites* proving the *Ephraimites*, Judg. 12. 6. by the pronunciation of *Shibboleth*, with a *Schin*, or *Sibboleth* with a *Samech*, is well known. So *a Lapide* ſaith, the *Flemings* prove whether a Man be a *Frenchman* or not, by bidding him pronounce, *Acht en tachtentich*; which they pronounce, *Act en tactentic*, by reaſon they can't pronounce the Aſpirate *ch*.

(3) *Regi Antiocho unus ex æqualibus* —— *nomine Artemon, perquam ſimilis fuiſſe traditur. Quem Laodice, uxor Antiochi, interfecto viro, diſſimulandi ſceleris gratia in lectulo perinde quaſi ipſum Regem ægrum collocavit. Admiſſumq; univerſum populum, & ſermone ejus & vultu conſimili fefellit: crediderunteque homines ab Antiocho moriente Laodicem & natos ejus ſibi commendari.* Valer. Max. ib.

Male or Female; but all would have been turned topsey turvey, by being exposed to the Malice of the Envious and ill Natured, to the Fraud and Violence of Knaves and Robbers, to the Forgeries of the crafty Cheat, to the Lusts of the Effeminate and Debauched, and what not! Our Courts of Justice (4) can abundantly testify the dire Effects of mistaking Men's Faces, of counterfeiting their Hands, and forging Writings. But now as the infinitely wise Creator and Ruler hath ordered the Matter, every Man's Face can distinguish him in the Light, and his Voice in the Dark; his Hand-writing can speak for him though absent, and be his Witness, and secure his Contracts in future Generations. A manifest as well as admirable Indication of the divine Super-intendence and Management (5).

CHAP.

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(4) *Quid Trebellius Calca! quam asseveranter sese Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium adeo favorabilis descendit, ut vix justis & æquis sententiis consternatio populi ullum relinqueret locum. In illa tamen quæstione neque calumniæ petitoris, neque violentiæ plebis judicantium religio cessit.* Val. Max. ib. c. 15.

(5) To the foregoing Instances of Divine Management, with relation to the Political State of Man, I shall add another thing, that I confess hath always seemed to me somewhat odd, but very providential, and that is, the value that Mankind, at least the civilized part of them, have in all Ages put upon Gems, and the purer finer Metals, Gold and Silver; so as to think them equivalent unto, and exchange them for things of the greatest use for Food, Cloathing, and all other Necessaries and Conveniences of Life. Whereas those things themselves are of very little, if any use in Physick, Food, Building, or Cloathing, otherwise than for Ornament, or to minister to Luxury; as *Suetonius* tells us of *Nero*, who fished with a Net gilt with Gold, and shod his Mules with Silver; but his Wife *Poppæa*, shod her Horses with Gold, *Vit. Ner.* c. 30. Plin. N. H. L. 33. c. 11. So the same *Suetonius* tells us, *Jul. Cæsar* lay in a Bed of Gold,

Gold, and rode in a Silver Chariot. But *Heliogabalus* rode in one of Gold, and had his Close-stool Pans of the same Metal. And *Pliny* saith, *Vasa Coquinaria ex argento Calvus Orator fieri queritur*, Ibid. Neither are those precious Things of greater use to the making of Vessels, and Utensils, unless some little Niceties and Curiosities, by means of their Beauty, Imperdibility, and Ductility. Of which last, the great Mr. *Boyl* hath among others, these two Instances in his *Essay about the Subtilty of Effluviums*, ch. 2. *Silver, whose Ductility and Tractility are very much inferior to those of Gold, was, by my procuring, drawn out to so slender a Wire, that —— a single grain of it amounted to* 27 *feet*. As to Gold, he demonstrates it possible to extend an Ounce thereof, to reach to 777600 Feet, or 155½ Mile, yea to an incredibly greater length.

And as to Gems, the very Stories that are told of their prodigious Vertues, are an Argument, that they have very little, or none more than other hard Stones. That a *Diamond* should discover whether a Woman be true or false to her Husband's Bed; cause Love between Man and Wife: secure against Witchcraft, Plague, and Poisons; that the *Ruby* should dispose to Cheerfulness, cause pleasant Dreams, change its Colour against a Misfortune befalling, &c. that the *Saphire* should grow foul, and lose its Beauty when worn by one that is Leacherous; that the *Emerald* should fly to pieces, if it touch the Skin of any unchaste Person in the Act of Uncleanness: that the *Chrysolite* should lose its Colour if Poyson be on the Table, and recover it again when the Poyson is off: and to name no more, that the *Turcoise* (and the same is said of a Gold Ring) should strike the Hour when hung over a drinking Glass, and much more to the same purpose: all these, and many other such fabulous Stories, I say, of Gems, are no great Arguments, that their Vertue is equivalent to their Value. Of these and other Vertues, consult *Worm* in his *Musæum*, L. 1. §. 2. c. 17, &c.

But as to *Gems* changing their Colour, there may be somewhat of Truth in that, particularly in the *Turcoise* last mentioned. Mr. *Boyl* observed the Spots in a *Turcoise*, to shift their Place from one part to another, by gentle degrees. So did the Cloud in an *Agate*-handle of a Knife. A *Diamond* he wore on his Finger, he observed to be more illustrious at some times than others: which a curious Lady told him she had also observed in hers. So likewise a rich *Ruby* did the same. *Boyl of Absol. Rest in Bodies.*

CHAP. X.

The CONCLUSION *of the* SURVEY *of Man.*

AND now having taken a View of *Man* and finding every Part of him, every thing relating to him contrived and made in the very beſt manner; his Body fitted up with the utmoſt Foreſight, Art, and Care; and this Body (to the great Honour Priviledge, and Benefit of Man) poſſeſſed by a divine Part, the *Soul*, a Subſtance made as 'twere on purpoſe to contemplate the Works of God, and glorify the great Creator; and ſince this Soul can diſcern, think, reaſon, and ſpeak; what can we conclude upon the whole matter, but that we lie under all the Obligations of Duty and Gratitude to be thankful and obedient to, and to ſet forth the Glories of our great Creator, and noble Benefactor? And what ungrateful Wretches are we, how much worſe than the poor Irrationals, if we do not employ the utmoſt Power of our Tongue, and all our Members, and all the Faculties of our Souls in the Praiſes of God! But above all, ſhould we who have the Benefit of thoſe glorious Acts and Contrivances of the Creator, be ſuch wicked, ſuch baſe, ſuch worſe-than brutal Fools to deny the Creator (1) in ſome of his nobleſt Works? ſhould we

(1) It was a pious as well as juſt Concluſion, the ingenious *Laurence Bellini* makes of his *Opuſculum de Motu Cordis*, in theſe words. *De Motu Cordis iſthæc. Quæ equidem omnia, ſi a rudi intelligentia Hominis tantum conſilii, tantum ratiocinii, tantum peritiæ mille rerum, tantum ſcientiarum exigunt, ad hoc, ut inveniantur, ſeu ad hoc, ut percipiantur poſſ-*

we so abuse our Reason, yea our very Senses; should we be so besotted by the Devil, and blinded by our Lusts, as to attribute one of the best contrived Pieces of Workmanship to blind Chance, or unguided Matter and Motion, or any other such sottish, wretched, atheistical Stuff; which we never saw, nor ever heard made any one Being (2) in any Age since the Creation? No, No;

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postquam facta sunt; illum, cujus opera fabrefacta sunt hæc singula, tam vani erimus atque inanes, ut existimemus esse consilii impotem rationis expertem, imperitum, aut ignarum omnium rerum? Quantum ad me attinet, nolim esse Rationis compos, si tantum insudandum mihi esset ad consequendam intelligentiam earum rerum, quas fabrefaceret nescio quæ Vis, quæ nihil intelligeret eorum quæ fabrefaceret; mihi etenim viderer esse vile quidam, atque ridiculum, qui vellem totam ætatem meam, sanitatem, & quicquid humanum est deterere, nihil curare quicquid est jucunditatum, quicquid lætitiarum, quicquid commodorum; non divitias, non dignitates; non pœnas etiam, & vitam ipsam, ut gloriari possem postremo invenisse unum, aut alterum, & fortasse me invenisse quidem ex iis innumeris, quæ produxisset, nescio quis ille, qui sine labore, sine cura, nihil cogitans, nihil cognoscens, non unam aut alteram rem, neque dubie, sed certo produxisset innumeras innumerabilitates rerum in hoc tam immenso spatio corporum, ex quibus totus Mundus contingitur. Ah Deum immortalem! video præsens numen tuum in hisce tam prodigiosis Generationis initiis, & in altissima eorum contemplatione defixus, nescio quo æstro admirationis concitor, & quæsi divine furens cohibere me minime possum quin exclamem.

Magnus Dominus! Magnus Fabricator Hominum Deus! Magnus atque Admirabilis! Conditor rerum Deus quam Magnus es! Bellin. de Mot. Cord. fin.

(2) *Hoc* [i. e. mundum effici ornatissimum, & pulcherrimum ex concursione fortuitâ] *qui existimat fieri potuisse, non intelligo cur non idem putet, si innumerabiles unius, & viginti formæ literarum vel aureæ, vel qualibet, aliquo conjiciantur, posse ex his in terram excussis annales Ennii ut deinceps legi possint, effici, &c.* ——— *Quod si Mundum efficere potest concursus Atomorum, cur porticum, cur templum, cur domum, cur urbem non potest? quæ sunt minus operosa, & multo quidem faciliora.* Cicero de Nat. Deor. L. 2. c. 37.

No! But like wise and unprejudiced Men, let us with *David* say, Psal. 139. 14. (with which I conclude) *I will praise thee, for I am fearfully and wonderfully made, marvellous are thy Works: and that my Soul knoweth right well.* Having thus made what (considering the copiousness and excellence of the Subject) may be called a very brief Survey of *Man*, and seen such admirable Marks of the divine Design and Art; let us next take a transient View of the other, inferiour Creatures; and begin with QUADRUPEDS.

BOOK

BOOK VI.

A SURVEY of QUADRUPEDS.

CHAP. I.

Of their Prone POSTURE.

IN taking a View of this Part of the Animal World, ſo far as the Structure of their Bodies is conformable to that of Man, I ſhall paſs them by, and only take Notice of ſome Peculiarities in them, which are plain Indications of deſign, and the divine Super-intendence and Management. And 1. The moſt viſible apparent Variation is the *Prone Poſture of their Body*. Concerning which I ſhall take Notice only of two things, the Parts miniſtring thereto; and the Uſe and Benefit thereof.

1. As for the Parts, 'tis obſervable that in all theſe Creatures the *Legs* are made exactly conformable to this Poſture, as thoſe in Man are to his erect Poſture: and what is farther obſervable alſo is than the Legs and Feet are always admirably ſuited to the Motion and Exerciſes of each Animal: in ſome they are made for Strength only, to ſupport a vaſt unweildy Body (1); in others they

(1) The Elephant being a Creature of prodigious Weight, the largeſt of all Animals, *Pliny* ſaith, hath its Legs accordingly made of an immenſe Strength, like Pillars, rather than Legs.

they are made for Agility and Swiftneſs (2), in ſome they are made for only Walking and Running, in others for that, and Swimming too (3); in others for Walking and Digging (4); and in others for Walking and Flying (5): in ſome they are made more lax and weak, for the plainer Lands; in others rigid, ſtiff, and leſs flexible (6) for

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(2) Deer, Hares, and other Creatures, remarkable for Swiftneſs, have their Legs accordingly ſlender, but withal ſtrong, and every way adapted to their Swiftneſs.

(3) Thus the Feet of the *Otter* are made, the Toes being all conjoyned with Membranes, as the Feet of Geeſe and Ducks are. And in Swimming, it is obſervable, that when the Foot goes forward in the Water, the Toes are cloſe; but when backward, they are ſpread out, whereby they more forcibly ſtrike the Water, and drive themſelves forward. The ſame may be obſerved alſo in Ducks and Geeſe, &c.

Of the *Caſtor* or *Beaver*, the French Academiſts ſay, *The Structure of the Feet was very extraordinary, and ſufficiently demonſtrated, that Nature hath deſigned this Animal to live in the Water, as well as upon Land. For although it had four Feet, like terreſtrial Animals, yet the hindmoſt ſeemed more proper to ſwim than walk with, the five Toes of which they were compos'd, being joined together like thoſe of a Gooſe, by a Membrane, which ſerves this Animal to ſwim with. But the fore-ones were made otherwiſe; for there was no Membrane which held thoſe Toes joyned together: and this was requiſite for the conveniency of this Animal, which uſeth them as Hands like a Squirrel, when he eats.* Memoirs for a Nat. Hiſt. of Animals. pag. 84.

(4) The *Mole*'s Feet are a remarkable Inſtance.

(5) The Wings of the *Bat* are a prodigious deviation from Natures ordinary way. So 'tis in the *Virginian Squirrel*, whoſe Skin is extended between the Fore-Legs and its Body.

(6) Of the Legs of the *Elk*, the *French Academiſts* ſay, *Although ſome Authors report, that there are* Elks *in* Moſcovia, *whoſe Legs are jointleſs: there is great probability, that this Opinion is founded on what is reported of thoſe* Elks *of* Moſcovia, *as well as of* Cæſar's Alce, *and* Pliny's Machlis, *that they have Legs ſo ſtiff and inflexible, that they do run on*

(-) Ice

for traversing the Ice, and dangerous Precipices of the high Mountains (7), in some they are shod with tough and hard Hoofs, some whole, some cleft; in others with only a callous Skin. In which latter, 'tis observable that the Feet are composed of Toes, some short for bare going; some long to supply the Place of a Hand (8); some armed with long and strong Talons, to catch, hold, and tear the Prey; some fenced only with short Nails, to confirm the Steps in Running and Walking.

2. As the Posture of Man's Body is the fittest for a Rational Animal, so is the Prone Posture of Quadrupeds the most useful and beneficial to themselves, as also most serviceable to Man. For they are hereby better made for their gathering their Food, to pursue their Prey, to leap, to climb, to swim, to guard themselves against their Enemies, and in a Word, to do whatever may be of principal use to themselves; as also they are hereby rendered more useful and serviceable to Man, for carrying his Burdens, for tilling his Ground, yea even for his Sports and Diversions.

Ice without slipping; which is a way that is reported that they have to save themselves from the Wolves, &c. ibid. p. 108.

(7) The common tame *Goat* (whose Habitation is generally Mountains and Rocks, and who delighteth to walk on the tops of Pales, Houses, &c. and to take great and seemingly dangerous Leaps) I have observ'd, hath the Joynts of the Legs very stiff and strong, the Hoof hollow underneath, and its Edges sharp. The like I doubt not is to be found in the *Wild Goat*, considering what Dr. *Scheuchzer* hath said of its climbing the most dangerous Craggs of the *Alps*, and the manner of their hunting it. *vid. Iter Alpin.* 3. p. 9.

(8) Thus in *Apes* and *Monkeys*, in the *Beaver* before, and divers others.

(9)

And now I might here add a Survey of the excellent Contrivances of the Parts miniſtring to this Poſture of the Four-footed Animals, the admirable Structure of the Bones (9), the Joynts and Muſcles; their various Sizes and Strength; their commodious Lodgment and Situation, the nice Æquipoiſe of the Body, with a great deal more to the ſame Purpoſe. But I ſhould be tedious to inſiſt minutely upon ſuch Particulars, and beſides I have given a Touch upon theſe kinds of things, when I ſpake of Man.

Paſſing by therefore many things of this Kind, that might deſerve Remark, I ſhall only conſider ſome of the Parts of Quadrupeds, differing from what is found in Man (10), and which are manifeſt Works of Deſign.

CHAP. II.

Of the HEADS *of Quadrupeds.*

IT is remarkable that in Man the Head is of one ſingular Form: in the Four-footed Race,

(9) It is a ſingular Proviſion Nature hath made for the ſtrength of the Lion, if that be true which *Galen* ſaith is reported of its Bones being not hollow, as in other Animals, but ſolid. Which report he thus far confirms, that moſt of the Bones are ſo; and that thoſe in the Legs, and ſome other parts, have only a ſmall and obſcure Cavity in them. Vid. *Galen. de Uſ. Part.* L. 11. c. 18.

(10) *Theſe ſorts of Differences in the Mechaniſm of Animals, upon the ſcore of the Poſition of their Bodies, occur ſo often, that it would be no mean Service to Anatomy;* ——— *if any one would give us a Hiſtory of thoſe Variations of the parts of Animals, which ſpring from the different Poſtures of their Bodies.* Drake Anat. V. 1. B. 1. c. 17.

(1)

Race, as various as their Species. In ſome ſquare and large, ſuitable to their ſlow Motion, Food, and Abode; in other leſs, ſlender, and ſharp, agreeable to their ſwifter Motion, or to make their Way to their Food (1), or Habitation under Ground (2). But paſſing by a great many Obſervations that might be made of this Kind, I ſhall ſtop a little at the Brain, as the moſt conſiderable Part of this Part of the Body, being the great Inſtrument of Life and Motion in Quadrupeds as 'tis in Man of that, as alſo in all probability the chief Seat of his immortal Soul. And accordingly it is a remarkable Difference, that in Man, the Brain is large, affording Subſtance and Room for ſo noble a Gueſt; whereas in Quadrupeds, it is but ſmall. And another thing no leſs remarkable is the Situation of the *Cerebrum* and *Cerebellum*, or the greater or leſſer Brain, which I ſhall give in the Words of one of the moſt exact Anatomiſts we have of that Part (3): "Since, ſaith he, God hath given to Man "a lofty Countenance, to behold the Heavens, "and hath alſo ſeated an immortal Soul in the "Brain, capable of the Contemplation of heavenly "things;

(1) Thus *Swine*, for Inſtance, who dig in the Earth for Roots and other Food, have their Neck, and all parts of their Head very well adapted to that Service. Their Neck ſhort, brawny, and ſtrong; their Eyes ſet pretty high out of the way; their Snout long; their Noſe callous and ſtrong; and their Senſe of Smelling very accurate, to hunt out and diſtinguiſh their Food in Mud, under ground, and other the like Places where it lies concealed.

(2) What hath been ſaid of *Swine* is no leſs, rather more, remarkable in the *Mole*, whoſe Neck, Noſe, Eyes, and Ears, are all fitted in the niceſt manner to its ſubterraneous way of Life.

(3) *Willis Cerebr. Anat.* cap. 6. *Cumque huic Deus os ſublime dederit*, &c.

(4)

" things; therefore as his Face is erect, so the " Brain is set in an higher Place, namely above " the *Cerebellum* and all the Senſories. But in " Brutes, whoſe Face is prone towards the Earth, " and whoſe Brain is incapable of Speculation, " the *Cerebellum*, (whoſe Buſineſs it is to mi- " niſter to the Actions and Functions of the " *Præcordia*, the principal Office in thoſe Crea- " tures) in them is ſituated in the higher Place, " and the *Cerebrum* lower. Alſo ſome of the Or- " gans of Senſe, as the Ears and Eyes, are pla- " ced, if not above the *Cerebrum*, yet at leaſt " equal thereto.

Another Convenience in this Poſition of the *Cerebrum* and *Cerebellum*, the laſt ingenious Anatomiſt (4) tells us is this, " In the Head of Man, " ſaith he, the Baſe of the *Brain* and *Cerebell*, yea " of the whole Skull, is ſet parallel to the Horizon, " by which means there is the leſs Danger of the " two Brains jogling, or ſlipping out of their " place. But in Quadrupeds, whoſe Head hangs " down, the Baſe of the Skull makes a right An- " gle with the Horizon, by which means the " Brain is undermoſt, and the Cerebell upper- " moſt; ſo that one would be apt to imagine the " Cerebell ſhould not be ſteady, but joggle out " of it's Place. To remedy which Inconveni- ence (he tells us) " and leaſt the frequent Con- " cuſſions of the *Cerebell* ſhould cauſe a fainting, " or diſorderly Motion of the Spirits about the " *Præcordia*, therefore by the Artifice of Nature, " ſufficient Proviſion is made in all, by the " *dura Meninx* cloſely encompaſſing the *Cerebel-* " *lum*; beſides which, it is (in ſome) guarded with

(4) Il. paulo poſt. *In capite humano Cerebri & Cerebelli &c.*

(5)

" with a ſtrong bony Fence; and in others, as " the Hare, the Coney, and ſuch leſſer Quadru- " peds, a Part of the Cerebell is on each ſide " fenced with the *Os petroſum*: So that by this " double Stay, it's whole Maſs is firmly contain- " ed within the Skull.

Beſides theſe Peculiarities, I might take Notice of divers other things no leſs remarkable, as the *Nictitating Membrane* of the Eye (5), the different Paſſages of the *Carotid Arteries* (6) through the Skull, their Branching into the *Rete Mirabile* (7), the

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(5) See Book 4. Ch. 2. Note 33.

(6) *Arteria Carotis aliquanto poſterius in homine quam in alio quovis animali Calvariam ingreditur, ſi juxta illud foramen, per quod ſinus lateralis in Venam jugularem deſiturus cranio elabitur; nam in cæteris hæc arteria ſub extremitate, ſeu proceſſu acuto oſſis petroſi, inter cranium emergit: verum in capite humano, eadem, ambage longiori circumducta (ut ſanguinis torrens, priuſquam ad cerebri oram appellit, fracto impetu, lenius & placidius fluat) prope ſpecum ab ingreſſu ſinus lateralis factum, Calvariæ baſin attingit; —— & in majorem cautelam, tunica inſuper aſcititia craſſiore inveſtitur.* And ſo he goes on to ſhew the Conveniency of this Guard the Artery hath, and its paſſage to the Brain, and then ſaith, *Si hujuſmodi conformationis ratio inquiritur, facile occurrit, in capite humano, ubi generoſi affectus, & magni animorum impetus ac ardores excitantur, ſanguinis in Cerebri oras appulſum debere eſſe liberum & expeditum*, &c. *Atque hoc quidem reſpectu differt Homo a pleriſque Brutis, quibus Arteria in mille ſurculos diviſa, ne ſanguinem pleniore alveo, aut citatiore, quam par eſt, curſu, ad cerebrum evehat, Plexus Retiformes conſtituit, quibus nempe efficitur, ut ſanguis tardi admodum, lenique & æquabili fere ſtellicidio, in cerebrum illabatur.* And then he goes on to give a farther Account of this *Artery*, and the *Rete mirabile* in divers Creatures. *Willis* ibid. cap. 8.

(7) *Galen* thinks the *Rete mirabile* is for concocting and elaborating the Animal Spirits, as the *Epididymides*, [the Convolutions κρσσοειδῆς ἕλικος] are for elaborating the Seed. *De Uſ. Part.* L. 9. c. 4. This *Rete* is much more conſpicuous in Beaſts than Man; and as Dr. *Willis* well judges, ſerves: 1. To bridle the too rapid incurſion of the Blood into

the different magnitude of the *Nates*, and ſome other Parts of the Brain in Beaſts, quite different from what it is in Man: but the Touches already given, may be Inſtances ſufficient to prevent my being tedious in inlarging upon theſe admirable Works of God.

CHAP. III.

Of the NECKS *of Quadrupeds.*

FROM the Head paſs we to the Neck, no principal Part of the Body, but yet a good Inſtance of the Creator's Wiſdom and Deſign, inaſmuch as in Man it is ſhort, agreeable to the Erection of his Body; but in the Four-footed Tribe it is long, anſwerable to the Length of the Legs (1); and in ſome of theſe long, and leſs ſtrong,

into the Brain of thoſe Creatures, whoſe Heads hang down much. 2. To ſeparate ſome of the ſuperfluous ſerous parts of the Blood, and ſend them to the Salival Glands, before the Blood enters the Brain of thoſe Animals, whoſe Blood is naturally of a watery Conſtitution. 3. To obviate any Obſtructions that may happen in the Arteries, by giving a free Paſſage through other Veſſels, when ſome are ſtopped.

In Quadrupeds, as the *Carotid Arteries* are branched into the *Rete mirabile*, for the bridling the too rapid Current of the Blood into the Brain; ſo the *Vertebral Arteries* are, near their entrance into the Skull, bent into an acuter Angle than in Man, which is a wiſe Proviſion for the ſame Purpoſe.

(1) It is very remarkable, that in all the Species of Quadrupeds, this Equality holds, except only the Elephant; and that there ſhould be a ſufficient ſpecial Proviſion made for that Creature, by its *Proboſcis* or *Trunk*. A Member ſo admirably contrived, ſo curiouſly wrought, and with ſo great Agility and Readineſs, applied by that unweildly Creature

ſtrong, ſerving to carry the Mouth to the ground; in others ſhorter, brawny and ſtrong, ſerving to dig, and heave up great Burdens (2).

But that which deſerves eſpecial Remark, is that peculiar Proviſion made in the Necks of all, or moſt granivorous Quadrupeds, for the perpetual holding down their Head in gathering their Food, by that ſtrong tendinous and inſenſible *Aponeuroſis*, or Ligament (3) braced from the Head to the middle of the Back. By which means the Head although heavy, may be long held down without any Labour, Pain, or Uneaſineſs to the Muſcles of the Neck, that would otherwiſe be wearied by being ſo long put upon the Stretch.

CHAP.

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ture to all its ſeveral Occaſions, that I take it to be a manifeſt Inſtance of the Creator's Workmanſhip; ſee its Anatomy in Dr. *A. Moulens's Anat. of the Elephant*, p. 33. As alſo in Mr. *Blair's* Account in *Phil. Tranſ.* No. 326.

Aliorum ea eſt humilitas ut cibum terreſtrem voſtris facile contingant. Quæ autem altiora ſunt, ut Anſeres, ut Cygni, ut Grues, ut Cameli, adjuvantur proceritate collorum. Manus etiam data Elephantis, quia propter magnitudinem corporis difficiles aditus habebant ad paſtum. Cic. de N. D. L. 2.

Quod iis animalibus quæ pedes habent fiſſos in digitos, Collum brevius ſit factum, quam ut per ipſum Cibum ori admovere queant: iis vero quæ ungulas habent ſolidas, aut bifidas, longius, ut prona atque inclinantia paſci queant. Qui id etiam opus non ſit Artificis utilitatis memoris? Ad hæc quod Grues ac Ciconiæ, cum crura haberent longiora, ob eam cauſam Roſtrum etiam magnum, & Collum longius habuerint. Piſces autem neque Collum penitus habuere, utpote qui neque Crura habent. Quo pacto non id etiam eſt admirandum? Galen. de Uſ. part. L. 11. c. 8.

(2) As in Moles and Swine, in Ch. 2. Note 1.

(3) Called the *Whiteleather*, *Packwax*, *Taxwax*, and *Fixfax*.

CHAP. IV.

Of the STOMACHS *of Quadrupeds.*

FROM the Neck, let us deſcend to the *Stomach*; a part, as of abſolute Neceſſity to the Being, and Well-being of Animals, ſo is in the ſeveral Species of Quadrupeds ſized, contrived, and made with the utmoſt Variety, and Art (1). What Artiſt, what Being, but the infinite Conſervator of the World, could ſo well adapt every Food to all the ſeveral Kinds of thoſe grand Devourers of it! Who could ſo well ſuit their Stomachs to the Reception and Digeſtion thereof; one kind of Stomach to the Carnivorous, another to the Herbaceous Animals; one fitted to digeſt by bare Maſtication; and a whole ſet of Stomachs in others to digeſt with the Help of *Rumination*! Which laſt Act, together with the Apparatus for that Service, is ſo peculiar, and withal ſo curious an Artifice of Nature, that it might juſtly deſerve a more particular Enquiry: but having formerly mentioned it (2), and leſt I ſhould be too tedious, I ſhall paſs it by. CHAP.

(1) The peculiar contrivance and make of the *Dromedaries*, or *Camel's* Stomach, is very remarkable, which I will give from the *Pariſian Anatomiſts: At the top of the ſecond* [of the 4 Ventricles] *there were ſeveral ſquare Holes, which were the Orifices of about* 30 *Cavities, made like Sacks placed between the two Membranes, which do compoſe the Subſtance of this Ventricle. The view of theſe Sacks made us to think, that they might well be the Reſervatories where* Pliny *ſaith that Camels do a long time keep the Water, which they drink in great abundance* —— *to ſupply the wants thereof in the dry Deſarts*, &c. vid. Memoirs, &c. Anat. of Dromedary, p. 39. See alſo *Peyer Merycol.* L. 2. c. 3.

(4) Book 4. ch. 11.

CHAP. V.

Of the HEART *of Quadrupeds.*

IN this Part there is a notable Difference found between the Heart of Man and that of Beasts. Concerning the latter of which I might take notice of the remarkable Conformation of the Hearts of Amphibious Quadrupeds, and their difference from those of Land-Animals, some having but one Ventricle (1), some three (2), and some but two (like Land-Animals) but then the *Foramen ovale* therewith (3). All which may be justly esteemed as wonderful, as they are excellent Provisions for the manner of those Animals living. But I shall content my self with bare Hints

(1) *Frogs* are generally thought to have but one Ventricle in their Hearts.

(2) The *Tortoise* hath 3 Ventricles, as the *Parisian Academists* in their *Memoirs* affirm. *Besides these 2 Ventricles* [before spoken of] *which were in the hinder part of the Heart which faceth the Spine, there was*, say they, *a third in the fore-part, inclining a little towards the right side*, &c. Memoirs, *&c.* p. 259. But Mr. *Bussiere* charges this as a Mistake in those ingenious Gentlemen, and asserts there is but one Ventricle in the *Tortoise*'s Heart. See his Description of the Heart of the *Land-Tortoise*, in *Philos. Transact.* No. 328.

(3) The *Sea-Calf* is said by the *French Academists*, to have this Provision, and their Account of it is this: *Its Heart was round and flat. Its Ventricles appeared very large, and its Auricles small.* —— *Underneath the great Aperture, through which the Trunk of the* Vena Cava, *conveyed the Blood into the right Ventricle of the Heart, there was another which penetrated into the* Arteria Venosa, *and from thence into the left Ventricle, and afterwards into the* Aorta. *This Hole, called the* Foramen Ovale *in the* Fœtus, *makes the* Anastomosis, *by the means of which, the Blood goes from the* Cava *into the* Aorta, *without passing through the Lungs.* French Anatomists, p. 124.

Hints of these things, and speak only of two peculiars more, and that but briefly.

One is the Situation of the Heart. Which in Beasts is near the middle of the whole Body; in Man nearer the Head (4). The Reason of which I shall give from one of the most curious Anatomists of that Part (5). "Seeing, saith he, the "Trajection and Distribution of the Blood de- "pends wholly on the Systole of the Heart, and "that it's Liquor is not driven of it's own Nature "so readily into the upper Parts as into Vessels "even with it, or downwards into those under it: "if the Situation of the Heart had been further "from the Head, it must needs either have been "made stronger to cast out it's Liquor with greater Force; or else the Head would want it's "due Proportion of Blood. But in Animals "that have a longer Neck, and which is extended towards their Food as it were, the Heart is "seated as far from the other Parts; and they "find no Inconvenience from it, because they "feed with their Head for the most part hanging "down; and so the Blood, as it hath farther to "go to their Head than in others, so it goes a "plainer and often a steep Way (6).

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(4) Τῶν τε Καρδίαν περὶ τὸ μέσον, πλὴν ἐν Ἀνθρώπῳ. Arist. Hist. An. L. 2. c. 17.

(5) Dr. *Lower de Corde*, c. 1.

(6) I might have mentioned another wise Provision from the same Author, which take in his own words; *In Vitulis & Equis, imo plerisque aliis animalibus majoribus, non solas propagines a Nervo sexti paris ut in Homine, sed etiam plurimas a Nervo intercostali, ubi recta cor transit, cor accedere, imo in parenchyma ejus dimitti: & hoc ideo a Natura quasi subsidium Brutis comparatum, ne capita quæ terram prona spectant, non satis facile aut copiose Spiritus Animales impertirent*, Blasii Anat. Animal. Par. 1. c. 4. ex Lowero de Corde.

(7)

The other peculiar Matter is the faſtning (I formerly mentioned) which the Cone of the *Pericardium* hath in Man to the *Diaphragm* (7), whereas in all Quadrupeds it is looſe. By which means the Motion of the *Midriff*, in that neceſſary Act of Reſpiration, is aſſiſted both in the upright Poſture of Man, as alſo in the prone Poſture of Quadrupeds (8), which would be hindered, or rendered more difficult, if the Caſe was otherwiſe: " which muſt needs be the Effect of Wiſdom and " Deſign, and that Man was intended by Nature " to walk erect, and not upon all four, as Qua- " drupeds do: to expreſs it in the Words of a great Judge in ſuch matters (9).

CHAP.

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(7) *Diaphragmatis circulo nerveo firmiter adhæret* [Pericardium] *quod Homini ſingulare: nam ab eo in Canibus & Simiis diſtat, item in aliis animalibus omnibus.* Bartholin. Anat. L. 2. c. 5.

(8) *Finalem cauſam quod attinet,——cum erectus ſit Hominis inceſſus atque figura, eoque facilius abdominis viſcera ſuo pondere deſcendant, minore Diaphragmatis nixu atque Syſtole ad Inſpirationem opus eſt: porro, cum in Exſpiratione pariter neceſſarium ſit Diaphragma relaxari,——cum capſula cordis omnino connectendum fuit in Homine, ne forte, quamdiu erectus incedit, ab Hepatis aliorumque viſcerum appenſorum pondere deorſum adeo deprimeretur, ut neque Pulmo ſatis concidere, neque Exſpiratio debito modo peragi potuerit. Quocirca in Quadrupedibus, ubi abdominis viſcera in ipſum Diaphragma incumbunt, ipſumque in pectoris cavitatem ſuo pondere impellunt, iſta partium accretio Exſpirationi quidem inutilis, Inſpirationi autem debitam Diaphragmatis tenſionem impediendo, prorſus incommoda fuiſſet.* Lower ib. p. 8.

(9) Dr. Tyſon's *Anat. of the Orang-Outang in* Ray's *Wiſd. of God*, p. 262.

CHAP. VI.

Of the Difference between Man and Quadrupeds in the NERVOUS *Kind.*

THere is only one Difference more between Man and Quadrupeds that I shall take Notice of, and that is the Nervous Kind: and because it would be tedious to insist upon many Particulars (1), I shall, for a Sample, insist chiefly upon one, and that is of Nature's prodigious Care for a due Communication and Correspondence between the Head and Heart of Man, more than what is in the four-footed Tribe. For this Purpose besides the Correspondence those Parts have by Means of the Nerves of the *Par vagum* (common both to Man and Beast) there is a farther and more special Communication and Correspondence occasioned by the Branches (2) of the *Intercostal Pair* sent from the *Cervical Plexus* to the Heart, and the *Præcordia* By which means the Heart and Brain of Man have a mutual and very inti-

(1) Amongst these I might name the site of the Nerves proceeding from the *Medulla Spinalis*, which Dr. *Lower* takes notice of; in Beasts, whose Spine is above the rest of the Body, the Nerves tend directly downwards; but in Man, it being erect, the Nerves spring out of the Spine, not at Right, but in Oblique Angles downwards, and pass also in the Body the same way, *ibid.* p. 16.

(2) *In plerisq; Brutis tantum hac via* (i.e. by the *Par vagum*) *& vix omnino per ullos Paris Intercostalis nervos, aditus ad cor aut Appendicem ejus patescit. Verum in Homine, Nervus Intercostalis, præter officia ejus in imo ventre huic cum cæteris animalibus communia, etiam ante pectoris claustra internuncii specialis loco est, qui Cerebri & Cordis sensa mutua ultra citraque refert.* Willis Nervos. descr. & usus. Cap. 26.

(3)

intimate Correſpondence, and Concern with each other, more than is in other Creatures; or as one of the moſt curious Anatomiſts and Obſervers of theſe things ſaith (3), "Brutes are as 'twere "Machines made with a ſimpler, and leſs ope-"roſe Apparatus, and endowed therefore with "only one and the ſame kind of Motion, or de-"termined to do the ſame thing: whereas in "Man, there is a great Variety of Motions and "Actions. For by the Commerce of the afore-ſaid *Cervical Plexus* (4), he ſaith, "The Con-"ceptions of the Brain preſently affect the Heart, "and agitate it's Veſſels and whole Appendage, "together with the *Diaphragm*. From whence "the Alteration in the Motion of the Blood, the "Pulſe and Reſpiration. So alſo on the contra-"ry, when any thing affects, or alters the "Heart, thoſe Impreſſions are not only retor-"ted to the Brain by the ſame Duct of the "Nerves, but alſo the Blood itſelf (it's Courſe "being once changed) flies to the Brain with a "different and unuſual Courſe, and there agita-"ting the animal Spirits with divers impulſes, "produceth various Conceptions and Thoughts "in the Mind. And he tells us, "that hence it "was that the ancient Divines and Philoſophers "too, made the Heart the Seat of Wiſdom; and "cer-

(3) Id ib. *Dum hanc utriuſque ſpeciei differentiam perpendo, ſuccurrit animo, Bruta eſſe velut machinas*, &c.

(4) That our great Man was not miſtaken, there is great Reaſon to imagine, from what he obſerved in diſſecting a *Fool*. Beſides the Brain being but ſmall, he ſaith, *Præcipua autem diſcriminis nota quam inter illius & viri cordati partes advertimus hæcce erat; nempe quod prædictus Nervi Intercoſtalis Plexus, quem Cerebri & Cordis internuncium & Hominis proprium diximus, in Stulto hoc valde exilis, & minori Nervorum ſatellitio ſtipatus fuerit.* Ibid.

" certainly (ſaith he) the Works of Wiſdom and " Virtue do very much depend upon this Com- " merce which is between the Heart and Brain: and ſo he goeth on with more to the ſame Purpoſe. Upon the Account of this *Intercoſtal Commerce* with the Heart being wanting in Brutes, there is another ſingularly careful and wiſe Proviſion the infinite Creator hath made in them, and that is, That by reaſon both the *Par vagum* and the *Intercoſtal* too, do not ſend their Branches to the Heart, and it's Appendage in Brutes, therefore, leſt their Heart ſhould want a due Proportion of Nervous Veſſels, the *Par vagum* ſends more Branches to Their Heart than to that of Man. This as it is a remarkable Difference between Rational and Irrational Creatures; ſo it is as remarkable an Argument of the Creator's Art and Care; who altho' he hath denied Brute-Animals Reaſon and the Nerves miniſtring thereto, yet hath another way ſupplied what is neceſſary to their Life and State. But let us hear the ſame great Author's Deſcant upon the Point (5); " In- " aſmuch, ſaith he, as Beaſts are void of Diſ- " cretion, and but little ſubject to various and " different Paſſions, therefore there was no need " that the Spirits that were to be conveyed from " the Brain to the *Præcordia*, ſhould paſs two diffe- " rent Ways, namely one for the Service of the " vital Functions, and another for the recipro- " cal Impreſſions of the Affections; but it was " ſufficient that all their Spirits, whatever uſe " they were deſigned for, ſhould be conveyed " one and the ſame Way.

Here

(5) Id. ib. cap. 29. *In quantum Beſtiæ prudentia carent, & variis diverſiſque paſſionibus*, &c.

(In

Here now in the *Nervous Kind* we have manifeſt Acts of the Creator's Deſign and Wiſdom, in this ſo manifeſt and diſtinct a Proviſion for Rational and Irrational Creatures; and that *Man* was evidently intended to be the one, as the *Genus* of *Quadrupeds* was the other.

CHAP. VII.

The CONCLUSION.

AND now 'tis time to pauſe a while, and reflect upon the whole. And as from the Conſiderations in the preceding Book, we have eſpecial Reaſon to be thankful to our infinitely merciful Maker for his no leſs kind than wonderful Contrivances of our Body; ſo we have Reaſon from this Brief View I have taken of this laſt Tribe of the Creation, to acknowledge and admire the ſame Creator's Work and Contrivances in them. For we have here a large Family of Animals, in every particular Reſpect, curiouſly contrived and made for that eſpecial Poſture, Place, Food, and Office or Buſineſs which they obtain in the World. So that if we conſider their own particular Happineſs and Good, or Man's Uſe and Service; or if we view them throughout, and conſider the Parts wherein they agree with Man, or thoſe eſpecially wherein they differ, we ſhall find all to be ſo far from being things fortuitous, undeſigned, or any way accidental, that every thing is done for the beſt; all wiſely contrived, and incomparably fitted up, and every way worthy of the great Creator. And he

that will ſhut his Eyes, and not ſee God (‖) in theſe his Works even of the poor Beaſts of the Earth, that will not ſay (as *Elihu* hath it, Job 35. 10, 11.) *Where is God my Maker, who teacheth us more than the Beaſts of the Earth, and maketh us wiſer than the Fowls of the Heaven*; of ſuch an one we may uſe the Pſalmiſt's Expreſſion, Pſal. 49. 12. That *he is like the Beaſts* (†) *that periſh.*

(‖) ——— *Deum namque ire per omnes*
Terraſque tractuſque Maris, Cœlumque profundum.
Hinc Pecudes, Armenta, Viros, genus omne Ferarum.
Virgil Georg. L. 4.

(†) *Illos qui nullum omnino Deum eſſe dixerunt, non modo non Philoſophos, ſed ne homines quidem fuiſſe dixerim; qui, mutis ſimillimi, ex ſolo corpore conſtiterunt, nihil videntes animo,* Lactant. L. 7. c. 9.

BOOK

BOOK VII.

A SURVEY *of* BIRDS.

HAVING as briefly as well I could diſpatched the Tribe of *Quadrupeds*, I ſhall next take as brief and tranſient a View of the *Feather'd Tribe*.

And here we have another large Province to expatiate in, if we ſhould deſcend to every thing wherein the Workmanſhip of the Almighty appears. But I muſt contract my Survey as much as may be, and ſhall therefore give only ſuch Hints and Touches upon this curious Family of Animals, as may ſerve for Samples of the reſt of what might be obſerved.

CHAP. I.

Of the MOTION *of Birds, and the* PARTS *miniſtring thereto.*

AS this Tribe hath a different Motion from that of other Animals, and an Amphibious way of Life, partly in the Air, and partly on the Land and Waters, ſo is their Body accordingly ſhaped, and all their Parts incomparably fitted for that way of Life and Motion; as will be found by a curſory View of ſome of the Particulars. And the

1. And moſt viſible thing, is the Shape and Make of their Body, not thick and clumſie, but incom-

incomparably adapted to their Flight: ſharp before, to pierce, and make Way through the Air, and then by gentle Degrees riſing to it's full Bulk. To which we may add

2. The neat Poſition of the *Feathers* throughout the Body; not ruffled, or diſcompoſed, or placed ſome this, ſome a contrary Way, according to the Method of Chance; but all artificially placed (1) for facilitating the Motion of the Body, and it's Security at the ſame time by Way of Cloathing: and for that End, moſt of the Feathers tend backward, and are laid over one another in exact regular Method, armed with warm and ſoft Down next the Body, and more ſtrongly made, and curiouſly cloſed next the Air and Weather, to fence off the Injuries thereof. To which purpoſe, as alſo for the more eaſy and nimble gliding of the Body through the Air, the Proviſion Nature hath made, and the Inſtinct of theſe Animals to *preen* and *dreſs* their Feathers, is admirable; both in reſpect of their Art and Curioſity in doing it, and the *Oyl-bag* (2), Glands, and whole Apparatus for that Service.

And now having ſaid thus much relating to the Body's Motion, let us 3. Survey the grand Inſtrument

(1) See before, Book 4. Ch. 12. Note 11.

(2) Mr. *Willughby* ſaith there are two Glands for the Secretion of the unctuous Matter in the *Oyl-bag*. And ſo they appear to be in Geeſe. But upon Examination, I find, that in moſt other Birds (ſuch at leaſt as I have enquired into) there is only one Gland: in which are divers little Cells, ending in two or three larger Cells, lying under the Nipple of the *Oyl-bag*. This *Nipple* is perforated, and being preſſed, or drawn by the Bird's Bill, or Head, emits the liquid Oyl, as it is in ſome Birds, or thicker unctuous Greaſe, as it is in others. The whole *Oyl-bag* is in its ſtructure ſomewhat conformable to the Breaſts of ſuch Animals as afford Milk.

(3)

ment thereof, the *Wings*. Which as they are principal Parts, ſo are made with great Skill, and placed in the moſt commodious Point of the Body (3), to give it an exact Æquipoiſe in that ſubtile Medium, the Air.

And here it is obſervable, with what incomparable Curioſity every Feather is made; the *Shaft* exceeding ſtrong, but hollow below for Strength and Lightneſs ſake; and above, not much leſs ſtrong, and filled with a *Parenchyma* or *Pith*, both ſtrong and light too. The *Vanes* as nicely gauged on each ſide as made; broad on one ſide, and narrower on the other; both which incomparably miniſter to the progreſſive Motion of the Bird, as alſo to the Union and Cloſeneſs of the Wing (4).

And

(3) In all Birds that fly much, or that have the moſt occaſion for their Wings, it is manifeſt that their Wings are placed in the very beſt part, to ballance their Body in the Air, and to give as ſwift a Progreſſion, as their Wings and Body are capable of: for otherwiſe, we ſhould perceive them to reel, and fly unſteadily; as we ſee them to do, if we alter their Æquipoiſe, by cutting the end of one of the Wings, or hanging a Weight at any of the extreme parts of the Body. But as for ſuch Birds as have as much occaſion for Swimming as Flying, and whoſe Wings are therefore ſet a little out of the Center of the Bodies gravity, ſee Ch. 3. Note 9. And for ſuch as have more occaſion for Diving than Flying, and whoſe Legs are for that Reaſon ſet more backward, and their Wings more forward, ſee Ch. 4 Note 9.

(4) The wiſe Author of Nature hath afforded an Example of the great Nicety in the Formation of Birds, by the Nicety obſerved in a part no more conſiderable than the Vanes of the Flag-feathers of the Wing. Among others, theſe two Things are obſervable. 1. The Edges of the exterior or narrow Vanes bend downwards, but of the interior, wider Vanes upwards; by which means they catch hold, and lie cloſe to one another, when the Wing is ſpread, ſo that not one Feather may miſs its full Force and Impulſe upon

And no leſs exquiſite is the Textrine Art of the *Plumage* (5) alſo; which is ſo curiouſly wrought, and

upon the Air. 2. A yet leſſer Nicety is obſerved, and that is in the very ſloping the tips of the Flag-feathers: the interiour Vanes being neatly ſloped away to a Point, towards the outward part of the Wing; and the exteriour Vanes, towards the Body, at leaſt in many Birds; and in the middle of the Wing, the Vanes being equal, and but little ſloped. So that the Wing, whether extended or ſhut, is as neatly ſloped and formed, as if conſtantly trimmed with a pair of Sciſſors.

(5) Since no exact account that I know of, hath been given of the Mechaniſm of the *Vanes* or *Webs* of Feathers, my Obſervations may not be unacceptable. The *Vane* conſiſts not of one continued Membrane, becauſe if once broken, it would hardly be reparable: but of many *Laminæ*, which are thin, ſtiff, and ſomewhat of the nature of a thin Quill. Towards the Shaft of the Feather (eſpecially in the Flag-feathers of the Wing) thoſe *Laminæ* are broad, &c. of a ſemicircular Form; which ſerves for ſtrength, and for the cloſer ſhutting of the *Laminæ* to one another, when impulſes are made upon the Air. Towards the outer part of the Vane, theſe *Laminæ* grow ſlender and taper: on their under ſide they are thin and ſmooth, but their upper outer Edge is parted into two hairy Edges, each ſide having a different ſort of Hairs, laminated or broad at bottom, and ſlender and bearded above the other half. I have, as well as I could, repreſented the uppermoſt Edge of one of theſe *Laminæ* in Fig. 18. with ſome of the Hairs on each ſide, magnified with a Microſcope. Theſe bearded Briſtles or Hairs on one ſide the *Laminæ*, have ſtrait Beards, as in Fig. 19. thoſe on the other ſide, have hooked Beards on one ſide the ſlender part of the Briſtle, and ſtrait ones on the other, as in Fig. 20. Both theſe ſorts of Briſtles magnified (only ſcattering and not cloſe) are repreſented as they grow upon the upper Edge of the *Lamina ſ. t.* in Fig. 18. And in the Vane, the hooked Beards of one *Lamina*, always lye next the ſtrait Beards of the next *Lamina*, and by that means lock and hold each other, and by a pretty Mechaniſm brace the *Laminæ* cloſe to one another. And if at any time the Vane happens to be ruffled and diſcompoſed, it can by this pretty eaſy Mechaniſm, be reduced and repaired. V. Book 4. Ch. 12. at Note 12.

(6)

and ſo artificially interwoven, that it cannot be viewed without Admiration, eſpecially when the Eye is aſſiſted with Glaſſes.

And as curiouſly made, ſo no leſs curiouſly are the Feathers placed in the Wing, exactly according to their ſeveral Lengths and Strength: the *Principals* ſet for Stay and Strength, and theſe again well lined, faced and guarded with the *Covert* and *Secondary Feathers*, to keep the Air from paſſing through, whereby the ſtronger Impulſes are made thereupon.

And laſtly, to ſay no more of this Part, that deſerves more to be ſaid of it, what an admirable *Apparatus* is there of *Bones*, very ſtrong, but withal light and incomparably wrought? of *Joynts*, which open, ſhut, and every way move, according to the Occaſions either of extending it in Flight, or withdrawing the Wing again to the Body? and of various *Muſcles*; among which the peculiar Strength of the *Pectoral Muſcles* deſerves eſpecial Remark, by reaſon they are much ſtronger (6) in Birds, than in Man, or any other Animal, not made for Flying.

4. Next the Wings, the Tail is in Flight conſiderable; greatly aſſiſting in all Aſcents and Deſcent

(6) *Pectorales Muſculi Hominis ſtectentes humeros, parvi & parum carnoſi ſunt; non æquant* 50^m^ *aut* 70^m^ *partem omnium Muſculorum Hominis. E contra in Avibus, Pectorales Muſculi vaſtiſſimi ſunt, & æquant, imo excedunt, & magis pendent, quam reliqui omnes Muſculi ejuſdem Avis ſimul ſumpti.* Borell. de Mot. Animal. Vol. 1. Prop. 184.

Mr. *Willughby* having made the like Obſervation, hath this Reflection on it, *whence, if it be poſſible for Man to fly, it is thought by them who have curiouſly weighed and conſidered the matter, that he that would attempt ſuch a thing with hopes of ſucceſs, muſt ſo contrive and adapt his Wings, that he may make uſe of his Legs, and not his Arms in managing them:* [becauſe the Muſcles of the Legs are ſtronger, as he obſerves.] Willugh. Ornith. L. 1. c. 1. §. 19.

(7)

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for ſteady Going, for Perching, for Catching and Holding of Prey (10), or for Hanging by the Heels to gather their Food (11), or to fix themſelves in their Places of Retreat and Safety. And the latter, namely the *Legs*, all curved for their eaſy Perching, Rooſting, and Reſt, as alſo to help them upon their Wings in taking their Flight, and to be therein commodiouſly tucked up to the Body, ſo as not to obſtruct their Flight. In ſome long, for Wading and Searching the Waters; in ſome of a moderate Length, anſwerable to their vulgar Occaſions; and in others as remarkably ſhort, to anſwer their eſpecial Occaſions and Manner of Life (12). To all which let us add the pla-

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purpoſe. Their Toes alſo are all broad; and in ſuch as bear the name of *Mudſuckers*, two of the Toes are ſomewhat joined, that they may not eaſily ſink in walking upon boggy Places. And as for ſuch as are whole-footed, or whoſe Toes are webbed together (excepting ſome few) their Legs are generally ſhort, which is the moſt convenient ſize for Swimming. And 'tis pretty enough to ſee how artificially they gather up their Toes and Feet when they withdraw their Legs, or go to take their Stroke; and as artificially again extend or open their whole Foot, when they preſs upon, or drive themſelves forward in the Waters.

(10) Some of the Characteriſtics of Rapacious Birds, are *to have hooked, ſtrong, and ſharp-pointed Beaks and Talons, fitted for Rapine, and tearing of Fleſh: and ſtrong and brawny Thighs, for ſtriking down their Prey.* Willughby Ornith. L. 2. c. 1. Raii Synopſ. Av. Method. p. 1.

(11) Such Birds as climb, particularly thoſe of the *Woodpecker* kind, have for this purpoſe (as Mr. *Willughby* obſerves, L. 2. c. 4.) 1. Strong and muſculous Thighs. 2. Short Legs and very ſtrong. 3. Toes ſtanding two forwards, and two backwards. Their Toes alſo are cloſe joined together, that they may more ſtrongly and firmly lay hold on the Tree they climb upon. 4. All of them ——— have a hard ſtiff Tail, bending alſo downwards, on which they lean, and ſo bear up themſelves in climbing.

(12) *Swifts* and *Swallows* have remarkably ſhort Legs, eſpecially the former, and their Toes graſp any thing very ſtrong-

placing theſe laſt mentioned Parts in the Body. In all ſomewhat out of the Center of the Body's Gravity (13), but in ſuch as ſwim, more than in others, for the better rowing their Bodies through the Waters, or to help them in that and Diving (14) too.

CHAP. II.

Of the HEAD, STOMACH, *and other Parts of Birds.*

THus having diſpatched the Parts principally concerned in the Motion of the *Feathered Tribe*, let us proceed to ſome other Parts not yet ani-

ſtrongly. All which is uſeful to them in building their Neſts, and other ſuch Occaſions as neceſſitate them to hang frequently by their Heels. But there is far greater uſe of this Structure of their Legs and Feet, if the reports be true of their hanging by the Heels in great Cluſters (after the manner of Bees) in Mines and Grottos, and on the Rocks by the Sea, all the Winter. Of which latter, I remember the late learned Dr. *Fry* told this Story at the Univerſity, and confirmed it to me ſince, *viz.* That an ancient Fiſherman, accounted an honeſt Man, being near ſome Rocks on the Coaſt of *Cornwal*, ſaw at a very low Ebb, a black Liſt of ſomething adhering to the Rock, which when he came to examine, he found it was a great number of *Swallows*, and, if I miſremember not, of *Swifts* alſo, hanging by the Feet to one another, as Bees do; which were covered commonly by the Sea-Waters, but revived in his warm Hand, and by the Fire. All this the Fiſherman himſelf aſſured the Doctor of. Of this, ſee more Ch. 3. Note 4.

(13) In Birds that frequent not the Waters, the Wings are in the Center of Gravity, when the Bird lies along, as in Flying; but when it ſtands or walks, the erection of the Body throws the Center of Gravity upon the Thighs and Feet.

(14) See Ch. 4. Note 7.

animadverted upon. And we will begin with the *Head*. Concerning which I have already taken Notice of its Shape for making way through the Air; of the make of the *Bill*, for gathering Food, and other Uſes; the commodious Situation of the *Eye*; and I might add that of the *Ear* too, which would be in the way, and obſtruct Flight, if 'twas like that of moſt other Animals: Alſo I might ſay a great deal of the Conformation of the *Brain*, and of the Parts therein wanting, and of others added, like to what is obſervable in Fiſhes; whoſe Poſture in the Waters reſembles that of Birds in the Air (1), and both very different from Man and Beaſts; and laſtly, to hint at no more, I might ſurvey the peculiar Structure of the *Larynx* (2), the *Tongue* (3), the inner Ear (4), and many

(1) *Cerebra Hominum & Quadrupedum in pleriſque ſimilia exiſtunt. —— Capitibus Volucrum & Piſcium contenta, ab utriſque prioribus longe diverſa, tamen inter ſe, quoad præcipuas ἐγκεφάλου partes, Symbola reperiuntur.* The particulars wherein the Brains of Birds and Fiſhes agree with one another, and wherein they differ from the Brain of Man and Beaſts, ſee in the ſame juſtly famous Author, *Willis Cereb. Anat.* c. 5.

(2) *Circa bifurcationem Aſperæ Arteriæ, elegans Artificis libere agentis indicium detegitur ex Avium compaxatione cum Quadrupedibus: cum Vocis gratia in diverſis Avibus diverſam muſculorum fabricam bifurcationi Aſperæ Arteriæ dederit, quorum nullum veſtigium extat in Homine & Quadrupedibus mihi viſis, ubi omnes vocis muſculos capiti Arteriæ junxit. In Aquila,* &c. *ſupra bifurcationem,* &c. Steno in Blaſ. Anat. Animal. P. 2. c. 4.

The *Aſpera Arteria* is very remarkable in the *Swan*, which is thus deſcribed by *T. Bartholin*, viz. *Aſpera Arteria admirandæ ſatis ſtructuræ. Nam pro Colli longitudine deorſum Oeſophagi comes protenditur donec ad ſternum perveniat, in cujus capſulam ſe incurvo flexu inſinuat & recondit, velut in tuto loco & theca, moxque ad fundum ejuſdem cavitatis delata, ſurſum reflectitur, egrediturque anguſtias Sterni, & Clavicu-*

lis mediis conſcenſis, quibus ut fulcro nititur, ad Thoracem ſe flectit——Miranda hercle modis omnibus conſtitutio, & Reſpirationi inſervit & Voci. Nam cum in ſtagnorum fundo edulia pro victu quærat, longiſſimo indiguit collo, ne longa mora ſuffocationis incurreret periculum. Et certe dum dimidiam fere horam toto Capite & Collo pronis vado immergitur, pedibus in altum elatis cœloque obverſis, ex ea Arteriæ quæ pectoris dictæ vaginæ recluſa eſt portione, tanquam ex condo promo ſpiritum haurit. Blaſ. ib. c. 10.

(3) The ſtructure of the *Tongue* of the *Wood-pecker* is very ſingular and remarkable, whether we look at its great length, its Bones and Muſcles, its encompaſſing part of the Neck and Head, the better to exert it ſelf in length, and again, to retract it into its Cell; and laſtly, whether we look at its ſharp horny bearded Point, and the glewy Matter at the end of it, the better to ſtab, to ſtick unto, and draw out little Maggots out of Wood. *Utilis enim Picis* (ſaith *Coiter*) *ad Vermiculos, Formicas, aliaque Inſecta venanda talis Lingua foret. Siquidem Picus, innata ſua ſagacitate cum deprehendit alibi in arboribus, vel carie, vel alia de cauſa cavatis, Vermes inſectaque deliteſcere, ad illas volitat, ſeſeque digitis, unguliſque poſterioribus robuſtiſſimis, & Caudæ pennis rigidiſſimis ſuſtentat, donec valido ac peracuto Roſtro arborem pertundat, arbore pertusâ, foramini roſtrum immittit, ac quo animalcula ſtridore excitet percellatque, magnam in arboris cavo emittit vocem, inſecta vociferatione hac concitata huc illucque repunt; Picus* v. *linguam ſuam exerit, atque aculeis, hamiſque animalia infigit, infixa attrahit & devorat.* vid. Blaſii ubi ſupra. P. 2. c. 24.

(4) I have before in Book 4. Ch. 3. Note 19. taken notice of what others have obſerved concerning the *inner Ear* of *Birds*, reſerving my own Obſervations for this place: which I hope may be acceptable, not only for being ſome of them new, but alſo as ſhewing the Mechaniſm of Hearing.

In this Organ of Birds, I ſhall take notice only of three Parts, the *Membranes* and *Cartilages*; the *Columella*; and the *Conclave*: The *Drum*, as ſome call it, or *Membrana Tympani*, as others, conſiſts of two Membranes, the Outer, which covers the whole *Meatus*, Baſon, or *Drum* (as ſome call it) and the inner Membrane. To ſupport, diſtend and relax the outermoſt, there is one ſingle Cartilage, reaching from the ſide of the *Meatus*, to near the middle of the Membrane. On the top of the *Columella* is another Cartilage, conſiſting of 3 Branches, *a. b. c.* in Fig. 23. The longeſt middle Branch (*a*) is joyned to the top of the ſingle upper Cartilage before ſpoken of, and aſſiſts it to bear up the upper outer Membrane: the two Branches, *b. c.*

are

are joyned to the *Os Petrosum*, at some distance from the outer Membrane: upon this inner Cartilage, is the inner Membrane fixed, the two outer sides of which, *a*, *b*, and *a*, *c*, are joyned to the outer Membrane, and makes a kind of three-square Bag. The design of the two Branches, or Legs of the Cartilage, *b*, *c*, are I conceive to keep the *Cartilage* and *Columella* from wavering sideways: and to hinder them from flying too much back, there is a very fine slender Ligament, extended from the opposite side, quite cross the *Meatus* or Bason, to the bottom of the Cartilage, near its joyning to the *Columella*. Thus much for the *Membranæ Tympani*, and their *Cartilages*.

The next Part is the *Columella* (as *Schelhammer* calls it.) This is a very fine, thin, light Tube; the bottom of which spreads about, and gives it the resemblance of a wooden Potlid, such as I have seen in Country Houses. It exactly shuts into, and covers a *Foramen* of the *Conclave*, to which it is braced all round with a fine subtile Membrane, composed of the tender Auditory Nerve. This Bottom, or Base of the *Columella*, I call the *Operculum*.

The last part which some call the *Labyrinth* and *Cochlea*, consisting of Branches more like the *Canales Semicirculares* in Man, than the *Cochlea*, I call the *Conclave Auditûs*. It is (as in most other Animals) made of hard, context Bone: In most of the Birds I have opened, there are *circular Canals*, some larger, some lesser, crossing one another at right Angles, which open into the *Conclave*. But in the *Goose* it is otherwise, there being cochleous Canals, but not like those of other Birds. In the *Conclave*, at the side opposite to the *Operculum*, the tender part of the *Auditory Nerve* enters, and lineth all those inner retired parts, *viz.* the *Conclave* and *Canals*.

As to the *Passages*, *Columnæ*, and other parts observable in the Ear of Birds, I shall pass them by, it being sufficient to my purpose, to have described the Parts principally concerned in the act of Hearing. And as the Ear is in Birds the most simple and incomplex of any Animals Ear; so we may from it make an easy and rational Judgment, how *Hearing* is performed: *viz.* *Sound* being a *Tremor*, or *Undulation* in the Air, caused by the collision of Bodies, doth, as it moves along, strike upon the *Drum*, or *Membrana Tympani* of the Ear. Which Motion, whether strong or languid, shrill or soft, tuneful or not, is at the same instant impressed upon the *Cartilages*, *Columella*, and *Operculum*, and so communicated to the *Auditory Nerve* in the *Conclave*.

And now if we compare the Organ and Act of Hearing, with those of Sight, we shall find, that the *Conclave* is to

ny matters beſides; but for a Sample I ſhall only inſiſt upon the wonderful Proviſion in the Bill for the judging of the Food, and that is by peculiar Nerves lodged therein for that purpoſe; ſmall and leſs numerous in ſuch as have the Aſſiſtance of another Senſe, the Eye; but large, more numerous, and thickly branched about, to the very End of the Beak, in ſuch as hunt for their Food out of Sight in the Waters, in Mud, or under Ground (5).

And

Hearing, as the *Retina* is to Sight? that ſonorous Bodies make their impreſſions thereby on the Brain, as viſible Objects do by the *Retina*. Alſo, that as there is an Apparatus in the Eye, by the opening and ſhutting of the Pupil, to make it correſpond to all the degrees of Light; ſo there is in the Ear, to make it conformable to all the degrees of Sound; a noble train of little Bones, and Muſcles in Man, *&c.* to ſtrain and relax the Membrane, and at the ſame time to open and ſhut the *Baſis* of the *Stapes* (the ſame as what I call the *Operculum* in Birds:) but in Birds, there is a more ſimple, but ſufficient Apparatus for this purpoſe, tender Cartilages, inſtead of Bones and Joynts, to correſpond to the various impreſſions of Sounds, and to open and ſhut the *Operculum*. Beſides which, I ſuſpect the Ligament I mentioned is only the Tendon of a Muſcle, reaching to the inner *Membrana Tympani*, and joyned thereto (as I find by a ſtricter Scrutiny) and not to the Cartilage, as I imagined. By this Muſcle, the inner Membrane, and by means of that, the Outer alſo can be diſtended or relaxed, as it is in Man, by the *Malleus* and its Muſcle, *&c.*

(5) *Flat-billed Birds, that grope for their Meat, have three pair of Nerves, that come into their Bills; wherely they have that accuracy to diſtinguiſh what is proper for Food, and what to be rejected, by their Taſte, when they did not ſee it. This was moſt evident in a Ducks Bill and Head; a Duck having larger Nerves that come into their Bills than Geeſe, or any other Bird that I have ſeen; and therefore quaffer and grope out their Meat the moſt. But then I diſcovered none of theſe Nerves in Round-billed Birds. But ſince, in my Anatomies in the Country, in a Rook I firſt obſerved two Nerves that came down betwixt the Eyes into the upper Bill, but conſiderably ſmaller*

than

And now from the Head and Mouth, paſs we to its near Allie the Stomach, another no leſs notable than uſeful Part; whether we conſider the Elegancy of its Fibres and Muſcles; or its Multiplicity, one to ſoften and macerate, another to digeſt; or its Variety, ſuited to various Foods, ſome Membranaceous, agreeable to the frugivorous or carnivorous kind; ſome Muſculous and ſtrong (6), ſuited to the Comminution and grinding of Corn and Grain, and ſo to ſupply the Defect of Teeth.

And now to this Specimen of the Parts, I might add many others no leſs curiouſly contrived, made and ſuited to the Occaſions of theſe Volatiles; as particularly the Structure and Lodgment of the *Lungs*

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than any of the three pair of Nerves in the Bills of Ducks, but larger than the Nerves in any other round-billed Birds. And 'tis remarkable, that theſe Birds, more than any other round-billed Birds, ſeem to grope for their Meat in Cow-dung, &c. Mr. J. Clayton, in Philoſ. Tranſact. No. 206.

I obſerved three pair of Nerves in all the broad-billed Birds that I could meet with, and in all ſuch as feel for their Food out of Sight, as Snites, Woodcocks, Curlews, Geeſe, Ducks, Teals, Widgeons, &c. *Theſe Nerves are very large, equalling almoſt the Optic Nerve in thickneſs.* ——— *Two are diſtributed nigh the end of the upper Bill, and are there very much expanded, paſſing through the Bone into the Membrane, lining the Roof of the Mouth.* Dr. *Al. Moulen*, ibid. No. 199. or both in Mr. *Lowthorp*'s Abridg. V. 2. p. 861, 862.

(6) The *Gizzard* is not only made very ſtrong, eſpecially in the Granivorous, but hath alſo a Faculty of grinding what is therein. For which purpoſe, the Bird ſwalloweth rough Stones down, which, when grown ſmooth, are rejected and caſt out of the Stomach, as uſeleſs. This grinding may be heard in Falcons, Eagles, &c. by laying the Ear cloſe to them when their Stomachs are empty, as the famous Dr. *Harvey* ſaith, *De Generat. Exer.* 7.

As to the ſtrength of the Gizzard, and the uſe of Stones to the Digeſtion of Fowls, divers curious Experiments may be met with, tryed by *Seigneur Redi*, with glaſs Bubbles, ſolid Glaſs, Diamonds, and other hard Bodies. See his *Exp. Nat.*

Lungs (7); the Configuration of the *Breaſt*, and it's Bone, made like a Keel, for commodious Paſſage through the Air, to bear the large and ſtrong Muſcles which move the Wings, and to counterpoiſe the Body, and ſupport and reſt it upon at Rooſt; the *Neck* alſo might deſerve our notice, always either exactly proportioned to the Length of the Legs, or elſe longer, to hunt out Food, to ſearch in the Waters (8), as alſo to counterpoiſe the Body in Flight (9). And laſtly,

I

(7) It is no leſs remarkable in Birds, that their *Lungs* adhere to the *Thorax*, and have but little play, than that in other Animals they are looſe and play much: which is a good proviſion for their ſteady flight. Alſo they want the *Diaphragm*; and inſtead thereof, have divers large Bladders made of thin tranſparent Membranes, with pretty large Holes out of one into the other. Theſe Membranes ſeem to me to ſerve for *Ligaments* or *Braces* to the *Viſcera*, as well as to contain Air. Towards the upper part, each Lobe of the Lungs is perforated in two Places with large Perforations, whereof one is towards the outer, the other towards the inner part of the Lobe. Through theſe Perforations, the Air hath a Paſſage into the Belly (as in B. 1. Ch 1. Note 8.) that is, into the forementioned Bladders: ſo that by blowing into the *Aſpera Arteria*, the Lungs will be a little raiſed, and the whole Belly blown up, ſo as to be very turgid. Which doubtleſs is a Means to make their Bodies more or leſs buoyant, according as they take in more or leſs Air, to facilitate thereby, their Aſcents and Deſcents: like as it is in the *Air-bladders* of Fiſhes, in the laſt cited place, Note 9.

(8) *Such Birds as have long Legs, have alſo a long Neck; for that otherwiſe they could not commodiouſly gather up their Food, either on Land, or in the Water. But on the other ſide, thoſe which have long Necks, have not always long Legs, as in Swans —— whoſe Necks ſerve them to reach to the bottoms of Rivers*, &c. Willughby's Ornithol. L. 1. c. 1. §. 7.

(9) We have ſufficient Inſtances of this in *Geeſe*, *Ducks*, &c. whoſe Wings (their Bodies being made for the convenience of Swimming) are placed out of the Center of Gravity, neater the Head. But the extending the Neck and

Head

I might here take Notice of the Defect of the Diaphragm, ſo neceſſary in other Animals to Reſpiration, and alſo of divers other Parts redundant, defective, or varying from other Animals. But it would be tedious to inſiſt upon all, and therefore to the Examples already given, I would rather recommend a nice Inſpection (10) of thoſe curious Works of God, which would be manifeſt Demonſtrations of the admirable Contrivance and Oeconomy of the Bodies of thoſe Creatures.

From the Fabrick therefore of their Bodies, I ſhall paſs to take a Glance of one or two things relating to their *State*, and ſo conclude this Genus of the Animal World.

CHAP. III.

Of the MIGRATION *of Birds.*

CONcerning the *State* of this Tribe of *Animals*, the firſt thing I ſhall ſpeak of (by reaſon God

Head in Flight, cauſeth a due Æquipoiſe and Libration of the Body upon the Wings. Which is another excellent uſe of the long Necks of theſe Birds, beſides that of reaching and ſearching in the Waters for their Food.

But in the *Heron*, whoſe Head and long Neck (although tucked up in Flight) over-ballance the hinder part of the Body, the long Legs are extended in Flight, to counterpoiſe the Body, as well as to ſupply what is wanting in the Tail, from the ſhortneſs of it.

(10) *Steno* thus concludes his Myology of the Eagle, *Imperfecta hæc Muſculorum deſcriptio non minus arida eſt Legentibus, quam Inſpectantibus fuerit jucunda eorundem præparatio. Eleganti ſſima enim Mechanices artificia, creberrime in illis obvia, verbis non niſi obſcure exprimuntur, carnium autem ductu, tendinum colore, inſertionum proportione, & trochlearum diſtributioae oculis expoſita omnem ſuperant admirationem.* Steno in Blaſ. Anat. Animal. P. 2. c. 4.

God himself instanceth in it) shall be their Migration, mentioned Jer. 8. 7. *Yea, the Stork in the Heaven knoweth her appointed Times, and the Turtle, and the Crane, and the Swallow observe the Time of their Coming; but my People,* &c.

In which Act of *Migration* there are two things to me exceedingly notable. One is what the Text speaks of, their knowing their proper Times for their *Passage*, when to come (1), when to go; as also that some should come, when others go; and some others go, when these come. There is no doubt but the Temperature of the Air, as to Heat and Cold, and their natural Propensity to breed their Young may be great Incentives to those Creatures to change their Habitation: but yet it is a very odd Instinct that they should at all shift their Habitation; that some certain Place is not to be found in all the terraqueous Globe affording them convenient Food and Habitation all the Year, either in the colder Climes, for such as delight in the colder Regions, or the hotter, for such *Birds of Passage* as fly to us in Summer.

Also it is somewhat strange, that those untaught, unthinking Creatures should so exactly know the best and only proper Seasons to go and come. This gives us good Reason to interpret the מוֹעֲדִים *Appointed Times*, (2), in the Text, to be such

(1) *Curiosa res est, scire, quam exacte hoc genus avium* [Gruum] *quotannis observet tempora sui reditus ad nos. Anno* 1667. *primæ Grues comparuerunt in campestribus Pisæ* 20 *Feb.* &c. F. Redi Exp. Nat. p. 100. ubi plura.

(2) From יָעַד *indixit, constituit, scil. locum, vel tempus, ubi vel quando aliquid fieri debet.* Buxt. in verb.

De voluntate sua certiorem reddidit. Con. Kircher concordant. Pars 1. Col. 1846. מוֹעֵד *Generaliter pro re aliqua certa, attestata, & definita accipitur.* 1. *Pro tempore certo & constituto.* 2. *Deinde pro festo seu Solennitate, quæ certo & statо tempore celebratur.* 3. *Pro loco certo & constituto.* Id. ibid. Col. 1847.

(2)

ſuch Times as the Creator hath appointed thoſe Animals, and hath accordingly, for this end, imprinted upon their Natures ſuch an Inſtinct as exciteth and moveth them thus, at proper Times, to fly from a Place that would obſtruct their Generation, or not afford convenient Food for them, and their Young, and betake themſelves to another Place, affording all that is wanting for Food or Incubation.

And this leads me to another thing remarkable in this Act of Migration, and that is, That thoſe unthinking Creatures ſhould know what Way to ſteer their Courſe (3), and whither to go. What but the great Creator's Inſtinct, ſhould ever move a poor fooliſh Bird to venture over vaſt Tracts of Land, but eſpecially over large Seas? If it ſhould be ſaid, That by their high Aſcents up into the Air, they can ſee croſs the Seas, yet what ſhould teach or perſwade them, that that Land is more proper for their Purpoſe, than this? that *Britain* (for inſtance) ſhould afford them better Accomodations than *Egypt* (4), than the *Canaries*, than *Spain*, or

(3) *Quis non cum admiratione videat ordinem & politiam peregrinantium Avium, in itinere turmatim volantium, per longos terrarum & maris tractus abſque Acu marina?* —— *Quis eas certum iter in aeris mutabili regione docuit? quis præteritæ ſigna, & futuræ viæ indicia; quis eas ducit, nutrit, & vitæ neceſſaria miniſtrat! Quis inſulas & hoſpitia illa, in quibus victum reperiant, indicavit; modumque ejuſmodi loca in peregrinationibus ſuis inveniendi? Hæc ſane ſuperant hominum captum & induſtriam, qui non niſi longis experientiis, multis itinerariis, chartis geographicis,* —— *& acus magneticæ beneficio,* —— *ejuſmodi marium & terrarum tractus conficere tentant & audent.* Lud. de Beaufort. Coſmop. divina Sect. 5. c. 1.

(4) I inſtance particularly in *Egypt*, becauſe Mr. *Willughby* thinks *Swallows* fly thither, and into *Æthiopia*, &c. and that they do not lurk in Holes, or under Water, as *Olaus Mag-*

or any of thoſe many intermediate Places over which ſome of them probably fly?

And laſtly, to all this let us briefly add the Accommodations theſe *Birds of Paſſage* have to enable them to take ſuch long Flights, *viz.* the Length of their Wings, or their more than ordinary Strength (5) for Flight.

CHAP.

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nus reports. *vid. Ornith.* L. 2. c. 3. But *Etmuller* puts the Matter out of doubt; who ſaith, *Memini me plures, quam quas Medimnus caperet, Hirundines arcte coacervatas intra Piſcinæ cannas, ſub glacie prorſus ad ſenſum exanimes, pulſantes tamen, reperiiſſe.* Etmuller Diſſert. 2. c. 10. §. 5. This as it is like what *Ol. Magnus* ſaith, ſo is a Confirmation of it. The A. Bp's Account is, *In Septentrionalibus aquis ſæpius caſu Piſcatoris extrahuntur Hirundines, in modum conglomeratæ maſſæ, quæ ore ad os, & ala ad alam, & pede ad pedem poſt principium autumni ſeſe inter cannas deſcenſuræ colligarunt. —— Maſſa autem illa per imperitos adoleſcentes —— extracta, atque in æſtuaria portata, caloris acceſſu Hirundines reſolutæ, volare quidem incipiunt, ſed exiguo tempore durant.* Ol. Mag. Hiſt. L. 19. c. 29.

Since my penning this Note, we had at a meeting of the Royal-Society, *Feb.* 12. 171$\frac{2}{3}$, a farther Confirmation of *Swallows* retiring under Water in Winter, from Dr. *Colas*, a Perſon very curious in theſe Matters: who ſpeaking of their way of Fiſhing in the Northern Parts by breaking Holes, and drawing their Nets under the Ice, ſaith, that he ſaw 16 Swallows ſo drawn out of the *Lake of Samrodt*; and about 30 out of the Kings great Pond in *Roſineilen*: and that at *Schlebitten*, near an Houſe of the *E. of Dohna*, he ſaw two Swallows juſt come out of the Waters, that could ſcarce ſtand, being very wet and weak, with their Wings hanging on the ground: and that he hath obſerved the Swallows to be often weak for ſome Days after their appearance.

(5) As *Swallows* are well accommodated for long Flights by their long Wings, ſo are *Quails* by the ſtrength of their *Pectoral Muſcles*, by the breadth of their Wings, *&c.* For Quails have but ſhort Wings for the weight of their Body; and yet they fly from us into warmer Parts, againſt Winter, and to us in Spring, croſſing our Seas. So divers Travellers tell us, they croſs the Mediterranean twice a Year, flying from *Europe* to *Africa*, and back again. Thus *Bellonius*

CHAP. IV.

Of the INCUBATION *of Birds.*

ANother thing relating to the State of this Tribe of Animals, is their *Incubation.*

And first, the *Egg* it self deserves our Notice. It's Parts within, and it's crusty Coat without are admirably well fitted for the Business of Incubation. That there should be one part provided for the Formation of the Body (1) before it's Exit into the World, and another for it's Nourishment after it is come into the World, till the Bird is able

nius in Mr. *Willoughby*, saith; When we sailed from *Rhodes* to *Alexandria* of *Egypt*, many Quails flying from the N. towards the S. were taken in our Ship: *whence I am verily perswaded, that they shift places. For formerly also, when I sailed out of the Isle of* Zant *to* Morea *or* Negropont, *in the Spring-time I had observed* Quails *flying the contrary way from* S. *to* N. *that they might abide there all Summer. At which time also, there were a great many taken in our Ship.* Ornith. pag. 170.

(1) *The Chicken is formed out of, and nourished by the White alone, till it be grown great. The Yolk serves for the Chickens Nourishment after it is well grown, and partly also after it is hatched. For a good part of the Yolk remains after Exclusion, being received into the Chickens Belly; and being there reserved as in a Store-house, is by the* [Appendicula, *or* Ductus intestinalis] *as by a Funnel, conveyed into the Guts, and serves instead of Milk*, &c. Willugh. Ornith. L. 1. c. 3. *Ipsum animal ex albo liquore Ovi corporatur. Cibus ejus in luteo est.* Plin. L. 10. c. 53.

Aristotle saith, *The long sharp Eggs bring Females; the round ones, with a larger compass at the sharper end, Males.* Hist. An. L. 6. c. 2. After which, he tells of a Sot at *Syracuse*, that sate drinking so long, till Eggs were hatched: as also of the Custom of *Egypt*, of hatching Eggs in Dunghills.

(II)

able to ſhift for, and help it ſelf; and that theſe Parts ſhould be ſo accurately braced, and kept in due Place (||), is certainly a deſigned, as well as curious Piece of Workmanſhip.

And then as to the Act itſelf of *Incubation*, what a prodigious Inſtinct is it in all, or almoſt all the ſeveral Species of Birds, that they, and only they of all Creatures, ſhould betake themſelves to this very Way of Generation! How ſhould they be aware that their Eggs contain their Young, and that their Production is in their Power (2)? What ſhould

(||) As the Shell and Skin keep the Yolk and two Whites together, ſo each of the Parts (the Yolk and inner White at leaſt) are ſeparated by Membranes, involving them. At each end of the Egg is a Treddle, ſo called, becauſe it was formerly thought to be the Sperm of the Cock. *But the uſe of theſe* (ſaith Dr. *Harvey* in *Willugh. Ornith.* c. 3.) *is to be as 'twere, the Poles of this Microcoſm, and the Connexions of all the Membranes twiſted and knit together, by which the Liquors are not only conſerved each in its place, but do alſo retain their due Poſition one to another.* This although in a great Meaſure true, yet doth not come up to what I have my ſelf obſerved. For I find, that theſe *Chalazæ* or *Treddles*, ſerve not barely to keep the Liquors in their Place and Poſition to one another; but alſo too keep one and the ſame part of the Yolk uppermoſt, let the Egg be turned nearly which way it will. Which is done by this Mechaniſm: The *Chalazæ* are ſpecifically lighter than the Whites, in which they Swim, and being braced to the Membrane of the Yolk, not exactly in the Axis of the Yolk, but ſomewhat out of it, cauſeth one ſide of the Yolk, to be heavier than the other: ſo that the Yolk being by the *Chalazæ* made buoyant, and kept ſwimming in the midſt of the two Whites, is by its own heavy ſide, kept with the ſame ſide always uppermoſt. Which uppermoſt ſide, I have ſome Reaſon to think, is that on which the *Cicatricula* lies, that being commonly uppermoſt in the Shell, eſpecially in ſome Species of Eggs more I think than others.

(2) All Birds lay a certain number of Eggs, or nearly that number, and then betake themſelves to their Incubation: but if their Eggs be withdrawn, they will lay more. Of which, ſee Mr. *Ray*'s *Wiſd.* of God. p. 137.

(3)

ſhould move them to betake themſelves to their Neſts, and there with Delight and Patience to abide the due Number of Days? And when their Young are gotten into the World, I have already ſhewn how admirable their Art, their Care, and Στοργὴ is in bringing them up until, and only until, they are able to ſhift for themſelves.

And laſtly, when almoſt the whole Tribe of Birds do thus by Incubation produce their Young, it is a wonderful Deviation, that ſome few Families only ſhould do it in a more novercal Way (3), without any Care or Trouble at all, only by laying their Eggs in the Sand, expoſed to the Heat and Incubation of the Sun. Of this the Holy Scripture itſelf gives us an Inſtance in the Oſtrich. Of which we have an Hint, Lam. 4. 3. *The Daughter of my People is become cruel, like the Oſtriches in the Wilderneſs.* This is more plainly expreſſed in Job. 39. 14, 15, 16, 17. [The Oſtrich] *leaveth her Eggs in the Earth, and warmeth them in the Duſt, and forgetteth that the Foot may cruſh them, or*

(3) The *Tabon* is a Bird no bigger than a Chicken, but lays an Egg larger than a Gooſe's Egg, and bigger than the Bird it ſelf. Theſe they lay a Yard deep in the Sand, where they are hatched by the warmth of the Sun; after which they creep out, and get to Sea for Proviſions. *Navarett's Account of China in Collect. of Voyages.* Vol. 1. This account is in all probability borrowed from *Nieremberg*, or *Hernandez* (that copied from him) who call this Bird by the name of *Daie*, and its Eggs *Tapun*, not the Bird itſelf as *Navarette* doth. But my Friend Mr. *Ray* ſaith of it, *Hiſtoria iſthæc proculdubio fabuloſa & falſa eſt. Quamvis enim Aves nonnullæ maxima ova pariunt, ut v. g.* Alkæ, Lomwiæ, Anates Arcticæ, *&c. hujuſmodi tamen unum duntaxat, non plura ova ponunt antequam incubent: nec ullam in rerum natura avem dari exiſtimo cujus ova albumine careant. Cum Albumen præcipua ovi pars ſit, quodque primum fœtui alimentum ſubminiſtrat.* Raii Synop. Av. Method. p. 155.

(4)

or that the Wild-Beaſt may break them. She is hardened againſt her Young ones, as though they were not hers: her Labour is in vain without Fear. Becauſe God hath deprived her of Wiſdom, neither hath he imparted unto her Underſtanding. In which Words I ſhall take Notice of three things, 1. Of this anomalous Way of Generation. It is not very ſtrange, that no other Incubation but that of the Sun ſhould produce the Young; but 'tis very odd and wonderful that any one Species ſhould vary from all the reſt of the Tribe. But above all, 2. The ſingular Care of the Creator in this Caſe is very remarkable, in ſupplying ſome other Way the Want of the Parent-Animals Care and Σπεργὴ (4), ſo that the Young ſhould be notwithſtanding bred up in thoſe large and barren Deſarts of *Arabia* and *Africa*, and ſuch like Places where thoſe Birds dwell, the moſt unlikely and unfitting (in all human Opinion) to afford Suſtenance to young helpleſs Creatures, but the fitteſt therefore to give Demonſtrations of the Wiſdom, Care, and eſpecial Providence of the infinite Creator and Conſervator of the World. 3. The laſt thing I ſhall remark is, That the Inſtincts of Irrational Animals, at leaſt of this ſpecified in the Text, is attributed to GOD. For the Reaſon the Text gives

(4) *The Eggs of the Oſtrich being buried in the Sand, are cheriſhed only by the Heat of the Sun, till the Young be excluded. For the Writers of Natural Hiſtory do generally agree, that the old Birds, after they have laid, and covered their Eggs in the Sand, forſake them, and take no more care of them.* Willugh. Ornith. L. 2. c. 8. §. 1.

But there is another *Oſtrich* [of *America*] which *Acaret* tells us of, that takes more care of her Young, by carrying four of her Eggs, a little before ſhe hatcheth, to four parts of her Neſt, there to breed Worms for Food for her Young. *Acaret's Diſc. in Philoſ. Tranſact.* No. 89.

(5)

gives why the *Ostrich is hardened against her Young ones, as though they were not her's*, is *Because GOD hath deprived her of Wisdom, and not imparted Understanding to her*: i. e. he hath denied her that Wisdom, he hath not imparted that Understanding, that Στοργὴ, that natural Instinct to provide for, and nurse up her Young, that most other Creatures of the same, and other Tribes are endowed with.

Thus I have dispatched what I intend to insist upon concerning the State of this Set of Animals; of which, as also of their admirable Instincts, a great deal more might deserve our especial Observation; particularly the admirable Curiosity, Art and Variety of Nidification (5) used among the various Species of Birds; the great Sagacity, and many Artifices used by them in the Investigation and Capture of their Prey (6), the due Proportion of the more and less useful, the Scarcity of the Voracious and Pernicious, and the Plenty of the Mansuete and Useful 7). Also the Variety of their Motion and Flight might deserve consideration, the Swiftness of such whose Food is to be sought in far distant Places, and different Seasons (8); the slower Motion, and short Flights of others more domestick; and even the Awkwardness of some others to Flight, whose Food is near at Hand, and to be gotten without any great occasion of Flight (9). These and divers other

(5) See Book 4. ch. 13.
(6) See Book 4. ch. 11, and 14.
(7) See Book 4. ch. 10. begin.
(8) See Book 4. chap. 8.
(9) The *Colymbi*, or *Douckers*, having their Food near at hand in the Waters, are remarkably made for diving therein. Their Heads are small, Bills sharp-pointed, Wings small,

other such like things as these, I say, I might have spoken more largely unto; but I shall pass them by with only a bare Mention, having already taken Notice of them in the Company of other Matters of the like Nature, and manifested them to be Acts of excellent Design, Wisdom, and Providence, in the Great Creator.

CHAP. V.

The CONCLUSION.

AND now, if we reflect upon the whole Matter, we shall here find another large Tribe of the Creation abundantly setting forth the Wisdom and Glory of their great Creator. We praise the Ingenuity and Invention of Man, for the Contrivance of various pneumatick Engines; we think them witty even for their unsuccessful Attempts to swim in, and sail through that subtile Element the Air; and the curious Mechanism of that Artist is had in remembrance, and praised to this day, who made a Dove, or an Eagle (†) to fly but a short space. And is not therefore all imaginable Honour and Praise due to that infinite Artist that hath so admirably contrived and made, all the noble Variety of Birds; that hath with such incomparable Curiosity, and Art, formed their Bodies from Head to Tail, without and within, that not so much as any

small, Legs flat and broad, and placed backward, and nearer the Tail than in other Birds; and lastly, their Feet, some whole footed, some cloven-footed, but fin-toed. *vid. Willugh. Ornith.* L. 3. C. 5.

(†) *Vid.* Book 5. ch. 1. Note 25.

(H)

any Muſcle or Bone, no not even a Feather (||) is unartificially made, miſplaced, redundant, or defective, in all the ſeveral Families of this large Tribe! but every thing is ſo incomparably performed, ſo nicely fitted up for Flight, as to ſurpaſs even the Imitation of the moſt ingenious Artificer among mortal rational Beings.

CHAP.

(||) *Deus non ſolum Angelum, & Hominem, ſed nec exigui & contemptibilis animantis viſcera, nec Avis pennulam, nec Herbæ floſculum, nec Arboris folium ſine ſuarum partium convenientia dereliquit.* Auguſtin. de Civ. Dei, L. 5. c. 11.

BOOK VIII.

Of INSECTS *and* REPTILES.

CHAP. I.

Of INSECTS *in general.*

HAVING diſpatched that part of the animal World, which uſed to be accounted the more perfect, thoſe Animals ſtyled leſs perfect, or imperfect, will next deſerve a Place in our Survey, becauſe when ſtrictly enquired into, we ſhall find them to be ſo far from deſerving to be accounted mean and deſpicable Parts of the Creation, owing their Original and Production to Putrefactions, *&c.* as ſome have thought, that we ſhall find them, I ſay, noble, and moſt admirable Works of GOD. For, as the famous Natural Hiſtorian, *Pliny* (1), prefaceth his Treatiſe of *Inſects* to prevent the Reproach of condeſcending (as might be thought) to ſo mean a Subject: *In great Bodies* ſaith he, *Nature had a large and eaſy Shop to work upon obſequious Matter. Whereas,* ſaith he, *in theſe ſo ſmall, and as it were no Bodies, what Footſteps of Reaſon, what Power, what great Perfection is*

(1) *In magnis ſiquidem corporibus,* &c. Plin. Nat. Hiſt. L. II. C. 2.

(2)

is there! Of this having given an Instance or two of the exquisite Senses, and curious Make of some Insects (2), he then goes on, *We admire,* saith he, *the turrigerous Shoulders of Elephants, the lofty Necks and Crests of others; but,* saith he, *the Nature of things is never more compleat than in the least things.* For which Reasons he intreats his Readers (as I do mine) *that because they slighted many of the things themselves which he took Notice of, they would not therefore disdainfully condemn his Accounts of them, since,* saith he, *in the Contemplation of Nature nothing ought to seem superfluous.*

Thus that eminent Naturalist hath made his own, and my Excuse too; the Force and Verity whereof will farther appear by what I shall say of these Animals, which (as despicable as they have been, or perhaps may be thought) we shall find as exquisitely contrived, and curiously made for that Place and Station they bear in the World, as any other Part of the Animal World. For if we consider the innumerable Variety of their Species, the prodigious Numbers of Individuals, the Shape and Make of their little Bodies, and every

(2) *Ubi tot sensus collocavit in Culice? & sunt alia dictu minora. Sed ubi Visum in eo prætendit: Ubi Gustatum applicavit? Ubi Odoratum inseruit? Ubi vero truculentam illam & portione maximam vocem ingeneravit? qua subtilitate Pennas adnexuit? prælongavit Pedum crura? Dispositi jejunam Caveam, uti Alvum? Avidam Sanguinis, & potissimum humani sitim accendit? Telum vero persodiendo tergori, quo spiculavit ingenio? Atque ut in capaci, cum cerni non possit exilitas, ita reciproca geminavit arte, ut sodiendo acuminatum pariter sorbendoque fistulosum esset. Quos Teredini ad perforanda Robora cum sono teste dentes affixit? Potissimumque è ligno cibatum fecit: Sed turrigeros Elephantorum miramur humeros, Taurorumque colla, & truces in sublime jactus, Tigrium rapinas, Leonum jubas, cum rerum natura nusquam magis quam in minimis, tota sit.* Plin. ibid.

every Part thereof, their Motion, their Instincts, their regular Generation and Production, and to name no more, the incomparable Beauty and Lustre of the Colours of many of them, what more admirable and more manifest Demonstration of the infinite Creator, than even this little contemned Branch of the Animal World. But let us take a short View of Particulars.

CHAP. II.

Of the SHAPE *and* STRUCTURE *of Insects.*

LET us begin with the Shape and Fabrick of their Bodies. Which although it be somewhat different from that of Birds, being particularly for the most part not so sharp before, to cut and make way through the Air, yet is better adapted to their manner of Life. For considering that there is little Necessity of long Flights, and that the Strength and Activity of their Wings doth much surpass the Resistance their Bodies meet with from the Air, there was no great Occasion their Bodies should be so sharpened before. But the Condition of their Food, and manner of gathering it, together with the great Necessity of accurate Vision by that admirable Provision made for them by the reticulated *Cornea* of their Eyes; these things, I say, as they required a larger Room, so were a good Occasion for the largeness of the Head, and it's Amplitude before. But for the rest of their Body, all is well made, and nicely poised for their Flight, and every other of their Occasions.

And as their *Shape*, so the *Fabrick* and *Make* of their Bodies, is no less accurate, admirable, and singu-

singular; not built throughout with Bones, and covered with Flesh and Skin, as in most other Animals; but covered with a curious Mail of a middle Nature (||), serving both as Skin and Bone too, for the Shape, as well as Strength and Guard of the Body, and as it were on purpose to shew that the great Contriver of Nature is not bound up to one way only.

CHAP. III.

Of the EYES *and* ANTENNÆ *of Insects.*

TO this last mentioned Guard we may add that farther Guard provided in the *Eyes* and *Antennæ*. The Structure of the Eye is in all Creatures an admirable Piece of Mechanism; but that observable in the Eyes of Insects so peculiar, that it must needs excite our Admiration: fenced with it's own Hardness, yea even it's own accurate Vision is a good Guard against external Injuries; and it's *Cornea*, or outward Coat all over beset with curious, transparent, lenticular (1) Inlets,

(||) *Insecta non videntur Nervos habere, nec Ossa, nec Spinas, nec Cartilaginem, nec Pinguia, nec Carnes, ne Crustam quidem fragilem, ut quædam marina, nec quæ jure dicatur Cutis: sed mediæ cujusdam inter omnia hæc naturæ corpus*, &c. Plin. N. H. L. 11. c. 4.

(1) The *Cornea* of Flies, Wasps, &c. are so common an Entertainment with the Microscope, that every body knows it is a curious piece of Lattice-work. In which this is remarkable, that every *Foramen* is of a lenticular Nature; so that we see Objects through them topsey-turvey, as through so many convex Glasses: yea, they become a small Telescope, when there is a due focal distance between them and the Lens of the Microscope.

lets, enabling those Creatures to see (no doubt) very accurately every Way, without any Interval of time or Trouble to move the Eye towards Objects.

And as for the other part, the *Antennæ* or *Feelers*, whatever their Use may be in cleaning the Eyes, or other such like Use, they are in all probability a good Guard to the Eyes and Head, in their Walk and Flight, enabling them by the Sense of Feeling to discover such Annoyances, which by their Proximity may perhaps escape the Reach of the Eyes and Sight (2). Besides which they

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This lenticular Power of the *Cornea*, supplies (as I imagine) the place of the Crystalline, if not of the Vitreous Humour too, there being neither of those Humours that I could ever find (although, for truth sake, I confess I have not been so diligent as I might in this Enquiry) But instead of *Humours* and *Tunicks*, I imagine that every *Lens* of the *Cornea*, hath a distinct Branch of the *Optick Nerve* ministring to it, and rendring it as so many distinct Eyes. So that as most Animals are Binocular, Spiders for the most part Octonocular, and some (as Mr. *Willughby* thought, *Raii Hist. Insect.* p. 12.) Senocular; so Flies, *&c.* are Multocular, having as many Eyes as there are Perforations in their *Corneæ*. By which means, as other Creatures are obliged to turn their Eyes to Objects, these have some or other of their Eyes ready placed towards Objects nearly all round them: Thus particularly, the *Dragon-Fly* [*Libella*] the greatest part of whose Head is possessed by its Eyes: which is of excellent use to that predatious Insect, for the ready seeing and darting at small Flies all round it, on which it preys.

(2) It is manifest, that Insects clean their Eyes with their Forelegs, as well as *Antennæ*. And considering, that as they walk along, they are perpetually feeling and searching before them with their *Feelers*, or *Antennæ*; therefore I am apt to think, that besides wiping and cleaning the Eyes, the Uses here named may be admitted. For as their Eyes are immoveable, so that no time is required for the turning their Eyes to Objects; so there is no necessity of the *Retina* or *Optick Nerve* being brought nigher unto, or set far-

they are a curious Piece of Workmanship, and in many, a very beautiful Piece of (3) Garniture to the Body.

CHAP. IV.

Of the PARTS *and* MOTION *of Insects.*

FROM the Head pass we to the Members concerned in their Motion. And here we have a copious Subject, if I was minded to expatiate. I might take Notice of the admirable Mechanism in those that creep: the curious Oars in those amphibious Insects that swim and walk (1): the incomparable Provision made in the Feet of

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farther off from the *Cornea* (which would require time) as it is in other Animals: but their *Cornea* and *Optick Nerve*, being always at one and the same Distance, are fitted only to see distantial Objects, but not such as are very nigh: which Inconvenience the *Feelers* obviate, lest it should be prejudicial, in occasioning the Insect to run its Head against any thing.

And that this, rather than wiping the Eyes, is the chief use of the *Feelers*, is farther manifest from the *Antennæ* of the *Flesh-Fly*, and many other Insects, which are short, and strait, and incapable of being bent unto, or extended over the Eyes: as also from others enormously long, such as those of the *Capricorni* or *Goat-chafers*, the *Cadew-Fly*, and divers others, both Beetles and Flies.

(3) The lamellated *Antennæ* of some, the clavellated of others, the neatly articulated of others, the feathered and divers other forms of others of the *Scarab*, *Papilionaceous*, *Gnat*, and other Kinds, are surprizingly beautiful, when viewed through a Microscope. And in some, those *Antennæ* distinguish the Sexes. As in the *Gnats-kind*, all those with Tufts, Feathers, and Brush-horns, are Males; those with short, single shafted *Antennæ*, are Females.

(1) All the Families of *Hydrocanthari*, *Notonecti*, &c, have their hindmost Legs made very nicely with commo-

of such as walk, or hang upon smooth Surfaces (2): the great Strength and Spring in the Legs of such as Leap(3): the strong and well made Feet and Talons of such as dig (4): and to name no more, the admirable Faculty of such as cannot fly, to convey themselves with Speed and Safety, by the help of their Webs (5), or some other

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dious Joynts flat, and Bristles on each side towards the end, serving for Oars to swim; aad then nearer the Body, are two stiff Spikes, to enable them to walk when Occasion is.

(2) I might here name divers Flies and other Insects, who besides their sharp, hooked Nails, have also skinny Palms to their Feet, to enable them to stick on Glass, and other smooth Bodies, by means of the pressure of the Atmosphere. But because the Example will illustrate another work of Nature as well as this, I shall chuse a singular piece of Mechanism in one of the largest sorts of *Hydrocanthari*. Of these there are two sorts, one largest, all black, with *Antennæ* handsomly embossed at the ends. The other somewhat lesser, hardly so black, with capillary *Antennæ*; the Forehead, Edges of the *Vaginæ*, and two Rings on the *Thorax*, of a tawny Colour. The Female hath *Vaginæ* prettily furrowed; the Male smooth. But that which is most to our purpose in this Male, is a Flap, or hollowish Cap near the middle Joynt of the Fore-legs: which when clap'd on the Shoulders of the Female in *Coitu*, sticks firmly thereon; after the manner as I have seen Boys carry heavy Stones with only a wet piece of Leather clap'd on the top of the Stone.

(3) Thus *Grashoppers* and *Crickets* have brawny strong Thighs, with long, slender, but strong Legs, which enable them to leap with great Agility and Strength.

(4) I have wondered to see with what great Quickness, Art, and Strength, many *Vespæ-Ichneumons*, *Wild Bees*, and *Beetles*, perforate the Earth, yea, even Wood it self: but the most remarkable Animal in this way, is the *Mole-Cricket*, in Book 4. Ch. 13. Note 17.

(5) I have with pleasure often seen Spiders dart out their Webs, and sail away by the help thereof. For the manner of which, see Mr. *Lowth.* Abridg. Vol. 2. p. 794. from Dr. *Lister* and Dr. *Hulse*, who both claimed the Discovery thereof;

other Artifice to make their Bodies lighter than the Air (6): these and a Multitude of other such like

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of: and do both seem to have hit thereupon, without any foreknowledge of what each other had discovered, as is said in the last cited place, and as I more plainly find by some original Letters of Mr. *Ray*'s, Dr. *Lister*'s, and Dr. *Hulse*'s, in my Hands: by which also I find the two ingenious Doctors were very modest in their Claims, and very amicable in the matter. In one of Dr. *Lister*'s to Mr. *Ray*, he thinks there is a fair hint of the Darting of Spiders in *Arist. Hist. An.* L. 9. c. 39. and in *Pliny*, L. 11. c. 24: but for their Sailing, that the Ancients are silent of, and he thinks it was seen first by him. And in another Letter, *Jan.* 20. 1670, speaking of the height Spiders are able to fly, he saith, *The last* October, *&c. I took notice, that the Air was very full of Webs, I forthwith mounted to the top of the highest Steeple on the Minster* [in York] *and could thence discern them yet exceeding high above me. Some that fell, and were intangled upon the Pinacles, I took and found them to be* Lupi; *which Kind seldom or never enter Houses, and cannot be supposed to have taken their Flight from the Steeple.*

(6) There are (I imagine) divers Animals, as well as Spiders, that have some way of conveyance, as little known to us, as that of Spiders formerly was. Thus the *Squillulæ*, *Pulices arborescentes*, and *Microscopical Animalcules* of the stagnating Waters, so numerous in them as to discolour sometimes the Water, and make them look as if they were tinged Red, Yellow, or Green, or covered with a thick green Scum; all which is nothing but Animalcules of that Colour. That these Creatures have some way of Conveyance, I conclude, because most stagnating Waters are stock'd with them; new Pits and Ponds, yea Holes and Gutters on the tops of Houses and Steeples. That they are not bred there by Æquivocal Generation, every ingenious considering Philosopher will grant; that they have not Legs for travelling so far is manifest from Inspection: and therefore I am apt to think, that they have some faculty of inflating their Bodies or darting out Webs, and making their Bodies buoyant, and lighter than Air; or their Bodies, when dry, may be lighter than Air, and so they can swim from place to place; or the Eggs of such as are oviparous, may be light enough to float in the Air. But then the Viviparous (as my late ingenious Friend, Mr. *Charles King*, shewed me the *Pulices aquat. arboresc.* are; these I say) can't be this way

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like things as these I might, I say, take Notice of, as great Evidences of the Infinite Creator's Wisdom: but lest I should be too tedious, I will confine my Observations to the Legs and Wings only. And these at first View we find to be incomparably fitted up for their intended Service, not to overload the Body, not in the least to retard it, but to give it the most proper and convenient Motion. What for Example can be better contrived and made for this Service than the Wings? distended and strengthened by the finest Bones, and these covered with the finest and lightest Membranes, some of them adorn'd with neat and beautiful Feathers (7), and many of them provided with the finest Articulations, and Foldings, for the Wings to be withdrawn, and neatly laid up in their *Vaginæ* and Cases, and again readily extended for Flight (8).

And

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accounted for. The cause of these latter Suspicions was, that in the Summer Months I have seen the *Pulices arboref.* and the green Scum on the Waters (nothing but Animalcules, as I said) lye in a manner dry on the surface of the Waters: at which time (as I have shewn in B. 4. ch. 11. Note 13.) those Animalcules copulate: And perhaps, they may at the same time change their Quarters, and seek out new Habitations for their numerous Offspring, as well as themselves.

(7) It is well known to all Persons any way conversant in Microscopical Observations, that these elegant Colours of *Moths*, and *Butterflies*, are owing to neat and well made Feathers, set with great Curiosity and Exactness in rows, and good order.

(8) All that have *Elytra*, *Scarabs*, (who have whole *Elytra*, or reaching to the *Podex*) or the Ἡμικολεόπτερα, such as *Earwigs*, and *Staphylini* of all sorts, do by a very curious Mechanism extend and withdraw their Membranaceous Wings (wherewith chiefly they fly) and it is very pretty to see them prepare themselves for Flight, by thrusting out, and unfolding their Wings; and again, withdraw those

Joynts,

And then for the poising of the Body, and keeping it upright, and steady in Flight, it is an admirable Artifice and Provision for this Purpose; in some, by four Wings (9); and in such as have but two, by Pointils and Poises placed under the Wings, on each side the Body.

And lastly, it is an amazing thing to reflect upon the surprising Minuteness, Art, and Curiosity of the (10) Joynts, the Muscles, the Tendons, the Nerves necessary to perform all the Motions of the Legs, the Wings, and every other Part. I have already mentioned this in the larger Animals: but to consider that all these things

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Joynts, and neatly fold in the Membranes, to be laid up safely in their *Elytra* or Cases. For which Service the Bones are well placed, and the Joynts ministring thereunto, are accurately contrived for the most compendious and commodious folding up the Wings.

(9) For the keeping the Body steady and upright in Flight, it generally holds true (if I mistake not) that all bipennated Insects have *Poises* under the hinder part of their Wings, but such as have four Wings, or Wings with *Elytra*, none. If one of the Poises be cut off, or one of the lesser Auxiliary Wings, the Insect will fly as if one side overballanced the other, until it falleth on the Ground. So if both be cut off, they will fly awkwardly and unsteadily, manifesting the Defect of some very necessary part. These *Poises* or *Piontells* are, for the most part, little Balls set at the top of a slender Stalk, which they can move every way at pleasure. In some they stand alone, in others, (as in the whole *Flesh-Fly* Tribe) they have little Covers or Shields under which they lye and move. The Use, no doubt, of these *Poises*, and *Secondary* lesser Wings, is to poise the Body, and to obviate all the Vacillations thereof in Flight, serving to the Insect, as the long Pole loaden at the ends with Lead doth the *Rope-dancer*.

(10) As all the parts of Animals are moved by the help of these; so there is no doubt but the minutest Animals have such like Parts. But the Muscles and Tendons of some of the larger Insects, and some of the lesser too, may be seen with a Microscope.

(11)

things concur in minute Animals, even in the smallest Mite, yea the Animalcules, that (without good Microscopes) escape our Sight; to consider, I say, that those minutest Animals have all the Joynts, Bones, Muscles, Tendons and Nerves, necessary to that brisk and swift Motion that many of them have, is so stupendous a piece of curious Art (11), as plainly manifesteth the Power and Wisdom of the infinite Contriver of those inimitable Fineries. But having named those minute Animals, why should I mention only any one Part of their Bodies, when we have in that little Compass a whole and compleat Body, as exquisitely formed, and (as far our Scrutiny can possibly reach) as neatly adorned as the largest Ani-

(11) The minute Curiosities and inimitable Fineries, observable in those lesser Animals, in which our best Microscopes discover no Botch, no rude ill made Work (contrary to what is in all artificial Works of Man) do they not far more deserve our Admiration, than those celebrated pieces of humane Art? such as the Cup made of a Pepper-Corn, by *Oswald Nerlinger* that held 1200 little Ivory Cups, all gilt on the Edges, and having each of them a Foot, and yet afforded room for 400 more, in the *Ephem. Germ.* T. 1. Addend. ad Obs. 13. Such also was *Phaethon* in a Ring, which *Galen* thus reflects upon, when he speaks of the Art and Wisdom of the Maker of Animals, particularly such as are small, *Quanto*, saith he, *ipsum minus fuerit, tanto majorem admirationem tibi excitabit; quod declarant Opifices cum in corporibus parvis aliquid insculpant: cujus generis est quod nuper quidam in Annulo Phaetonta quatuor equis invectum sculpsit. Omnes enim equi frenum, os, & dentes anteriores habebant*, &c. And then having taken notice, that the Legs were no bigger than those of a Gnat, he shews that their Make did not come up to those of the Gnat, as also, saith he, *Major adhuc alia quædam esse videtur artis ejus, qui Pulicem condidit, Vis atque Sapientia, quod*, &c. *Cum igitur Ars tanta in tam abjectis animalibus appareat, —— quantam ejus Vim ac Sapientiam in præstantioribus inesse putabimus?* Galen. de Us. Part. L. 17. c. 1. fin.

(12)

Animal. Let us consider that there we have Eyes, a Brain, a Mouth, a Stomach, Entrails, and every other part of an Animal-Body, as well as Legs and Feet; and that all those Parts have each of them their necessary *Apparatus* of Nerves, of various Muscles; and every other Part that other Insects have; and that all is covered and guarded with a well-made Tegument, beset with Bristles, adorned with neat Imbrications, and many other Fineries. And lastly, let us consider in how little Compass all this Art and Curiosity may lie, even in a Body many times less than a small Grain of Sand (12), so that the least Drop of Water can contain many of them, and afford them also sufficient Room to dance and frisk about (13).

Having surveyed as many of the Parts of Insects as I care to take notice of, I shall in the next place say somewhat of their State, and Circumstances of Life. And here I shall take notice only of two things, which have been only hinted at before, but will deserve more particular Consideration here, as being Acts of a wonderful Instinct, namely, Their Security of themselves against Winter; and their special Care of preserving their Species.

CHAP.

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(12) It will in some Measure appear, how wonderfully minute some Microscopical Animalcules are, by what follows in the next Note. But because more particular Examples would be endless, I shall refer to the Observations of Mr. *Leuwenhock*, and others, in the *Philos. Trans.* and elsewhere.

(13) It is almost impossible, by reason of their perpetual Motion, and changing Places, to count the Number of the Animalcules, in only a drop of the green Scum upon Water; but I guess I have sometimes seen not fewer than 100 frisking about in a Drop no bigger than a Pin's head. But in such a Drop of Pepper-Water, a far greater Number; these being much less than those.

CHAP. V.

The SAGACITY *of Insects to secure themselves against Winter.*

IT is an extraordinary Act of Instinct and Sagacity observable in the generality of the Insect-Tribe, that they all take care to secure themselves, and provide against the Necessities of Winter. That when the Distresses of Cold and Wet force them, they should retire to warm and dry Places of Safety, is not strange: but it is a prodigious Act of the infinite Conservator's Care to enable some to live in a different kind of Insect-state; others to live, as without Action, so without Food; and others that act and eat, to lay up in Summer sufficient Provisions against the approaching Winter. Some, I say, live in a different State. For having sufficiently fed, nourished and bred up themselves to the Perfection of their *Vermicular*, *Nympha-state*, in the Summer Months, they then retire to Places of Safety, and there throw off their *Nympha*, and put on their *Aurelia* or *Chrysalis-state* for all the Winter, in which there are no Occasions for Food. This is the constant Method of many Families of the Insect-Tribe (1).

But

(1) It would be endless to enter into Particulars here, because all the *Papilionaceous*, *Flesh*, and *Ichneumon-Fly* Tribes, and all others that undergo the *Nympha* and *Aurelia*-state, between that of the Egg and *Mature*-state, (which are very numerous) appertain to this Note. For a Sample therefore only, I shall take what some may think a mean one, but if considered, deserves our Admiration, and that is the sagacity

But there are others, and some of them in their most perfect State too, that are able to subsist in a kind of Torpitude or Sleeping-state, without any Food at all; by Reason as there is no Action, so no Waste of Body, no Expence of Spirits, and therefore no need of Food (2).

But for others that move and act, and need Food, it is a prodigious Instinct and Foresight the Creator hath imprinted on them to lay up sufficient Food in Summer for the Winter's (3) Necessities

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city of the *White-Butterfly Caterpillar*, which having fed it self its due time, then retires to places of Security. I have seen great Trains of them creeping up the Walls and Posts of the next Houses, where, with the help of some Cobweb-like Filaments, they hang themselves to the Ceilings, and other commodious Places, and then become *Aureliæ*; in which State and Places they hang secure from Wet and Cold, till the Spring and warmer Months, when they are transmitted into Butter-Flies.

(2) I shall not name any of the particular Species of Insects which live in this state, because they are very numerous, but only remark two Things observable in their Sagacity in this Matter: 1. That they are not driven by stress of Weather to their Retirement, but seem as naturally to betake themselves thereto, as other Animals do to rest and sleep. For before the approach of cold Weather, towards the end of Summer, we may see some kinds of them flocking together in great numbers within Doors (as *Swallows* do a little before they leave us) as if they were making ready for their Winter's rest. 2. That every Species betakes it self to a proper convenient Receptacle; some under the Waters to the bottoms of Ponds; some under the Earth, below the Frosts; some under Timber, Stone, *&c.* lying on the ground; some into hollow Trees, or under the Bark, or in the Wood; some into warm and dry Places; and some into dry alone.

(3) There are not many Kinds that thus provide their Food before-hand. The most remarkable, are the *Ant* and the *Bee*; concerning the first of which, *Origen* hath this Remark, *viz. De solertia Formicarum, venturæ hyemi mature prospicientium, sibique invicem sub onere fessis succurrentium; quodque fruges arrosas condunt, ne rursus enascantur, sed per annum*

ties and Occasions. And it is very pretty to see with what unwearied Diligence all Hands are at work for that Purpose, all the warmer Months. Of this the Holy Scripture it self gives us an Instance in the *Ant*, calling that little Animal *exceeding wise*, Prov. 30. 24. And the Reason is *v.* 25. *The Ants are a People not strong, yet they prepare their Meat in the Summer.* And therefore *Solomon* sends the Sluggard to this little contemptible Creature, to learn Wisdom, Foresight, Care, and Diligence, Prov. 6. 6, 7, 8. *Go to the Ant, thou Sluggard, consider her Ways, and be wise: which having no Guide, Overseer, or Ruler, provideth her Meat in the Summer, and gathereth her Food in the Harvest.*

To this Scriptural Example, give me leave to anticipate, and subjoyn an Observation of the farther great Wisdom of this little Creature; and that is their unparallelled Στοργή, their Tenderness, Sagacity, and Diligence about their Young (4). 'Tis very diverting, as well as admira-

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annum alimento sint, non ratiocinationem Formicarum in causa debemus credere, sed almam matrem Naturam bruta quoque sic ornantem, ut etiam minimis addat sua quædam ingenia. Orig. cont. Cels. L. 4.

But as for *Wasps*, *Hornets*, *Humble-Bees*, and other *Wild-Bees*, *Vespæ-Ichneumons*, and divers others that carry in Materials for Nests and Food; this is only for the Service of their Generation, for hatching their Eggs, and nourishing their Young, not for Supplies in Winter. For they all forsake their Nests towards Winter, and retire to other Quarters, living (I conceive) without Food all that time.

(4) *Hos vermiculos* [Formicarum Ova vulgo vocatos] *incredibili* στοργῇ *& cura Formicæ educant, summamque dant operam, ne vel tantillum, quod spectet eorum vermiculorum educationem atque nutritionem, omittant: quem in finem fere semper eosdem ore circumportant secum, ne ulla eos lædat injuria. In musæo meo nonnullas istius generis formicas vitro terra repleto concluſas cum Vermiculis istis adservabam: ibi non sine jucunditate spectabam, quo terra fieret in superficie siccior*

mirable to see, with what Affection, and Care they carry about their Young in their Mouths, how they expose themselves to the greatest Dangers, rather than leave their Young exposed, or forsaken; how they remove them from Place to Place in their little Hills, sometimes to this Part, sometimes to that, for the Benefit of convenient Warmth, and proper Moisture; and then again withdraw, and guard them against Rain, and Cold. Now that this great Wisdom which the Scriptures attribute unto, and is discernible in this little Animal, is owing only to the Instinct, or Infusions of the great Conservator of the World, is evident, because either this Wisdom, Thought, and Forecast, is an Act of the Animal it

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siccior, eo profundius Formicas cum fœtibus suis prorepere: cum vero aquam adfunderem, visu mirificum erat, quanto affectu, quanta solicitudine, quanta Σπεργῇ omnem in eo collocarent operam, ut fœtus suos sicciore & tuto loco reponerent. Sæpius vidi, cum aliquot diebus aqua caruissent, atque cum affuso tantillo aquæ terram illam humectarem, e vestigio a Formicis fœtus suos eo loci fuisse allatos, quos ibi distincte conspiciebam moveri atque fugere humorem. Multoties sui conatus, ut eos Vermiculos ipse educarem, at semper conatum fefellit eventus: neque ipsas Formicarum Nymphas alimenti jam non indigas unquam sine ipsis Formicis potui fotu artificiali excludere. J. Swammerd. Epilog. ad Hist. Insect. p. 153.

Sir *Edward King*, who was very curious in examining the Generation of Ants, observes their great Care and Diligence. 1. About their Sperm, or true Eggs, which is a fine white Substance like Sugar, which they diligently gather together into an heap when scattered; and on which they lye in Multitudes, (I suppose, by way of Incubation.) 2. I have observed, saith he, in Summer, that in the Morning they bring up those of their Young (call'd Ant-Eggs) towards the top of the Bank: so that you may from 10 in the Morning, until 5 or 6 Afternoon, find them near the Top —— for the most part on the South side the Bank. But towards 7 or 8 at Night, if it be cool, or likely to rain, you may dig a Foot deep before you can find them. *Philos. Transf.* No. 23. or *Lowthorp's Abridg.* V. 2. p. 7, and 9.

it self, or of some other Being that hath Wisdom. But the Animal being irrational, 'tis impossible it can be it's own Act, but must be derived, or received from some wise Being. And Who! What can that be, but the infinite Lord, Conservator and Governour of all the World?

CHAP. VI.

Of the Care *of* INSECTS *about their* YOUNG.

THE other notable Instinct I am to treat of, is the peculiar Art and Care of the Insect-Tribe about the Preservation of their Species. Here I might speak of many things, but I have occasionally mentioned divers of them before, under some or other of the general Heads, and therefore shall fix only upon two things relating to their special Art and Care about the Production (1) of their Young, which have not been so particularly spoken to as they deserve.

One thing is their singular Providence for their Young, in making or finding out such proper Receptacles and Places for their Eggs and Seed, as that they may receive the Advantage of a sufficient Incubation, and that the Young, when produced, may have the Benefit of proper and sufficient Food for their Nurture and Education, till they

(1) The Doctrine of Æquivocal Generation, is at this Day so sufficiently exploded by all Learned Philosophers, that I shall not enter the Dispute, but take it for granted, that all Animals spring from other Parent-Animals. If the Reader hath any doubt about it, I refer him to *Seigneur Redi de Gen. Insect.* and Mr. *Ray's Wisd. of God*, &c. p. 344. See also before Book 4. Ch. 15. Note 1.

(2)

they are able to shift for themselves. It is admirable to see with what Diligence and Care the several Species of Insects lay up their Eggs or Sperm in their several proper Places: not all in the Waters, in Wood, or on Vegetables; but those whose Subsistance is in the Waters, (2) in the Water; those to whom Flesh is a proper Food, in Flesh (3); those to

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(2) It would be endless to specify the various Species of Insects, that have their Generation in the Waters. And therefore I shall only observe of them. 1. That their Eggs are always laid up with great Care, and in good order. And also, 2. Where proper and sufficient Food is. 3. That in their *Nympha*-state in the Waters, they have parts proper for Food and Motion; and in many or most of them, very different from what they have in their *Mature* State, a manifest Argument of the Creator's Wisdom and Providence. For an Instance, see Note 17.

(3) As *Seigneur Redi* was one of the first that made it his Business to discard Anomalous Generation, so he tryed more Experiments relating to the Vermination of Serpents, Flesh, Fish, putrified Vegetables, and in short, whatever was commonly known to be the Nursery of Maggots, more I say probably, than any one hath done since. And in all his Observations, he constantly found the Maggots to turn to *Aureliæ*, and these into Flies. But then saith, *Dubitare cœpi, utrum omne hoc vermium in carne genus, ex solo Muscarum semine, an ex ipsis putrefactis carnibus oriretur, tantoque magis confirmabar in hoc meo dubio, quanto in omnibus generationibus ——— sæpius videram, in carnibus, antequam verminare inciperent, resedisse ejusdem speciei Muscas, cujus propago postea nascebatur.* Upon this he tells us, he put Fish, Flesh, &c. into Pots, which he covered close from the Flies with Paper, and afterwards (for the free Air sake) with Lawn, whilst other Pots were left open, with such like Flesh, &c. in them: that the Flies were very eager to get into the covered Pots: and that they produced not one Maggot, when the open ones had many. *Fr. Redi de Gener. Insect.*

Among the Insects that come from the Maggots he mentions, he names *Culices*. Now from the most critical Observations I have made, I never observed any sort of *Gnat* to come from putrified Flesh, Vegetables, or any other thing

to whom the Fruits(4) or Leaves of Vegetables are Food,

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he taxeth with them. So that either he means by *Culex*, some Fly that we call not by the Name of *Gnat*; or else their *Gnats* in *Italy*, vary in their Generation from ours in *England*. For among above 30, near 40 distinct Species of Gnats that I have observed about the Place where I live, I never found any to lay their Eggs in Flesh, Fish, &c. but the largest Sort called by *Aldrovand*, *Culices maximi*, by *Swammerdam*, *Tipulæ terrestres*, lay their Eggs in Meadows, &c. under the Grass: one of the larger middle sort, in dead Beer, Yeast, &c. lying on the tops, or in the leaks of Beer-Barrels, &c. and all the rest (as far as ever I have observed) lay and hatch in the Waters, as in Note 17.

The Generation of the second of these being akin to some of the foregoing Instances, and a little out of the way, may deserve a Place here. This Gnat lays its Eggs commonly in dead Beer, &c. as I said, and probably in Vinegar, and other such Liquors. Some time after which, the Maggots are so numerous, that the whole Liquor stirreth as if it was alive; being full of Maggots, some larger, some smaller. The larger are the Offspring of our Gnat; the smaller, of a small dark coloured Fly tending to reddish; frequent in Cellars, and such obscure Places. All these *Maggots* turn to *Aureliæ*, the larger of which, of a Tan-Colour, turn to our *Gnat*. This Gnat is of the unarmed Kind, having no Spear in its Mouth. Its Head is larger than of the common Gnats; a longer Neck; short joynted *Antennæ*; spotted Wings reaching beyond its slender *Alvus*: it is throughout of a brown Colour, tending to Red, especially in the Female. The chief difference between the Male and Female, is (as in other Gnats, yea most Insects) the Male is less than the Female, and hath a slenderer Belly, and its Podex not so sharp as the Females is.

(4) The Insects that infest Fruits, are either of the *Ichneumon-Fly* kind, or *Phalænæ*. Plums, Pease, Nuts, &c. produce some or other *Ichneumon-Fly*. That generated in the *Plum* is black, of a middle-size, its *Body* near $\frac{3}{4}$ Inch long, its *Tail* not much less, consisting of 3 Bristles, wherewith it conveys its Eggs into Fruits: its *Antennæ*, or Horns long, slender, recurved; its *Belly* longish, tapering small towards the Thorax; *Legs* reddish; *Wings* membranaceous, thin and transparent, in number 4, which is one Characteristick of the *Ichneumon-Fly*.

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Food are accordingly repoſited, ſome in this Fruit, ſome on this Tree (5), ſome on that Plant (6), ſome

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The *Peaſe Ichneumon-Fly* is very ſmall, Wings large, reaching beyond the *Podex*; *Antennæ* long; *Alvus* ſhort, ſhaped like an Heart, with the point towards the *Anus*: it walketh and flieth ſlowly. No Tail appears as in the former; but they have one lieth hidden under the Belly, which they can at pleaſure bend back, to pierce Peaſe when young and tender, and other things alſo, as I have reaſon to ſuſpect, having met with this (as indeed the former too) in divers Vegetables.

Pears and *Apples* I could never diſcover any thing to breed in but only the leſſer *Phalænæ*, about $\frac{1}{10}$ Inch long, whitiſh underneath; greyiſh brown above (dappled with brown Spots, inclining to a dirty Red) all but about a third part at the end of the Wings, which is not grey, but brown, elegantly ſtriped with wavey Lines of a Gold-Colour, as if Gilt. Its Head is ſmall, with a Tuft of whitiſh brown Down in the Forehead; *Antennæ* ſmooth, moderately long. The *Aurelia* of this Moth is ſmall, of a yellowiſh brown. I know not what time they require for their Generation out of Boxes: but thoſe I laid up in *Auguſt*, did not become Moths before *June* following.

(6) There are many of the *Phalænæ* and *Ichneumon-Fly* Tribes, that have their Generation on the Leaves, or other Parts of Trees and Shrubs, too many to be here reckoned up. The *Oak* hath many very beautiful *Phalænæ*, bred in it's convolved Leaves, White, Green, Yellow, Brown ſpotted prettily, and neatly dappled, and many more beſides: and it's Buds afford a Place for Caſes, and Balls of various ſorts, as ſhall be ſhewn hereafter; it's Leaves expanded miniſter to the Germination of globular and other ſphæroidal Balls, and flat Thecæ, ſome like Hats, ſome like Buttons excavated in the middle, and divers other ſuch like Repoſitories, all belonging to the *Ichneumon-Fly* kind. And not only the *Oak*, but the *Maple* alſo, the *White-thorn*; the *Briar*, *Privet*, and indeed almoſt every Tree, and Shrub.

(6) And as Trees and Shrubs, ſo Plants have their peculiar Inſects. The *White-Butterfly* lays it's voracious Offſpring on Cabbage-leaves; a very beautiful reddiſh ocellated one, it's no leſs voracious black Offſpring of an horrid Aſpect, on the Leaves of Nettles; as alſo doth a very beau-

some on another, and another: but constantly the same Family on the same Tree, or Plant, the most agreeable to that Family. And as for others that require a constant and greater Degree of Warmth, they are accordingly provided by the Parent-Animal with some Place in or about the Body of other Animals; some in the Feathers of Birds (7); some in the Hair of Beasts (8); some in

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tiful small greenish *Ichneumon-Fly* in Cases on the Leaves of the same Plant: and to name no more (because it would be endless) the beautiful *Ragwort-Moth*, whose Upper-Wings are brown, elegantly spotted with red, and Under-Wings are red, edged with brown; these, I say, provide for their beautiful golden-ring'd *Erucæ* upon the *Ragwort-Plant*.

(7) Many, if not most sort of Birds, are infested with a distinct kind of *Lice*, very different from one another in Shape, Size, *&c.* For Figures and Descriptions of them, I shall refer to *Seigneur Redi of Insects*. See also *Mouffet*, L. 2. c. 23. These Lice lay their Nits among the Feathers of the respective Birds, where they are hatched and nourished; and as *Aristotle* saith, would destroy the Birds, particularly Pheasants, if they did not dust their Feathers. *Loco infr. citat.*

(8) And as Birds, so the several sorts of Beasts have their peculiar sorts of Lice; all distinct from the two Sorts infesting Man. Only the *Ass*, they say, is free, because our *Saviour* rode upon one, as some think: but I presume it is rather from the Passage in *Pliny*, L. 11. c. 33. or rather *Arist. Hist. Animal.* L. 3. c. 31. who saith, *Quibus pilus est, non carent eodem* [Pediculo] *excepto Asino, qui non Pediculo tantum, verum etiam Redivio immunis est.* And a little before, speaking of those in Men, he shews what Constitutions are most subject to them, and instanceth in *Alcman* the Poet, and *Pherecydes Syrius* that died of the *Pthiriasis*, or Lowsy Disease. For which foul Distemper, if Medicines are desired, *Mouffet de Insect.* p. 262. may be consulted. Who in the same page hath this Observation, *Animadverterunt nostrates —— ubi Asores insulas a tergo reliquerint, Pediculos confestim omnes tabescere; atque ubi eas revisserint, iterum innumeros alios subito oriri.* Which Observation is confirmed by Dr. *Stubbs*. V. *Lowth. Abridg.* V. 3. p. 558.

(9)

in the very Scales of Fishes (9); some in the Nose (10); some in the Flesh (11); yea some in the

(9) Fishes, one would think, should be free from Lice, by reason they live in the Waters, and are perpetually moving in, and brushing through them: but yet they have their Sorts too.

Besides which, I have frequently found great Numbers of long slender Worms in the Stomachs and other Parts of Fish, particularly *Cod-Fish*, especially such as are poor: which Worms have worked themselves deeply into the Coats and Flesh, so that they could not easily be gotten out. So *Aristotle* saith of some Fishes, *Ballero & Tilloni Lumbricus innascitur, qui debilitat*, &c. *Chalcis vitio infestatur diro, ut Pediculi sub Branchiis innati quam multi interimant.* Hist. An. L. 8. c. 20.

(10) Of Insects bred in the Nose of Animals, those in the Nostrils of *Sheep* are remarkable. I have my self taken out not fewer at a time than 20 or 30 rough Maggots lying among the Laminæ of the Nostrils. But I could never hatch any of them, and so know not what Animal they proceed from: but I have no great doubt, they are of the *Ichneumon-Fly* Kind; and not improbably of that with a long Tail, called *Trifeta*, whose three Bristles seem very commodious for conveying its Eggs into deep Places.

I have also seen a rough whitish Maggot, above 2 Inches within the *Intestinum rectum* of Horses, firmly adhering thereto, that the hard Dung did not rub off. I never could bring them to Perfection, but suspect the *Side-Fly* proceeds from it.

(11) In the Backs of *Cows* in the Summer-Months, there are Maggots generated, which in *Essex* we call *Wornils*: which are first only a small Knot in the Skin, and I suppose no other than an Egg laid there by some Insect. By degrees these Knots grow bigger, and contain in them a Maggot, lying in a purulent Matter: they grow to be as large as the end of one's Finger, and may be squeezed out at a Hole they have always open: they are round and rough, and of a dirty white. With my utmost Endeavours and Vigilance, I could never discover the Animal they turn into; but as they are somewhat like, so may be the same as those in the Note before.

In *Persia* there are very long slender Worms, bred in the Legs, and other Parts of Men's Bodies, 6 or 7 Yards long.

In Philos. Transf. Mr. *Dent*, and Mr. *Lewis*, relate divers Examples of *Worms* taken out of the Tongue, Gums, Nose,

the very Bowels (12); and inmost Recesses of the

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and other Parts, by a Woman at *Leicester*, which they were Eye-witnesses of. These and divers others mentioned in the *Transactions*, may be seen together in Mr. *Lowthorp's Abridg.* Vol. 3. p. 132.

Narrat mihi vir fide dignus —— Casp. Wendlandt —— se in Polonia puero cuidam rustico duorum annorum Vermiculum album e palpebra extraxisse, —— magnitudinis Erucæ. —— Similem fere huic casum mihi [Schulzio] *& D. Segero narravit hoc Anno 1676. chirurgus noster Ant. Statlender, qui cuidam puero ex Aure extraxit Vermiculum talem, qualis in nucibus avellanis perforatis latitare solet, sed paulo majorem, coloris albissimi; alteri minores 5 ejusdem generis similiter ex Aure: omnes aliquot horas supervixerunt —— Vermiculos adhuc viventes oculis nostris vidimus.* Ephem. Germ. T. 2. Obs. 24. ubi Vermiculi Icon. Many other Instances may be met with in the same Tome, Obs. 147, 148, 154.

The Worms in *Deer* are mentioned often among ancient Writers. *Aristotle* saith Σκώληκας μόνοι πάντες ἔχουσιν, ἐν τῇ κεφαλῇ ζῶντας, &c. *They* [Deer] *all have live Worms in their Heads; bred under the Tongue, in a Cavity near the Vertebra on which the Head is placed; their Size not less than of the largest Maggots; they are bred all together, in number about* 20. Aristot. Hist. Animal. l. 2. c. 15.

To these Examples may be added the Generation of the *Ichneumon-Fly* in the Bodies of Caterpillars, and other *Nymphæ* of Insects. In many of which that I have laid up to be hatched in Boxes, instead of *Papilios*, &c. as I expected, I have found a great number of small *Ichneumon-Flies*, whose Parent-Animal had wounded those *Nymphæ*, and darted its Eggs into them, and so made them the Foster-Mother of its Young. More particulars of this way of Generation may be seen in the great Mr. *Fr. Willughby*'s Observations in *Philos. Transf.* No. 76. But concerning the farther Generation of this Insect, I have taken notice of other Particulars in other places of these Notes.

(12) The Animals ordinarily bred in the Stomach and Guts, are the three sorts of Worms called *Lati*, *Teretes*, and *Ascarides*; concerning which, it would be irksome to speak in particular, and therefore I shall refer to *Mouset*, L. 2. c. 31, 32, 33. Dr. *Tyson*'s Anatomy of them in Mr. *Lowthorp*'s *Abridg.* V. 3. p. 121, *Signr Redi*'s *Obs.* and others that have written of them.

And

the Bodies of Man and other Creatures (13): And

And not only *Worms*, but other Creatures alſo are ſaid to be found in the Stomach: Inſtances of which are ſo innumerable, that I ſhall only ſelect a few related by Perſons of the beſt Credit. And firſt of all, by ſome of our own Country-men. Dr. *Liſter* (whoſe Credit and Judgment will hardly be queſtioned) gives an account of true Caterpillars, vomited up by a Boy of nine Years old; and another odd Animal by a poor Man. Mr. *Jeſſop* (another very judicious, curious, and ingenious Gentleman) ſaw *Hexapods* vomited up by a Girl; which *Hexapods* lived and fed for 5 Weeks. See *Lowth.* ib. p. 135.

And as to Foreigners, it is a very ſtrange Story (but atteſted by Perſons of great Repute) of *Catharina Geileria*, that died in *Feb.* 1662, in the Hoſpital of *Altenburg*, in *Germany*, who for 20 Years voided by Vomit and Stool, *Toads* and *Lizards*, &c. *Ephemer. Germ.* T. 1. Obſ. 103. See alſo the 109. Obſervation of a Kitten bred in the Stomach, and vomited up: of Whelps alſo, and other Animals, bred in like manner. But I fear a Stretch of Fancy might help in ſome of thoſe laſt Inſtances, in thoſe days when ſpontaneous Generation was held, when the Philoſophers ſeem to have more ſlightly examined ſuch Appearances than now they do. But for the breeding of *Frogs* or *Toads*, or *Lacertæ Aquaticæ* in the Stomach, when their Spawn happeneth to be drank, there is a Story in the 2d *Tome* of the *Ephem. Germ.* Obſ. 56. that favours it; *viz.* *In the Year* 1667, *A Butcher's Man going to buy ſome Lambs in the Spring, being thirſty, drank greedily of ſome ſtanding Water, which a while after, cauſed great Pains in his Stomach, which grew worſe and worſe, and ended in dangerous Symptoms. At laſt he thought ſomewhat was alive in his Stomach, and after that, vomited up three live Toads; and ſo recovered his former Health.*

Such another Story, Dr. *Sorbait* tells, and avoucheth it ſeen with his own Eyes, of one that had a Toad came out of an Abſceſs, which came upon drinking foul Water. *Obſ.* 103.

(13) Not only in the Guts, and in the Fleſh, but in many other parts of the Body Worms have been diſcovered. One was voided by Urine, by Mr. *Mat. Milford*, ſuppoſed to have come from the Kidneys. *Lowth.* ib. p. 135. More ſuch Examples *Mouſet* tells of, *ibid.* So the *Vermes Cucurbitini* are very common in the Veſſels in Sheeps Livers: and Dr.

Liſter

And as for others to whom none of these Methods are proper, but make themselves Nests by Perforations in the Earth, in Wood, or Combs they build, or such like Ways, 'tis admirable to see with what Labour and Care they carry in, and seal up Provisions that serve both for the Production

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Lister tells of them, found in the Kidney of a Dog, and thinks that the Snakes and Toads, *&c.* said to be found in Animals Bodies, may be nothing else. *Lowth.* ib. p. 120. Nay, more than all this: in Dr. *Bern. Verzascha's* 6th Observation, there are divers Instances of Worms bred in the *Brain* of Man. One, a Patient of his, troubled with a violent Headach, and an itching about the Nostrils, and frequent Sneezing; with the use of a sneezing-Powder, voided a Worm, with a great deal of Snot from his Nose. A like Instance he gives from *Bartholine*, of a Worm voided from the Nose of *O. W.* which he guesseth was the famous *Olaus Wormius*: another, from a Country Woman of *Dietmarsh*; and others in *Tulpius*, *F. Hildanus*, *Schenckius*, &c. These Worms he thinks are undoubtedly bred in the Brain: but what way they can come from thence, I can't tell. Wherefore I rather think, they are such Worms as are mentioned in Note 10, and even that Worm that was actually found in the Brain of the *Paris Girl* (when opened) I guess might be laid in the *Laminæ* of the Nostrils, by some of the *Ichneumon*, or other Insect-Kind, and might gnaw its way into the Brain through the *Os cribriforme*. Of this he tells us from *Bartholine*, *Tandem cum tabida obiisset, statim aperto cranio præsentes Medici totam cerebelli substantiam qua ad dextrum vergit a reliquo corpore sejunctam, nigraque tunica involutam deprehenderunt: hæc tunica rupta latentem Vermem vivum & pilosum duobus punctis splendidis loco oculorum prodidit, ejusdem fere molis cum reliqua Cerebri portione, qui duarum horarum spacio supervixit.* B. Verzas. Obs. Medicæ p. 16.

Hildanus tells us such another Story, *viz. Filius Theod. auff der Roulen Avunculi mei diuturno vexabatur dolore capitis. ——— Deinde febricula & sternutatione exorta, ruptus est Abscessus circa os cribrosum —— & Vermis prorepsit.* By his Figure of it, the Maggot was an Inch long, and full of Bristles. *Fabri Hildan. Cent.* 1. Obs.

Galenus Wierus (Physician to the *Princ. Jul.* & *Cleve*) he saith, told him, that he had at divers times found Worms in the *Gall-bladder* in Persons he had opened at *Duseldorp*. Id. ib. Obs. 69.

(14)

on of their Young, as also for their Food and Nurture when produced (14).

The other Piece of remarkable Art and Care about the Production of their Young, is their Curiosity and Neatness in repositing their Eggs, and in their Nidification.

As to the first of which, we may observe that great Curiosity, and nice Order is generally observed by them in this matter. You shall always see their Eggs laid carefully and commodiously up (15); when upon the Leaves of Vegetables, or other Material on Land, always glued thereon with Care with one certain End lowermost, and with handsome juxta-Positions (16). Or if in the Waters in neat and beautiful Rows oftentimes, in that spermatick Gelatine Matter in which they are reposited, and that matter carefully tied and fastned in the Waters to prevent it's Dissipation (17), or if made to float, so carefully spread and poi-

(14) See before Book 4. Chap. 13. Note 2.

(15) Some Insects lay up their Eggs in Clusters, as in holes of Flesh, and such Places, where it is necessary they should be crouded together; which, no Question, prevents their being too much dried up in dry places, and promotes their hatching. But,

(16) As for such as are not to be clustered up, great order is used. I have seen upon the Post and Sides of Windows, little round Eggs resembling small Pearl, which produced small hairy Caterpillars, that were very neatly and orderly laid. And to name no more, the *White-Butterfly* lays it's neat Eggs on the Cabbage-leaves in good order, always gluing one certain end of the Egg to the Leaf. I call them neat Eggs, because if we view them in a Microscope, we shall find them very curiously furrowed, and handsomely made and adorned.

(17) By reason it would be endless to specify the various Generation of Insects in the Waters, I shall therefore (because it is little observed) take *Pliny*'s Instance of the *Gnat*, a mean and contemned Animal, but a notable Instance of Natures Work, as he saith,

The

The first thing considerable in the Generation of this Insect is (for the size of the Animal) its vast *Spawn*, being some of them above an Inch long, and half a quarter diameter; made to float in the Waters, and tied to some Stick, Stone, or other fixt thing in the Waters, by a small Stem, or Stalk. In this gelatine, transparent Spawn the Eggs are neatly laid; in some Spawns in a single, in some in a double spiral Line, running round from end to end, as in Fig. 9, and 10; and in some transversly, as Fig. 8.

When the Eggs are by the Heat of the Sun, and Warmth of the Season hatched into small Maggots, these Maggots descend to the bottom, and by means of some of the gelatine Matter of the Spawn (which they take along with them) they stick to Stones and other Bodies at the bottom, and there make themselves little Cases or Cells, which they creep into, and out of at pleasure, until they are arrived to a more mature *Nympha-state*, and can swim about here and there to seek for what Food they have occasion for: at which time, they are a kind of Red-worms above half an Inch long, as in Fig. 11.

Thus far this mean Insect is a good Instance of the divine Providence towards it. But if we farther consider and compare the three States it undergoes after it is hatched, we shall find yet greater Signals of the Creator's Management, even in these meanest of Creatures. The three States I mean, are its *Nympha-Vermicular* State, its *Aurelia*, and *Mature*-State, all as different as to Shape and Accoutrements, as if the Insect was three different Animals. In its *Vermicular*-State, it is a Red-Maggot, as I said, and hath a Mouth and other parts accommodated to Food; in its *Aurelia*-State it hath no such Parts, because it then subsists without Food; but in its *Mature*, *Gnat*-State, it hath a curious well made Spear, to wound and suck the Blood of other Animals. In its *Vermicular*-State, it hath a long Worm-like Body, and something analogous to Fins or Feathers, standing erect near its Tail, and running parallel with the Body, by means of which resisting the Waters, it is enabled to swim about by Curvations, or flapping its Body side-ways this way and that, as in Fig. 12.

But in its *Aurelia*-State, it hath a quite different Body, with a *Club-Head* (in which the Head, Thorax, and Wings of the Gnat are inclosed) a slender *Alvus*, and a neat *finny-Tail*, standing at right angles with the Body, quite contrary to what it was before; by which means, instead of easy flapping side-ways, it swims by rapid, brisk Jirks, the quite contrary way: as is in some measure represented in Fig. 13. But when it becomes a *Gnat*, no finny Tail, no club Head, but all is made in the most accurate manner for Flight and Motion in the Air, as before it was for the Waters. (18)

poised, as to Swim about with all possible Artifice.

And as to their other Faculty, that of Nidification, whether it be exerted by boring the Earth or Wood, or building themselves Cells (18), or spinning and weaving themselves Cases and Webs, it is all a wonderful Faculty of those poor little Animals, whether we consider their Parts wherewith they work, or their Work it self. Thus those who perforate the Earth, Wood, or such like, they have their Legs, Feet, Mouth, yea, and whole Body accommodated to that Service; their Mouth exactly formed to gnaw those handsome round Holes, their Feet as well made to scratch and bore (19), and their Body handsomely turned and fitted to follow. But for such as build or spin themselves Nests, their Art justly bids Defiance to the most ingenious Artist among Men, so much as tolerably to copy the nice Geometrical Combs of some (20), the earthen Cells of others, or the Webs, Nets and Cases (21) woven

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(18) See Book 4. Ch. 13. Notes 12, 13.

(19) Thus the Mouths and other parts of the *Ichneumon-Wasps* in Book 4. Ch. 13. Note 2. So the Feet of the *Gryllotalpa*, *ibid.* Note 17.

(20) See the last cited places, Note 13.

(21) Of the textrine art of the *Spider*, and its Parts serving to that purpose; see the last cited Place, Note 21.

Besides these, *Caterpillars*, and divers other Insects, can emit Threads, or Webs for their use. In this their *Nympha-state*, they secure themselves from falling, and let themselves down from the Boughs of Trees, and other high Places, with one of these Threads. And in the Cases they weave, they secure themselves in their *Aurelia-state*.

And not only the Offspring of the *Phalæna-Tribe*, but there are some of the *Ichneumon-Fly* kind also, endowed with this textrine Art. Of these I have met with two sorts: one that spun a Milk white, long, round silken Web, as big as the top of ones Finger, woven round Bents, Stalks of Ribwort, &c. in Mea-

ven by others. And here that natural Glue (22) which their Bodies afford some of them to consolidate their Work, and combine it's Materials together, and which in others can be darted out at Pleasure, and spun and woven by them into silken Balls (23), or Webs, I say, this so peculiar, so serviceable a Material, together with the curious Structure of all Parts ministering to this textrine Power, as mean a Business as it may seem, is such as

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Meadows. The other is a lump of many yellow, silken Cases, sticking confusedly together on Posts, under Coleworts, &c. These Webs contain in them, small whitish Maggots; which turn to a small black *Ichneumon-Fly*, with long Capillary *Antennæ*; Tan-coloured Legs; long Wings reaching beyond their Body, with a black Spot near the middle; the *Alvus*, like an Heart; and in some, a small setaceous Tail. Some of these Flies were of a shining beautiful green Colour. I could not perceive any difference, at least, not specifical, between the Flies coming from these two Productions.

(22) I have often admired how Wasps, *Hornets*, *Ichneumon Wasps*, and other Insects that gather dry Materials for building their Nests, have found a proper matter to cement, and glue their Combs, and line their Cells; which we find always sufficiently context and firm. But in all probability, this useful Material is in their own Bodies; as 'tis in the *Tinea vestivora*, *Cadew worm*, and divers others. *Goedart* observes of his *Eruca Num.* 20. 6. that fed upon *Sallow-leaves*, that *hæc pulveris aut arenæ instar comminuit, ac pituitoso quodam sui corporis succo ita maceravit, ut inde accomodatum subeundæ mutationi instanti locum sibi exstruxerit. Domuncula hæc a communi Salicum ligno nihil differre videbatur, nisi quod longe esset durior, adeo ut cultro vix disrumpi posset.*

(23) *An ingenious Gentlewoman of my acquaintance, Wife to a learned Physician, taking much Pleasure to keep Silk-Worms, had once the curiosity to draw out one of the oval Cases, which the Silk-Worm Spins —— into all the Silken Wire it was made up of, which to the great Wonder as well of her Husband, as her self, —— appeared to be, by measure, a great deal above* 300 *Yards, and yet weighed but two grains and an half.* Boyl Subtil. of Effluv. ch. 2.

(24)

as may justly be accounted among the noble Designs and Works of the infinite Creator and Conservator of the World.

In the last Place, there is another prodigious Faculty, Art, Cunning, or what shall I call it? that others of those little Animals have to make even Nature it self serviceable to their Purpose, and that is the making the Vegetation and Growth of Trees and Plants, the very means of the building of their little Nests and Cells (24); such as

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(24) Since my penning this, I have met with the most sagacious *Malpighi*'s Account of *Galls*, &c. and find his Descriptions to be exceedingly accurate and true, having traced my self many of the Productions he hath mentioned. But I find *Italy* and *Sicily* (his Book *de Gallis* being published long after he was made Professor of *Messina*) more luxuriant in such Productions than *England*, at least, than the parts about *Upminster* (where I live) are. For many, if not most of those about us, are taken notice of by him, and several others besides that I never met with; although I have as critically observed all the Excrescences, and other morbid Tumors of Vegetables, as is almost possible, and do believe that few of them have escaped me.

As to the method how those *Galls* and *Balls* are produced, the most simple, and consequently the most easy to be accounted for, is that in the Gems of Oak, which may be called *Squamous-Oak-Cones*. *Capitula squamata*, in *Malpighi*. Whose Description not exactly answering our *English-Cones* in divers respects, I shall therefore pass his by, and shew only what I have observed my self concerning them.

These *Cones* are, in outward appearance, perfectly like the Gems, only vastly bigger: and indeed they are no other than the Gems, encreased in bigness, which naturally ought to be pushed out in length. The cause of which Obstruction of the Vegetation is this; into the very heart of the young tender Gem or Bud (which begins to be turgid in *June*, and to shoot towards the latter end of that Month, or beginning of the next; into this I say) the Parent-Insect thrusts one or more Eggs, and not perhaps without some venemous Ichor therewith. This Egg soon becomes a Maggot, which eats it self a little Cell, in the very heart

of

as are the Galls and Balls found on the Leaves and Branches of divers Vegetables, such as the Oak, the Willow (25), the Briar, and some others.

Now

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or pith of the Gem, which is the rudiment of the Branch, together with its Leaves and Fruit, as shall be hereafter shewn. The Branch being thus wholly destroyed, or at least, its Vegetation being obstructed, the Sap that was to nourish it, is diverted to the remaining parts of the Bud, which are only the scaly Teguments; which by these means grow large and flourishing, and become a covering to the Insect-Case, as before they were to the tender Branch and its Appendage.

The *Case* lying within this Cone is at first but small, as the Maggot included in it is, but by degrees, as the Maggot increaseth, so it grows bigger to about the size of a large White-Pease, long and round, resembling the shape of a small Acorn.

The *Insect* it self, is (according to the modern Insectologers) of the *Ichneumon-Fly* kind: with four Membranaceous *Wings*, reaching a little beyond the Body, articulated *Horns*, a large *Thorax*, bigger than the Belly; the *Belly* short and conical; much like the Heart of Animals: the *Legs* partly whitish, partly black. The *Length* of the Body from Head to Tail, about $\frac{2}{10}$ of an Inch; its *Colour*, a very beautiful shining Green, in some tending to a dark copper Colour. Figures both of the Cones, Cases, and Insects, may be seen among *Malpighi's* Cutts of Galls, Tab. 13. and Tab. 20. Fig. 72; which Fig. 72. exhibits well enough some others of the *Gall-Insects*, but its *Thorax* is somewhat too short for ours.

(25) Not only the Willow, and some other Trees, but Plants also, as *Nettles*, *Ground-Ivy*, &c. have Cases produced on their Leaves, by the Injection of the Eggs of an *Ichneumon-Fly*. I have observed those Cases always to grow in, or adjoyning to some Rib of the Leaf, and their Production I conceive to be thus, *viz.* The Parent-Insect, with its stiff setaceous Tail, terebrates the Rib of the Leaf, when tender, and makes way for its Egg into the very Pith or Heart thereof, and probably lays in therewith, some proper Juice of its Body, to pervert the regular vegetation of it. From this Wound arises a small Excrescence, which (when the Egg is hatched into a Maggot) grows bigger and bigger as the Maggot increases, swelling on each side the

Leaf

Now this is so peculiar an Artifice, and so far out of the Reach of any mortal Understanding, Wit, or Power, that if we consider the Matter, with some of it's Circumstances, we must needs perceive manifest Design, and that there is the Concurrence of some great and wise Being, that hath from the Beginning taken Care of, and provided for the Animal's Good. For which Reason, as mean as the Instance may seem, I might be excused, if I should enlarge upon it's Particulars. But two or three Hints shall suffice.

In the first Place 'tis certain that the Formation of those *Cases* and *Balls* is quite beyond the cunning of the Animal itself; but it is the Act partly of the Vegetable, and partly of some Virulency, or what shall I call it, in the Juyce, or Egg or both reposited on the Vegetable by the Parent-Animal (26). And as this Virulency is various accor-

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Leaf between the two Membranes, and extending it self into the Parenchymous part thereof, until it is grown as big as two Grains of Wheat. In this Case, lies a small white rough Maggot; which turns to an *Aurelia*, and afterwards to a very beautiful green small *Ichneumon-Fly*.

(26) What I suspected my self, I find confirmed by *Malpighi*, who in his exact and true Description of the Fly bred in the *Oaken Galls*, saith, *Non sat fuit naturæ tam miro artificio Terebram, seu Limam condidisse; sed inflicto vulnere, vel excitato foramine infundendum exinde liquorem intra Terebram condidit: quare fracta per transversum muscarum terebra frequentissime, vivente animali, guttæ aliquot diaphani humoris effluunt.* And a little after, he confirms by ocular Observation, what he imagined before, *viz. Semel prope Junii finem vidi Muscam, qualem superius delineavi, insidentem quercinæ gemmæ, adhuc germinanti; hærebat etenim foliolo stabili ab apice hiantis gemmæ erumpenti; & convulso in arcum corpore, terebram evaginabat, ipsamque tensam immittebat; & tumefacto ventre circa terebræ radicem tumorem excitabat, quem interpolatis vicibus remittebat. In folio igitur, avulsa Musca, minima & diaphana reperii ejectæ ova, simillima iis, quæ adhuc in tubis supererant. Non licuit iterum idem admirari spectaculum*, &c.

according to the Difference of it's Animal, so is the Form and Texture of the Cases and Balls excited thereby; some being hard Shells (27), some tender Balls (28), some Scaly (29), some Smooth (30),

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Somewhat like this which *Malpighi* saw. I had the good Fortune to see my self once some Years ago: And that was, the beautiful shining *Oak-Ball Ichneumon* strike its Terebra into an Oak-Apple divers times, no doubt to lay its Eggs therein. And hence I apprehend we see many Vermicles towards the Outside of many of the Oak-Apples, which I guess were not what the Primitive Insects laid up in the Gem, from which the Oak-Apple had its Rise; but some other supervenient, additional Insects, laid in after the Apple was grown, and whilst it was tender and soft.

(27) The *Aleppo-Galls*, wherewith we make Ink, may be reckoned of this Number, being hard, and no other than Cases of Insects which are bred in them: who, when come to Maturity, gnaw their way out of them; which is the Cause of those little Holes observable in them. Of the Insects bred in them, see *Philos. Transact.* No. 245. Of this Number also are those little smooth Cases, as big as large Pepper-Corns, growing close to the Ribs under Oaken-Leaves, globous, but flattish; at first touched with a blushing Red, afterwards growing brown; hollow within, and an hard thin Shell without. In this lieth commonly a rough white Maggot, which becomes a little long winged, black *Ichneumon-Fly*, that eats a little Hole in the Side of the Gall, and so gets out.

(28) For a Sample of the tender Balls, I shall choose the globous Ball, as round and some as big as small Musket-Bullets, growing close to the Ribs, under Oaken-Leaves, of a greenish yellowish Colour, with a blush of Red; their Skin smooth, with frequent Risings therein. Inwardly they are very soft and spongy; and in the very Center is a Case with a white Maggot therein, which becomes an *Ichneumon-Fly*, not much unlike the last. As to this Gall, there is one thing I have observed somewhat peculiar, and I may say providential, and that is, that the Fly lies all the Winter in these Balls in its Infantile-state, and comes not to its Maturity till the following Spring. In the Autumn and Winter these Balls fall down with their Leaves to the Ground, and the Insect inclosed in them is there fenced against the Winter Frosts, partly by other Leaves falling pretty

(30), some Hairy (31), some Long, some Round, some

pretty thick upon them, and especially by the thick Parenchymous Spongy Walls, afforded by the *Galls* themselves.

Another Sample shall be the large *Oak-Balls*, called *Oak-Apples*, growing in the place of the Buds, whose Generation, Vegetation and Figure, may be seen in *Malpig. de Gallis*, p. 24. and Tab. 10. Fig. 33, &c. Out of these Galls, he saith, various Species of Flies come, but he names only two, and they are the only two I ever saw come out of them: *frequenter* (saith he) *subnigræ sunt muscæ brevi munitæ terebra. Inter has aliquæ observantur aureæ, levi viridis tinctura suffusæ, oblonga pollentes terebra.* These two differently coloured Flies, I take to be no other than Male and Female of the same Species. I have not observed Tails (which are their *Terebræ*) in all, as *Malpighi* seems to intimate: perhaps they were hid in their *Thecæ*, and I could not discover them: but I rather think there were none, and that those were the Males: but in others, I have observed long recurvous Tails, longer than their whole Bodies: And these I take to be the Females. And in the *Oak-Apples* themselves, I have seen the *Aureliæ*, some with, some without Tails. And I must confess, 'twas not without Admiration as well as Pleasure, that I have seen with what exact Neatness and Artifice, the Tail hath been wrapt about the *Aurelia*, whereby it is secured from either annoying the Insect, or being hurt it self.

(29) See before Note 24.

(30) As in the preceding Note.

(31) Of the rough or hairy Excrescences, those on the *Briar*, or *Dog-Rose*, are a good Instance. These *Spongiolæ villosæ*, as Mr. *Ray*, *Gallæ ramosæ* as Dr. *Malpighi*, calls them, are thus accounted for by the latter; *Ex copiosis relictis cuti ita turbatur affluens* [Rubi] *succus, ut strumosa fiant complura tubercula simul confuse congesta, quæ utriculorum seriebus, & fibrarum implicatione contexta, ramosas propagines germinant, ita ut minima quasi sylva appareat. Quælibet propago ramos, hinc inde villosos edit. Hinc inde pili pariter erumpunt*, &c.

These Balls are a safe Repository to the Insect all the Winter in its Vermicular-State. For the Eggs laid up, and hatched the Summer before, do not come to mature Insects until the Spring following, as Mr. *Ray* rightly observes in *Cat. Cantab.*

some Conical, &c. (32). And in the last Place, let us add, That those Species of Insects are all endowed with peculiar and exactly made Parts for this Service, to bore and pierce the Vegetable, and to reach and inject their Eggs and Juyce into the tender Parts thereof.

The CONCLUSION.

AND now these things being seriously considered, what less can be concluded than that there is manifest Design and Forecast in this Case, and that

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As to the *Insects* themselves, they are manifestly *Ichneumon-Flies*, having four Wings, their *Alvus* thick and large towards the Tail; and tapering up till it is small and slender at its setting on to the *Thorax*. But the *Alvi* or Bellies are not alike in all, though coloured alike. In some they are as is now described, and longer, without *Terebræ*, or Tails; in some shorter with Tails: and in some yet shorter, and thick, like the Belly of the *Ant*, or the Heart of Animals, as in those before, Note 24. But for a farther Description of them, I shall refer to Mr. *Ray Cat. Plant. circa Cantab.* under *Rosa sylvest.*

(32) It being an Instance somewhat out of the way, I shall pitch upon it for an Example here, *viz.* The *gouty Swellings* in the Body, and the Branches of the *Blackberry-Bush*; of which *Malpighi* hath given us two good Cuts in Tab. 17. Fig. 62. The Cause of these is manifestly from the Eggs of Insects laid in, whilst the Shoot is young and tender, as far as the Pith, and in some Places not so deep: which for the Reasons before mentioned, makes the young Shoots tumify, and grow knotty and gouty.

The Insect that comes from hence is of the former Tribe, a small shining black *Ichneumon-Fly*, about a tenth of an Inch long; with joynted red capillary Horns, four long Wings, reaching beyond the Body, a large *Thorax*, red Legs, and a short, heart-like Belly. They hop like Fleas. The Males are less than the Females; are very venereous, endeavouring a *Coit* in the very Box in which they are hatch'd; getting up on the Females, and tickling and thumping them with their Breeches and Horns, to excite them to Venery.

(*)

that there must needs be some wise Artist, some Careful Prudent Conservator, that from the very Beginning of the Existence of this Species of Animals hath with great Dexterity and Forecast provided for it's Preservation and Good. For what else could contrive and make such a Set of curious Parts, exactly fitted up for that special Purpose: and withal implant in the Body such peculiar Impregnations as should have such a strange uncouth Power on a quite different Rank of Creatures? And lastly, what should make the Insect aware of this it s strange Faculty and Power, and teach it so cunningly and dextrously to employ it for it's own Service and Good?

BOOK IX.

Of REPTILES *and the Inhabitants of the* WATERS.

CHAP. I.

Of REPTILES.

HAVING dispatched the Insect-Tribe, there is but one *Genus* of the Land-Animals remaining to be surveyed, and that is, that of *Reptiles* (1). Which I shall dispatch in a little Compass, by Reason I have somewhat amply

(1) Notwithstanding I have before in Book 4. Ch. 12. Note 15. taken notice of the *Earth-Worm*, yet it being a good Example of the Creator's wise and curious Workmanship, in even this meanest Branch of the Creation, I shall superadd a few farther Remarks from Doctors *Willis* and *Tyson*. Saith *Willis*, *Lumbricus terrestris, licet vile & contemptibile habetur, Organa vitalia, necnon & alia viscera, & membra divino artificio admirabiliter fabrefacta sortitur: totius corporis compages musculorum annularium catena est, quorum fibræ orbiculares contractæ, quemque annulum, prius amplum, & dilatum, angustiorem & longiorem reddunt.* [This Muscle in Earth-Worms, I find is Spiral, as in a good Measure is their Motion likewise; *so that by this means they can (like the Worm of an Augre) the better bore their passage into the Earth. Their reptile Motion also, may be explained by a Wire wound on a Cylinder, which when slipt off, and one End extended and held fast, will bring the other nearer it. So the Earth-Worm, having shot out, or extended*

its

amply treated of others, and many of the things may be applied here. But there are ſome things in which this Tribe is ſomewhat ſingular, which I ſhall therefore take Notice of briefly in this Place. One is their Motion, which I have in another Place (2) taken Notice of to be not leſs curious, than it is different from that of other Animals, whether we conſider the manner of it, as Vermicular, or Sinuous (3) or like that of the Snail

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its body (which is with a wreathing) it takes hold by thoſe ſmall Feet it hath, and ſo contracts the hinder part of its Body. Thus the curious and learned Dr. *Tyſon*, Phil. Tranſ. No. 147.] *Nam proinde cum portio corporis ſuperior elongata, & exporrecta ad ſpatium ulterius extenditur, ibidemque plano affigitur, ad ipſum quaſi ad centrum portio corporis inferior relaxata, & abbreviata facile pertrahitur. Pedunculi ſerie quadruplici, per totam longitudinem Lumbrici diſponuntur: his quaſi totidem uncis, partem modo hanc, modo iſtam, plano affigit, dum alteram exporrigit, aut poſt ſeducit. Supra oris hiatum, Proboſcide, qua terram perforat, & elevat, donatur.* And then he goes on with the other parts that fall under View, the *Brain*, the *Gullet*, the *Heart*, the *Spermatick Veſſels*, the *Stomachs* and *Inteſtines*, the *Foramina* on the top of the back, adjoyning to each Ring, ſupplying the place of Lungs and other parts. *Willis de Anim. Brut.* P. 1. c. 3.

(2) In Book 4. ch. 8.

(3) There is a great deal of Geometrical Neatneſs and Nicety in the ſinuous Motion of Snakes and other Serpents. For the aſſiſting in which Action, the annular Scales under their Body, are very remarkable, lying croſs the Belly, contrary to what thoſe in the Back, and reſt of the Body do; alſo as the Edges of the foremoſt Scales lye over the Edges of their following Scales, from Head to Tail, ſo thoſe Edges run out a little beyond, or over their following Scales; ſo as that when each Scale is drawn back, or ſet a little upright by its Muſcle, the outer Edge thereof (or Foot it may be called) is raiſed alſo a little from the Body, to lay hold on the Earth, and ſo promote and facilitate the Serpents Motion. This is what may be eaſily ſeen in the Slough, or Body of the Serpent-kind. But there is another admirable piece of Mechaniſm, that my Antipathy to thoſe Animals hath prevented my prying

Snail (4), or the Caterpillar (5), or the Multipedous (6), or any other Way, or the Parts miniſtering

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into, and that is, that every Scale hath a diſtinct Muſcle, one end of which is tacked to the middle of its Scale; the other, to the upper Edge of its following Scale. This Dr. *Tyſon* found in the *Rattle-Snake*, and I doubt not is in the whole Tribe.

(4) The wiſe Author of Nature, having denied Feet and Claws to enable Snails to creep and climb, hath made them amends in a way more commodious for their ſtate of Life, by the broad Skin along each ſide of the Belly, and the undulating Motion obſervable there. By this latter 'tis they creep; by the former, aſſiſted with the Glutinous Slime emitted from the Snail's Body, they adhere firmly and ſecurely to all kinds of Superficies, partly by the tenacity of their Slime, and partly by the preſſure of the Atmoſphere. Concerning this part (which he calls the *Snails Feet*) and their Undulation. See Dr. *Liſter's Exercit. Anat.* 1. §. 1. and 37.

(5) The motive Parts and Motion of Caterpillars, are uſeful, not only to their Progreſſion and Conveyance from Place to Place, but alſo to their more certain, eaſy and commodious gathering of Food. For having Feet before and behind, they are not only enabled to go by a kind of Steps of their fore and hind Parts, but alſo to climb up Vegetables, and to reach from their Boughs and Stalks for Food at a diſtance. For which Services, their Feet are very nicely made both before and behind. Behind, they have broad Palms for ſticking to, and theſe beſet almoſt round with ſmall ſharp Nails, to hold and graſp what they are upon: before, their Feet are ſharp and hooked to draw Leaves, &c. to them, and to hold the forepart of the Body, whilſt the hind-parts are brought up thereto. But nothing is more remarkable in theſe Reptiles, than that theſe Parts and Motion are only temporary, and incomparably adapted only to their preſent *Nympha-ſtate*; whereas in their *Aurelia-ſtate*, they have neither Feet, nor Motion, only a little in their hind-parts: and in their *mature-ſtate*, they have the Parts and Motion of a flying Inſect, made for Flight.

(6) It is a wonderful pretty Mechaniſm obſervable in the going of *Multipedes*, as the *Juli*, *Scolopendra*, &c. that on each ſide the Body, every Leg hath its Motion, one very regularly following the other from one end of the Body to the other, in a way not eaſy to be deſcribed in Words;

ſo

ring to it, particularly the Spine (7) and the Muſcles co-operating with the Spine, in ſuch as have Bones, and the Annular and other Muſcles in ſuch as have none, all incomparably made for thoſe curious, and I may ſay, Geometrical Windings and Turnings, Undulations, and all the various Motions to be met with in the Reptile Kind.

Another thing that will deſerve our Notice is the Poyſon (8) that many of this Tribe are ſtocked with

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ſo that their Legs in going make a kind of Undulation, and give the Body a ſwifter Progreſſion than one would imagine it ſhould have, where ſo many Feet are to take ſo many ſhort Steps.

(7) *Vertebrarum Apophyſes breviores ſunt præcipue juxta caput, cujus propterea flexus in averſum, & latera facilis Viperis eſt: ſecus Leonibus*, &c. —— *Incumbit his Oſſibus ingens Muſculorum minutorum præſidium, tum ſpinas tendinum exilium magno apparatu diducentium, tum vertebras notiſſimum in diverſa flectentium, atque erigentium. Adeoque illam corporis miram agilitatem, non tantum* (*ut Ariſtot.*) ὅτι εὐκαμπεῖς καὶ χονδρώδεις οἱ σπόνδυλοι *quoniam faciles ad flexum, & cartilagineas produxit vertebras, ſed quia etiam multiplicia motus localis inſtrumenta muſculos fabrefecit provida rerum Parens Natura, conſecuta fuit.* Blaſ. Anat. Anim. P. 1. c. 39. de Vipera è Veſlingio.

That which is moſt remarkable in the Vertebræ [of the *Rattle-Snake*, beſides the other curious Articulations] *is, that the round Ball in the lower part of the upper Vertebra, enters a Socket of the upper part of the lower Vertebra, like as the head of the Os Femoris doth the Acetabulum of the Os Iſchii; by which contrivance, as alſo the Articulation with one another, they have that free Motion of winding their Bodies any way.* Dr. *Tyſon*'s Anat. of the Rattle-Snake in Phil. Tranſ. No. 144. What is here obſerved of the Vertebræ of this *Snake*, is common to this whole Genus of Reptiles.

(8) My Ingenious and Learned Friend, Dr. *Mead*, examined with his Microſcope the texture of a *Viper's Poyſon*, and found therein at firſt only *a Parcel of ſmall Salts nimbly floating in the Liquor; but in a ſhort time the appearance was changed, and theſe ſaline Particles were ſhot out into Cryſtals, of an incredible Tenuity and Sharpneſs, with ſome-*

thing

with. Which I the rather mention, becauſe ſome make it an Objection againſt the divine Superintendence and Providence, as being a thing ſo far from uſeful (they think) that 'tis rather miſchievous, and deſtructive of God's Creatures. But the Anſwer is eaſy, *viz.* That as to Man, thoſe Creatures are not without their great Uſes, particularly in the Cure of (9) ſome of the moſt ſtubborn

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thing like Knots here and there, from which they ſeemed to proceed; ſo that the whole Texture did in a manner repreſent a Spiders-Web, though infinitely finer. Mead of Poyſons, p. 9.

As to the Nature and Operation of this *Poyſon*, ſee the ſame ingenious Author's Hypotheſis, in his fol. Pages.

This *Poyſon* of the *Viper* lieth in a Bag in the Gums, at the upper end of the Teeth. It is ſeparated from the Blood by a *Conglomerated Gland*, lying in the anterior lateral part of the *Os Sincipitis*, juſt behind the Orbit of the Eye: from which Gland lieth a Duct, that conveys the Poyſon to the Bags at the Teeth.

The Teeth are tubulated, for the conveyance or emiſſion of the Poyſon into the Wound the Teeth make: but their hollowneſs doth not reach to the Apex, or Top of the Tooth (that being ſolid and ſharp, the better to pierce) but it ends in a long ſlit below the Point; out of which the Poyſon is emitted. Theſe Perforations of the Teeth, *Galen* ſaith, the Mountebanks uſed to ſtop with ſome kind of Paſt, before they ſuffered the Vipers to bite them before their Spectators. Cuts of theſe Parts, &c. may be ſeen in the laſt cited Book of Dr. *Mead*. Alſo Dr. *Tyſon*'s *Anat. of the Rattle-Snake*, in *Philoſ. Tranſact.* No. 144.

(9) That Vipers have their great Uſes in Phyſick, is manifeſt from their bearing a great ſhare in ſome of our beſt Antidotes, ſuch as *Theriaca Andromachi*, and others; alſo in the Cure of the *Elephantiaſis*, and other the like ſtubborn Maladies, for which I ſhall refer to the Medical Writers. But there is ſo ſingular a Caſe in the curious Collection of Dr. *Ol. Worm*, related from *Kircher*, that I ſhall entertain the Reader with it. Near the Village of *Saſſa*, about eight Miles from the City *Bracciano* in *Italy*, ſaith he, *Specus ſeu caverna (vulgo La Grotta delli Serpi) duorum hominum capax, fiſtuloſis quibuſdam foraminibus in formam cribri perforata cernitur, ex quibus ingens quadam principio*

Veris

born Diſeaſes: however if they were not, there would be no Injuſtice for God to make a ſet of ſuch noxious Creatures, as Rods and Scourges, to execute the divine Chaſtiſements upon ungrateful and ſinful Men. And I am apt to think that the Nations which know not God, are the moſt annoyed with thoſe noxious Reptiles, and other pernicious Creatures. As to the Animals themſelves, their Poyſon is no doubt of ſome great and eſpecial Uſe to themſelves, ſerving to the more eaſy Conqueſt, and ſure Capture of their Prey,

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Veris diverſicolorum Serpentum, nulla tamen, ut dicitur, ſingulari veneni qualitate imbutorum progenies quotannis pullulare ſolet. In hac ſpelunca Elephantiacos, Leproſos, Paralyticos, Arthriticos, Podagricos, &c. *nudos exponere ſolent, qui mox halituum ſubterraneorum calore in ſudorem reſoluti, Serpentum propullulantium, totum corpus infirmi implicantium, ſuctu linctuque ita omni vitioſo virulentoque humore privare dicuntur, ut repetito hoc per aliquod tempus medicamento, tandem perfectæ ſanitati reſtituantur.* This Cave *Kircher* viſited himſelf, found it warm, and every way agreeable to the Deſcription he had of it; he ſaw their Holes, heard a murmuring hiſſing noiſe in them; but although he miſſed ſeeing the Serpents (it being not the Seaſon of their creeping out) yet he ſaw great numbers of their *Exuviæ*, or *Sluſs*, and an Elm growing hard by laden with them.

The Diſcovery of this Cave was by the Cure of a *Leper* going from *Rome* to ſome Baths near this Place; who loſing his way, and being benighted, happened upon this Cave; and finding it very warm, pull'd off his Cloaths, and being weary and ſleepy, had the good fortune not to feel the Serpents about him, till they had wrought his Cure, *Vid. Muſæum Worm.* L. 3. c. 9.

The before commended Dr. *Mead*, thinks our Phyſicians deal too cautiouſly and ſparingly, in their preſcribing only ſmall Quantities of the Viper's Fleſh, &c. in the *Elephantiaſis*, and ſtubborn *Leproſies*: but he recommendeth rather the Gelly, or Broth of Vipers; or, as the ancient Manner was, to boil Vipers, and eat them like Fiſh; or at leaſt to drink Wine, in which they have been long infuſed, vid. *Mead ubi ſupr.* p. 34.

Prey, which might otherwiſe be too reſty and ſtrong, and if once eſcaped, would hardly be again recovered, by Reaſon of their ſwifter Motion, and the Help of their Legs: beſides all which, this their Poyſon may be probably of very great Uſe to the Digeſtion of their Food.

And as to the innocuous Part of the Reptile-Kind, they as well deſerve our Notice for their Harmleſſneſs, as the others did for their Poyſon. For as thoſe are endowed with Poyſon, becauſe they are predaceous; ſo theſe need it not, becauſe their Food is near at hand, and may be obtained without Strife and Conteſt, the next Earth (10) affording Food to ſuch as can terebrate, and make Way into it by their Vermicular Faculty; and the next Vegetable being Food to others that can climb and reach (11) or but crawl to it.

CHAP. II.

Of the Inhabitants of the WATERS.

I Have now gone through that Part of the Animal World, which I propoſed to ſurvey, the Animals inhabiting the Land. As

(10) That *Earth-worms* live upon Earth is manifeſt from the little curled Heaps of their Dung ejected out of their Holes. But in *Philoſ. Tranſ.* No. 291. I have ſaid it is in all probability Earth made of rotted Roots and Plants, and ſuch like nutritive things, not pure Earth. And there is farther reaſon for it, becauſe Worms will drag the Leaves of Trees into their Holes.

(11) Snails might be in danger of wanting Food, if they were to live only upon ſuch tender Plants as are near the Ground, within their Reach only: to impower them therefore to extend their Purſuits farther, they are enabled by the means mentioned in Note 4. to ſtick unto, and creep up Walls and Vegetables at their Pleaſure.

As to the other Part of the Terraqueous Globe, the Waters, and the Inhabitants thereof, not having time at preſent to finiſh what I have done on that large Subject, I ſhall quit it, unleſs I am encouraged to re-aſſume it, altho' we have there as ample and glorious a Scene of the Infinite Creator's Power and Art, as hath been already ſet forth on the dry Land. For the Waters themſelves are an admirable Work of God (1), and of Infinite Uſe (2) to that Part of the Globe already ſurveyed: and the prodigious Variety (3), and Multitudes of curious and wonderful things obſervable in it's Inhabitants of all ſorts, are an inexhauſtible Scene of the Creator's Wiſdom and Power. The vaſt Bulk of ſome (4), and prodi-

(1) Beſides their abſolute Neceſſity, and great Uſe to the World, there are ſeveral Topicks, from whence the Waters may be demonſtrated to be God's Work, as the forming ſo vaſt a Part of our Globe; the placing it therein, and giving it Bounds; the Methods of keeping it ſweet and clean, by its Saltneſs, by the Tides, and Agitations by the Winds; the making them uſeful to the Vegetation of Plants, and for Food to Animals, by the noble Methods of ſweetning them; and many other things beſides, which are inſiſted on in that part of my Survey.

(2) *Pliny* having named divers *Mirabilia Aquarum*, to ſhew their Power; then proceeds to their Uſes, viz. *Eædem cadentes omnium terra naſcentium cauſa fiunt, prorſus mirabili natura, ſiquis velit reputare, ut fruges gignantur, arbores fruticeſque vivant, in cœlum migrare aquas, animamque herbis vitalem inde deferre: juſta confeſſione, omnes terræ quoque vires aquarum beneficii. Quapropter ante omnia ipſarum potentiæ exempla ponemus. Cunctas enim quis mortalium enumerare queat?* And then he goes on with an Enumeration of ſome Waters famed for being medicinal, or ſome other unuſual Quality. *Plin.* L. 31. c. 1. & 2.

(3) *Pliny* reckons 176 kinds in the Waters, whoſe Names may be met with in his L. 32. c. 11. but he is ſhort in his Account.

(4) *Pliny*, L. 9. c. 3. ſaith, that in the *Indian* Sea there are *Balenæ quaternûm jugerum* (i. e. 960 Feet) *Priſtes* 200 *cubitorum*

digious Minuteneſs of others (5) together with the incomparable Contrivance and Structure of the Bodies (6) of all; the Proviſions and Supplies of Food afforded to ſuch an innumerable company of Eaters, and that in an Element, unlikely one would think, to afford any great ſtore of Supplies (7); the buſineſs of Reſpiration performed in a way ſo different from, but equivalent to what is in Land Animals (8); the Adjuſtment of

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bitorum (i. e. 300 Feet.) And L. 32. c. 1. he mentions Whales 600 Foot long, and 360 broad, that came into a River of *Arabia*. If the Reader hath a Mind, he may ſee his Reaſon why the largeſt Animals are bred in the Sea. L. 9. c. 2.

(5) As the largeſt, ſo the moſt minute Animals are bred in the Waters, as thoſe in Pepper-water; and ſuch as make the green Scum on the Waters, or make them ſeem as if green, and many others.

(6) It might be here ſhewn that the Bodies of all the ſeveral Inhabitants of the Waters are the beſt contrived and ſuited to that Place and Buſineſs in the Waters which is proper for them; that particularly their Bodies are cloathed and guarded in the beſt manner with Scales, or Shells, *&c.* ſuitable to the Place they are to reſide in, the Dangers they may there be expoſed unto, and the Motion and Buſineſs they are there to perform: that the Center of Gravity (of great Conſideration in that Fluid Element) is always placed in the fitteſt part of the Body: that the Shape of their Bodies (eſpecially the more ſwift) is the moſt commodious for making way through the Waters, and moſt agreeable to Geometrical Rules; and many other Matters beſides would deſerve a Place here, were they not too long for Notes, and that I ſhall anticipate what will be more proper for another Place, and more accurately treated of.

(7) See before Book 4. Ch. 11.

(8) *Galen* was aware of the Reſpiration of Fiſhes by their *Branchiæ*. For having ſaid that Fiſhes have no Occaſion of a Voice, neither reſpire through the Mouth as Land Animals do, he ſaith, *Sed earum, quas Branchias nuncupamus, conſtructio, ipſis vice Pulmonis eſt. Cum enim crebris ac tenuibus foraminibus ſint Branchiæ hæ interceptæ, aeri quidem & vapori perviis, ſubtilioribus tamen quam pro mole aquæ; hanc quidem extra repellunt, illa autem prompte intromittunt.*

Galen.

of the Organs of Viſion (9) to that Element in which the Animal liveth; the Poiſe (10), the Support (11), the Motion of the Body (12) forwards with great Swiftneſs, and upwards and downwards with great Readineſs and Agility, and all

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Galen. de Uſ. Part. L. 6. c. 9. So alſo *Pliny* held that Fiſhes reſpired by their Gills, but he ſaith *Ariſtotle* was of a different Opinion. *Plin.* L. 9. c. 7. And ſo *Ariſtotle* ſeems to be in his *Hiſt. Animal.* L. 8. c. 2. and in other Places. And I may add our famous Dr. *Needham.* See his *De form. Fœtu*, Ch. 6. and *Anſwer to* Severinus.

(9) A protuberant Eye would have been inconvenient for Fiſhes, by hindring their Motion in ſo denſe a Medium as Water is; or elſe their bruſhing through ſo thick a Medium would have been apt to wear, and prejudice their Eyes. Therefore their *Cornea* is flat. To make amends for which, as alſo for the Refraction of Water different from that of the Air, the wiſe Contriver of the Eye hath made the *Cryſtalline* ſphærical in Fiſhes, which in Animals living in the Air is *Lenticular*, and more flat.

(10) As I have ſhewed before, that the Bodies of Birds are nicely poiſed to ſwim in the Air: ſo are thoſe of Fiſhes for the Waters, every part of the Body being duly balanced, and the Center of Gravity (as I ſaid in Note 6.) accurately fixed. And to prevent Vacillations, ſome of the Fins ſerve, particularly thoſe of the Belly; as *Borelli* proved by cutting of the Belly-fins, which cauſed the Fiſh to reel to the right and left Hand, and render'd it unable to ſtand ſteadily in an upright Poſture.

(11) To enable the Fiſh to abide at the top, or bottom, or any other part of the Waters, the Air-Bladder is given to moſt Fiſhes, which as 'tis more full or empty, makes the Body more or leſs buoyant.

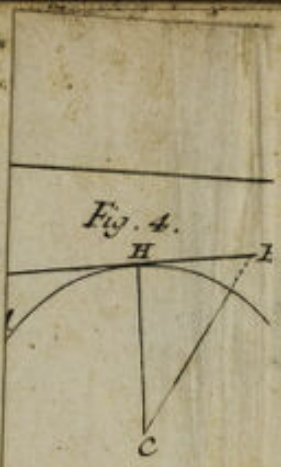
(12) The *Tail* is the grand Inſtrument of the Motion of the Body; not the *Finns*, as ſome imagine. For which reaſon, Fiſhes are more muſculous and ſtrong in that part, than in all the reſt of their Body, according as it is in the motive Parts of all Animals, in the pectoral Muſcles of Birds, the Thighs of Man, *&c.*

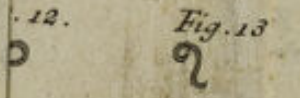
If the Reader hath a mind to ſee the admirable Method, how Fiſhes row themſelves by their Tail, and other Curioſities relating to their ſwimming, I ſhall refer him to *Borelli de mot. Anim.* Part I. ch. 23. particularly to Prop. 213.

(1)

all without Feet and Hands, and ten thouſand things beſides; all theſe things, I ſay, do lay before us ſo various, ſo glorious, and withal ſo inexhauſtible a Scene of the divine Power, Wiſdom and Goodneſs, that it would be in vain to engage my ſelf in ſo large a Province without allotting as much time and pains to it, as the preceeding Survey hath coſt me. Paſſing by therefore that Part of our Globe, I ſhall only ſay ſomewhat very briefly concerning the *Inſenſitive* Creatures, particularly thoſe of the *Vegetable Kingdom*, and ſo conclude this Survey.

BOOK





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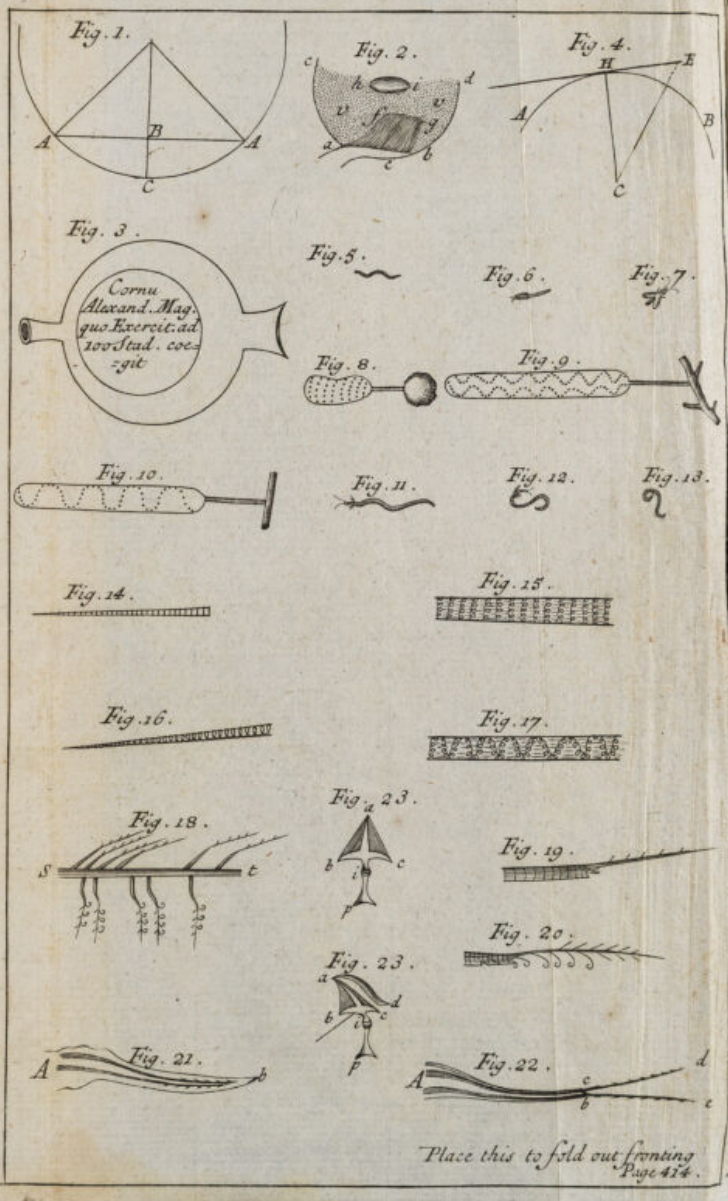

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BOOK X.

Of VEGETABLES.

THE Vegetable Kingdom, although an inferiour Branch of the Creation, exhibits to us ſuch an ample Scene of the Creator's Contrivance, Curioſity, and Art, that I much rather chuſe to ſhew what might be ſaid, than engage too far in particulars. I might inſiſt upon the great Variety there is, both of Trees and Plants provided for all Ages, and for every Uſe and Occaſion of the World (1); ſome for Building, for Tools and Utenſils of every kind; ſome hard, ſome ſoft; ſome tough and ſtrong, ſome brittle; ſome long and tall, ſome ſhort and low; ſome thick and large, ſome ſmall and ſlender; ſome for Phyſick (2), ſome for Food, ſome for Pleaſure; yea the moſt

(1) The fifth Book of *Theophraſtus*'s *Hiſt. Plant.* may be here conſulted: where he gives ample Inſtances of the various Conſtitutions and Uſes of Trees, in various Works, *&c.* See alſo before B. 4. ch. 13. Note 1.

(2) *Inviſis quoque herbis inſeruit* [Natura] *remedia: quippe cum medicinas dederit etiam aculeatis——in quibus ipſis providentiam Naturæ ſatis admirari amplectique non eſt.—— Inde excogitavit aliquas aſpectu hiſpidas, tactu truces, ut tantum non vocem ipſius fingentis illas, patienemque reddentis exaudire videamur, ne ſe depaſcat avida Quadrupes, ne procaces manus rapiant, ne neglecta Veſtigia obterant, ne inſidens Ales infringat: his muniendo Aculeis, teliſque armando, remediis ut tuta ac ſalva ſint. Ita hoc quoque quod in iis odimus, hominum cauſa excogitatum eſt.* Plin. N. H. L. 22. c. 6.

most abject (3) Shrubs, and the very Bushes and Brambles themselves the Husbandman can testify the Use of.

I might also survey here the curious Anatomy and Structure of their Bodies (4), and shew the admi-

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Are some of the Species of Nature noxious? They are also useful.—— Doth a Nettle sting? It is to secure so good a Medicine from the Rapes of Children and Cattle. Doth the Bramble cumber a Garden? It makes the better Hedge? where if it chanceth to prick the Owner, it will tear the Thief. Grew Cosmolog. L. 3. c. 2. §. 47.

(3) That the most abject Vegetables, &c. have their use, and are beneficial to the World, may in some Measure appear from the use the Northern People put rotten Wood, &c. unto. *Satis ingeniosum modum habent populi septentrionales in nemoribus nocturno tempore pertranseuntes, imo & diurno, quando in remotioribus Aquilonis partibus ante, & post Solstitium hyemale continuæ noctes habentur. Quique his remediis indigent, Cortices quercinos inquirunt putres, easque collocant certo interstitio itineris instituti, ut eorum splendore, quo voluerint, perficiunt iter. Nec solum hoc præstat Cortex, sed & Truncus putrefactus, ac Fungus ipse Agaricus appellatus*, &c. Ol. Mag. Hist. L. 2. c. 16.

To this we may add *Thistles* in making Glass, whose Ashes Dr. *Merret* saith are the best, *viz.* the Ashes of the *common way Thistle*, though all *Thistles* serve to this purpose. Next to *Thistles* are *Hop-strings*, cut after the Flowers are gathered. Plants that are Thorny and Prickly, seem to afford the best and most Salt. *Merret's Observ. on Anton. Ner.* p. 265.

Quid majora sequar? Salices, humilesque Genistæ,
Aut illæ pecori frondem, aut pastoribus umbram
Sufficiunt, Sepemque satis, & pabula melli. Virg. ubi supr.

(4) Dr. *Beal* (who was very curious, and tryed many Experiments upon Vegetables) gives some good Reasons to imagine, that there is a direct Communication between the parts of the Tree and the Fruit, so that the same Fibres which constitute the Root, Trunk and Boughs are extended into the very Fruit. And in old *Horn-beams*, I have observed something very like this; in many of which there are divers great and small Ribs (almost like Ivy, only united to the Body) running from the Root up along the outside of the Body, and terminating in one single, or a

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admirable Proviſion made for the Conveyance of the lymphatick and eſſential Juyces, for communicating the Air, as neceſſary to Vegetable, as Animal Life (5): I might alſo ſpeak of even the very Covering they are provided with, becauſe it is a curious Work in Reality, although leſs ſo in Appearance: and much more therefore might I ſurvey the neat Variety and Texture of their Leaves (6), the admirable Finery, Gaiety, and Fra-

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few Boughs: which Bough or Boughs ſpread again into Branches, Leaves and Fruit. See what Dr. *Beal* hath in *Lowth. Abr.* V. 2. p. 710.

But as to the particular Canals, and other parts relating to the Anatomy of Vegetables, it is too long a Subject for this place, and therefore I ſhall refer to *Seigneur Malpighi's* and Dr. *Grew's* Labours in this kind.

(5) *Tanta eſt Reſpirationis neceſſitas, & uſus, ut Natura in ſingulis viventium ordinibus varia, ſed analoga, paraverit inſtrumenta, quæ Pulmones vocamus* [and ſo he goes on with obſerving the *Apparatus* made in the various *Genera* of Animals; and then ſaith] *In Plantis vero, quæ infimum animalium attingunt ordinem, tantam Trachearum copiam & productionem extare par eſt, ut his minimæ Vegetantium partes præter corticem irrigentur.* —— *Plantæ igitur (ut conjectari fas eſt) cum ſint viventia, viſceribus infixa terræ, ab hac, ſeu potius ab aqua & aere, commixtis & percolatis a terra, Reſpirationis ſuæ materiam recipiunt, ipſarumque Trachææ ab halitu terræ, extremas radices ſubingreſſo, replentur.* Malpig. Op. Anat. Plant. p. 15.

Theſe *Trachææ* or *Air-Veſſels*, are viſible, and appear very pretty in the Leaf of *Scabions*, or the Vine, by pulling aſunder ſome of its principal Ribs or great Fibres; between which may be ſeen the Spiral *Air-Veſſels* (like Threads of Cob-web) a litte uncoyled: a Figure whereof Dr. *Grew* hath given us in his *Anat. Plant.* Tab. 51, 52.

As to the curious coyling, and other things relating to the ſtructure of thoſe *Air-Veſſels*, I refer to *Malpig.* p. 14. and Dr. *Grew*, ib. L. 3. c. 3. §. 16, *&c.* and L. 4. c. 4. §. 19. or Mr. *Ray*, from them ſuccinctly, *Hiſt. Plant.* L. 1. c. 4.

(6) Concerning the *Leaves*, I ſhall note only two or three things. 1. As to the *Fibres of the Leaf*, they ſtand not in the Stalk in an even Line, but always in an Angular or

Fragrancy of their Flowers (7). I might alſo in-

Circular Poſture, and their vaſcular Fibres or Threads, are 3, 5 or 7. The reaſon of their Poſition thus, is for the more erect growth and greater Strength of the Leaf, as alſo for the ſecurity of its Sap. Of all which, ſee Dr. *Grew*, L. 1. c. 4. §. 8. *&c.* and L. 4. Part 1. c. 3. alſo Tab. 4. Fig. 2. to 11. Another Obſervable in the Fibres of the Leaf, is their orderly Poſition, ſo as to take in an eighth part of a Circle, as in *Mallows*; in ſome a tenth, but in moſt a twelfth, as in *Holy-Oak*; or a Sixth, as in *Sirynga*. Id. ib. Tab. 46,47.

2. The Art in *Folding up the Leaves* before their eruption out of their Gems, *&c.* is incomparable, both for its Elegancy and Security, *viz. in taking up (ſo as their Forms will bear) the leaſt room; and in being ſo conveniently couched, as to be capable of receiving protection from other parts, or of giving it to one another. e.g. Firſt, there is the Bow-lap, where the Leaves are all laid ſomewhat convexly one over another, but not plaited——but where the Leaves are not ſo thick ſet, as to ſtand in the Bow-lap, there we have the Plicature, or the Flat-lap; as in Roſe-tree*, &c. And ſo that curious Obſerver goes on ſhewing the various Foldings, to which he gives the names of the *Duplicature*, *Multiplicature*, the *Fore-rowl*, *Back-rowl*, and *Tre-rowl*, or *Treble-rowl*. Grew. ib. L. 1. c. 4. §. 14. *&c.* To theſe he adds ſome others, L. 4. P. 1. c. 1. §. 9. *Conſule quoque Malpig. de Gemmis.* p. 22. &c.

To theſe curious Foldings, we may add another noble Guard by the interpoſition of *Films*, &c. of which Dr. *Grew* ſaith, there are about ſix Ways, viz. *Leaves*, *Surfoyls*, *Interfoyls*, *Stalks*, *Hoods and Mantlings*. Grew. ib. and Tab. 41, 42. Malpig. ibid.

(7) In the *Flower* may be conſidered the *Empalement*, as Dr. *Grew*, the *Calyx*, or *Perianthium*, as Mr. *Ray* and others, call it, deſigned to be a Security and Bands to the other parts of the Flower. *Floris velut baſis & fulcimentum eſt.* Ray. Hiſt. L. 1. c. 10. Flowers whoſe *Petala* are ſtrong (as Tulips) have no *Calyx*. *Carnations* whoſe *Petala* are long and ſlender, have an Empalement of one Piece: and others, ſuch as the *Knapweeds*, have it conſiſting of ſeveral Pieces, and in divers Rounds, and all with a counterchangeable reſpect to each other, for the greater Strength and Security of themſelves, and the *Petala*, &c. they include.

The next is the *Foliation*, as Dr. *Grew*, the *Petala*, or *Folia*, as Mr. *Ray*, and others. In theſe, not only the admirable Beauty and luxuriant Colours are obſervable, but alſo

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inquire into the wonderful Generation and Male of the Seed (8), and the great Uſefulneſs of their Fruit, I might ſhew that the Rudiments and Lineaments of the Parent-Vegetable, though never ſo large and ſpacious, is locked up in the little Compaſs of their Fruit or Seed, though ſome of thoſe Seeds are ſcarce viſible to the naked Eye (9). And foraſmuch as the Perpetuity and Safety of

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their curious *Foldings* in the *Calyx* before their Expanſion. Of which Dr. *Grew* hath theſe Varieties, *viz.* The *Cloſe-Couch* as in *Roſes*; the *Concave-Couch*, as in *Blattaria flore albo*: the *Single-Plait*, as in Peaſe-bloſſoms; the *Double-Plait*, as in *Blew-bottles*, &c. the *Couch* and *Plait* together, as in *Marigolds*, &c. The *Rowl*, as in *Ladies Bower*: the *Spire*, as in *Mallows*: and laſtly, the *Plait* and *Spire* together, as in *Convolvulus Doronici folio*. L. 1. c. 5. §. 6. and Tab. 54.

As to the *Stamina* with their *Apices*, and the *Stylus*, (called the *Attire* by Dr. *Grew*) they are admirable whether we conſider their Colours, or their Make, eſpecially their Uſe, if it be as Dr. *Grew*, Mr. *Ray*, and others imagine, namely, as a *Male Sperm*, to impregnate and fructify the Seed. Which Opinion is corroborated by the ingenious Obſervations of Mr. *Sam. Morland*, in *Philoſ. Tranſ.* No. 287.

Reliqua uſus alimentique gratia genuit [Natura] *ideoque ſecula annoſque tribuit iis. Flores vero odoreſque in diem gignit: magna (ut palam eſt) admonitione hominum, qua ſpectatiſſime floreant, celerrime marceſcere.* Plin. N. H. L. 21. c. 1.

(8) As to the curious and gradual proceſs of Nature in the Formation of the Seed or Fruit of Vegetables, Cutts being neceſſary, I ſhall refer to Dr. *Grew*, p. 45, and 209. and *Malpig.* p. 57.

(9) *Vetus eſt Empedoclis dogma Plantarum ſemina Ova eſſe, ab iiſdem decidua —— Ineſt in eo* [Ovo vel Semine] *velut in cicatrice, non ſola viventis carina, ſed cum minimo trunco aſſurgentes partes, Gemma ſcilicet, & inſignis radicis Conus*, &c. Malpig. ib. p. 81. vid. plura in tract. *de Seminum veget.* p. 14. & paſſim.

In *Malpighi*'s Life, a Debate may be ſeen between him and *Seign. Triumphetti*, the Provoſt of the Garden at *Rome*, whether the whole Plant be actually in the Seed? The

Affirmative is maintained by *Malpighi*, with cogent Arguments: among which, this is one: *Non præoccupata mente, oculis microscopio armatis, lustret quaso Phascelorum seminalem plantulam nondum satam, in qua folia stabilia, hæcque ampla evidenter observabit; in eadem pariter gemmam, nodos, seu implantationes varias foliorum caulis deprehendet. Caulem insignem fibris ligneis, & utriculorum seriebus constantem conspicue attinget.* And whereas *S. Triumphetti* had objected that *vegetatione, metamorphosi, inedia plantas in alias degenerare, ut exemplo plurium* [constat] *præcipue tritici in lolium, & lolii in triticum versi.* In answer to this (which is one of the strongest Argumenrs against *Malpighi*'s Assertion) *Malpighi* replies, *nondum certum est de integritate, & successu experimenti, nam facienti mihi, & amicis, tritici metamorphosis non cessit. Admissa tamen metamorphosi, quoniam hæc neglecta cultura, aut vitio soli, aut aeris contingit---ideo ex morboso, & monstruoso affectu non licet inferre permanentem statum a Natura intentum. Observo plantas sylvestres cultura varias reddi*, &c. I have more largely taken notice of *Malpighi*'s Answer, because he therein shews his Opinion about the transmutation of Vegetables. *Vid. Malpig. Vit.* p. 67.

So Mr. *Leewenhoek*, after his nice Observations of an *Orange-Kernel*, which he made to germinate in his Pocket, &c. concludes, *Thus we see, how small a Particle, no bigger than a course Sand* (as the Plant is represented) *is increased*, &c. *a plain Demonstration, that the Plant, and all belonging to it, was actually in the Seed, in the young Plant, its Body, Root*, &c. Philos. Transf. No. 287. See also *Raii Cat. Cant.* in *Acer maj.* from Dr. *Highmore*. But in all the Seeds which I have viewed except the *Maple*, the Plant appears the plainest to the naked Eye, and also very elegant in the *Nux Vomica*.

Natura non observat magnitudinis proportionem inter semina & plantas ab iisdem ortas, ita ut majus semen majorem semper producat plantam, minus minorem. Sunt enim in genere herbarum non pauca, quarum semina arborum nonnullarum seminibus non dico æqualia sunt, sed multo majora. Sic v. g. *Semina Fabæ*, &c. *semina Ulmi*, &c. *multis vicibus magnitudine superant.* Raii ubi supra. L. 1. c. 13.

Filicem reliquasque Capillares herbas Semine carere Veteres plerique —— prodidere; quos etiam secuti sunt e Recentioribus nonnulli, Dodonæus, &c. —— *Alii e contra, Bauhinus*, &c. *Filices & congeneres spermatophoras esse contendunt: partim quia Historia Creationis* Genes. 11. 12. &c. —— *Hanc sententiam verissimam esse —— autopsia convincit. Fredericus Cæsius*, he saith, was the first that discovered these Seeds, with the help of a Microscope. And since him, Mr. *W. C.* hath more critically observed them. Among other things observed

of the Species depends upon the Safety of the Seed and Fruit in a great measure, I might therefore take notice of the peculiar Care the great God of Nature hath taken for the Conservation and Safety hereof: as particularly in such as dare to shew their Heads all the Year, how securely their Flower, Seed or Fruit is locked up all the Winter, together with their Leaves and Branches, in their Gems (10), and well fenced and cove-

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served by that ingenious Gent. are these, *Pyxidulæ seu capsulæ semina continentes in plerisque hoc genus plantis perquam exili granulo arenæ vulgaris cinereæ plus duplo minores sunt; imo in nonnullis speciebus vix tertiam quartamve arenulæ partem magnitudine æquant, vesicularum quarundam annulis aut fasciolis vermiformibus obvolutarum speciem exhibentes. Nonnullæ ex his vesiculis* 100 *circiter semina continere deprehendebantur.* ——— *adeo eximia parvitate ut nudo oculo prorsus essent invisibilia, nec nisi microscopii interventu detegi possent.* ——— *Osmunda regalis, quæ aliis omnibus Filicis speciebus mole* ——— *antecellit* —— *vascula seminalia obtinet æquæ cum reliquis congeneribus magnitudinis* ——— *quorum immensa & visum fugiens parvitas cum magnitudine plantæ collata* ——— *adeo nullam gerere proportionem invenietur, ut tantam plantam e tantillo semine produci attentum observatorem merito in admirationem rapiat.* Ray ibid. L. 3. pag. 132. This *W. C.* was Mr. *Wil. Cole*, as he owneth in a Letter I have now in my hands of his to Mr. *Ray*, of *Octob.* 18. 1684.

(10) *Vegetantium genus, ut debitam magnitudinem sortiatur, & suæ mortalitatis jacturam successiva prolis eductione reparet, statis temporibus novas promit partes, ut tandem emergentes Uteri, recentes edant Soboles. Emanantes igitur a caule, caudice, ramis, & radicibus novellæ hujusmodi partes, non illico laxatæ extenduntur, sed compendio quodam coagmentatæ intra folii axillam cubantes, non parum subsistunt, Gemmæ appellantur*, &c. And then that great Man goes on to shew the admirable various Methods of Nature in repositing in that little compass so large a part of a Tree or Plant, the curious Structure of the Gems, the admirable Guard afforded them, and the Leaves, Flowers and Seed contained in them, *&c.* Of which having taken notice before, I pass over it now, and only refer to our Author *Malpighi*, and Dr. *Grew*, in the Places cited in Note 6, and 7.

covered there with neat and close Tunicks. And for such as dare not so to expose themselves, with what Safety are they preserved under the Coverture of the Earth in their Root (11), Seed (12), or Fruit, till invited out by the kindly Warmth of the Spring! And when the whole Vegetable Race is thus called out, it is very pretty to observe the Methods of Nature in guarding those insensitive Creatures against Harms and Inconveniences, by making some (for Instance) to lie down prostrate, and

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(11) Of *Bulbous*, and a great many more, probably of the far greater number of *Perennial Roots* of Herbs, as *Arum*, *Rape-Crowfoot*, &c. it is very observable, that their Root is annually renewed, or repaired out of the Trunk or Stalk it self. That is to say, the *Basis* of the *Stalk* continually, and by insensible degrees descending below the Surface of the Earth, and hiding it self therein, is thus both in Nature, Place and Office, changed into a true Root.——So in *Brownwort*, the Basis of the Stalk sinking down by degrees, till it lies under ground, becomes the upper part of the Root; and continuing still to sink, the next Year becomes the lower part; and the next after that, rots away; a new Addition being still yearly made out of the Stalk, as the elder Parts yearly rot away. *Grew. ibid.* L. 2. pag. 59. *ubi plura vid.*

(12) How safe and agreeable a Conservatory the Earth is to Vegetables, more than any other, is manifest from their rotting, drying, or being rendered infecund in the Waters, or the Air; but in the Earth their Vigour is long preserved. Thus Seeds particularly, Mr. *Ray* thinks some, may probably retain their fecundity for Ten Years, and others lose it in five: but saith he, *In terræ gremio latitantia, quamvis tot caloris, frigoris, humoris & siccitatis varietatibus ibidem obnoxia, diutius tamen (ut puto) fertilitatem suam tuentur, quam ab hominibus diligentissime custodita; nam & ego & alii ante me multi observarunt Sinapeos vim magnam, enatam in aggeribus fossarum recens factis, inque areis gramineis effossis, ubi post hominum memoriam nulla unquam Sinapeos seges succreverat. Quam tamen non sponte ortam suspicor, sed e seminibus in terra per tot annos residuis etiam prolificis.* Ray. Hist. Pl. L. 1. c. 13.

(13)

and others to close themselves up (13) upon the Touch of Animals, and the most to shut up their Flowers, their Down (14) or other their like Guard, upon the Close and Cool of the Evening, by means of Rain, or other Matters that may be prejudicial to the tender Seed.

And now to these Considerations relating to the Seed, I might add the various Ways of Nature in dissipating and sowing it, some being for this end, winged with light Down or Wings to be conveyed about by the Winds; others being laid in elastick springy Cases, that when they burst and crack, dart their Seed at convenient distances, performing thereby the Part of a good Husbandman (15); others by their agreeable Tast and

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(13) *Plantæ nonnullæ Æschynomenæ Veteribus dictæ, Recentioribus Vivæ & Sensitivæ & Mimosæ haud obscuræ sensus indicia produnt: siquidem folia earum manu aut baculo tacta, & paululum compressa, pleno etiam meridie, splendente Sole, illico se contrahunt; in nonnullis etiam speciebus cauliculi teneriores concidunt & velut marcescunt; quod idem ab aere frigidiore admisso patiuntur.* Ray. Hist. Pl. T. 1. L. 18. App. S. 2. c. 2. p. 978.

(14) I have observed that many, if not most Vegetables, do expand their Flowers, Down, &c. in warm Sunshiny Weather, and again close them towards Evening, or in Rain, &c. especially at the beginning of Flowering, when the Seed is young and tender; as is manifest in the Down of *Dandelion*, and other Downs; and eminently in the Flowers of *Pimpernel*, the opening and shutting of which are the Country-Man's Weather-wiser; whereby *Gerard* saith, he foretelleth what Weather shall follow the next day; for saith he, *if the Flowers be close shut up, it betokeneth Rain and foul Weather; contrariwise, if they be spread abroad, fair Weather*, Ger. Herb. B. 2. ch. 183.

Est & alia [arbor in Tylis] *similis, folioscor tamen roseique floris; quem noctu comprimens, aperire incipit Solis exortu, meridie expandit. Incolæ dormire eam dicunt.* Plin. Nat. Hist. L. 12. c. 11.

(15) *So soon as the Seed is ripe, Nature taketh several Methods for its being duly Sown: not only in the opening of the*

Uterus,

Uterus, but also in the make of the Seed it self. For first, the Seeds of many Plants, which affect a peculiar Soil or Seat, as of Arum, Poppy, &c. are heavy and small enough, without further care, to fall directly down into the Ground——But if they are so large and light, as to be exposed to the Wind, they are often furnished with one or more Hooks, to stay them from straying too far from their proper Place. —— So the Seeds of Avens *have one single Hook; those of* Agrimony *and* Goose-grass *many; both the former loving a warm bank; the latter, an Hedge for its support. On the contrary, many Seeds are furnished with Wings or Feathers; partly with the help of the Wind to carry them, when ripe, from off the Plant, as of Ash, &c. —— and partly to enable them to make their flight more or less abroad, that so they may not, by falling together, come up too thick; and that if one should miss a good Soyl or Bed, another may hit. So the Kernels of* Pine *have Wings —— yet short —— whereby they fly not into the Air, but only flutter upon the Ground. But those of Typha, Dandelion, and most of the Pappous kind—— have long numerous Feathers, by which they are wafted every way.—— Again there are Seeds, which are scattered not by flying abroad, but by being either spirted, or slung away. The first of those are Wood-sorrel, which having a running Root, Nature sees fit to sow the Seeds at some distance. The doing of which is effected by a white sturdy Cover, of a tendinous or springy nature. —— This Cover, so soon as it begins to dry, bursts open on one side, in an instant, and is violently turned inside outward —— and so smartly throws off the Seed. The Seeds of Hartstongue, is slung or shot away —— by the curious Contrivance of the Seed-Case, as in Codded-Arsmart, only there the Spring moves and curls inward, but here outward;* viz. *Every Seed-Case —— is of a Spherick Figure, and girded about with a sturdy Spring. —— The Surface of the Spring resembles a fine Screw. —— So soon as —— this Spring is become stark enough, it suddenly breaks the Case into two Halfs, like two little Cups, and so slings the Seed.* Grew. ib. p. 199. and in Tab. 72. all these admirable Artifices are handsomely represented.

Quin si quantitas modica seminum (Filicis, Phyllitidis quoque) *a foliis in subjectam chartæ mundæ —— schedam decutiatur, detergatur ve, & deinde in acervum converratur, vesicularum seminalium plurimis una dissilientibus, & sibi invicem allisis, acervulus varie moveri per partes videbitur, non secus ac si Syronibus aut istiusmodi bestiolis repletus esset —— quin si locus tranquillus sit, aure proxime admota, crepitantium interrumpendum vasculorum sonitu, —— percipietur; & si microscopio chartam oculis oberres, semina per eam undique sparsa, & ad notabilem ab acervo distantiam projecta comperies.* Ray ibid, p. 132.

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and Smell and ſalutary Nature inviting themſelves to be ſwallowed and carried about by the Birds, and thereby alſo fertilized by paſſing through

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The admirable Contrivance of Nature, in this Plant, is moſt plain. For the Seed-Veſſels being the beſt Preſerver of the Seed, 'tis there kept from the Injuries of Air and Earth, 'till it be rainy, when it is a proper time for it to grow, and then it is thrown round the Earth, as Grain by a skilful Sower.---When any Wet touches the End of the Seed-Veſſels, with a ſmart Noiſe, and ſudden Leap it opens it ſelf, and with a Spring ſcatters its Seed to a pretty Diſtance round it, where it grows. Dr. Sloane Voy. to Jamaica, p. 150. of the *Gentianella flore cæruleo*, &c. or *Spirit-Leaf.*

The Plants of the *Cardamine*-Family and many others may be added here, whoſe Cods fly open, and dart out their Seed upon a ſmall Touch of the Hand. But the moſt remarkable Inſtance is in the *Cardamine impatiens, cujus Siliquæ* (ſaith Mr. *Ray*) *vel leviter tactæ actutum ejaculantur* [Semina] *imo quod longe mirabilius videtur, etſi ſiliquas non tetigeris, ſi tamen manum velut tacturus proxime admoveas, ſemina in appropinquantem evibrabunt; quod tum Moriſonus ſe ſæpius expertum ſcribit, tum Johnſtonus apud Gerardum verum eſſe affirmat.* Hiſt. Plant. L. 16. c. 20.

Neither is this Proviſion made only for Land Vegetables, but for ſuch alſo as grow in the Sea. Of which I ſhall give an Inſtance from my before commended Friend Dr. *Sloane. As to the Fuci,---their Seed hath been diſcovered (and ſhewed me firſt) by the induſtry of the ingenious Herbariſt, Mr.* Sam. Doody, *who found on many of this kind ſolid Tubercules, or Riſings in ſome Seaſons, wherein were lodged ſeveral round Seeds, as big as Muſtard-Seed, which, when ripe, the outward Membrane of the Tubercule breaking, leaveth the Seed to float up and down with the Waves. This Seed coming near Stones, or any ſolid Foundation, by means of a Mucilage it carries with it, ſticks to them, and ſhoots forth Ligulæ with Branches, and in time comes to its Perfection and Magnitude.* Sloan. Voy. Jamaica p. 50.

But although Mr. *Doody* had hinted, and conjectured at the thing, yet the firſt that diſcovered the Seeds in *Fuci*, was the before commended Dr. *Tancred Robinſon*; as may be ſeen by comparing what Mr. *Ray* ſaith in his *Synopſ. Stirp. Brit.* p. 6. with his *Append. Hiſt.* p. 1849. Beſides which *Fuci*, the Dr. tells me, he obſerved Veſſels and Seed in *Coralloid Shrubs*, as alſo in ſeveral *Fungi*, not only in the

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their Bodies (16); and others not thus taken Care of

Species of *Crepitus Lupi*, but alſo between the *Lamellæ* of other Species and in that ſubterraneous kind called *Truffles*, whoſe Seed and Veſſels open in the Cortex, at ſome Seaſons he ſaith, like that of Mallows in Shape.

As to the *Crepitus Lupi*, I have more than once examined their Powder, with thoſe excellent Microſcopes of Mr. *Wilſon*'s make: but the moſt ſatisfactory View Mr. *Wilſon* himſelf gave me; by which I found the Seeds to be ſo many exceedingly ſmall *Puff-Balls*, with round Heads, and longer than ordinary, ſharp pointed Stalks, as if made on purpoſe to prick eaſily into the Ground. Theſe Seeds are intermixed with much duſty matter, and become hurtful to the Eyes, probably by their ſharp Stalks pricking and wounding that tender Organ.

(16) The ancient Naturaliſts do generally agree, that *Miſſeltoe* is propagated by its Seeds carried about by, and paſſing through the Body of Birds. Thus *Theophraſtus de Cauſ. Plant.* L. 2. c. 24. Τὸ δὲ ἀπὸ τῆς ἕδρ ὀρμίζειν, &c. *Initium vero a paſtu avium.* —— *Quippe Viſco detracto confectoque in alveis, quod frigidiſſimum eſt, ſemen cum excremento purum dimittitur, & facta mutatione aliqua in arbore Stercoris cauſa pullulat, erumpitque*, &c. So alſo *Pliny* ſaith, *viz. Omnino autem ſatum* [Viſcum] *nullo modo naſcitur, nec niſi per alvum Avium redditum, maxime Palumbis ac Turdi. Hæc eſt natura, ut niſi maturatum in ventre Avium non proveniat.* Plin. N. H. L. 16. c. 44. Whether what *Theophraſtus* and *Pliny* affirm, be conducive to the better fertilizing the Seeds of *Miſſeltoe*, I know not; but that it is not of abſolute neceſſity, I can affirm upon mine own Experience, having ſeen the Seeds germinate, even in the Bark of Oak. But although they ſhot above an Inch, and ſeemed to root in the Tree, yet they came to nothing, whether deſtroyed by Ants, &c. which I ſuſpected, or whether diſagreeing with the Oak I know not. But I ſince find the Matter put out of doubt by Mr. *Doody*, which ſee in Mr. *Ray's Hiſt. Plant. App.* p. 1918.

Nutmegs are ſaid to be fertilized after the ſame manner, as *Tavernier* ſaith, was confirmed to him by Perſons that lived many Years in thoſe Parts; whoſe Relation was, The Nutmeg being ripe, ſeveral Birds come from the Iſlands toward the South, and devour it whole, but are forced to throw it up again, before it be digeſted. That the Nutmeg, then beſmeared with a Viſcous Matter, falling to the Ground, takes root, and produces a Tree, which would

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of, do many of them by their Uſefulneſs in human Life, invite the Husbandman and Gardiner carefully to ſow and nurſe them up.

To this ſo ſingular a Care about the Propagation and Conſervation of the Species of Vegetables, I might add the nice Proviſion that is made for their Support and Aid in ſtanding and growing, that they may keep their Heads above ground, and not be rotted and ſpoiled in the earth themſelves, nor thereby annoy us; but on the contrary miniſter to all their Ends, and our Uſes; to afford us Houſes, Utenſils, Food (17), Phyſick, Cloath-

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never thrive, was it planted. *Tavern. of the Commod. of the G. Mogul.* And *Monſieur Thevenot*, in his Travels to the *Indies*, gives this Account; the Tree is produced after this manner; there is a kind of Birds in the Iſland, that having picked off the green Husk, ſwallow the Nuts, which having been ſome time in their Stomach, they void by the ordinary way; and they fail not to take rooting in the Place where they fall, and in time, to grow up to a Tree. This Bird is ſhaped like a *Cuckow*, and the *Dutch* prohibit their Subjects under pain of Death, to kill any of them. *v. Sir T. Pope Blunt's Nat. Hiſt.*

But Mr. *Ray* gives a ſomewhat different account: *Hunc fructum* [Nucem Moſchatam] *variæ quidem aves depaſcuntur, ſed maxime Columbæ genus album & parvum, quæ dehiſcente nucamento, illectæ ſuavitate Macis hunc cum Nuce eripiunt & devorant, nec niſi repleta ingluvie capaciſſima ſaginam deſerunt. Noſtrates ibi mercatores Columbis iſtis Neuteeters ſive Nucivoris nomen impoſuerunt. Quas autem vorant Nuces, poſt integras per alvum reddunt. Redditæ citius deinde germinant, utpote præmaceratæ fervore Ventriculi. Arbores inde natæ ceu præcociores, facile ſunt corruptioni obnoxiæ, fructumque ferunt cæteris multo viliorem, & hâc causâ neglectum incolis contemptumque, præter Macin, quem ad adulterandum meliorem adhibent.* Ray H. P. L. 27. c. 4.

(17) *Arbores blandioribus fruge ſuccis hominem mitigavere. Ex iis recreans membra Olei liquor, vireſque potus Vini: tot denique ſapores annui ſponte venientes: & menſæ, depugnetur ſi et earum cauſa cum feris, & paſti naufragorum corporibus piſces expetantur, etiamnum tamen ſecundæ. Mille præterea*

ſunt

Cloathing, yea Diverſion too, by the Beauty of their Looks, by the Fragrancy of their Smell, by creating us pleaſant Shades againſt the ſcorching Beams of Summer, and skreening us againſt the piercing Winds, and Cold of Winter (18).

And it is very obſervable what admirable Proviſions are made for this purpoſe of their Support and Standing, both in ſuch as ſtand by their own Strength, and ſuch as need the Help of others. In ſuch as ſtand by their own Strength by means of the ſtronger, and more ligneous Parts (equivalent to the Bones in Animals) being made not inflexible, as Bones; becauſe they would then be apt to break, but of a yielding elaſtick Nature, to eſcape and dodge the Violence of the Winds: and by

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ſunt uſus earum, ſine quibus vita degi non poſſit. Arbore ſultamus maria, terraſque admovemus, arbore exædificamus tecta. Plin. N. H. L. 12. c. 1.

(18) *Plantarum Uſus latiſſime patet, & in omni vitæ parte occurrit. Sine illis laute, ſine illis commode non vivitur, at nec vivitur omnino: Quæcunque ad victum neceſſaria ſunt, quæcunque ad delicias faciunt, è locupletiſſimo ſuo penu abunde ſubminiſtrant. Quanto ex iis menſa innocentior, mundior, ſalubrior quam ex Animalium cæde & laniena? Homo certe natura Animal carnivorum non eſt; nullis ad prædam & rapinam armis inſtructum, non dentibus exertis & ſerratis, non unguibus aduncis. Manus ad fructus colligendos, dentes ad mandendos comparati. Non legimus ei ante Diluvium carnes ad eſum conceſſas. At non Victum tantum nobis ſuppeditant, ſed & Veſtitum, & Medicinam, & Domicilia aliaque ædificia, & Navigia, & Suppellectilem, & Focum, & Oblectamenta Senſuum Animique: Ex his naribus odoramenta & ſuffumigia parantur. Horum flores inenarrabili colorum & Schematum varietate & elegantia oculos exhilarant, ſuaviſſima odorum quos expirant fragrantia ſpiritus recreant. Horum fructus gulæ illecebræ menſas ſecundas inſtruunt, & languentem appetitum excitant. Taceo virorem amœniſſimum oculis amicum, quem per prata, paſcua, agros, ſylvas ſpatiantibus objiciunt, & Umbras quas contra æſtum & ſolis ardores præbent.* Ray. ib. L. 1. c. 24 p. 46.

(19)

by means alſo of the Branches ſpreading handſomely and commodiouſly about, at an Angle of about 45 *gr.* by which means they equally fill up, and at the ſame time make an Æquilibration of the Top (19).

And as for ſuch Vegetables as are weak, and not able to ſupport themſelves, 'tis a wonderful Faculty they have, ſo readily and naturally to make Uſe of the Help of their Neighbours, embracing and climbing up upon them (20), and uſing

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(19) *All Vegetables of a tall and ſpreading Growth ſeem to have a natural Tendency to a Hemiſpherical Dilatation, but generally confine their ſpreading within an Angle of* 90 gr. *as being the moſt becoming and uſeful Diſpoſition of its Parts and Branches. Now the ſhorteſt way to give a moſt graceful and uſeful filling to that Space of dilating and ſpreading out, is to proceed in ſtrait Lines, and to diſpoſe of thoſe Lines, in a Variety of Parallels,* &c. *And to do that in a quadrantal Space,* &c. *there appears but one way poſſible, and that is, to form all the Interſections which the Shoots and Branches make, with Angles of* 45 gr. *only. And I dare appeal to all if it be not in this manner, almoſt to a nicety, obſerved by Nature,* &c. *A viſible Argument that the Plaſtic Capacities of Matter are governed and diſpoſed by an All-wiſe and infinite Agent, the native Strictneſſes and Regularities of them plainly ſhewing from whoſe Hand they come.* Account of the Origine and Format. of Foſſ. Shells, &c. Print. *Lond.* 1705. pag. 38, 41.

(20). *In Hedera ſurculi, & rami hinc inde claviculos, quaſi radiculas emittunt, quæ parietibus, vel occurrentibus arboribus veluti digitis firmantur, & in altum ſuſpenduntur. Hujuſmodi radiculæ ſubrotundæ ſunt, & pilis cooperiuntur; & quod mirum eſt, glutinoſum fundunt humorem ſeu Terebinthinam, quâ arctè lapidibus nectuntur & agglutinantur.* —— *Non minori induſtria Natura utitur in Vite Canadenſi,* &c. The admirable and curious make of whoſe Tendrels and their Feet, ſee in the illuſtrious Author *Malpig. de Capreolis,* &c. pag. 48.

Claſpers are of a compound Nature between that of a Root, and a Trunk. Their Uſe is ſometimes for Support only; as in the Claſpers of Vines, Briony, &c. *whoſe Branches being long, ſlender, and fragile, would fall by their own Weight, and that of their Fruit: but theſe Claſpers taking hold of any thing that*

using them as Crutches to their feeble Bodies: some by their odd convolving Faculty, by twisting themselves like a Screw about others; some advancing themselves, by catching and holding with their curious *Claspers* and *Tendrels*, equivalent to the Hands; some by striking in their rooty Feet; and others by the emission of a natural Glue, closely and firmly adhering to something or other that administers sufficient Support unto them. All which various Methods being so nicely accommodated to the Indigencies of those helpless Vegetables, and not to be met with in any besides, is a manifest Indication of their being the Contrivance and Work of the Creator, and that his infinite Wisdom and Care condescends even to the Service and Wellbeing of the meanest, most weak and helpless insensitive Parts of the Creation.

In the last Place, to the Uses already hinted at, I might add a large Catalogue of such among Vegetables, as are of peculiar Use and Service to the World, and seem to be designed as 'twere on purpose, by the most merciful Creator, for the good of Man, or other Creatures (||). Among *Grain*,

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that is at Hand: which they do by a natural Circumvolution which they have (those of Briony have a retrograd: Motion about every third Circle, in the Form of a double Clasp, so that if they miss one way, they may catch the other.) Sometimes the Use of Claspers is also for a Supply, as in the Trunk Roots of Ivy; which being a Plant that mounts very high, and being of a closer and more compact Substance than that of Vines, the Sap would not be sufficiently supplied to the upper Sprouts, unless these assisted the mother Root: but these serve also for Support too. Sometimes also they serve for Stabiliment, Propagation, and Shade: for the first of these serve the Claspers of Cucumers; for the second, those, or rather the Trunk-Roots of Chamomil; and for all three the Trunk Roots of Strawberries. Harris Lex. Tech. in verb. *Claspers.*

(||) Vegetables afford not only Food to Irrationals, but also Physick, if it be true which *Aristotle* saith, and after him

Grain, I might Name the great Fertility (21) of such as serves for Bread, the easy Culture and Propagation thereof, and the Agreement of every Soil and Climate to it. Among Trees and Plants I might instance in some that seem to be designed as 'twere on purpose for almost every Use (22), and Convenience: some to heal the most stubborn and

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him *Pliny*; which latter in his 8th Book, ch. 27. specifies divers Plants made use of as Specificks by divers both Beasts and Birds; as *Dittany* by wounded *Deer*, *Celandine* by *Swallows*, to cure the sore Eyes of their Young, &c. And if the Reader hath a mind to see more Instances of this nature (many of them fanciful enough) he may consult *Mersenne in Genes.* pag. 933.

(21) See before Book 4. Chap. 11. Note 2.

(22) *Planta hæc unica* [Aloe Americana] *inquit Fr. Hernandez quicquid vitæ esse potest necessarium præstare facile potest, si esset rebus humanis modus. Tota enim illa lignorum sepiendorumque agrorum usum præstat, caules tignorum, folia vero tecta tegendi imbricum, lancium eorundem nervuli & fibræ eundem habent usum ad linteamina, calceos, & vestimenta conficienda quem apud nos Linum, Cannabis, Gossipium*, &c. *E mucronibus fiunt clavi, aculei, fubulæ, quibus perforandis cruribus, macerandi corporis gratia, Indis uti mos erat cum Damonum vacarent cultui*; *item aciculæ, acus, tribuli militares, & rostella idonea pectendis subtegminibus. Præterea e succo mananti, cujus evulsis germinibus internis foliisve tenerioribus cultis* [Yztlinis] *in mediam cavitatem, stillat planta unica ad* 50 *interdum amphoras* (*quod dictu est mirabile*) *Vina, Mel, Acetum ac Saccharum parantur* [The Methods of which he tells.] *Idem fluctus menses ciet, alvum lenit, Urinam evocat, Renes & Vesicam emundat. E radice quoque Restes fiunt firmissimæ. Crassiores foliorum partes truncusque decocta sub terra edendo sunt apta, sapiuntque Citrea frusta saccharo condita: quin & vulnera recentia mirè conglutinat.*——*Folia quoque assa & affecto loco imposita convulsionem curant, ac dolores leniunt* (*præcipue si succus ipse calens bibatur*) *quamvis ab Indicâ proficiscantur lue, sensum hebetant atq; torporem inducunt. Radicis succus luem Veneream curat apud Indos.* D. Palmer. Ray ib. L. 22. c. 7. See also Dr. *Sloane Voy. to Jamaica* p. 247.

There are also two sorts of *Aloe* besides, mentioned by the same Dr. *Sloane*, one of which is made use of for Fish-

dangerous Distempers (23), to alleviate and ease the Pains (24) of our poor infirm Bodies all the World over: And some designed for the peculiar Service and Good of particular Places, either to cure such Distempers as are peculiar to them, by growing more plentifully there than elsewhere (25); or else to obviate some Inconvenience there

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ing-Lines, Bow-strings, Stockins, and Hammocks. Another hath Leaves that hold Rain-water, to which Travellers, &c. resort to quench their Thirst, in scarcity of Wells, or Waters, in those dry Countries. ibid. p. 249.

(23) For an instance here I shall name the *Cortex Peruvianus*, which Dr. *Morton* calls *Antidotus in levamen arumnarum vitæ humanæ plurimarum divinitus concessa.* De Febr. Exer. 1. c. 3. *In Sanitatem Gentium procul dubio a Deo O. M. conditus. Cujus gratia, Arbor vitæ, siqua alia, jure merito appellari potest.* Id. ib. c. 7. *Eheu! quot convitiis Herculea & divina hæc Antidotus jactabatur?* Ibid.

To this (if we may believe the *Ephemer. German.* An. 12. Obser. 74. and some other Authors) we may add *Trifolium paludosum*, which is become the *Panacæa* of the *Germans* and Northern Nations.

(24) *Pro doloribus quibuscunque sedandis præstantissimi semper usus Opium habetur; quamobrem merito* Nepenthe *appellari solet, & remedium vere divinum existit. Et quidem satis mirari vix possumus, quomodo urgente visceris aut membri cujuspiam tortura insigni, & intolerabili cruciatu, pharmacum hoc, incantamenti instar, levamen & ἀναλγησίαν subitam, immo interdum absque somno, aut saltem prius quam advenerit, concedit. Porro adhuc magis stupendum est, quod donec particulæ Opiaticæ operari, & potentiam suam narcoticam exerere continuant, immo etiam aliquamdiu postquam somnus finitur, summa nlleviatio, & indolentia in parte affecta persisti* Willis Phar. rat. par. 1. S. 7. c. 1. §. 15.

(25) *Tales Plantarum species in quacunque regione a Deo creantur quales hominibus & animalibus ibidem natis maxime conveniunt; imo ex plantarum nascentium frequentia se fere animadvertere posse quibus morbis* [endemiis] *quælibet regio subjecta sit, scribit Solenander. Sic apud Danos, Frisios, Hollandos, quibus Scorbutus frequens, Cochlearia copiose provenit.* Ra; H. Pl. L. 16. c. 3.

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there or to supply some constant Necessity, or Occasion, not possible, or at least not easy, to be supplyed any other Way (26). 'Tis, for instance, an admirable Provision made for some Countries subject to Drought, that when the Waters every where fail, there are Vegetables which contain not only Moisture enough to supply their own Vegetation and Wants, but afford Drink also both to

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To this may be added *Elsner*'s Observations concerning the Vertues of divers things in his Observations *de Vincetoxico Scrophularium remedio*. Eph. Germ. T. 1. Obs. 57.

John Benerovinus a Physician of *Dort* may be here consulted, who wrote a Book on purpose to shew, that every Country hath every thing serving to its Occasions, and particularly Remedies afforded to all the Distempers it is subject unto. V. *Bener.* Αὐτάρκεια *Batav. sive Introd. ad Medic. indigenam.*

(26) The Description Dr. *Sloane* gives of the *Wild-Pine* is, that its Leaves are channelled fit to catch and convey Water down into their Reservatories, that these Reservatories are so made, as to hold much Water, and close at top when full, to hinder its evaporation; that these Plants grow on the Arms of the Trees in the Woods every where [in those Parts] as also on the Barks of their Trunks. And *one contrivance of Nature in this Vegetable*, he saith, *is very admirable. The Seed hath long and many Threads of Tomentum, not only that it may be carried every where by the Wind* ——— *but also that it may by those Threads, when driven through the Boughs, be held fast, and stick to the Arms, and extant parts of the Barks of Trees. So soon as it sprouts or germinates, although it be on the under part of a Bough,* ——— *its Leaves and Stalk rise perpendicular, or strait up, because if it had any other Position, the Cistern (before mentioned, by which it is chiefly nourished* ———) *made of the hollow Leaves, could not hold Water, which is necessary for the Nourishment and Life of the Plant.* —— *In scarcity of Water, this Reservatory is necessary and sufficient, not only for the Plant it self, but likewise is very useful to Men, Birds, and all sorts of Insects, whither they come in Troops, and seldom go away without refreshment.* Id. ib. p. 188. and Phil. Transact. No. 251. where a Figure is of this notable Plant, as also in *Lowthorp*'s Abridg. V. 2. p. 669.

to Man and other Creatures, in their great Extremities (27); and a great deal more might be instanced in of a like nature, and things that bear such plain Impresses of the divine Wisdom and Care, that they manifest the super-intendence of the infinite Creator.

Thus I have given a Skecth of another Branch of the Creation, which (although one of the mea-

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The Wild-Pine, so called, &c. hath Leaves that will hold a Pint and half, or Quart of Rain-Water; and this Water refreshes the Leaves, and nourishes the Root. When we find these Pines, we stick our Knives into the Leaves just above the Root, and that lets out the Water, which we catch in our Hats, as I have done many times to my great Relief. Dampier's Voy. to Campeachy. ch. 2. p. 56.

(27) *Navarette* tells us of a Tree called the *Bejuco*, which twines about other Trees, with its End hanging downwards; and that *Travellers cut the nib off it, and presently a spout of Water runs out from it, as clear as Crystal, enough and to spare for six or eight Men. I drank*, saith he, *to my satisfaction of it, found it cool and sweet, and would drink it as often as I found it in my way. It is a Juice and natural Water. It is the common Relief of the Herds-men on the Mountains. When they are Thirsty, they lay hold on the Bejuco, and drink their Fill.* Collect. of Voy. and Trav. Vol. 1. in the Suppl. to *Navarette*'s Account of *China*, p. 355

The *Waterwith* of *Jamaica* hath the same Uses, concerning which my before commended Friend Dr. *Sloane* favoured me with this Account from his original Papers: *This Vine growing on dry Hills, in the Woods where no Water is to be met with, its Trunk, if cut into pieces two or three Yards long, and held by either End to the Mouth, affords so plentifully a limpid, innocent and refreshing Water, or Sap, as gives new Life tot he droughty Traveller or Hunter. Whence this is very much celebrated by all the Inhabitants of these Islands, as an immediate Gift of Providence to their distressed Condition.*

To this we may add what Mr. *Ray* takes notice of concerning the Birch-Tree. *In initiis Veris antequam folia prodiere, vulnerata dulcem succum copiose effundit, quem siti pressi Pastores in sylvis sæpenumero potare solent. Nos etiam non semel eo liquore recreati sumus, cum herbarum gratia vastas peragravimus sylvas, inquit Tragus.* Raii Cat. Plant. circa Cantabr. in *Betula*.

meaneſt, yet) if it was accurately viewed, would abundantly manifeſt itſelf to be the Work of God. But becauſe I have been ſo long upon the other Parts, although leſs than they deſerve, I muſt therefore content my ſelf with thoſe general Hints I have given; which may however ſerve as Specimens of what might have been more largely ſaid about this inferiour Part of the animated Creation.

As to the *Inanimate Part*, ſuch as Stones, Minerals, Earths and ſuch like, that which I have already ſaid in the Beginning ſhall ſuffice.

BOOK XI.

Practical INFERENCES *from the foregoing* SURVEY.

HAVING in the preceding Books carried my Survey as far as I care at present to engage my self, all that remaineth is to draw some Inferences from the foregoing Scene of the great Creator's Works, and so conclude this Part of my intended Work.

CHAP. I.

That GOD's *Works are Great and Excellent.*

THE first Inference I shall make, shall be by way of Confirmation of the Text, That *the Works of the Lord are great* (1). And this is necessary to be observed, not against the Atheist only, but all other careless, incurious Observers of God's Works. Many of our useful Labours, and some of our best modern Books shall be condemned with only this Note of Reproach, That they are about

(1) *Equidem ne laudare quidem satis pro merito possum ejus Sapientiam ac Potentiam, qui animalia fabricatus est. Nam ejusmodi opera non Laudibus modo, verum etiam Hymnis sunt majora, qua priusquam inspexissemus, fieri non posse persuasum habeamus. conspicati vero falsos nos opinione fuisse comperimus.* Galen. de Us. Part. L. 7. c. 15,

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about trivial Matters (2), when in truth they are ingenious and noble Discoveries of the Works of GOD. And how often will many own the World in general to be a Manifestation of the Infinite Creator, but look upon the several Parts thereof as only Toys and Trifles, scarce deserving their Regard? But in the foregoing (I may call it) transient View I have given of this lower, and most slighted Part of the Creation, I have, I hope, abundantly made out that all the Works of the Lord, from the most regarded, admired, and praised, to the meanest and most slighted, are great and glorious Works, incomparably contrived, and as admirably made, fitted up, and placed in the World. So far then are any of the Works of the LORD, (even those esteemed the meanest) from deserving to be disregarded or contemned by us (3), that on the contrary they deserve (as shall be shewn in the next Chapter) to be *sought out, enquired after*, and *curiously* and *diligently pryed into* by us; as I have shewed the Word in the Text implies.

CHAP.

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(2) *Non tamen pigere debet Lectores, ea intelligere, quemadmodum ne Naturam quidem piguit ea reipsa efficere.* Galen. ibid. L. 11. fin.

(3) *An igitur etiam si quemadmodum Natura hæc & ejusmodi summa ratione ac providentia agere potuit, ita & nos imitari aliquando possemus? ego vero existimo multos nostrûm ne id quidem posse, neque enim artem Naturæ exponunt: eo enim modo omnino eam admirarentur: sin minus, eam saltem non vituperarent.* Galen, ib. L. 10, c. 3.

CHAP. II.

That GOD's *Works ought to be enquired into, and that such Enquiries are commendable.*

THE *Creator* doubtless did not bestow so much Curiosity, and exquisite Workmanship and Skill upon his Creatures, to be looked upon with a careless, incurious Eye, especially to have them slighted or contemned; but to be admired by the Rational Part of the World, to magnify his own Power, Wisdom and Goodness to all the World, and the Ages thereof. And therefore we may look upon it as a great Errour, not to answer those Ends of the infinite *Creator*, but rather to oppose and affront them. On the contrary, my Text commends GOD's Works not only for being great, but also those curious and ingenious Enquirers that *seek them out*, or *pry into them*. And the more we pry into, and discover of them, the greater and more glorious we find them to be, the more worthy of, and the more expresly to proclaim their great *Creator*.

Commendable then are the Researches, which many amongst us have of late Years made into the Works of Nature, more than hath been done in some Ages before. And therefore when we are asked, *Cui Bono?* To what purpose such Enquiries, such Pains, such Expence? The Answer is easy, It is to answer the Ends for which GOD bestowed so much Art, Wisdom and Power about them, as well as given us Senses to view and survey them; and an Understanding and Curiosity to search into them: it is to follow and trace him, when and whither he leads us, that we may

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ſee and admire his Handy-work our ſelves, and ſet it forth to others, that they may ſee, admire and praiſe it alſo. I ſhall then conclude this Inference with what *Elihu* recommends, Job. 36, 24, 25. *Remember that thou magnifie his Work, which Men behold. Every Man may ſee it, Men may behold it afar off.*

CHAP. III.

That GOD's *Works are manifeſt to all: whence the Unreaſonableneſs of Infidelity.*

THE concluding Words of the preceeding Chapter ſuggeſts a third Inference; that the Works of GOD are ſo viſible to all the World, and withal ſuch manifeſt Indications of the Being and Attributes of the infinite Creator, that they plainly argue the Vileneſs and Perverſeneſs of the Atheiſt, and leave him inexcuſable. For it is a ſign a Man is a wilful perverſe Atheiſt, that will impute ſo glorious a Work, as the Creation is, to any thing yea a meer *Nothing* (as Chance is) rather than to GOD (1). 'Tis a ſign the Man is wil-

(1) *Galen* having taken notice of the neat Diſtribution of the Nerves to the Muſcles, and other Parts of the Face, cries out, *Hæc enim fortunæ ſunt opera! Cæterum tum omnibus* [partibus] *immitti, tantoſque eſſe ſingulos* [nervos] *magnitudine, quanta particulæ erat neceſſe; haud ſcio an hominum ſit ſobriorum ad Fortunam opificem id revocare. Alioqui quid tandem erit, quod cum Providentia & Arte efficitur? Omnino enim hoc ei contrarium eſſe debet, quod Caſu ac Fortuito fit.* And afterwards, *Hæc quidem atque ejuſmodi Artis ſcil. ac ſapientiæ opera eſſe dicemus, ſi modo Fortunæ tribuenda ſunt quæ ſunt contraria; fietque jam quod in proverbiis ------ Fluvii ſurſum fluent; ſi opera quæ nullum habent neque ornamentum neque*

wilfully blind, that he is under the Power of the Devil, under the Government of Prejudice, Luſt, and Paſſion, not right Reaſon, that will not diſcern what *every one can ſee, what every Man may behold afar off*, even the Exiſtence and Attributes of the CREATOR from his Works. For as *there is no Speech or Language where their Voice is not heard, their Line is gone out through all the Earth, and their Words to the End of the World*: ſo all, even the barbarous Nations, that never heard of GOD, have from theſe his Works inferred the Exiſtence of a Deity, and paid their Homages to ſome Deity, although they have been under great Miſtakes in their Notions and Concluſions about him. But however, this ſhews how naturally and univerſally all Mankind agree in deducing their Belief of a God from the Contemplation of his Works, or as even *Epicurus* himſelf in *Tully* (2) ſaith, from *a Notion that Nature it ſelf hath imprinted upon the Minds of Men. For*, ſaith he, *what Nation is there, or what kind of Men, that without any Teaching or Inſtructions, have not a kind of Anticipation, or preconceived Notion of a Deity?*

An Atheiſt therefore (if ever there was any ſuch) may juſtly be eſteemed a Monſter among Rational Beings; a thing hard to be met with in the whole Tribe of Mankind; an Oppoſer of all the

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neque rationem, neque modum Artis eſſe; contraria vero Fortunæ duxerimus, &c. Galen. ubi ſupra. L. 11. c. 7.

(2) *Primum eſſe Deos, quod in omnium animis*, &c. And a little after, *Cum enim non inſtituto aliquo, aut more, aut lege ſit opinio conſtituta, maneatque ad unum omnium firma conſenſio, intelligi neceſſe eſt, eſſe Deos, quoniam inſitas eorum vel potius innatas cognitiones habemus. De quo autem omnium Natura conſentit, id verum eſſe neceſſe eſt. Eſſe igitur Deos conſitendum eſt.* Cicer. de Nat. Deor. L. 1.

(4)

the World (3); a Rebel againſt human Nature and Reaſon, as well as againſt his GOD.

But above all, monſtrous is this, or would be, in ſuch as have heard of GOD, who have had the Benefit of the clear Goſpel-Revelation. And ſtill more monſtrous this would be in one born and baptized in the Chriſtian Church, that hath ſtudied Nature, and pryed farther than others into Gods Works. For ſuch an one (if it be poſſible for ſuch to be) to deny the Exiſtence, or any of the Attributes of GOD, would be a great Argument of the Infinite Inconvenience of thoſe Sins of Intemperance, Luſt, and Riot, that have made the Man abandon his Reaſon, his Senſes, yea I had almoſt ſaid his very human Nature (4), to engage him thus to deny the Being of GOD.

So alſo it is much the ſame monſtrous Infidelity, at leaſt betrays the ſame atheiſtical Mind, to deny GOD's Providence, Care and Government of the World, or (which is a Spawn of the ſame *Epicurean Principles*) to deny *Final Cauſes* (5) in God s Works of Creation; or with the Profane in *Pſal.* 73. 11. to ſay, *How doth God know? and is there*

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(3) The Atheiſt in denying a God, doth, as *Plutarch* ſaith, endeavour —— *immobilia movere, & bellum inferre non tantum longo tempori, ſed & multis hominibus, gentibus, & familiis, quas religioſus Deorum cultus, quaſi divino furore correptas, tenuit.* Plutar. de Iſide.

(4) See before Note 2.

(5) *Galen* having ſubſtantially refuted the Epicurean Principles of *Aſclepiades*, by ſhewing his ignorance in Anatomy, and Philoſophy, and by demonſtrating all the *Cauſes* to be evidently in the Works of *Nature*, viz. *Final, Efficient, Inſtrumental, Material and Formal Cauſes*, concludes thus againſt his fortuitous Atoms, *ex quibus intelligi poteſt, Conditorem noſtrum in formandis particulis unum hunc ſequi ſopum, nempe ut quod melius eſt eligat.* Galen. de Uſ. Part. L. 6. c. 13.

(6)

there Knowledge in the moſt High? For as the witty and eloquent *Salvian* ſaith (6) *They that affirm nothing is ſeen by* GOD, *will,* in all probability, *take away the Subſtance, as well as Sight of God.* —— *But what ſo great Madneſs,* ſaith he, *as that when a Man doth not deny* GOD *to be the Creator of all things, he ſhould deny him to be the Governour of them? or when he confeſſeth him to be the Maker, he ſhould ſay* GOD *neglecteth what he hath ſo made?*

CHAP. IV.

That God's *Works ought to excite us to Fear and Obedience to* God.

SInce the Works of the Creation are all of them ſo many Demonſtrations of the infinite Wiſdom and Power of God, they may ſerve to us as ſo many Arguments exciting us to the conſtant *Fear of God,* and to a ſteady hearty *Obedience* to all his Laws. And thus we may make theſe Works as ſerviceable to our ſpiritual Intereſt, as they all are to our Life, and temporal Intereſt. For if whenever we ſee them, we would conſider that theſe are the Works of our infinite *Lord* and *Maſter,* towhom we are to be accountable for all our Thoughts, Words and Works, and that in theſe we may ſee his infinite Power and Wiſdom; this would check us in Sinning, and excite us to ſerve and pleaſe him who is above all Controul, and who hath our Life and whole Happineſs in his Power. After this manner GOD himſelf argues with his own *fooliſh Peop'e, and without Underſtanding,*

(6) *De Gubern. Dei.* L. 4. p. 124. *meo Libro:* alſo L. 7. c. 14.

ing, who had Eyes, and ſaw not, and had Ears, and heard not, Jer. 5. 21, 22. *Fear ye not me, ſaith the Lord? will ye not tremble at my Preſence, which have placed the Sand for the Bound of the Sea, by a perpetual Decree, that it cannot paſs it, and though the Waves thereof toſs themſelves, yet can they not prevail, though they roar, yet can they not paſs over it?*

This was an Argument that the moſt ignorant ſtupid Wretches could not but apprehend; that a Being that had ſo vaſt and unruly an Element, as the Sea abſolutely at his Command, ought to be feared and obeyed: and that he ought to be conſidered as the ſovereign Lord of the World, on whom the World's Proſperity and Happineſs did wholly depend; v. 24. *Neither ſay they in their Heart, let us now Fear the Lord our God, that giveth Rain, both the former and the latter in his Seaſon; he reſerveth unto us the appointed Weeks of the Harveſt.*

CHAP. V.

That GOD's *Works ought to excite us to Thankfulneſs.*

AS the Demonſtrations GOD hath given of his infinite Power and Wiſdom ſhould excite us to Fear and Obedience; ſo I ſhall ſhew in this Chapter, that the Demonſtrations God hath given of his infinite Goodneſs in his Works, may excite us to a due Thankfulneſs and Praiſe. It appears throughout the foregoing Survey, what Kindneſs GOD hath ſhewn to his Creatures in providing every thing conducing to their Life, Proſperity, and Happineſs (1); how they are all

(1) *Si pauca quis tibi donaſſet jugera, accepiſſe te diceres beneficium: immenſa terrarum late patentium ſpatia negas eſſe*

all contrived and made in the beſt Manner, placed in the fitteſt Places of the World for their Habitation and Comfort; accoutered in the beſt Manner, and accommodated with every, even all, the minuteſt things that may miniſter to their Health, Happineſs, Office, Occaſions, and Buſineſs in the World.

Upon which account Thankfulneſs and Praiſe is ſo reaſonable, ſo juſt a Debt to the *Creator*, that the Pſalmiſt calleth upon all the Creatures to praiſe God, in Pſalm 148. *Praiſe him all his Angels; Praiſe him all his Hoſts; Sun, Moon, Stars of Light, Heavens of Heaven, and Waters above the Heavens.* The Reaſon given for which is, v. 5,6. *For he commanded, and they were created: he hath alſo eſtabliſhed them for ever and ever: he hath made a Decree which they ſhall not paſs.* And not theſe Celeſtials alone, but the Creatures of the Earth and Waters too, even the Meteors, *Fire and Hail, Snow and Vapours, ſtormy Wind fulfilling his Word.* Yea, the very *Mountains and Hills, Trees, Beaſts and all Cattel, Creeping things, and flying Fowl.* But in a particular manner, all the Ranks and Orders, all the Ages and Sexes of Mankind are charged with this Duty; *Let them praiſe the Name of the Lord, for his Name alone is excellent: his Glory is above the Earth and Heavens,* v. 13. And

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eſſe beneficium? Si pecuniam tibi aliquis donaverit, —— *beneficium vocabis: tot metalla defodit, tot flumina emiſit in æra, ſuper quæ decurrunt ſola aurum vehentia: argenti, æris, ferri immane pondus omnibus locis obrutum, cujus inveſtigandi tibi facultatem dedit,* —— *negas te accepiſſe beneficium? Si domus tibi donetur, in quâ marmoris aliquid reſplendeat, &c. Num mediocre munus vocabis? Ingens tibi domicilium, ſine ullo incendii, aut minæ metu ſtruxit, in quo vides non tenues cruſtas,* —— *ſed integras lapidis preticſiſſimi moles, &c. negas te ullum munus accepiſſe? Et cum iſta quæ habes magno æſtimes, quod eſt ingrati hominis, nulli debere te judicas? Unde tibi iſtum quem trahis ſpiritum? Unde iſtam, per quam actus vitæ tuæ diſponis atque ordinas, lucem?* &c. Senec. de Benef. L. 4. c. 6.

(2)

And great Reaſon there is we ſhould be excited to true and unfeigned Thankfulneſs and Praiſe (2) to this our great Benefactor, if we reflect upon what hath been ſhewn, in the preceeding Survey, the *Creator* hath done for Man alone, without any regard to the reſt of the Creatures, which ſome have held were made for the Sake of Man. Let us but reflect upon the Excellence and Immortality of our Soul; the incomparable Contrivance, and curious Structure of our Body; and the Care and Caution taken for the Security and Happineſs of our State, and we ſhall find that among the whole Race of Beings, Man hath eſpecial Reaſon to magnify the Creator's Goodneſs, and with ſuitable ardent Affections to be thankful unto him.

CHAP. VI.

That we ought to pay GOD *all due Homage and Worſhip, particularly that of the Lord's Day.*

FOR a Concluſion of theſe Lectures, the laſt thing I ſhall infer, from the foregoing Demon-

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(2) *Tempeſtivum tibi jam fuerit, qui in hiſce libris verſaris conſiderare, in utram Familiam recipi malis,* Platonicamne *ac* Hippocraticam, *& aliorum virorum, qui Naturæ opera mirantur; an eorum qui ea inſectantur, quod non per Pedes natura conſtituit effluere Excrementa.* Of which having told a Story of an Acquaintance of his that blamed Nature on this account, he then goes on, *At vero ſi de hujuſmodi pecudibus plura verba fecero, melioris mentis homines merito mihi forte ſuccenſeant, dicantque me polluere ſacrum ſermonem, quem ego* CONDITORIS *noſtri verum Hymnum compono, exiſtimoque in eo veram eſſe pietatem, —— ut ſi noverim ipſe primus, deinde & aliis expoſuerim, quænam ſit ipſius Sapientia, quæ Virtus, quæ Bonitas. Quod enim cultu conveniente exornaverit omnia, nullique bona inviderit, id perfectiſſimæ Bonitatis ſpecimen eſſe ſtatuo: & hac quidem ratione ejus Bonitas*

monſtration of the Being and Attributes of GOD, ſhall be, that we ought to pay GOD all that *Homage* and *Worſhip* which his Right of Creation and Dominion entitle him unto, and his great Mercies call for from us. And foraſmuch as the *Creator* appointed, from the very Creation, one Day in ſeven to, his Service, it will not therefore be improper to ſay ſomething upon that Subject: and if I inſiſt ſomewhat particularly and largely thereon, the Congruity thereof to the Deſign of theſe Lectures, and the foregoing Demonſtration, together with the too great Inadvertency about, and neglect of, this ancient, univerſal, and moſt reaſonable and neceſſary Duty, will I hope plead my Excuſe. But that I may ſay no more than is neceſſary on this Point, I ſhall confine my ſelf to two things, the *Time* God hath taken, and the *Buſineſs* then to be performed.

1. The *Time* is one Day in ſeven, and one of the ancienteſt Appointments it is which GOD gave to the World. For as ſoon as GOD had finiſhed his ſix Days Works of Creation, it is ſaid Exod. 2. 2, 3. *he reſted on the ſeventh Day from all his Work which he had made. And GOD bleſſed the ſeventh Day, and ſanctified it, becauſe that in it he had reſted from all his Work.* This Sanctification, and Bleſſing the Seventh Day, was ſetting it apart as a Day of Diſtinction from the Reſt of the Week-Days, and appropriating (1) it to Hoy Uſes and Pur-

nitas Hymnis nobis eſt celebranda. Hoc autem omne inveniſſe quo pacto omnia potiſſimum adornarentur, ſummæ Sapientiæ eſt: effeciſſe autem omnia, quæ voluit, Virtutis eſt invictæ. Galen. de Uſ. Part. L. 3. c. 10.

(1) קדש *Uſibus divinis accommodavit, a communi & profano uſu ſegregavit, in uſum ſacrum ad cultum Dei deſtinavit.* Kirch. Concord. p. 1336. *Deſtinari ad aliquid, Sacrari,* &c. Buxtorf. in Verbo.

(2)

Purpoſes, namely, the Commemoration of that great Work of the Creation, and paying Homage and Worſhip to that infinite Being, who was the Effector of it.

This Day, thus conſecrated from the Beginning, for the Celebration of the τῦ κόσμυ γενέσιον, the *World's Birth-Day*, as *Philo* calls it, was probably in ſome meaſure forgotten in the following wicked Ages, which God complains of, *Gen.* 6. 5. and ſo after the Flood likewiſe. But after the Return out of *Egypt*, when GOD ſettled the Jewiſh Polity, he was pleaſed to renew this Day, and to eſtabliſh it for a perpetual ſtanding Law. And accordingly it was obſerved down to our bleſſed SAVIOUR's Time, countenanced, and ſtrictly obſerved by our great LORD and Maſter himſelf, and his Apoſtles and Diſciples in, and after his time; and although for good Reaſons the Day was changed by them, yet a Seventh Day hath been conſtantly obſerved in all Ages of Chriſtianity down to our preſent time.

Thus we have a Day appointed by GOD himſelf, and obſerved throughout all Ages, except ſome few perhaps, which deſerve not to be brought into Example.

And a wiſe Deſignation of time this is, well becoming the divine Care and Precaution; ſerving for the recruiting our Bodies, and diſpatching our Affairs, and at the ſame time to keep up a ſpiritual Temper of Mind. For by allowing Six Days to labour, the Poor hath time to earn his Bread, the Man of Buſineſs time to diſpatch his Affairs, and every Man time for the work of his reſpective Calling. But had there been more, or all our time allotted to Labour and Buſineſs, and none to Reſt and Recruit, our Bodies and Spirits would have been too much fatigued and waſted, and our Minds have been too long engaged about

worldly Matters, so as to have forgotten divine Things. But the Infinitely Wise Ruler of the World, having taken the seventh Part of our time to his own Service, hath prevented these Inconveniences; hath given a Relaxation to our selves, and Ease and Refreshment to our wearied Beasts, to poor fatigued Slaves, and such as are under the Bondage of avaritious cruel Masters. And this is one Reason *Moses* gives of the Reservation and Rest of the seventh Day, Deut. 5. 13, 14, 15. *Six Days shalt thou labour, and do all thy work: but the Seventh is the Sabbath of the* LORD *thy* GOD; in it thou shalt not *do any work, thou,* nor thy Children, Servants, Cattle, or Stranger, *that thy Man Servant, and Maid Servant may rest as well as thou. And remember, that thou wast a Servant,* &c. *therefore the Lord thy God commanded thee to keep the Sabbath day.* That carnal, greedy People, so bent upon Gain, without such a Precept, would have scarce favoured their own Bodies, much less have had Mercy upon their poor Bondsmen and Beasts; but by this wise Provision, this great Burden is taken off. But on the other hand, as a longer Liberty would too much have robbed the Master's time, and bred Idleness, so by this wise Provision, of only one day of Rest to Six of Labour, that Inconvenience was also prevented.

Thus the wise Governour of the World, hath taken care for the dispatch of Business. But then as too long engagement about worldly Matters, would take off Mens Minds from God and Divine Matters, so by this reservation of every Seventh Day, that great Inconvenience is prevented also; all being then bound to worship their great Lord and Master, to pay their Homages and Acknowledgments to their infinitely kind Benefactor; and in a word, to exercise

themſelves in Divine Religious Buſineſs, and ſo keep up that ſpiritual temper of Mind, that a perpetual, or too long application to the World would deſtroy.

This, as it was a good Reaſon for the order of a Sabbath to the Jews; ſo is as good a Reaſon for our Saviour's continuance of the like time in the Chriſtian Church.

And a Law this is becoming the infinitely wiſe Creator and Conſervator of the World, a Law, not only of great uſe to the perpetuating the remembrance of thoſe greateſt of God's Mercies then commemorated, but alſo exactly adapted to the Life, Occaſions, and State of Man; of Man living in this, and a kin to another World; a Law well calculated to the diſpatch of our Affairs, without hurting our Bodies or Minds. And ſince the Law is ſo Wiſe and Good, we have great reaſon to practiſe carefully the Duties then incumbent upon us: which will fall under the Conſideration of the

2. Thing I propoſed, the *Buſineſs* of the Day, which God hath reſerved to himſelf. And there are two Things enjoyned in the Commandment, a *Ceſſation* from Labour and worldly Buſineſs, and that we *remember* to *keep* the Day holy.

1. There muſt be a Ceſſation from worldly Buſineſs, or a Reſt from Labour, as the Word *Sabbath* (2) ſignifies. *Six Days thou ſhalt do all thy work, but the Seventh is the Sabbath of the Lord thy* GOD (not thy Day but his) *in which neither thou, nor any belonging to thee, ſhall do any work.* In which Injunction it is obſervable, how expreſs and particular this Commandment is, more than others, in ordering all ſorts of Perſons to ceaſe from Work.

(2) שַׁבָּת *Ceſſatio, Requies.*

2. We must *remember to keep the Day holy.* Which *Remembrance* is another thing also in this more than in the other Commandments, and implies,

1. That there is great danger of our forgetting, neglecting, or being hindered from keeping the Day holy, either by the Infirmity and Carnality of our own Nature, or from the Avocations of the World.

2. That the keeping it holy, is a Duty of more than ordinary Consequence and Necessity. And of greatest Consequence this is,

1. To perpetuate the Remembrance of those grand Works of GOD commemorated on that Day; in the first Ages of the World, the Creation; in the middle Ages, the Creation and Delivery from *Egypt*; and under Christianity, the Creation and Redemption by Christ. Which Mercies, without such frequent Occasions, would be ready to be forgotten, or disregarded, in so long a tract of time, as the World hath already stood, and may, by God's Mercy, still stand.

2. To keep up a spiritual Temper of Mind, by those frequent weekly Exercises of Religion, as hath been already mentioned.

3. To procure GOD's Blessing upon the Labours and Business of our six Days, which we can never expect should be prosperous, if we are negligent of GOD's time. For how can we expect GOD's Blessing upon a Week so ill begun, with a Neglect, or Abuse of GOD's first Day. And therefore if we become unprosperous in the World; if Losses, Troubles or Dangers befall, let us reflect how we have spent the *Lord's* Day; whether we have not wholly neglected it, or abused it in Riot, or made it a Day for taking Journeys, for more private Business, and less scandalous Labour, as the Custom of too many is.

Thus

Thus having ſhewn what reaſon there is to *remember* to keep holy the Day dedicated to GOD, I ſhall conſider how we are to keep it holy, and ſo conclude. Now the way to keep it holy, is not by bare reſting from Work; for that, as a Father ſaith, is *Sabbatum Boum & Aſinorum*, a *Sabbath of Beaſts*: but holy Acts are the proper Buſineſs for a holy Day, celebrated by rational Beings. Among all which, the grand, principal, and moſt univerſally practiſed, is the *Publick Worſhip of* GOD, the Aſſembling at the *Publick Place* of his *Worſhip*, to pay, with our Fellow-Creatures, our Homages, Thanks, and Praiſes to the infinite *Creator* and *Redeemer* of the World. This as it is the moſt reaſonable Service, and proper Buſineſs for this Day, ſo is what hath been the Practice of all Ages. It was as early as *Cain* and *Abel's* Days, *Gen.* 4. 3. what was practiſed by Religious Perſons in the following Ages till the giving of the Law; and at the giving of that, God was pleaſed to order Places, and his particular Worſhip, as well as the Seventh Day. The Tabernacle and Temple were appointed by God's expreſs Command; beſides which, there were Synagogues all over the Nation: ſo that in our Saviour's time, every great Town or Village had one, or more in it, and *Jeruſalem* 460, or more (3).

The Worſhip of theſe Places, our bleſſed SAVIOUR was a conſtant and diligent frequenter of. 'Tis ſaid, *he went about all the Cities and Villages, Teaching in their Synagogues, and Preaching, and Healing*, &c. *Matt.* 9. 35. And S. *Luke* reporteth it, as his conſtant Cuſtom or Practice, Luke 4. 16. *And as his cuſtom was, he went into the Synagogue on the Sabbath-Day.*

(3) Vid. *Lightfoot's* Works Vol. 2. p. 35. & 646.

Having thus mentioned the Practice of CHRIST, it is not neceſſary I ſhould ſay much of the Practice of his *Apoſtles*, and the following purer Ages of Chriſtianity, who, in ſhort, as their Duty was, diligently followed their great Maſter's Example. *They did not think it enough to Read and Pray, and Praiſe God at home, but made conſcience of appearing in the publick Aſſemblies: from which nothing but Sickneſs and abſolute Neceſſity did detain them: and if Sick, or in Priſon, or under Baniſhment, nothing troubled them more, than that they could not come to Church, and joyn their Devotions to the common Services. If Perſecution at any time forced them to keep a little cloſe, yet no ſooner was there the leaſt Mitigation, but they preſently returned to their open Duty, and Publickly met all together. No trivial Pretences, no light Excuſes were then admitted for any ones Abſence from the Congregation, but according to the merit of the Cauſe, ſevere Cenſures were paſſed upon them*, &c. to expreſs it in the Words of One of our beſt Antiquaries. (4).

The *Publick Worſhip* of GOD then, is not a Matter of Indifference, which Men have in their own Power to do, or omit, as they pleaſe; neither is it enough to Read, Pray, or Praiſe God at home (unleſs ſome inevitable neceſſity hindereth) becauſe the appearing in GOD's Houſe, on *his* Day, is an Act of *Homage* and *Fealty*, due to the CREATOR, a *Right of Sovereignty* we pay him. And the with-holding thoſe Rights and Dues from GOD, is a kind of rejecting GOD, a diſowning his Sovereignty, and a withdrawing our Obedience and Service. And this was the very Reaſon why the Profanation of the Sabbath was

(4) Dr. *Cave's Prim. Chriſt.* Par. 1. c. 7.

(5)

was punished with Death among the Jews, the Sabbath being a Sign, or Badge of the GOD they Owned and Worshipped. (5) Thus Exod. 31. 13. *My Sabbaths ye shall keep; for it is a SIGN between me and you, throughout your Generations; that ye may know that I am the LORD, that doth sanctify you*: or as the Original may be rendered; *a Sign to acknowledge, that I Jehovah am your Sanctifier*, or *your God*. For as our Learned *Mede* observes, *to be the Sanctifier of a People, and to be their God, is all one*. So likewise very expressly in Ezek. 20. 20. *Hal-*

(5) As at this Day it is customary for Servants to wear the Livery of their Masters, and others to bear Badges of their Order, Profession, Servility, &c. So in former Ages, and divers Countries, it was usual to bear Badges, Marks and Signs on divers Occasions. In *Ezek.* 9. 4. *a Mark was to be set on the Forehead of those that lamented the Abominations of the City*. The like was to be done upon them in *Rev.* 7. 3. and 9. 4. So the Worshippers of the Beast, *Rev.* 13. 16. were to receive a χάραγμα, *a Mark in their right Hand, or their Foreheads*. Those χαράγματα, Στιγμάς, *Badges*, &c. were very common. Soldiers and Slaves bare them in their Arms or Foreheads: such as were matriculated in the *Hæteriæ*, or Companies bare the Badge or Mark of their Company; and whoever listed himself into the Society of any of the several *Gods*, received a χάραγμα, or a Mark in his Body (commonly made with red-hot Needles, or some burning in the Flesh) of the God he had listed himself under. And after Christianity was planted, the Christians had also their *Sign of the Cross*. And not only Marks in their Flesh, Badges on their Cloaths, &c. were usual, but also the Dedication of Days to their imaginary Deities. Not to speak of their Festivals, &c. the Days of the Week were all dedicated to some of their Deities. Among the *Romans*, Sunday and Monday, to the *Sun* and *Moon*; Tuesday to *Mars*, Wednesday to *Mercury*, &c. So our *Saxon* Ancestors did the same; Sunday and Monday (as the *Romans* did) to the *Sun* and *Moon*; Tuesday to *Tuysco*; Wednesday to *Woden*; Thursday to *Thor*; Friday to *Friga*; and Saturday to *Seater*; an Account of which Deities, with the Figures under which they were worshipped, may be met with in our Learned *Verstegan*. Chap. 3. p. 68.

Hallow my Sabbaths, and they shall be a Sign between me and you, that ye may know that I am the LORD *your* GOD; or rather as before, *to acknowledge that I* JEHOVAH *am your* GOD.

The Sabbath being thus a Sign, a Mark, or Badge to acknowledge God to be their God, it follows, that a Neglect, or Contempt of that Day, redounded to GOD; to slight that, was slighting God; to profane that, was to affront God: for the Punishment of which, what more equitable Penalty than Death. And although under Christianity, the Punishment is not made Capital, yet have we no less Reason for the strict Observance of this holy Day, than the Jews, but rather greater Reasons. For the GOD we worship, is the same: if after six Days Labour, he was by the Seventh owned to be GOD, the *Creator*; no less is he by our Christian Lord's Day: if by the Celebration of the Sabbath, the remembrance of their Deliverance from the *Egyptian* Bondage was kept up, and GOD acknowledged to be the Effecter thereof; we Christians have a greater Deliverance, we own our Deliverance from Sin and Satan, wrought by a greater Redeemer than *Moses*, even the blessed JESUS, whose Resurrection, and the Completion of our Redemption thereby, was performed on the Christian Lord's Day.

And now to sum up, and conclude these Inferences, and so put an end to this part of my Survey: Since it appears, that the Works of the LORD are so great, so wisely contrived, so accurately made, as to deserve to be enquired into; since they are also so manifest Demonstrations of the Creator's Being and Attributes, that all the World is sensible thereof, to the great Reproach of Atheism: what remaineth, but that we Fear and Obey so Great and Tremendous a

Being

Being; that we be truly Thankful for, and Magnify and Praise his infinite Mercy manifested to us in his Works. And forasmuch as he hath appointed a Day on purpose, from the Beginning, for these Services, that we may weekly meet together, commemorate and celebrate the great Work of Creation, that we may pay our Acts of Devotion, Worship, Homage and Fealty to him; and since this is a Wise and Excellent Distribution of our time, what should we do, but conscientiously and faithfully pay GOD these his Rights and Dues? and as carefully and diligently manage GOD's time, and discharge his Business then, as we do our own upon our six Days: particularly that with the Pious *Psalmist*, *we love the Habitation of God's House, and the place where his Honour dwelleth*; and therefore take up his good Resolution in *Psal.* 5. 7. with which I shall conclude; *but as for me, I will come into thine House in the multitude of thy Mercy, and in thy fear will I worship towards thy holy Temple.*

Now to the same infinite GOD, the omnipotent Creator and Preserver of the World, the most gracious Redeemer, Sanctifier, and Inspirer of Mankind, be all Honour, Praise and Thanks, now and ever. *Amen.*

A

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