Presented to the Theological Seminary at Princeton, N.J.
By the Rev. John T. Clark
1821
PHYSICO-THEOLOGY: OR, A DEMONSTRATION OF THE BEING and ATTRIBUTES of GOD, FROM HIS WORKS of Creation. Being the Substance of Sixteen SERMONS

Preached in St. Mary-le-Bow-Church, London;
At the Honourable Mr. BOYLE's LECTURES, in the Years 1711, and 1712.

With large Notes, and many curious OBSERVATIONS.

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

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

The Fifth Edition, more Correct than any of the former.

LONDON: Printed for W. and J. INNYS, at the Prince's-Arms the West End of St. Paul's. 1720.
TO THE

Most Reverend Father in GOD,

THOMAS,

Lord Archbishop of Canterbury.
Primate of all ENGLAND, &c.

The Surviving Trustee of the Honourable Mr. Boyle's Lectures.

May it please Your Grace,

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
The Dedication.

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 diverting Exercises of my Leisure Hours, than more serious Theological Studies. This Work, (although I made a considerable Progress in it at first, whilst a Novelty, 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, and not much acquainted with Persons in high Stations, and not at all, particularly, with your Grace. So that therefore as it pleased your Grace, not only to confer an unsought profitable Honour upon me (a Stranger) but also to continue it 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, grateful Acknowledgment of your Grace's great and unexpected Favour.

But it is not my self alone; but the whole Lecture also is beholden to your Grace's kind and pious Endeavours. It was You that encouraged this noble Charity, and assisted in the Settlement of it, in the Honourable Founder's Life-time; and since his Death, it was You that procured a more certain
The Dedication.
certain Salary for the Lecturers, paid more constantly and duly than it was before *

These Benefits as I myself have been a Sharer of, so I should be very ungrateful should I not duly acknowledge, and repay

* It may not only gratify the Reader's Curiosity, but also be of Use for preventing Encroachments in Time to come, 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 Archbishop of Canterbury (then Dr. Tenison) Sir Henry Ashurst, Sir John Rotheram, and John Evelyn, Esq. The Business he appointed those Lectures for, was, among others, to be ready to satisfy 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, 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 50l. 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.
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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.

TO
TO THE

RAEDER.

S 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 published 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.

And forasmuch as his Lectures were appointed by him for the Proof of the Christian Religion against Atheists and other notorious 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 on purpose, but only casually, 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, and by being treated of in different Methods, should take in most of what could be said upon the Subject, 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 Merfenne on Genesis; Dr. Cockburne in his Essays; Mr. Ray in his Wisdom of God, &c. and I may add the first of Mr. Boyle's Lecturers, the most learned Dr. Bently in his Boyle's Lectures, the eloquent
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eloquent Arch-Bishop of Cambray, (and I hear, the ingenious Mons. Perault 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 endeavour'd to avoid doing over what they before had done; and for that Reason did not, for many Years, read their Books until I had finish'd 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 shorten'd my Discourse, and refer'd 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 mention'd before by others, and not accordingly acknowledged by me, I hope he will candidly think me no Plagiary, because I can assure him I have 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 this may happen from Persons making Observations about one, and the same Thing, without knowing what each other hath done; which indeed, when the first Edition of
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my Book was nearly printed off, I found to be my own Case, having (for want of Dr. Hook's Micrography being at hand, it being a very scarce Book, and many Years since I read it,) given Descriptions of two or three Things, which I thought had not been tolerably well observ'd before, but are describ'd 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. i. Scheme 22. which is somewhat different from what I have represented in my Fig. 18, &c. But I can stand by the Truth, though not the Elegance of my Figures. But as to the other Differences, they are accidental, occasion'd by our taking the Parts in a different View, or in a different Part of a 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 escap'd him, being enabled to do so, not only by the Help of such Microscopes as he made use of; but 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 figur'd and describ'd, is, The Sting of a Bee or Wasp; in which we differ more than in the last. But by a careful Re-examination, I find, that although Dr. Hook's Observa-
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tions 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 Poison 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 lie 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 left the Reader should think himself imposed upon both by Dr. Hook and my Self, it is necessary to be observ'd, 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 a due Posture in the Micro-
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Microscope, viz. sideways, not under, or atop 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, 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 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 others 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 solicitous 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, I desire it may be consider’d, that the textual Part being Sermons, to be deliver’d 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
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it 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 softening 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 shorten'd them, and had Thoughts of doing it, by casting some of them into the Text, as an ingenious, learned Friend advis'd. 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, being pretty well fatigu'd with it before. 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 out 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 consider'd as to the 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. 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 Publish'd; in which Case, it was necessary to be more Express and Particular, than in Matters better known, or where the Author may be reserr'd unto.

In the former Editions I promised another Part I Had relating to the Heavens, if I was thereunto encouraged. And two large Impressions of this Book, having been fold off, so as to admit of a Third before the Year was gone about; and hearing that it is translated into two, if not three Languages; but especially being importuned by divers learned Persons, both known and unknown, I have thought my self sufficiently engaged to perform that Promise; and have accordingly published that Part.

So that I have now carry'd my Survey through most Parts of the visible Creation, except the Waters, which are for the most Part omitted; and the Vegetables, which, for want of Time, I was forced to treat of in
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in a perfunctory Manner. And to the Undertaking of the former of these, having receiv’d divers Sollicitations from Persons unknown as well as known, I think my self bound in Civility to own their Favour, and to return them my hearty Thanks for the kind Opinion they have shown of my other Performances, that they have encourag’d me to undertake this other Task. And accordingly I have begun it, and (as far as my Affairs will permit) have made some Progress in it: But Age and Avocations growing upon me, I begin to fear I shall scarce be able to finish it as I would, and therefore must recommend that ample and noble Subject to others, who have more leisure, and would do it better than I.

As to Additions, I have been much sollicited thereto by divers curious and learned Persons, who would have had me to insert some of their Observations, and many more of my own: But in a Work of this Nature, this would have been endless; and although the Book would thereby be render’d much better, and more compleat, yet I could by no Means excuse so great an Injustice to the Purchasers of the former Editions. And therefore (except in the second Edition, where it was not easy to be avoided) few Additions or Alterations have been made, besides what were Typographical, or of small Consideration. Only in the third Edition I amended the first Paragraph of Note 1. Chap. 5. Book
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Book I. concerning Gravity; and in the Fourth, Page 16. and 18. I inserted two Passages out of Seneca, that were inadvertently left out, and corrected many Things, that upon a careful Review, seem'd to want amendment.

And lastly, as to the following Analysis, it was added at the Request of some of my learned and ingenious Friends; and although it might have been contracted, they would not suffer it to be so.
AN
ANALYSIS
OF THE
Following Book.

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 14.
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.
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If 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,

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Heat.

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The Winds 41.

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Its Motion ibid.

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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.

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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: 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.

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Tools.

Firing.

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Subterraneous Caverns and Vulcano's; of great Use to the

Countries where they are 67.

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The most Salubrious: to some Constitutions, the Hills;

to some, the Valleys 71.

Best to skreen us, and other things 72.

Beneficial to the

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Form, for the most part Spherical, which is best for

The Reception of Objects.

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Every way.

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All Creatures, according to their Occasions.

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b 2
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Seeing and Smelling at great Distances 205. [in. Climbing; the strong Tendons and Muscles acting there-
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Young Creatures.

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\( \Sigma \) extens, and Diligence in Nursing and Defend-
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to be found 209.

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\{ Are able to live long without Food 211.
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and clean.

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Ready furnished with proper Clothing.

On the dry Land with Hair, Fleeces, Furs, Shells,
hard Skins, &c. 220.

In the Air with Feathers, light, strong and warm.
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as move more slowly 223.

Provide for themselves by their Textrine, or Archi-
technick Art. Of which under the next Branch.
Well garnished, being all Workman-like, compleat,
in its kind beautiful, being 224.

Adorned with gay, various and elegant Colours.
If fordid, yet with exact Symmetry, and full of cu-
rious Mechanism.

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A SURVEY OF THE Terraqueous Globe.

INTRODUCTION.

IN Psal. cxi. 2. The Psalmist affirms, That the (a) 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 (b) signifieth, when heedfully and deeply pried into, solicitously observ'd and enquir'd out, especially when clearly discovered

(a) 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 יִשְׂרָאֵל being the same that in 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 יִשְׂרָאֵל Fecit, Paravit, Aptavit. And saith Kircher, signifiat tamem affectionem, qui aliquid exstit vel realiter, vel ornatus, vel ut non sit in pristino statu quo fuit. Concord. p. 2. col. 931.

to us; in this 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, (c) contrived with the utmost Sagacity, and ordered with plain wise Design, and ministring to admirable Ends. For which reason St. Paul might well affirm of those Ποιμανα of God, (d) 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; (e) especially to such as are unacquainted with the

(c) Quod si omnes mundi partes ita constituta sunt, ut neque ad usum meliores potuerint esse, neque ad speciem pulchrioriores; videamus utrim ea fortuita sint, an eo statu, quo coherere nullo modo potuerint, nisi sensu moderante divinaque providentia. Si ergo meliora sunt ea que Naturâ, quam illa, que Arte perfecta sunt, nec Ars efficit quid sit ratione; ne Natura quidem rationis express est habenda. Quâ igitur convenit, signum, aut tabulam pictam cum adspecteris, scire adhibitam esse artem; cumque procul cursum navigii videris, non dubitare, quin id ratione atque arte moveatur: aut cum Solarium, &c. Mundum autem, quicquae ipsas artes, & earum artifices, & cuncta complectatur, consilio & rationis esse expertem putaret? Quod si in Scythiam, aut in Britanniam, Sphæram alius tulerit banc, quam musicae familiaris nobis efficere possumus, cujus singula conversiones idem efficient in Sole, &c.—quod efficierit in celo singulis diebus & noctibus; quis in illâ barbarie dubitet, quin ea Sphæra sit perfecta Ratione? Hi autem, dum habitant de Mundo, ex quo & orientatur, & sunt omnia, casu ne ipse sit efficaci,—in Ratione, an Mente divina? Et Archimede arbitrantur plus valuiisse in imitandis Sphæris conversionibus, quam Naturam in essendiis, presertim cum multis partibus sint illa perfecta, quam hac simulata, solertius, &c. Cic. de Nat. l. 2. c. 34, 35.

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

(e) Mundus codex est Dei, in quo jugiter legere debemus, Bern. Serm.

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 (f) founded by one of the greatest Vertuoso'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 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 itself.

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 (a), and its Use to the World (b).

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
(c) As the Air is of absolute Necessity to Animal Life, so it is necessary that it should be of a due Temperament or Consi-
ence; not foul, by reason that suffocateth: not 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. 
Hawkesbee's Comprefing Engines, I closely shut up a Sparrow
without forcing any Air in; and in less than an Hour the Bird
began to pint, and be concerned; and in less than an Hour and
half to be sick, vomit, and more out of Breath; and in two
Hours time was nearly expiring.
Another I put in and comprefled the Air, but the Engine
leaking, I frequently renewed the Compreffure; by which
means, (although the Bird panted a little after the first Hour,) yet after such frequent Compreffures, and Immifion of fresh
Air, it was very little concerned, and taken out seemingly un-
hurt after three Hours.
After this I made two other Experiments in comprefled Air,
with the Weight of two Atmospheres injected, the Engine hold-
ing tight and well; the one with the Great Titmouse, the other
with a Sparrow. For near an Hour they seemed but little con-
cerned; but after that grew fainter, and in two Hours time
fick, and in three Hours time died. Another thing I took no-
tice of, was, that when the Birds were sick and very reflefs,
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 caufe was of both
the Birds living longer in comprefled, than uncompreffed Air;
whether a les Quantity of Air was not sooner fouled and
rendred unfit for Respiration, than a greater.
From these Experiments two Things are manifested; one is,
that Air, in some measure comprefled, or rather heavy, is ne-
cessary 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 Reafon, in the Diving-Bell, af-
ter some time of stay under Water, they are forced to come
up and take in fresh Air, or by some fuch means recruit it. But
the famous Cornelius Drebell contrived not only a Vefsel to be
rowed under Water, but also a Liquor to be carried in that
Vefsel, that would supply the want of fresh Air. The Vefsel
was made for King James I. It carried twelve Rowers, besides
the Passengers. It was tried in the River of Thames; and one
of the Persons that was in that submarine Navigation was then alive, and told it one, who related the Matter to our famous Founder, the Honourable, and most Ingenious Mr. Boyle. As to the Liquor, Mr. Boyle's faith, he discovered by a Doctor of Phyfick, 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 unflopping a Veilfull 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 assurred Mr. Boyle what it was. Vid. Boyle, Exp. Phys. Mech. of the Spring of the Air, Exp. 41. in the Digres. This Story I have related from Mr. Boyle, but at the same time much quellion whether the Virtues 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 reited) told Mr. Boyle, 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 happen'd to them when they were so high above the Plane, 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, call'd Pic de Midi, found the Air not so fit for Respiration, as the common Air, but he and his Company were fain to breath shorter and oftener than in the lower Air. Vid. Phil. Transac. 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 pass'd the high Mountains of Peru, which they call Periaca, (to which he faith, 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 calling up of Blood too,) and with so violent a Diftemper, 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 Subtily and Delicacy of the Air, which is not proportionable to humane Respiration, which requires a more gros and temperate Air, Vid. Boyle, ubi supra.

Thus
Thus it appears, that an Air too Subtile, Rare and Light, is unfit for Respiration: But the Cause is not the Subtlety or too great Delicacy, as Mr. Boyle thinks, but the too great Lightness thereof, which renders it unable to be a Counterbalance, or an Antagonist to the Heart, and all the Muscles miniftringing to Respiration, and the Diafphole 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 Whimfies of paf- sing to the Moon, &c. so to our being able to bear an heavier State of the Air is an excellent Provision for Mens Occafions in Mines, and other great Depths of the Earth; and thofe other greater Presfures made upon the Air, in the Diving-Bell, when we defcend into great Depths of the Waters.

(d) That the Inhabitants of the Air, (Birds and Insects,) need the Air as well as Man and other Animals, is manifeft from their speedy dying in too feculent, or too much rarefied Air; of which fee the preceding and following Note f. But yet Birds and Insects (fome Birds at leaft) 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 thofe Perfons were in the preceding Note. So Insects bear the Air-Pump long, as in the following Note f.

(e) Creatures inhabiting the Waters need the Air, as well as other Animals, yea, and fresh Air too. The Hydrocanthari of all Sorts, the Nympha of Gnats, and many other Water-Infests, have a singular Faculty, and an admirable Apparatus, to raife their back Parts to the top of the Waters, and take in fresh Air. It is pretty to fee, for Inftance, the Hydrocanthari come and thraff their Tails out of the Water, and take in a Bubble of Air, at the tip of their Vagine and Tails, and then nimblly carry it down with them into the Waters; and, when that is spent, or fouled, to ascend again and recruit it.

So Fihes alfo are well known to ufe Respiration, by pafling the Water through their Mouths and Gills. But Carps will live out of the Water, only in the Air; as is manifeft by the Expe- riment of their way of Fatting them in Holland, and which hath been practifed here in England, viz. they hang them up in a Cellar, or some cool Place, in wet Mofs in a small Net, with their Heads out, and feed them with white Bread soaked in Milk for many Days. This was told me by a Perfom very curious, and of great Honour and Eminence, whose Word (if I had leave to name him) no Body would quiffin: And it being an Inftance
most Animals live scarce half a Minute (f); and others, that are the most accustomed to the want of it, live not without it many Days.

And

of the Respiration of Fishes very singular, and somewhat out of the way, I have for the Reader's Diversion taken notice of it.

(f) By Experiments I made myself 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 Expiration; 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) suffocated the Pump two Minutes, and revived upon the re-admission of the Air. After that, he remained four Minutes and a half and revived. Last, After he had been 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, Grasshoppers, 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 Ear-wig, the great Staphylinus, the great black lowly 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, 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 expos'd a Day or two to the open Air, I found some of them dead, some alive.

(g) That
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 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 (g).

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 Buoyancy (b) to it, as shall be shewn in proper place: And even the watery Inhabitants themselves cannot ascend

(g) 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 affirment, In Plantis quaque peragi Aeris respirationem quandam impenetrabilis, quae carum 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 same 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.

ascend and descend into their Element, well without it (i).

But

(i) Fishes by reason of the 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 Infidentibus 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 itself, 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. Boyle 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 itself up in the Water. 2. Flat Fishes, as Soles, Plaice, &c. which lie always gourelling at the Bottom, have no Swimming-Bladders that I ever 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 lifts. See more very curious Observations relating to this Matter, of the late great Mr. Ray, as also of the curious anonymous Gentleman in the ingenious Mr. Lowthorp's Abridgment, before cited, p. 845. from Phil. Trans. N. 114, 115.

(k) Among
Chap. I. Atmosphere.

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 (k); in many of the Functions and Operations of Nature (l) in the Conveyance of Sounds; and a Thousand Things besides. And I shall but just

(k) Among the Engines in which the Air is useful, Pumps may be accounted not contemptible ones, and divers other Hydraulic 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 juitly famous Mr. Boyle 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.

(l) 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 concurring 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 Nuisances 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 Crystal-Glasses, which, with long keeping, especially if not used, will in Time be reduced to 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. Boyle 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 Transylvania, 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. Boyle's Sulphur about some hid. Qual. in the Air, p. 28. So the Trees 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 so exceedingly tough, hard, and found at first,
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 \((m)\); and retreating the Sun-beams to our Eye, before it ever surmounteth our Horizon \((n)\); by which means the Day is protracted throughout the whole Globe; and the long and dismal Nights are shorten'd in the frigid Zones, and Day sooner approacheth.

First, that I could make but little Impressions on them with the Strokes of an Ax; but being expos'd to the Air and Water, soon became fo rotten as to be crumbled between the Fingers. See my Observations in Philos. Transact. No 335.

\((m)\) By reflecting the Light of the heavenly Bodies to us, I mean that Whiteness or Lightness which is in the Air in the 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, \(\text{viz.}\) 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 this, 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 render'd visible; or (which amounts to the same) those swimming small Bodies are render'd 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 condenze, and that are not able to reflect the other Colours. \(V.\) Optic. l. 2. Par. 3. Prop. 7.

\((n)\) 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 this reflecive 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...
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 (o).

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

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 (faith 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 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 Navigation 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 uninfected 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. Hook's Poft. Works. Left of Navig. p. 466.


[These Hollanders] found, that the Night in that place short-ened no less than a whole Month; which must needs be a very great Comfort to all such Places as live 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.

CHAP. II.

Of the Winds (a).

To pass by other Considerations, whereby I might demonstrate the Winds to be the infinite Creator's Contrivance, I shall insist only upon their great usefulness to the World. And so great is their 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, fetid, and unfit for Respiration,

(a) Ventus est aer fluentes, 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 Caufe 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 Condenfations in one Place more than another; 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, faith he, dejecto levì pondere, quamvis tranquillò die, turbini similis emicat procella. But as to Caves it is observed, that they often emit Winds more or less. Dr. Connor, taking notice of this matter, specifies these, In regno Neapolitano ex immanni Cumane Sibylle antro tenuem ventum effluentem percepit. The like he observed at the Caves at Baie, and in some of the Mines of Germany, and in the large Salt-Mines of Cracow in Poland. Ubi, faith he, opifices, & ipse sodine dominus Andreas Moritin, Nob. Polonus, mihi afferuerunt, quod tanta aliquando Venterum tempestas ex ambagiosis hujus sodina recessibus surgere solebat, quod laborantes fossores humi prosternebas, nec non portas & domicilia (quæ sibi in bâc sodina artifices exstruunt) penitus evertebat. Bern. Connor. Differt. Med. Phyf. p. 33. Artic. 3.

And as great Caves, so great Lakes sometimes send forth Winds. So Gaffendus faith the Lacus Leginus doth, E quo dum exoritur sussus, nubes hând dúbie creanda est, que sì brevi in temporatem.
Chap. II. Of the Winds.

Respiration, as well as Health and Pleasure, a flagnating, 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


But the most universal and constant Alterations of the Balance 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: if the Cause there-of be (as some ingenious Men imagine) the Sun's daily Progress round that part of the Globe, and by his Heat rarifying one part of the Air, whilst the cooler and heavier Air behind prevails after. So the Sea and Land Breezes in Note a. 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, you may observe it to 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-Showersthe 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 upon March the 18th 1712, (and divers such like Instances I have had before and since) that the Morning was warm, and what Wind stirr'd 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 settled 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
But the perpetual Commotions it receives from the Gales and Storms, keep it pure and healthful (b).

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

the struggle between the warmth of ours, and the cold of the cloudy Region, flopped the airy Currents of both Regions. 3. That the falling of the Snow through our warmer Air melted 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.


(b) 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 soon as the Nile begins to overflow; although Mr. Boyle attributes it to nitrous Corpuscles. Determin. Nat. of fflav. Chap. 4.

Nulla enim propemodum regio est, que non habeat aliquem flavum ex se nascentem, et circa se cadentem.

Inter estera Iraq; Providentia opera, hoc quoque aliquis, ut dig-num admiratione superserit. Non enim ex una causa Ventos aut inventis, aut per diversa dispositions, sed primum ut aer non sinnerent pigrescer, sed asiduas vexationes utilem reddenter, vital-en; tradituris. Sen. Nat. Quaest. l. 5. c. 17, 18.

All this is more evident, from the Caufe 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 thofe Distempers. Vide Mead of Poisons, Essay 5. p. 161. But indeed, whether the Caufe be this, or poifonous, malignant Exhalations or Animalcules, as others think, the
or not without Danger of Health and Life (c). But especially, witness the perpetual Gales which throughout the whole Year do fan the Torrid Zone, and make that Climate an healthful and pleasant Habitation,

the Winds are however very salutiferous in such Cases, in cooling the Air, and dispersing and driving away the moist or pelliferous Vapours.

(c) July 8. 1707, (called for some time after the Hot Tues-
day,) 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 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 Instrurments, 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 Aequinocial: In these two different Climates, the Places were marked where the Spirits flood 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 28.4 Tenths of an Inch above the Ball. After that, in a much hotter Day, and indeed nearly as hot as any Day with us, and after I had heated my my self with strong Exercise too, as much as I could well bear, I again tried the same Experiment, but could not get the Spirits above 283 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 forgot-
Habitation, which would otherwise be scarce habitable.

To these I might add many other great Conveniencies 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 (d) and I might particularly speak of the general and coasting Trade-Winds, the Sea, and the Land-Breezes; (e) the one serving to carry the Mariner in long Voyages from East to West; the other serving to waft him to particular Places;

ten them) 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. No. 270.

(d) In hoc Providentia ac Dispositore ille Mundi Deus, aeris ventis exercendum dedit, — non ut nos clasfes partem freii occupaturas compleverimus milite armato, &c. Dedit ille ventos ad celsi terrarum; temperiem, ad evocandas faprimendafq; aquas, ad alendos fatorum atq; arborum fructus; quos ad maturitatem eum aliis causis adductus ipsa faciatio, atrahens cibum in summa, & petrues, promovens. Dedit ventos ad ultiora noscenda: faiffet enim imperium animal, & fines magnar experientia rerum Homo, si circumscriptaretur natalis solis fine. Dedit ventos ut commoda cujusq; regionis fieren communia; non ut legiones equitatem; gestarent, nec ut pennis civilibus arma transsubeberent. Seneca, ibid.

(e) Sea-Breezes commonly rise in the Morning about nine a Clock. — They first approach the Shore 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
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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 (f). Leaving therefore the Winds, I proceed in the next Place to the Clouds and Rain.

Comparison. In half an Hours 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 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.

(f) 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, New-England, 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. No. 297, and 321.

But to give a good and tolerable Account of this or any other of the Weather, it is necessary 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.
The Clouds and Rain (a) 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.

(a) 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 Vesiculae detached from the Waters by the Power of the Solar, or Subterraneous Heat, or both. Of which see Book 2. Chap. 5. Note (b). 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 this Formation of Meteors 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 Mists, 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 itself, (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.
Plants, which would languish and die with perpetual Drought, but are hereby made Verdant and Flourishing, Gay and Ornamental; so that (as the

Psalmist

without either Sun or Rain. And in this Cafe, I have scarce ever known it to Rain, till it hath been first Fair, and then Foul. And Mr. Clarke, (an ingenious Clergyman 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) faith, 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 Cafe 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, and with 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 Condenfation formed into Rain, fall down in Drops.

The Cold's approaching the Vapours, and consequently the Alteration of such dark Weather I have beforehand 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 flaggling Vapours, or the uppermost of them, and condensing them into Drops, before it arrives unto, and except it self upon the main Body of Vapours below.

I have more largely than ordinary insinced 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 eekindled 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 det-
tached from mineral Juices, or at least that are mingled with them, and are fired by Fermentation.

Another Phenomenon 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 Upminister, even in the wettest Months. And not only with us at Upminister, but in other Places, particularly at Zurich in Switzerland, they seem to have had as unfeasable Cold and Wet as we. Euit hic mensis——prater modum humidus, & magnis quidem vegetabilibus hominibusque damno. Multum computru-it 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. No. 321.

In which Transact I have observed farther, that about the Equinoxes we (at Upminister 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 loos'd from the brumal Conspirations, the Vapours arise in great Plenty: And the like they do in Autumn, when the Summer Heats, that both dissipate them, and warm'd the superior Regions, are abated; and then the Cold of the superior Regions meeting them, condense them into Showers, more plentifully 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 Vesicula of Water; when they meet with a colder Air than what is contained in them, the contained Air is reduced into a less 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
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And, if to theseUses, we should add the Origi-
gine of Fountains and Rivers, to Vapours and the
Rains,

thickened Vesicula 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
Transations assigned the Quantities; particularly in the last ci-
ted Transation, I have assigned these, viz. the Depth of the
Rain one Year with another, in English Measure, if it was to
flagonate on the Earth, would amount unto, at Townely in
Lancashire, 42$\frac{1}{2}$ Inches; at Upminfer in Essex 19$\frac{1}{4}$ Inches; at
Zurich in Switzerland 32$\frac{1}{4}$ Inches; at Pisa in Italy 43$\frac{1}{4}$ Inches;
at Paris in France 19 Inches; and at Lüfe in Flanders 2.4 Inches.

It would be endless to reckon up the bloody and other pro-
digious Rains taken notice of by Historians, and other Au-
thors, as præternatural and ominous Accidents; but, if stri-
lily 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 haffe flew to the
Neighbouring Houses. Peiresk (then in the Neighbourhood)
strictly enquiring into the Cause, found it to be only red
Drops coming from a sort of Butterfly 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 adficia, non in devexis lapidum superficiebus, ut
debuerat contingere, fi eæco sanguine pluiffet; sed in subcarvis
poisus & in foraminibus. — Accefit, quod parieses ii tinge-
bantur, non qui in mediis oppidis, sed qui agrorum vicini erant,
negque feendum partes elatiores, sed ad mediorem folium altitudi-
dinem, quantum volitare Papiliones solent. Gaffend in vit.

So Dr. Merret faith also, Pluvia Sanguinis quan certifímmè con-
flat esse tantum Infeactorum excrémenta: Pluvia Trisici quan ni-
hil alio frém esse quam Hedera baccifera grana à Stornis devorata ex-
creataque comparanti liquidíssìmè pater. Pinax rerum, &c. p. 220.

The curious Worm tells of the raining of Brimstone, An. 1646.
Mayi 16. Hic Hafnia cùm ingenti pluvià tota urbs, omnefeque iva
inundarentur platea, ut gressus hominum impediret, Sulphuroque
odore aërem inficiret, dilapsis aliquantulum aquis, quibusdam in
locis colligere licuit Sulphureum pulverem, cuius portionem fervo,
colore, odore, & aliis verum Sulphur ferentem. Mul. Worm.
L. I. c. 11. Sect. I.
Together with the Rain we might take notice of other Meteors, particularly Snow; which although an irksome Guest, yet hath its great Uses, if all be true that the famous T. Bartholin faith of it, who wrote a Book de Nivis usu Medico. In which he shews of what great Ufe Snow is in fruitifying the Earth, preserving from the Plague, curing Fevers, Collicks, Head-Aches, Tooth-Aches, Sore Eyes, Pleururies, (for which Ufe he faith his Country-Women of Denmark keep Snow-Water gathered in March), also in prolonging Life, (of which he instanceth in the Alpine Inhabitants, that live to a great Age,) and preserving dead Bodies; Instances of which he gives in Persons buried under the Snow in passing the Alps, which are found uncorrupted in the Summer, when the Snow is melted; which sad Spectacle he himself was an Eye-Witness of. And at Spitzberg in Greenland, dead Bodies remain entire and uncorrupted for thirty Years. And lastly, concerning such as are so preserv'd when slain, he faith they remain in the fame Poffure and Figure: Of which he gives this odd Example, Visum id extra urbem nosbram [Hafniam] quum, 11 Feb. 1659. oppugnantes hostes repellerentur, magnâque firage occumberent; ali enim rigidi iritum vultum offendebant, ali oculos elatos, alii ore diuæto ringentes, alii brachiis extensis Gladium minari, alii alio fiv proferati fadabant. Barthol. de ulu 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 fruitify the Earth, it doth so by guarding the Corn or 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 Conerving dead Bodies, it doth it by confutilg such Bodies, and preventing all such Fermentations or internal Conflicts of their Particles, as would produce Corruption.

Such an Example as the preceding is said to have happened some Years ago at Paris, in digging in a Cellar for suppos'd hid treas, in which, after digging some Hours, the Maid going to call her Mafter, found them all in their digging Poffures, but dead. This being nois'd abroad, brought in not only the People, but Magistrates also, who found them accordingly; Ille qui ligime terram effoderat, & sic cus qui palâ effossam terram removerat, ambo pedibus stabant, quasi suo quisque operi affixus incubuijlet; uxor unius quas ab opere defessa in scanno, solicitoe
Chap. III. Of the Clouds and Rain.

Of this Opinion was my late most ingenious and learned Friend, Mr. Ray, whose Reasons see in his Physico-Theolog. Discourses, Disc. 2. ch. 2. p. 89, &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.
readily acknowledge the Workman (c) and as easily conclude the Atmosphere to be made by God, as an Instrument wrought by its Power, any Pneumatick Engine, to be contrived and made by Man!

C H A P. IV.
Of Light.

THUS much for the first Thing ministers to the Terraqueous Globe, the Atmosphere and its Meteors: the next Appendage is Light. (a) Concerning which I have in my Survey of the Heavens (b) shewed what admirable Contrivances the infinitely wise Creator hath for the affording this noble, glorious,


(a) It is not worth while to enumerate the Opinions of the Aristotelians, Cartesian, 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 Prin- cip. 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, Tung- nage, 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 Sunbeams as he intended. Vid. Boyl Exp. to make Fire and Flame ponderable.

(b) Astro-Theol. Book 7.

(c) Gen.
Chap. IV. Of Light.

rious, 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 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 ourselves 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 (c), 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 delightful 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 God's exquisite Workmanship in every Creature.

(c) Gen. i. 3. And God said, Let there be Light, and there was Light.
Of Light.

Book I.

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 its 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, its swift and almost instantaneous Motion, and its 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 (d) (which is the swiftest Motion we have next Light), in this Case Light would take up, in its 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 Motion.

The Inconveniencies of which would be, its Energy and Vigour would be greatly cooled and abated;

(d) 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 Fathom in a Second of Time, (vid. Mersen. Balist.) which is equal to \(589\frac{1}{2}\) 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 its 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 to be, as in the next Note, a Bullet would be 32\frac{1}{2} 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 17\frac{1}{2} Years in flying as far as the distance is from the Earth to the Sun. Confer here the Experiments of the Acad. del Cimento. p. 140, &c.
ted; its 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 instantaneous Swiftness of almost Two hundred thousand English Miles in one Second of Time, (e) or (which is the same Thing) being but about seven or eight Minutes of an Hour in coming 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, its vast Expansion, it's almost incomprehensible, and inconceivable Extension, which as a

(e) 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 Monfieur 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. Trans. before-cited: As also in the before commended 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 0, 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 Sun and the Earth (according to the Computations in my Astro-Theology, B. 1. ch. 3. Note 2.) is 86651398 English Miles; therefore, at the rate of 7 1/2 Minutes, or 450 Seconds in passing from the Sun, Light will be found to fly above 191225 Miles in one Second of Time.
late ingenious Author (f) faith, "Is as boundless "and unlimited as the Universe itself, 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. Infomuch that ve-
"ry many have asserted it absolutely infinite, and "without any Limits or Bounds.

And that this noble Creature of God is of this Extent, (g) is manifest from our seeing some of the farthest distant Objects, the heavenly Bodies, some

(f) Dr. Hook Post. Works. Lea& of Light, pag. 76.

(g) For the proof of this vast Extent of Light, I shall take the Computation of the same great Man, pag. 77. If, faith 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 7925000 Miles; and if we consider that according to the Observations, 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 1699] the whole Diameter of the 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 fort 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 that Light extends itself 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 Expanse 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.
with our naked Eye, some with the help of Optical 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 to 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.

C H A P. V.

Of Gravity.

The last Thing subfervient to our Globe, that I shall take notice of, is Gravity (a), or that Tendency which Bodies have to the Centre of the Earth.

(a) That there is such a Thing as Gravity, is manifest from its Effects here upon Earth; and that the Heavenly Bodies attract or gravitate to one another, when placed at due Distances, is made highly probable by Sir Isaac Newton. This attractive or gravitating Power, I take to be congenial to Matter, and imprinted on all the Matter of the Universe by the Creator's fiat at the Creation. What the Cause of it is, the Newtonian Philosophy doth not pretend to determine for want of Phenomena, upon which Foundation it is that that Philosophy is grounded, and not upon chimerical and uncertain Hypotheses: But whatever the Cause is, that Cause penetrates even to the Centers of the Sun and Planets, without any Diminution of its Virtue; and is aetheth not according to the Superficies of Bodies (as Mechanical Causes do) but in proportion to the Quantity of their solid Matter; and lastly, is aetheth all round it at immense Distances, decreasing in duplicate proportion to those Distances,
In my Astro-Theology, Book 6. Ch. 2. I have shewn of what absolute Necessity, and what a noble

Distances, as Sir Isaac Newton faith, Princip. pag. ult. What useful Deductions, and what a rational Philosophy have been drawn from hence, may be seen in the same Book.

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 Resistence 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, Duff, &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 Galileo, Mr. Huygens, and Dr. Halley (after them) is 16 Feet one 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 glasf, hollow Balls, some empty, some filled with Quick-silver, the Barometer at 297, the Thermometer 69 Degrees above Freezing. The Weight of the Balls, their Diameters, and Time of the Descent is in this Table.

<table>
<thead>
<tr>
<th>Balls filled with Q.</th>
<th>Empty Balls.</th>
</tr>
</thead>
<tbody>
<tr>
<td>908</td>
<td>510</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
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<tr>
<td>903</td>
<td>642</td>
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<tr>
<td>8</td>
<td>5 nearly</td>
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<tr>
<td>866</td>
<td>599</td>
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<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>747</td>
<td>515</td>
</tr>
<tr>
<td>7½ more.</td>
<td>5 nearly</td>
</tr>
<tr>
<td>808</td>
<td>483</td>
</tr>
<tr>
<td>7½ more.</td>
<td>5</td>
</tr>
<tr>
<td>784</td>
<td>641</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

The Reason why the heavy, full Balls fell in half the Time of the hollow ones, was the Resistence of the Air: Which Resistence is very ingeniously and accurately assigned by Dr. Wallis, in Philos. Trans. No. 186. And the cause of the Resistence 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 Resistence a spherical Body meets with from Friction, is as the right Angle under the Diameter, and
noble Contrivance this of Gravity is, for 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 (b). The Terraqueous Globe particularly, which circumsolves at the rate of above 1000 Miles an Hour (c), would

and the Velocity of the moving Body: And the Resilience from the *Vis Inertia*, is as the Square of that Product.

For a farther Account of the Properties and Proportions, e. r. of Gravity in the Fall or Projection of Bodies, I shall refer to the larger Accounts of Galiliano, Torricelliano, Huygens, Sir Isaac Newton, &c. of to the shorter Accounts of Dr. Halley in Philos. Trans. abridged by Mr. Lowborp, Vol. I. p. 461. or Dr. Clarke in his Notes on Robartl, Phys. 2. c. 28. § 13, 16. And for the Resilience of Fluids, I refer to Dr. Wallis before-cited, and the _Att. Erudic._ Lip. May 1693, where there is a way to find the Force of Mediums upon Bodies of different Figures.

(b) 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 $\frac{1}{4}$ Days. The Spots on and prove those two Planets to revolve also from East to West, as Dr. Hook discover'd 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 the Creator observ'd 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.

(c) The Earth's Circumference being 25031 ½ Miles, (according to Book II. Chap. 2. Note a.) if we divide that into 24 Hours, we shall find the Motion of the Earth to be nearly 1043 Miles in an Hour. Which, by the by, 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 e, of the preceding Chapter, the Circumference of the Magnus Orbis is 540686225 English Miles, which divided by 24 Hours, gives 22528364 Miles in an Hour. But what is
would by the centrifugal force of that Motion, be soon dissipat ed and spiritted 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 (d). And the fleeting Waters, the most unruly of all its Parts, do by this means keep their constant aequipoise in the Globe (e), and remain in that Place which, the Psalmist faith, God had founded for them: a bound he had set, which they might not pass; that they turn not again to cover the Earth, Psal. civ. 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. lxxxix. 9. Thou rulest the raging of the Sea; when the Waves thereof arise, thou stilllest 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

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.

(d) Nihil majus, quàm quod ita stabillis est Mundus, atque ita cohaeres ad permanendum, ut nihil ne excogitari quidem possit aptius. Omnes enim partes ejus undique medium locum cepissent, nimirum equaliter: maximè autem corpora inter se junèta permanent, cum quodam quasi vinculo circumdata colligantur: quod factum est natura, qua per omnem mundum omnia Mente, & Ratione conscienti, funditur, & ad medium rapit, & convertit extrema, Cic. de Nat. Deor. I. 2. c. 45.

(e) Fædem ratione Mare, cum supra terram sit, medium tam tenent terræ locum expetens, conglobatur undique equaliter, neque redundat unquam, neque effunditur. Id. paulo post.

(f) that
(f) That there is no such Thing as positive Levity, but that Levity is only a less Gravity, is abundantly manifested by the acute Seig. Alph. Borelli de Mot. à Grav. pend. cap. 4. See also the Annotations of the learned and ingenious Dr. Clark on Rohaulti Phys. p. 1. c. 16. Note 3. Also the Exper. of the Acad. del Cimento, p. 118, &c. Dr. Wallis's Diff. of Gravity and Gravitation before the Royal Society, Nov. 12. 1674. p. 28, &c.

(g) I have before in Note a, Chap. 3. shewn what Vapours are, and how they are rais'd. 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. p. 168. 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 rais'd in Vapours, exceeds that which falleth in Rain. In the seven last Months of the Year 1683, the Evaporations amounted to 22 Inches 5 Lines; but the Rain only to Inches 6 1/2 Lines: In 1689, the Evaporations were 32 Inches 10 1/2 Lines; but the Rain 18 Inches 1 Line: In 1690, the Evaporations 30 Inches 11 Lines; the Rain 21 Inches 1/3 of a Line. Vid. Mem. de Math. Phys. Ann. 1692. p. 25.

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 of them haveabee n left.
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 (b), beset with pleasant Gardens, adorned with stately Avenues, furnished with well-contrived Aqueducts, 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 itself, or that conducteth 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 everything, even in the very Appendages alone, exactly answereth 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 Artift, of Power and Skill equivalent to to such a Work?

(b) See Book II. Chap. 3. Note c.
BOOK II.

Of the Terraqueous Globe itself 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 itself; a most stupendious Work in every particular of it, which doth no less aggrandize its Maker (a), than every curious, complete 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

Of the Terraqueous Globe, &c. Book II.

with our Microscopes, and most exquisite Instru-
mements (b) 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 Co-
pies 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 farther 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, Mo-
tion, Place, Distribution into Earth and Waters, and
the great Variety of all Things upon it and in it.

(b) I cannot here omit the Observations that have been made
in these later Times, since we have had the Use and Improve-
ment 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
CHAP. I.
Of the Figure of the Terraqueous Globe.

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

(a) Although the Terraqueous Globe be of an orbicular Figure, yet it is not strictly so, 1. On account of its Hills and Vallies. But these are inconsiderable to the Earth's Semidiameter; for 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 Sphaeroid, 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 3 to 40 3. 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 been of late able to take a review of that Planet; yet Saturn (so far as his Ring would permit,) and Mars appear perfectly round thro' 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 Jupiter's apparent Diameter, and by reason he is moving all the time of measuring him.

As to what is alleged 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. No. 294. But if the Degrees of a Meridian grow larger, the more we go towards the Line, (as Mr. Cassini affirms they do, by an 830 a

Part
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 Masses of Earth and Waters were (as some fancied) a large Plain; or as others, like

Part in every Degree, in Phil. Trans. No. 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 a hard Body, by reason their Gravity doth so far over-power 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 I have made.

(5) It would be frivolous as well as endless to reckon up the various Opinions of the Ancients about the Figure of the Terraqueous Globe; some of them may be seen in Varen, Geogr.
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 Distribution of the Waters in the Globe. For since, by the Laws of Gravity, the Waters will poslefs the lowest Place; therefore, if the Mass of the 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 Winds.

1. 1. c. 3. init. or Jonson's Thaumat. 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 Univerfe; and that all beneath the Ocean was Hades, or the invisible World. Hence, when the Sun set, he was said tingere fe 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 Laetus, St. Augustine, and others, who thought their Opinion was favoured by the Psalmist, in Psal. xxiv. 2. and cxxxvi. 6. See Bp. Usher's Anf. to a Jes. Chall. p. 366. &c.
Winds (c), 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 Inconveniences.

(c) Neither do these constant Trade-Winds usually blow near the Shore, but only on 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, faith 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 tends more East or West, from North or South on the Coast; 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). A Mass of above 260 Thousand Million 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,

(a) 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 Mr. Caffini in France. Whose Measures do in a surprizing manner agree. But Mr. Caffini's seeming to be the most accurate (as I have shewed in my Astro-Theology, B. 1. Ch. 2. Note a.) I have there made use of his Determinations. According to which the Diameter of the Earth being 7967.72 English Miles, its Ambit will be 25031 ½ Miles; and (supposing it to be Spherical) its Surface will be 199444220 Miles; which being multiplied into ¼ of its Semidiameter, gives the Solid Content, viz. 264856000000 Miles.

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 (a). That so vast a Body as the Earth and Waters should be moved at

(a) 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 for the Proof thereof I shall refer the Reader to the Preface of my Astro-Theology, and B. 4. Chap. 3.
all (b), that it should undergo two such different Motions, as the Diurnal and Annual are, and that these Motions should be so constant and regularly (c) performed for near 6000 Years, without any the least Alteration ever heard of (except some Hours which we read of in Jofb. x. 12, 13. and in Hezekiahs's Time, which, if they cannot be accounted for some other way, do greatly encrase

(b) 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 prime Mover, that is not moved by another. For it is impossible, that what moveth, and is moved by another, should proceed in infinitum. Ariftot. Phyf. 1. 8. c. 5.


Cogitemus qui fieri potīt, ut tanta magnitudo, ab aliqüe pos- sit natura, tanto tempore circumferri? Ego igitur affero Deum causam esse, nec aliter posse fieri. Plato in Epinom.

(c) Among the Causes which Cleanthes is laid in Tully to assign for Men's Belief of a Deity, one of the chief is, æquabilitatem motus, conversionem Cæli, Solis, Lunae, Siderumque omnium distinctionem, varietatem, pulchritudinem, ordinem: quorum rerum aspectus ipsaeflatis indicaret, non esse ea fortu- sta. Ut sit quis in domum aliquid, aut in gymnasio, aut in forum venerit; cùm videat omnium rerum rationem, modum, disciplinam, non possit ea sine causâ fieri judicare, sed esse ali- quem intelligat, qui præsit, & cui pareatur: multo magis in tan- tis motibus, tantisque vicissitudinisibus, tam multarum rerum ar- qua tantarum ordinibus, in quibus nihil unquam immensa & in- finita velutias mentiça sit, statuat necesse est ab aliqüa Mente tantos natura motus gubernari. Cic. de Nat. Deor. l. 2. c. 5.

Hominès coeperunt Deum agnoscre, cùm viderent Stellas, tan- tam concinnitatem esse:que; ac dies, noctesque, aestate, & hyeme, ìtos servare, flatos orius, atque obitus. Plutarch de placit. l. 1. c. 6.
the Wonder (d); these Things, I say,) do manifestly argue some divine infinite Power to be concerned therein (e): 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; (f) the one for Man, and most other Ani-

(d) We need not be sollicitous 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, iii. 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 Cafe, 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 Cafe, 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.

(e) Nam cum dispositione quassissimae fœderæ Mundi,
Præscriptosque Maris fines, Annique meatus,
Et Lucis, Nocturnis vicebus: tunc omnis rebar
Consilio firmata Dei, qui lege moveri
Sidera, qui fruges diverso tempore nasci,
Qui variam Phæben alieno jusserit igne
Completri, Solemque suo; porrexeris undis
Listera; Tellurem medio librarerat axe.
Claudian in Rufin. L. 1. initio.

(f) 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.
Cicero de Nat. Deor. l. 2. c. 53
mals to gather and provide Food, Habitation, and other Necessaries of Life; the other to rest, refresh, and recruit their Spirits, 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 Instances 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.

(g) The acute Dr. Cheyne, in his ingenious *Philos. Princ. of Natural Religion*, among other Uses of Day and Night, faith, 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.

**C H A P. 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 (a), its Fountain of Light and Heat;

(a) 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 counterpeering 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.
and from its neighbouring Planets of the solar System, and from the fixed Stars. But these Things I have spoken more largely of in my Survey of the Heavens (b), and therefore only barely mention them now; to insist more largely upon,

(b) Astro-Theology, Book vii. Chap. 7.

CHAP. V.

The Distribution of the Earth and Waters.

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

(a) 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 claims on this Point, Tellus nostra, si totam simul complectamur, non est ordinata & veniata rerum compages—sed moles aggesia vario, incertque situ partium, nulla ordinis aut veniatius habitura ratione. Theor. Sacr. i. i. c. 7. Ecquis autem a Deo hsec saepta? &c. ib. Quo autem Herculeo labor eopie effet ad excavandam terram in tantum hiatum? —Si immediate a causad primae effectus suffisset hic alveus, aliquem saltem ordinem, moresum, & proportionem notare voluisset in ipsius formâ, & partium dispositione; —sed confusa omnia, &c. ib. c. 8. Tellus nostra cim exigua sit, est etiam rudis: Et in illâ exiguitate multa sunt superflua, multa inelegantia. Dimidiam terrae superficiem inundat Oceanus; magna ex parte, ut mihi videtur, inundis. 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 it is well enough for a sinful World. But besides, what others have long ago abundantly
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 Counterpoife 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 (b), as to afford sufficient Vapours (c) for Clouds

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

(b) 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.

(c) I took notice before in Book I. Chap. 3. Note (a). That the Vapours constituting Clouds and Rain, are Vesicula 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 thenceby, 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
Chap. V. Earth and Waters.

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

ascending out of the Water. A small Heat throws off but few Vapours, scarce visible: A greater Heat, and ascending in greater Quantities, carries off greater, larger, and more numerous Vetricula, which we call a steam: And if the Heat breaks through the Water with such a Fury, as to lacerate and lift up great Quantities or Bubble 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 visible 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 and leffer 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 Maffes of Water, like those of Rain, &c. 3. These Vapours in their Ascent from the Water, may be observed, in cold frosty 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 Decent 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 00, the Vapours are sooner carried out of Sight, and make way for others. And accordingly I have often observed, that not Liquors, if not set too thin, and not frequently stirred, cool flower in the greatest Frosts, than in temperate Weather, specially if windy. And it is manifest by good Experiments, that the Evaporations are less at those times than these; least far in the Winter than the warmer Months.

(c) 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 least of, than most Parts of Europe besides; of which see VII. Chap. 12. Note c,) so this Temperature is owing to the warm Vapours afforded chiefly by the Sea, which by the receding Note must necessarily be warm, as they are Vapours, or Water inflated by Heat.

The Caufe of this Heat I take to be partly that of the Sun, and partly Subterraneous. That it is not wholly that of the
Heats (d) of the Torrid Zone, and to refresh the Earth with fertile Showers; yea, in some measure to minifier 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, or 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 flagnate, flink, and poison, or annoy them; but to be gently carried through convenient Chanela back again

the Sun. is manifest from Vapours, being as, or more copiously raised when the Sun Beams are weakest, as when strongest; there being greater 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 such as is 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, thereto by the same warm Vapours arising in the Earth, which animate them, as well as produce the succeeding Changes of the Weather.

(d) Besides the Trade-Winds, which serve to mitigate the excessive Heats in the Torrid Zone; the Clouds are a good Screen against the scorching Sun-Beams, especially when the Sun paffeth 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 Varenii takes notice of, is a great Providence of God, viz. Pleraque loca Zone Terride vicinum habent mare, ut India, Insula Indica, Lingua Africa, Guinea, Brasilia, Peruwsia, Mexicana, Hispania: Pauca loca Zone Terride sunt Mediterranea. Varenii. Geogr. I. 2. c. 26. Prop. 10. §. 7.
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to their grand Fountain (e) the Sea; and many of them through such large Tracts of Land, and to such prodigious Distances, that it is a great Wonder the Fountains

(e) That Springs have their Origine from the Sea, and not from Rains and Vapours, among many other strong Reasons, I 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 Upminfier, 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. Trans. No. 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 Land into it; which discolour-eth 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 increafe and decrease of the one, as there shou'd happen to be of the other: As actually it is in such temporary Springs as have undoubtedly their Source from Rain and Va-pours.

But besides this, another considerable Thing in this Upminfier 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 Hypothefis (suppose) than the lower Lands about it have. By some Critical Observations I made with a very nice portable Barometer, I found that my Houfe 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 I made nearer the Sea) 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 Houfe stands; and the Lands from whence it immediately fliues, I guess about 15 or 20 Feet higher than the Spring; and the Lands above that, of no very remarkable Height.
Fountains should be high enough (f), or the Seas low enough, ever to afford so long a Conveyance. Witness the Danube (g) and Wolga of Europe, the

And indeed, by actual Measure, one of the highest Hills I have met with in Essex, is but 363 Feet high; (Vid. Phil. Trans. No. 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 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 of all its Fountains and Rivulets?

But I shall no farther prosecute this Argument, but refer to the late learned, curious and industrious Dr. Plov’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 Basin of Water; where the Sand will represent the dry Land, or an Island, and the Basin of Water the Sea about it. And as the Water in the Basin riseth to, or near 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.

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.

(f) See Book III. Chap. 4.

(g) The Danube in a sober Account, performs a Course of above 1500 Miles, (i. e. in a straight Line) from its Rise to its Fall. Bohun’s Geogr. Dict.
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Nile (h) and the Niger (i) of Africk, the Ganges (k) and Euphrates of Asia, and the Amazons River (l) 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 Alterations 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.

(i) Varone reckons the Course of the Niger, at a middle Computation, 600 German Miles, that is 2400 Italian.
(k) 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.

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

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Creatures (a). 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 (b) hath its Variety of Diseases; nay, if Man, 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 Phy-}

(a) Non dat Deus beneficia? Unde ergò 19a quis possides? ——
Unde huc innumerabilia, occlus, aures & animum multacentia? Unde illa luxuriam quaque inservens copia? Neque enim necessi-
tatibus tantummodo nofiris provitum est: usque in delicias ana-
mur. {Tot arbusla, non uno modo frugifera, tot herba salutares,
tot varietates ciborum, per totum annum digesce, ut inerti quo-
que fortuita terre alimenta preberent. Jam animalia omnis
generis, alia in fico, &c. — ut omnis rerum nature pars tri-
butum aliquod nobis conferret. Senec. de Benef. l. 4. c. 5.
ubi plura vide.

Hic, ubi habitamus non intermitit suo tempore Caelum nite-
sere, arbores frondescere —— tum multitudinem pecudum partim
ad vestendum, partim ad cultum agrorum, partim ad veufendum,
partim ad corpora veufienda; hominemque ipsa quafi con-
platorem caeli ac deorum, ipsorumque cultorem. —— Hec igi-
xur, & alia innumerabilia cum cernimus, possumusne dabitate,
quim bis prefat aliquis vel Effèctor, si hoc naia sumi, ut Platoni
videtur: vel si semper fuerint, ut Aristotelici placet, Moderator

(b) Sumt & gentium differentia non mediocre —— que con-
templatio auter rursus nos ad ipsorum animalium naturas, inge-
niatisque iis vel certiores morborum omnium medicinas. Enim
vero rerum omnium Parent, nullum animal ad hoc tantum ut
patiseretur, aut alia satiaret nati velut: artesque salutares ii,
insinerit. Plin. N. H. l. 27. c. 13.
creation and Pleasure. But the Munificence of the Creator is such, that there is abundantly enough to supply the Wants, the Conveniencies, 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 (c)? 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 Fertility, 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 (d), as means to excite our Wisdom.

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(c) This was no very easy Question to be answered by such as held, that all Things were made for Man, as most of the Ancients did; as Aristotle, Seneca, Cicero and Pliny, (to name only some of the chief). And Cicero cites it as the celebrated Chrysippus's Opinion, Praecale enim Chrysippus, Cetera natura esse Hominum Causar, & Deorum. De fin. bon. & mal. l. 3. And in his De Nat. Desr. 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 faith, 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 Universè have been found to be of infinitely greater Extent than the Ancients supposed them; this narrow Opinion hath been exploded. And the Answer will be found 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. (See my Astro-Theology.) In the Earth and Waters, Why so many Creatures of no use to Man?

(d) Nec minus clara exiit documenta sunt etiam ex contem-pendicular animalibus. M. Varro author est, à cumulis jussuisin
Variety of Things

Book II.

Wisdom, Care, and Industry, with more to the same purpose. But these Things have been fully urged by others; and it is sufficient to say, that this great

in Hispania epidem, à talpis in Thessaliâ: ab ranis civitatem in Gallia pulsat, ab locustis in Africâ: ex Gyaro, Cycладum insulâ, incolas à muribus fugatos; in Ítalâ Amyclas à serpen-

To these Inflances may be added, the Plague they sometimes suffer from a kind of Mice (they call Leming, Lemin-
ger, 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.

Quaere patimur multa mala à creaturâ quam fecit Deus, nisi quia oendiimus Deum? — De paeâ tuâ peccatum tuum accusa,
non judicem. Nam proper Superbiam instituit Deus creaturam
îlam minimam & abjectissimam, ut ipsa nos torqueter, ut cim
superbus fuerit homo, & se jactaverit adversus Deum, — cim
se ereixerit, Pulcibus subjurator. Quid est, quod te infas humanâ
superbia? — Pulcibus resiste, ut dormias. Cognosce qui fis. Nam
proper superbiam nosstram demandâm — creata illa qua mole-
sia sunt: populum Pharaonis superbum potuit Deus d:mare de
Ursis, de &c. Muscas & Ranas illis immisit, ut rebus vulîssimis
superbia domaretur. Omnia ergo per ipsum —— factâ sunt;
& sine ipsâ factum est nihil. Augult. Träf t. r. 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 the in 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 venemous 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 cruised and rub-
bbed, and 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,
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 (e), 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 inferior Creatures themselves; even for which inferior 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

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 Puncture, immediately curing themselves by the Application of their Specifick. This though they keep 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 Mischiefs of such noxious Animals, belides 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 Inflame, 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.


*Non fomenta sua* ex tellure germinant Herba, qua contra quoscumque morbos accommoda sunt; sed ex voluntate Opificis, ab nostram utilitatem producere sunt. Basil. Ascert. Tom. 2.

Consult here, *Book X. Note z, aa, bb.*
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 (f), many Animals, many Minerals, which in one Form destroy, in another heal. The Casta Planta

(f) 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 faith, 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. No. 231. And a Woman which was cured of the Plague, but wanted 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 her 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. 1604. 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 Correfives, 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 9. to 38. 2. The Radic. Assari, Cicuta, and the Nappelus, in Agues and periodical Pains. Dos. 9. to 38. 3. The Hyoscyamus in Hemorrhagies, violent Heats and Perturbation of the Blood, and al-
Plant unprepared poisoneth, but prepared, is the very Bread of the West-Indies (g). 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 Phyllick, 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 (b), 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 (i), for whose happy and comfortable Subsistence, I have said the bountiful Creator hath liberally provided, as well as for that of Man.

so in all great Inflammations. Dof. 3/ to 3/5. 4. The Semoa Stramonis is a very good Anodyne, useful in Vigilia's, Rheumatisms, Hysterick Cakes, in all the Organs of the Blood or Spirits, and where-ever there is an Indication for a Paregorick. Dof. 3/ to 3/5.

5. Elaterium thus corrected, may be given from gr. x. to xv. in Hydropical Cakes, 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, and may be given very safely in great Doses, and proves more than usually prevalent in Convulsive Cakes, Fluxes, Catarrhs, and all painful Paroxysms, &c.

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

(b) I have shewn in the Phil. Trans. that the Pediculus satidicus, 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. No. 291.

(i) 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 itself 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 own 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 itself, the most remarkable Things that present themselves to our View, are,
CHAP. I.

Of the Soils and Moulds in the Earth.

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

(a) It is not to be doubted, that although Vegetables delight in peculiar Soils, yet they owe not their Life and Growth to the Earth itself, but to some agreeable Juices or Salts, &c. residing in the Earth. Of this the great Mr. Boyle hath given us some good Experiments. He ordered his Gardener 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 alleges 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. Boyle's Scept. Chym. Part 2. pag. 114.
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 (b); still we find Provision enough for all these Purposes: Every Country abounding with its proper Trees and Plants (c), 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. i. ii.

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, 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,

(b) \( \text{Tos} \, \frac{5}{7} \, \text{totes} \, \text{etet} \, \text{tiao \, dikaios}, \, \text{kai} \, \mu \, \text{monon} \, \text{ta} \, \pi \, \text{eiratia} \, \text{Tos} \, \text{diebeto}, \, \text{etc.} \, \text{ta} \, \mu \, \text{w} \, \text{ko} \, \text{pilai} \, \text{exuex}, \, \text{ta} \, \frac{5}{7} \, \text{diudex}, \, \text{ta} \, \frac{5}{7} \, \text{karunex}, \, \text{ta} \, \frac{5}{7} \, \text{petaliex}, \, \text{ta} \, \frac{5}{7} \, \text{paetixex}, \, \text{ka} \, \text{diis}, \, \text{ta} \, \mu \, \text{w} \, \text{mipnelis}, \, \text{ta} \, \frac{5}{7} \, \text{elubex}. \)

(c) \( \text{Nec} \, \text{veter Terra} \, \text{ferre} \, \text{omnes} \, \text{omnia} \, \text{possunt.} \)

\( \text{Fluminibus Salices, crassique paludibus Alni} \)

\( \text{Nascentur; fieriles saxostr montibus Orni:} \)

\( \text{Littora Myrtis latissima: denique apertos} \)

\( \text{Bacchus amat colles: Aquilonem & frigora Taxi.} \)

\( \text{Asps & extremis domitim cultoribus orbem,} \)

\( \text{Eaasque demis Arabium, piofoque Gelovos:} \)

\( \text{Divina arboribus patria, etc. Vir. Georg. L. 2.} \)
Chap. II. Of the Strata of, &c.

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 (a), Metals (b), Earth, and Stone (c), lying under that upper Stratum, or Tegument of

(a) 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 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. Boyle thinks, will grow by the Help of the Air. So Alum doth the same. We are assured (he faith) 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 expos'd to the Air. Boyle's Supp'd about some Hid. Qual. in the Air, p. 18.

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

And particularly as to the Growth of Iron, to the Instances he gives from Pliny, Fallopus, Cæsalpinus, and others; we may add, what is well known in the Forest of Dean in Gloucestershire: That the beet 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 Gloucestershire in Cambd. Brit. of the last Edition, p. 245. attributes to the Remininess 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.

(c) As for the Growth of Stone, Mr. Boyle gives two Instances. One is that famous Place in France, called Les Caves Goutieres.
Of the Earth last spoken of, all of a prodigious Use to Mankind: Some being of great Use for Building; 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

Goutiers: 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. Scept. Chym. pag. 360.

Such like Caves as these I have myself met with in England; particularly on the very Top of Bredon-Hill in Worcestershire, near the Precipice, facing Pershore, in or near the old Fortresses, called Bembbury-Camp; I saw some Years ago such a Cave, which (if I mistake 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 incrusted 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 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. Boyle, is from Linschoten, who faith, that in the East-Indies, when they have cleared the Diamond Mines of all the Diamonds, In a few Years Time they find in the same Place new Diamonds produced. Boyle. Ibid.
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 (d), and may probably be the Colanders whereby they are sweetened, and then at the same time also convey'd 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

(d) It is not only agreeable to Reason, but I am told by Persons conversant in digging of Wells throughout this Country of Essex, where I live, that the sweet Beds in which they find Water, are Gravel, and a coarse, dark coloured Sand; which Beds seldom fail to yield Plenty of sweet Waters: 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; yet 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 flinks. 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.
Of the Strata of Book III.

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, incohering 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. i. 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 suppose the Globe of Earth to have been dissolved by the Flood (e). At that Time (whatever it was) when the terraqueous Globe was in a chaotic 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 (f) of Gravity.

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 out of those watery Beds. Of which see Chap. 4. Note (k). 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.

(e) V. Dr. Woodward's Essay, Part 2. Steno's Prod. &c.
(f) Id. ib. pag. 28. and 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 fierfer 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 myself; 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 Striftness, 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 specific Gravity, both out of the same Hole, and out of different Holes, although the Sand was at last so gravelly, that it hinder’d our boring any deeper.

Upon this, fearing lest some Error might be in the former Experiments, I try’d them over again; and that with the same Success.

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 juftly 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.

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 (a) against the present Contrivance and Structure.

(a) Nemo dixerit terram pulchriorem esse quod cavernosae sit, quod debiscat in multis locis, quod disrupta caveis & spatibus in-
Structure of the Globe. But, if well considered, they will be found to be wise Contrivances of the Creator, serving to great Uses of the Globe, 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 (b). To instance in the very worst of the Things named, viz. the 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 itself; yet even these have their great Uses too, being as Spiracles or Tunnels (c) 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-

anibus; iisque nullo ordino dispositis, nullâ formâ: nec que alius continent, quàm tenèbras & fordes; unde graves & pestiferæ exhalationes, terræ motus, &c. Burnet ubi supr. c. 7.

(b) The Zirchnitzer Sea in Carniola, is of great Use to the Inhabitants of that Country, by affording them Fishe, 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.

The Grotto Podpetfchio 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 Specus's are enumerated, and some of their Uses.

Chap. III. The Caverns and Vulcano's.

...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 (d), "That there are scarcely any Countries, that are much annoyed with Earthquakes, that have not one of those fiery Vents. And these, (faith he) are constantly all in Flames whenever any Earthquake happens, they disgorging that Fire, which whilst underneath, was the Cause of the Disaster. Indeed, (faith he,) were it not for these Diverticula, whereby it thus gaineth an Exit, 'twould rage in the Bowels 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 Earthquakes; 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, (faith 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 continually 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 " auguf and flately in the beholding of them, that " inflpireth the Mind with great Thoughts and Pass- " fions, that we naturally on such Occasions think " of God and his Greatnefs". But then, at the fame Time he faith, " The Hills are the-greatest " Examples of Ruin and Confufion; that they have " neither Form nor Beauty, nor Shape, nor Order, " any more than the Clouds in the Air; that they " confift not of any proportion of Parts, referable " to any Design, nor have the leaft 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 inge- nious 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 anfwer- ed, and my Survey now leads me to fhew, that the Mountains are so far from being a Blunder of Chance, a Work without Design, that they are a noble, useful, yea, a neceflary part of our Globe (a).

And

(a) Though there are fome that think Mountains to be a De- formity to the Earth, &c. yet if well considered, they will be found as much to conduct to the Beauty and Conveniency of the Universe, as any of the other Parts. Nature (faith Pliny) pur- pofely framed them for many excellent Ufes; 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 Prote- ction of Beasts, the Psalmist testifies, The highest Hills are a Refuge for the wild Goats, and the Rocks for Conies. The Kingly
And in the first Place, as to the Business of Ornament, Beauty, and Pleasure, I may appeal to all Men’s Senses, whether the grateful Variety of Hills and Dales, be not more pleasing than the largest continued Planes. 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 would be so well worth visiting, if the Earth was every where of an even, level, globous Surface, or one large Plane 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 Restoratio of the Health of Man. Some Constitutions are indeed of so happy a Strength, and so confirmed an Health, as to be

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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 prosecuted 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 Wilkin's World in the Moon, pag. 114.

indifferent
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 contrariwise, others languish on the Hills, and grow lusdy 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 vale-tudinarian, feeble part of Mankind, affording those an easy and comfortable Life, who would 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 (b) word-eth 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 clearly in Winter; and promoting the Growth of Herbs and Fruit-Trees, and the Maturation of the Fruits in Summer.

3. Another Benefit of the Hills is, that they serve for the Production of great Varieties of Herbs and Trees (c). And as there was not a better Judge of those


(c) *Theophrastus* having reckoned up the Trees that delight most in the Hills, and others in the Valleys, observeth, "Astra-
thofe 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 (d), (who hath so fully discribed this Subject I am upon, that it is scarce possible to tread out of his Steps therein). His Observation is,

"That the Mountains do especially abound with different Species of Vegetables, because of the great Diversify of Soils that are found there, every Vertex or Eminence almost, affording new Kinds. Now these Plants, (faith he,) serve partly for the Food and Sustenance of such Animals as are proper to the Mountains, partly for medicinal Uses; the chief Physick, Herbs and Roots, and the best in their Kinds growing there: It being remarkable, that the greatest and most luxuriant Species in most Genera of Plants are native of the Mountains.

4. Another Convenience which my last named learned Friend observes (e) is, "That the Mountains serve for the Harbour, Entertainment, and Maintenance of various Animals; Birds, Beasts and Insects, that breed, feed and frequent there. For, (faith he) the highest Tops and Pikes of the Alps themselves are not delitute of their Inhabitants, the Ibex or Stein-buck, the Rupicapra or Chamois, among Quadrupeds; the Lagopus among Birds. And I myself (faith he) have observed beautiful Papilio's, and Store of other Insects upon the Tops of some of the Alpine Mountains. Nay, the highest Ridges of many of these

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(d) Wisdom of God, p. 252.
(e) Ubi supra.
Mountains, serve for the Maintenance of Cattle, for the Service of the Inhabitants of the Valleys.

5. Another Thing he observes, "That those long Ridges and Chains of lofty and topping Mountains, which run through whole Continents East and West (f), serve to stop the Evagation of the Vapours to the North and South in hot Countries, 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 Conveniences (g); as that the Hills serve to the

(f) 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, [Confor. with a Theif, 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 Moon in Africa, and so do Mount Taurus and 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.

(g) That the Generation of many of the Clouds is owing to the Hills, appears from the Observations of the ingenious and learned Dr. Job. Jam. Scheuchzer of Zurich, and Mr. Joach. Frid. Cretilovius cited by him. They observed at Sunrising, 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 paulo ante nulli nobis usui esse videbatur, maximis rebus definavet, adeoque ex illo tempore dubitare coepi, num Nubes essent future, si siifiusmodi Montes & Petra non darentur. Hypothese hæc fiant, elucidesert permagna utilitas, imò necessitas, quam Helvítæ Alpes non nobis tantum accolis sed & vicinis aliis regionibus præstans, dispenfando, quas gignunt Nubes, Ventos, Aquas. Scheuch. Iter. Alpin. 2. p. 20.
Chap. IV. and Valleys.

Generation of Minerals and Metals \((b)\), and that in them principally are the most useful Fossiles found; or if not found and generated only in them, yet at least all these subterraneous Treasures are most easily come at in them: Also their Use to several Nations of the Earth, in being Boundaries and Boul-

works to them. But there is only one Use more that I shall insist on, and that is,

6. 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 \((i)\); 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 Maf-

ses and Ridges of Earth serving as so many huge Allembicks or Cula 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 Pur-

pose, that the Hills are a grand Agent in this so no-

ble and necessary a Work: And consequently, that those vast Mafles and lofty Piles are not as they are charged, such rude and useless Excrescences of our ill-formed Globe; but the admirable Tools of Na-

\((b)\) Let us take here Ol. Mag. Observation of his Northern Mountains, Montes excelsi sunt, sed pro majori parte steriles, & aridi; in quibus fere nil alium pro incolarum commoditate & conservacione gignitur, quam inexhausta pretiosorum Metaliorum ubertas, quam saepe opulentis, fertilesque sunt in omnibus vita necessariis, forisiam & superfluis aliusque sibi legit conquirendis, unan-


\((i)\) See Book I. Chap. 3. Note \((b)\).
ture, 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 Fossiles receive any Increase. For was the Surface of the Earth even and level, and the middle Parts of its Islands and Continents, not 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 flagship, and perhaps flink, 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 Planes; and when we do find them in them, it is generally at great and inconvenient Depths of the Earth; nay, those very subterraneous Waters, that are any where met with by digging in these Planes, 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 (k). Or if there be any such Place found

(k) Monfieur Blundel, related to the Parisian Academy, what Device the Inhabitants of the lower Austria, (which is encompassed
found throughout the Earth, that is devoid of Mountains, and yet well watered, as perhaps 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 Midland 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 these several Nations this excellent and most necessary Element the Waters.

passed 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 so deep, till the Waters break forcibly out; which Water it is probable comes from the neighbouring Mountains in subterraneous Canals. And Caflinius 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. Caflini made a Fountain at the Castle of Urbin, that cast up the Water five Foot high above the level of the Ground. Ray's Difc. t. 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 clayey 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 forcible a Flux of Water, that before he could get into his Bucket, he was above his Waist in Water; which soon ascended to 17 Feet height, and there stayed: And although 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,
For according to Nature's Tendency, when the Earth and Waters were separated, and order'd to their several Places, the Earth must have been of an even Surface, or nearly so. The several component Parts of the Earth, must have subsided according to their several specific Gravities, and at last have ended in a large, even, spherical Surface, every where equidistant 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 everywhere 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 dispos'd, so order'd, 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 (l); to the Verdure of the Vegetables without, and to the Increment and Vigour of the Treasures within them.

Thus

(l) 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
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 (m), 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 unfinish'd 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 incommmodious 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 order'd, and made without any Design or End; particularly the Distribution of the more Dews and Rains commonly than the Valleys. They are more frequently covered with Fogs; and by retarding, slopping, or compressing the Clouds, or by their greater Colds 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 (a). 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 (c).

(m) Accusandì sanè meâ sententiâ hic sunt Sophistæ, qui cium nondum invenire, neque exponere opera Natura queant, eam tamen inertiam atque infestiam condemnant, &c. Galen. de Uf. Part 1. l. 10. c. 9.
dry Land and Waters; the laying the several Stra-
ta, or Beds of Earth, Stone, and other Layers be-
fore 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 anci-
ent (n), as well as modern Complaint, that our Bo-
dies 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 Ac-
curacy of the Senses, with more to the same Pur-
pose. But these Objections are well answered by
Seneca (o), and will receive a fuller Solution from
what I shall observe of animal Bodies hereafter.

But indeed, after all, it is only for want of our
knowing these Things better, that we do not
admire

(n) Vide quàm iniqui sunt divinorum munera simillimores, e-
tiam quidam professi sapientiam. Queruntur quod non magnitu-
dine corporis aqueus Elephantes, velocitate Cervos, levitate A-
ves, impetus Taurus; quod solidior sit cutis Belluus, decentior
Damis, densior Ursis, mollior Fibris; quod sagacitate nos nari-
um Canes vincant, quod acie luminum Aquila, spatio atatis Cor-
vi, multa Animalia quærandi facilitate. Eò cum quodam ne coire
quidem in idem Natura patiatur, ut velocitatem corporis & vi-
res pares animalibus habeamus; ex diversis & diversitibus bonis
Hominem non esse compositum, injuriam vacat; et in negligentes
nostri Deos querimoniam jaciant, quod non bona valetudo, & vi-
ris inexcugnabilis data sit, quod non futuri scientia. Vix fide
temperant quin eousque impudentia provehantur, ut Naturam ode-
runt, quod infra Deos simus, quod non in aequ illis sestimus. Se-
 neca de Benef. l. 2. c. 29.

(o) Quanto satius est ad contemplationem tot tantorumque be-
 neficiorum reverti, & agere gratias, quod nos in hoc pulcherri-
admire (p) them enough; it is our own Ignorance, Dullness or Prejudice, that makes us charge those noble Works of the Almighty, as Defects or Blunders, as ill-contriv'd, 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 cen-

sure 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 Tempells; they have been terrified with the burning Mountains, and Earth-
quakes; they have been annoy'd by the noxious Animals, and fatigu'd by the Hills; and therefore are angry, and will pretend to amend these Works of the Almighty. But in the Words of St. Paul (q), we may say, Nay, but O Man, who art thou that

mo domicilio voluerunt (Dii) secundos fortiri, quid terrenis presscerunt. Then having reckoned up many of the Privileges and Benefits, which the Gods, he faith, have conferred upon us, he concludes, Ita est: carissimos nos habuerunt Dii immortales, habentique. Et qui maximus tribui bonos potuit, ab ipsis proximos colocaverunt. Magna accepimus, majora non cepimus. Senec. Ibid.

(p) Naturam maxime admiraberis, si omnia ejus opera perlu-
straris. Galen. de Us. Part. 1. 11. conclus.

(q) Rom. ix. 20, 21.
replies 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 worse Place, a more incommodious Habitation, than we meet with in this elegant, this well contriv'd, 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 (r). But yet so admirably well temper'd 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 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 Virtue, will

(r) 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 fee, and should avoid. Weezels, Kites, and other mischievous Animals, induce us to a 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 Weevil 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 Inconveniences. Grew's Cosmol. c. 2. §. 49, 50.
prevent many of the Harms (\textit{/}), 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 Comforts of Nature's own, as well as Man's making, sufficient to delight the Ear of the most harmonious and musical; 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 ally'd to another World, as well as this.

(\textit{/}) Non est gemendus, nec gravi urgens nece,  
\textit{Virtute quisquis absulit satis iter.}  

\textit{Nunquam Stygius fortur ad umbras}  
\textit{Inclyta virtus.}  
Id. Ibid. Car. 1982.
BOOK IV.
Of Animals in general.

In the last Book, having survey'd the Earth it self in Particular, I shall next take a View of the Inhabitants thereof, or the several Kinds of Creatures (a), that have their Habitation, Growth, or Subsistence thereon.

These Creatures are either Sensitive, or Insensitive Creatures.

In speaking of those endow'd with Sense, I shall consider:

I. Some Things common to them all.

II. Things peculiar to their Tribes.

I. 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.

(a) Principio colun, ac terras, camposque liquentes, Lucemque globum Luna, Titaniaque astra Spiritus intus alit, totamque insusa per artus Mens agitat molem, & magno se corpore miscet.
Inde hominum, pecudumque genus, vitæque volantium, Et que marmoreo fert monstra sub aquæ pontus.
Ignitus est illis vigor, & celestis origo
Seminibus.


4. The
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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.
10. Their Generation, and Conservation of their Species by that Means.

CHAP. I.

Of the five Senses in general.

The first Thing to be consider'd, in common to all the Sensitive Creatures, is, their Faculty of Seeing, Hearing, Smelling, Tasting and Feeling; and the Organs ministering 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 (a). 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 amaz'd 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 thou-

sands of Dangers (b), 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 (c)! How could also the Animal, without Smell and Taste, distinguish its Food, and discern between wholesome and unwholesome; 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 Music, 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 found 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.


(c) Examine alicue Megarense solis oculis discernere valebant inter Ova que ex Gallinâ nigra, & que ex albâ nata sunt, is what is affirmed (how truly I know not) by Grimald, de Lumin. & Color. Pr. 42. §. 60.
Of the Eye.

For our clearer proceeding in the consideration of this noble Part (a), and understanding its economy, 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 I can, mention chiefly what they have omitted. And,


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 animatis partes, quæ magni Conditoris nostri sapientiam ostendunt, nulla saepe referitur, quæ majori pompa elucet quâm ipse Oculus, aut quæ elegantiori forma concinnatur. Deum enim alie partes vel minori satellitio stipantur, vel in tantum venustatem haud assurgent; Ocelli peculiarum honorem & decus a supremo Numinis effatum referunt. ex nunquam non stupenda sue Potentia characteres representant. Nulla saepe pars tam divino artificio & ordine, &c. Cap. 1. § 1.
1. For the *Form* of the Eye; which is for the most part Globous, or somewhat of the spheroidal 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 (b). Was it a Cube, or of any multangular Form, some of its Parts would lie too far off (c), 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 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.

(b) It is a good Reason *Frier Bacon* assigns for the Sphæricality of the Eye: *Nam si esset plane figura, species rei majoris oculo non posset cadere perpendiculariter super eum* — *Cum ergo Oculus videt magna corpora, ut fere quartam cali uno aspeâtu, manifestum est, quod non posset esse plane figura, nec alius nis sphærica, quoniam super sphaem parvum possunt cadere perpendicularares infinita, que a magno corpore veniant, & tendunt in centrum Sphæra: Et sic magnam corpus potess ab oculo parvo videri.* For the Demonstration of which he hath given us a Figure. *Reg. Bacon. Perspœct. Distinct. 4. Cap. 4.*

Dr. Briggs faith, *Pars antica, (sic Cornæa,) convexior est posítica: hac enim ratione radii melius in pupillam detorquentur, & Oculi fundus ex alterâ parte in majorem (propert imagines rerum ibidem delineandos) expandidur.* Ibid. §. 2.

(c) Suppose the Eyce 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 confequently 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 *Sturmias* calls his Artificial Eye, in his *Exerci.* 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. To
Chap. II. Of the Eye.

To this we may add the aptitude of this Figure to the Motion of the Eye, for it is necessary for the Eye to move this way, and that way, in order 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 (d), the most creaf, eminent Part of the Body, near the most sensible, vital Part, the Brain. By its Eminence in the Body, it is prepar’d to take in the more (e) Objects. And by its Situation in the Head, besides it Proximity to the Brain, it is in the most convenient Place for Defence and Security. In the Hands, it might indeed (in Man) be render’d 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 (f) render’d a less active and useful Part. And the like may be said to its Sight, 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 Sight of the Eye, is the Manner of its Situation in the Head, in

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

(e) See Book V. Chap. 2. Note (e)

(f) Galen deserves to be here confuked, who in his Book De Utra 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.
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 order'd, 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 (g), 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 itself. And this is generally upwards, downwards, backwards, forwards, and every way (b), for the better, more easy, and distinct Reception of the visual Rays.

But where Nature any way deviateth from this Method, either by denying Motion to the Eyes, or the Head (i), it is a very wonderful Provision she hath

(g) 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.

(b) Sed lubricos Oculos fecit [Natura] & mobiles, ut & declinarent liquid noceret; & aspectum, quo vellent, facile convertent. Cicer. de Nat. Deor. 1. 2. c. 57.

(i) 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
Chap. II. Of the Eye.

hath made in the Case. Thus for a Remedy of this Inconvenience, in some Creatures their Eyes are set out at a Distance (k) from the Head, to be circumvolved here and there, or one this, the other 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 (l). By which Means those Creatures are so far from being deny'd any Benefit, of that noble and most necessary Sense of Sight, that they have probably

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; Whish Motion would have scared away so timorous an Insect. Power's Microf. Observ. pag. 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. Tran. No. 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 immovable; 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 these Motions to be so extreme, that they do carry the Pupilla under the Creft which makes the Eye-brow, and so far into the Canthi, or Corners of the Eyes, that the Sight can discern whatever is done just 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. Disf. of Camel. pag. 22.

(k) Snails tend out their Eyes at a distance, they being contained in their four Horns, like arramentous Spots, fitted 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. Liefer. Exercit. Anat. Cochli. & Limac.

(l) Vid. l. 8. c. 3. Note (a).
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 (m). As the Habitation of

(m) 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 faith, their Eyes have appendiculam nervem in cerebrum euntem, cuius beneficio globuli illi [the little Eyes] extra pellem facile poterant exseri, retrahique pro arbitrio — in illis oculorum globulis humor aquos copiosis satis natabat; ceterorum non nisi vene vestigium. Blas. Anat. Anim. c. 35.

Et quoniam Natura hoc vitre genus ipsi destinavit, etiam per quam exiguos Oculos — dedit eo concilio, ut ii, pretiosissima corporis pars, à terra pulvere ne affigerentur. Il insuper pilis respondit. Humores illis oculis insunt, et tunica nigra, uvea, se prudit. Ad hos tramite alio nervos venit. Schneider in Blas. ibid.

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. And upon a strict Scrutiny I plainly could distinguish the Vitreous and Crystalline 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 that are in all the Animal. These Creatures, I imagine, have the Faculty of withdrawing their Eyes, if
that uncouth Animal is wholly subterraneous, its 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 Busines, of digging for its Food and Passage; so it is endow'd 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; no less than two (n) in any Instance, that I know of; and in some Animals more, as I have already hinted (o).

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 prepar'd for the

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 faith, 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.

(n) 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 Nigre 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.

(o) Supra, Note (i).
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, and appears but one, though seen with two or more Eyes (p). A manifest

(p) 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 Sphenoïdes. But whether they decussate, coalesce, or only touch one another, they do not well agree. The Bartholomae expressly assert they are united, non per simplicem contactum vel intersectionem in homine, sed totalem substantia confusionem, Anat. I. 3. c. 2. And whereas Vesalius, and some others had found some Instances of their being disunited; they say, sed in plerisque ordinari confunditur interior substantia, ut accurata disquisitione reprehendi.

But our Learned Dr. Gibson, (Anat. I. 3. c. 10.) faith, 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 Fibrilles 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 Fibrilles are struck by any part of an Image, the corresponding Parts of the Brain are thereby affected, and the Soul thereby informed, &c. but see more hereafter under Note (o), 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 Retina, which are made of them; And farther, that those Fibrilles 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 Ὄμολογησια between the

Retina,
Chap. II. Of the Eye.

nifieth Sign of the infinite Skill of the Contriver of this so noble a Part, and of the exquisite Art he employed in the Formation thereof. But the Design and Skill of the infinite Workman, will best be let 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 ministring to this noble and necessary Sense. 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

RETINA, &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. Br. Ophthalmogr. cap. 11. & 5. and Nov. Vis. Theor. passim.

What the Opinion of our justly eminent Sir Isaac Newton is, may be seen in his Opticks, Qu. 15. 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 Camelion) do not meet, if I am rightly informed. Newt. Opt. Q. 15.
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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 (q).

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 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 how-

(q) Nigra eß [Uvea] ut radios (ab Oculi fundo ad anteriorem ejus partem reflexos) obumbret; nê hi (ut ait clar. Cartesius) ad Oculi fundum resorit ibidem confusam visionem effecerint. Alia fürsan ratio hujus nigredinis statuatur, quod radii in visione superficii, qui ab objectis lateralisibus proveniant, hoc ritu absorbantur. Ita enim e loco obscurò interdum objecta optime intuemur, quia radii tunc temporis circumfuso lumine non diluentur. Briggs's Ophthal. c. 3. §. 5.
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forever 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 (r); the Magnitude and Strength of the Attollent Muscle, somewhat exceeding that of its Antagonist; the peculiar Muscle, called the Seventh, or Suspensory Muscle (\(f\)), given to Brutes, by reason of the prone Posture of their


Of this Opinion alio was Bartholine Anat. 1. c. 8. and divers other eminent Anatomists.

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

The *Musculus Suspensorius* being in the Porpes, as well as Brutes, Dr. Tyson thinks the Ufe of it is not to fulpend the Bulk of the Eye; but rather by its equal Contrafection of the *Sclerotic*, to render the Ball of the Eye more or less Spherical, and so fitter for Vision. *Tyson's Anat. of the Porpes*, p. 39.
Bodies, and frequent Occasions to hang down their Heads: And I might speak also of the peculiar Origin and Insertion of the lower Oblique Muscle (t), 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, affected partly by the Equality of the Strength; which is the Case of the Adducent and Aducent Muscles; partly by their peculiar Origine, or the Addition of the Trochlea, which is the Case of the Oblique Muscles (u); and partly by the natural Posture of the Body, and the Eye, which is the Case of the Attollent and Depriment Muscles. By this so curious and exact a Libration, not only unseemly Contortions, and incommodious Vagations of the

(t) Musculus obliquus inferior oritur à peculiari quodam foramine in laterre Orbite ocularis facto, (contra quam in cæteris, &c.) quo sit ut ex una parte à Musculo trochleari, ex altera vero ab hujus Musculi commodissimâ positione, Oculus in equilibrio quodam constitutus, irretorto obtutu versus objecta fertur, nec plus juto accedat versus internum externum canthus; quæ sive Librato omnino nulla suiisset, abhinc hujus Musculi peculiari originatione (cujuß ratio omnès hucusque Anatomicos latuit). And so this curious Anatomist goes on to shew farther the stupendous Artifice of the great Creator in this Postion of the Oblique Muscles. Brigg's Nova Vis. Theor. p. 11. meo libro.

(u) Besides those particular Motions which the Eye receives from the Oblique Muscles, and I may add 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 and compresing 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 contraetis, or both the Oblique Muscles squeeze the middle of the Ball of the Eye, so render it Oblong when Objects are 100 near us. Keil's Anat. Chap. 4. Sect. 4. See Note (y).
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 Arachnoïdes, the acute Sense of the Retina, the delicate Transparency of the Cornea (w), and the firm and strong Texture of that and the Sclera 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 (x), 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 (y). But it deserveth our especial Remark, that these Pupils are in divers Animals of divers Forms, according to their

(w) Quis verò opifex præter Naturam, quà nihil potest esse callidius, tantam focietiam persequi potuisset: in Sensibus quà primum Oculos membrānis tenueissimi vestiis, & fepit; quàs primum perlucidas fecit, ut per eam cerni posset: firmas autem, ut continerentur. Cic. de Nat. Deor. 1. 2. c. 57.

(x) Boyle of Final Causes.

(y) 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 an Increase of Light, and when the Objects are nigh. This Motion of the Pupil some say, is effected by the circular and srrait Fibres of the Uvea, and some attribute it to the Ligamentum Ciliare. Yet 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 compresse 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.
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 (z), with its Aperture large, which is an admirable Provision for such Creatures to see the better laterally, and thereby avoid Inconveniencies, as well as help them to gather their Food on the Ground, both by Day and Night. In other Animals the Fissure of the Pupil is erect (aa), and also capable of opening wide, and shutting up close. 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 (bb), to see upwards and downwards, to climb, &c. Thus much for the Tunicks.

The

(z) In Bove, Caprâ, Eque, Ove, & quibusdam aliis elliptica est (Pupilla) ut eo magis in hisce forran animalibus, qua pronn incessu victim in agris queritant, radios laterales ad mala & incommoda utrinque deviandi admittas. Briggs' Ophthal. c. 7. § 6.

Hominis erecto, aliique, &c. caput erigere, & quaquaeverus circumspicere solitis, plurima simul objecta, tum supra, tum infrà, tum è latero utroque—visu excipiuntur; quaapropter Occuli Pupilla rotunda esse debet.—Attamen bovi, &c. caput ferè semper pronum—gerentibus, tantum que coram, & paulo à latere obversantur, institu opus est: quaapropter Pupilla—oblonga est, &c. Willis de Anim. Brut. p. 1. c. 15.

(aa) Thus Cats (their Pupils being erect, and the shutting of their Eye-lids transverse thereunto) 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 by Day and Night.

(bb) There is besides this large opening of the Pupil, in some nocturnal Animals, another admirable Provision, enabling them
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The next Thing I shall take 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 (cc), that constringeth and dilateth it, and so

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 jubare insito, illuminare, ut res not#u, & in tenebris positas conspicere valeat: quare in Fele plurimum illustres est; at Homini, Aquibus, & 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 optic Nerve.

Besides which, he faith, 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 calidior praditum, qui post ubiorem vini genera potum in notte atrata, sive tenebris profundis, literas distincte legere potuit. Cujus ratio videtur esse, quod Spiritus animales velut accens, adeoque ab hac iride irradiantes, jubare insito Medium illuminabat. Willis ibid.

Such another Thing, Pliny tells us, was reported of Tiberius Caesar: Ferunt Trib. Cæs. nec alii genitorum mortalium, suisse naturam, ut expergescat#us noctu paulisper, haud alio modo quam luce clarâ, contueretur omnia. Nat. Hist. l. 11. c. 37.

So Dr. Briggs: Virum sanè calide indolis novi in Comitatu Bedfordiens degentem, qui oculis felineis—donatus est: adeò ut epifolam—mirè admodum in loco obsero (ubi eadem mibi vix apparuit) perlegit. Hujus vero Oculi (nisi quod Pupillus insigne#ores obtinuer# ab aliorum formatione neutiquam discrepabant. Ophthalm. c. 5. §. 12.

(cc) The Tunica Aranea is taken notice of by Frier Bacon, who calls it, Tela Aranea, and faith, in hac continetur—glaciale vel Crystallinum. Rog. Bacon's Perspect. Distinguish. 2. c. 3. The wrinkling of this, and the Cornea (as the Skin is of old Persons) he thinks is the Caufe 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. Boyle, Ann. 1682. annexed to his Anat. Account of the Elephant burnt in Dublin, p. 57.) affirms the Tunica Aranea, and faith, I have often seen it before was exposèd to the Air one Minute, notwithstanding what Dr. Briggs faith to the contrary, &c. But Dr. Briggs his Opinion is, eu-
mor Crystallinus, nisi aeri diutius expositus, vel leniter coctus (infar laebris) cuticulam non acquisit: quae vero impropriè, Tu-
onica Aranea dicitur, cum si tantum adventitiae, ut in Oculo Bo-
vis recens exspect appareat. Briggs's Ophthalm. c. 3.

The Crystalline Humour being of a double Substanct, out-
wardly like a Gelly, towards the Center as consistant as hard
Suet, upon occasion whereof its Figure may be varied; which
Variation may be made by the Ligamentum Ciliare; Dr. Grew
doeth, upon these Accounts, not doubt to ascribe to the Liga-
mentum Ciliare, a Power of making the Crystalline more Con-
vex, as well as of moving it to, or from the Retina. See
Grew's Cosm.lg. Sacr. I. I. c. 4. Now it is certain by the
Laws of Opticks, that somewhat of this is absolutely ne-
cessary 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 Hu-
mour shoule be made more Convex, or more flat; or else an
Elongation, or shortening of the Eye, or of the Distance be-
tween the Crystalline Humour and the Retina.

But although Dr. Briggs (to good a Judge) denies the Tun-
ica Crystallina, contrary to the Opinion of most former An-
atomists; 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 Cha-
mois, 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 Fibres of the Ligamentum Ciliare, are capable of
Contraction, and voluntary Dilatation, like 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. Descrip. of a Bear, p. 49.

Since my penning the foregoing Notes, having as critically
as I could, dissected many Eyes of Birds, Beasts and Fishes,
I manifestly found the Membrana Arachnoides, and will un-
dertake to shew it any one, with great Easè and Certainty.
It is indeed so transparent, as not to be seen distinct from the
Crystalline. But if the Cornea and Uveas be taken off before,
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Of the vitreous Humour behind it, and the out-side of the Cristalline be gently cut, the Arachnoides may be seen to open, and the Cristalline 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 finks under the sharpest Lancect, and requires (for so thin and weak a Membrane in appearance) a strong Pressure to pierce it.

(dd) 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 Convergences, and Divergences of the Rays, which the Variations of each of the Mediums may produce. For this Service the Tunica Choroeides, (in Fishes) hath a mucous Sub stance at the Bottom of it, lying round the optic 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 Sclerotic, are in a great Measure parted, that the Choroeides may have the greater Liberty of acting upon the Humours within.

But in Birds, I have my self found, that although the Choroeides be parted from the Sclerotic; yet the Choroeides hath no Muscle, but instead thereof, a curious pectinated Work, seated on the optic Nerve, represented in Fig. 2. In which c. a. e. b. d. represents the Choroeides and Sclerotic: a. b. the Part of the optic Nerve, that is within the Eye: v. u. v. the vitreous Humour: a. f. g. b. the Pecket: b. i. the Cristalline. For the Reception of this Pecket, the optic Nerve comes farther within the Eye, than in other Creatures. The Structure of this Pecket, is very like that of the Ligamentum Ciliare; and in the Eye of a Magpy, and some others, I could perceive it to be muculous towards the Bottom. This Pecket is so firmly fixed unto, or embodied in the vitreous Humour, that the vitreous Humour hangs firmly to it, and is not so easily parted from it. By which Means all the Motions of the Pecket are easily communicated to the vitreous Humour, and indeed to all contained in the Choroeides. And forasmuch as the Cristalline is connected to the vitreous Humour, therefore also the Alterations in the vitreous Humour affect also the Cristalline; and the Cristalline is hereby brought nearer unto, or farther from the Retina, as occasion is.
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Objects are far off or near, because these things are what are usually taken notice of; but that which I shall observe is, the prodigious Art and Finery of its constituent Parts, it being, according to some late nice Microscopical Observations (ee), composed

Besides all which Observables in the Choroeides, and inner Eye, I have also found this farther remarkable in the Scleroticca, and outer-part of the Eye of Birds, viz. That the fore-part of the Scleroticca is horny and hard, the middle-part thin and flexible, and Braces intervene between the fore and hind-part, running between the Choroeides and Scleroticca; 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 great 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, whether 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 fit 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 itself 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. Trans. No. 257. and some other Experiments since of the before-commended Mr. Hawkbee, both in natural, rarify'd and compressed Air; in each of which, the Refractions constantly varied in exact Proportion to the Rarity or Density of the Air. Vid. Hawkbee's Exp. pag. 175, &c.

Besides this Conformity in general, between the Eyes of Birds and Fishes, Du Hamel tells us of a singular Conformity in the Cormorant's Eye, and that is, that the Crystalline is globous, as in Fishes, to enable it to see and pursue its Prey under Water: Which J. Faber, in Mr. Willoughby's faith, they do with wonderful Swiftness, and for a long Time. Will. Ornit. p. 329.

(ee) The Crystalline Humour, when dry'd, doth manifestly enough appear to be made up of many very thin spherical...
posing of divers thin Scales, and these made up of one single minutest Thread or Fibre, wound round and round, so as not to cross one another in any one Place, and yet to meet, some in two, and some in more different Centers; a Web not to be woven, an Optick Lens, not to be wrought by any Art less than infinite Wisdom.

Lastly, To conclude the Parts of this admirable Organ, I shall make only one Remark more, and that is about its Nerves. And here, among others, the admirable Make of the Optick Nerves might deserve to be taken notice of in the first Place, their Medullary Part (ff) 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

Lamine, or Scales lying one upon another. Mr. Lewenhoek reckons there may be 2000 of them in one Crystalline, from the outermost to the Center. Every one of these Scales, he faith, he hath discovered to be made up of one single Fibre, or finest Thread wound, in a most stupendous Manner, this way, and that way, so as to run several Courses, and meet in as many Centers, and yet not to interfere, or cross one another, in any one Place. In Oxen, Sheep, Hogs, Dogs and Cats, the Thread spreads into three several Courses, and makes as many Centers: In Whales five; but in Hares and Rabbits only two. In the whole Surface of an Ox's Crystalline, he reckons there are more than 12000 Fibres juxtaposed. For the right and clear Understanding of the Manner of which admirable Piece of Mechanism, I shall refer to his Cuts and Descriptions in Philos. Trans. No. 165. and 293. The Truth hereof I have heard some ingenious Men question; but it is what I my self have seen, and can shew to any Body, with the Help of a good Microscope.

(ff) S. Malpighi observed the Middle of the optick Nerve of the 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 Duramater; whereas in Land-Animals it is a Bundle of Fibres. V. Phil. Trans. No. 27.
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obliquely towards one Side (gg). But most of these Things have been treated of, and the Convenience 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 (bb), each of which sending its Branches into each Mucle 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 from this transient and flight 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 (ii). And here


Nervi Optici in nobis, item in Cane, Fele (ω in ceteris forsan animalibus calidis) ad fundum Oculi delati Pupilla regioni prospicient, dum interim in aliis Quadrupedibus, uti etiam in Pisces & Volucribus, obliquè semper Tunica Sclerotici inferuntur. Unde, &c. Willis Ib. c. 7. §. 11.

(bb) This Pair is united at its Rise; whence is commonly drawn a Reason why one Eye being mov’d towards an Object, the other is directed also to the same. Gibbon’s Anat. Book III. Chap. 11. So Bartholome Anat. Libellus 3. c. 2.

(ii) 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 Corner
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here we shall find the Guard equivalent to the 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 (kk). Its Humours, and its inward Tunicks, are indeed tender, propor-


Another Cure of this kind, was experimented by Dr. Daniel Major, upon a Goose, Ann. 1670. the aqueous Humour of both whole Eyes they let our, 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 Turpency, and the Goose was in a Week after produced seeing before twenty eight or thirty Spectators. Ephem. Germ. T. 1. Add. ad. Obf. 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 funk, were restored by a Lithuanian Chymist, that passed for a Conjuror, by the Uie of a Liquor found in May, in the Vesicle of Elm. Of which see Mr. Ray’s Catal. Cantab. in Ulmus from Henr. ab Heers.

(kk) Palpebra, qua sunt rectamina Oculorum, mollissime saeta, in eaderent aciem, aptissima saeta, & ad claudendas Pupillae, nè quid incideret, & ad aperendas; idque providit, ut idem in duum fieri posset cum maxima celeritate. Munitateque sunt Palpebrae tanquam vallo pilorum: quibus & aperit Oculis, sè quid incideret, repellereetur, & somno conniventes, cum Oculis ad cornendum non egerimus, ut qui, tanquam involuti, quiescerent. Latent praeterea utiliter, & excelsis indique partibus sepium.
proportionate to their tender, curious Uses; but the Coats without, are context and callous, firm and strong. And in some Animals, particularly Birds


Tully, in the Perion 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 confit 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 Palliade 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: Alfo, 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 leaft and moft trivial Conveniencies 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 is a social 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 Nasilris, 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 OEcconomy and Contrivance in this (I had almost said) least considerable part of the Eye. But for

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Birds (II), 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 with-

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 11th 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 Membranofus conceditur, qui juxta interiorium oculi canthum stie, quando elevatur, Oculi globum ferè rotum obtigit. Hujus usus esse videtur, ut cum Besilia inter gramina, &c. capita sua propter viatum capellandum demergunt, hic Musculus Oculi Pupilam, ut à spalularum incursa seriatur, oculis, munite. 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; or if he hath, he can defend his Eyes with his Hands. But Birds (who frequent Trees and Bushes) and Quadrupeds, (Hedges and long Gras) 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 delitute of Eye-Lids, because in the Waters there is no occasion for a Defensive 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?

(II) 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 minimize to the lengthening and shortening the Eye, mentioned before in Nose (cc).
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drawing its Eyes into its Head (mm), 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 infinite Wise, Potent, and Indulgent Creator (nn). 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, 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 choose wholesome, yea delicate Food, to provide ourselves useful, yea gaudy Clothing, and commodious Places of Habitation and Retreat. We can now dispatch our Affairs with Ala-

(mm) Cochleis oculorum vicem Cornicula bina præsentu implant. Plin. Nat. Hist. I. 11. c. 37. See more of the Eyes of Snails before in Note (k); and in Note (l), I said that I suspected Moles also might thrust out, or withdraw their Eyes more or less within the Hair or Skin.

(nn) The diligent Sturmius was fully persuaded there could not be any speculative Atheism in any one that should well survey the Eye. Nobis, faith he, fuit persuaïssimum, Atheïsnum, quem vocant speculativum; b. e. observatum de Deitate in Universo nullâ persuasionem, habere locum aut inveniïr non possè in eo homine, qui vel unius corporis organis, er speciatim Oculi fabricam attesto animo aspexerit. Sturm. Exerc. Acad. 9. De Vil. Organ. & Rat. in Epilogu.
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crity 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 encroach 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 (oo), and fill

(oo) 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's 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 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 Cartes's Answer is, Notitia illius ex nullâ imagine pendet, nec ex ulla aetione ab objectis veniente, sed ex solo situs exiguarum partium cerebri, qui bus Nervi expullantam.—E. g. cogitandum in Oculo—situm capillamenti nervi optici—respondere ad alium quendam partis cerebri—qui facit ut Anima singula loca cognoscat, que patent in rectâ, aut quasi rectâ linea; ut ita mirari non debeamus corpora in naturali sito videri, quamvis imago in oculo delineata contrarium habeat. Diopt. c. 6. But our most ingenious Mr. Molyneux 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,
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fill us with Admiration and Pleasure. But I need not expatiate in the Usefulness and Praises of this Sense, 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.

Eye, or visive Faculty takes no notice of the internal Posture of its own 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 upper part of the 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 Sinister and Dexter. Molyneux’s Dioptr. Nov. Part I. Prop. 28.
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.

I. 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 a wise Provision for the utter Loss or Injury (a) of one of the Ears. But I shall a little insist upon its Situation, and its admirable Fabrick and Parts.

I. It

(a) 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 of 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 uncoath and odd, but intelligible enough. Phil. Trans. No. 312.

Such another Instance is that of Mr. Goddy, 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, she 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...
It is situated in the most convenient part of the body, (like as I said the eye is) in a part near the common senory 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 fabric 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 its curious organ.

1. For the outward ear: If we observe its structure in all kinds of animals, it must needs be acknowledged to be admirably artificial, it being so

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She can hold conversation whole days with those that can 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. p. 248.
nicely prepared, and adjusted to the peculiar Occa-
sions of each respective Animal. In Man \(b\), it is
of a Form proper for the erect Posture of his Body.
In Birds, of a Form proper for Flight; not protube-
rant, 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 vari-
ous Occasions. In some large, erect, and open, to
hear the least Approaches of Dangers \(c\), in others
covered, to keep out noxious Bodies. In the Sub-

\(b\) 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 faith there are
two; Dr. Drake the same Number; and Dr. Gibson makes
them to be four. So also doth Monfieur Dionis, and so did
the ancient Anatomists: But Dr. Schelhammer expressly de-
nies there are any, and faith, Seduxit autem reliquis Brutorum
Anatome, in quorum plerisque tales Musculi plures inveni-ntur;
putaturum autem fortassis ignominiosis Homini, si non &
his instructus esset, & minimis inde perfectionem animal fore. Schel.
de Auditu. p. r. c. i. §. 7. But Valsalva, who wrote very
lately, and is very accurate in his Survey of the Ear, faith,
Musculi auricula posteriores quandoque quatuor, quandoque duo;
sest ut plurimum tres adnotantur; & quando solum duo & man-
ifesstant, tunc unus ex illis duplicato tendine versus Concham de-
ferri solet. Horum musculorum in numero varietatem non solum
in diversis; verum etiam in eodem subiecto quandoque vidi—
Ex quibus differentiis suborte sunt Auctorum discrepantiae in ho-
rum Musculorum numero, & posito: — quod non evenisset,
se pluris in diversis Corporibus idem Musculi quaestri essent. Ant.
thinks some of Valsalva's Muscles the Product of Fancy. Mr.
Cowper makes them to be three, one Attollent, and two Retra-
Hent Muscles. See Anat. Tab. 12.

\(c\) Inter cetera [animalia aurita] maximè admirabilis est au-
ris leporina fabrica, quod cium timidiimun animal sit, &
orsus inerme, natura id tum auditum acetissimo, tanguam ho-
lium exploratore ad perfensenda pericula, tum pedibus eum ar-
mis ad currendum aptis muniff e videatur. A Kircher's Phonurg.
1. §. 7. Technaf. 2.
Of the Ear. Book IV.

terraneous 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 (d), their Ears short, lodged deep and backward in their Head, and pass-

(d) Moles have no protuberant Ear, but only a round Hole between the Neck and Shoulder; which Situation of it, together with the thick, short Fur that covers it, is a sufficient Defensive 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 aforefaid 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 the 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) is fastened 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 Processes, 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 Fenebra, or Foramen, the other at another; in which Fenebra I apprehend the Forks are tacked to the Auditory Nerve. These Fenebra (equivalent to the Fenebra Ovalis, and Rotunda in others) are the Inlets into the Cochlea and Canales Semicirculares, in which the Auditory Nerve lies. The Semicircular Canales 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, within the Skull, making
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singing 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 (e), even in this so inconsiderable Part of Animals. But I shall only carry my Survey to that

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

One Leg of the Malleus being fastned 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 (d), we may judge how the Sense of Hearing is performed.

(e) 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, for the better Reception of the least Sound.
that of Man. And here the first Thing that offers itself 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 Evagitation 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 (f), 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 Swooning like the Fall of Waters (g).

Sound. But in a Fox, that scouteth underneath the Prey at Roof; 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 a 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 Otocoustic, is so directed backward, as to receive the smallest and most distant Sound that comes behind her. Grew's Cosmolog. Sacr. lib. i. c. 5. §. 6.

(f) 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.

(g) Dr. Gibbon'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 just out, hear better than flat-eared Persons. Monsieur Dionis's Anat. Demonfr. 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 (b) observes) “If it had been Bone, “it would have been troublesome, and might by “many Accidents have been broken off: If Flesh, “it would have been subject to Contusion”. But indeed a worse Consequence than this would have ensu’d such a Softness as that of Flesh, and that is, it would neither have remain’d 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 easy 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 (i): But from the outward, let us carry our Survey,

2. To

(b) Gibs. Ibid.
(i) 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 moft 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 Chapel 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 ticking of a Watch (when no Noise is in the Streets) may
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 tunneled, 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 (k); 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 (l), with a bitter nauseous

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 Scaffold, 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.

(k) Auditus autem semper pateret: ejus enim sensu etiam dormientes egemus: A quo cùm sensus est acceptus, etiam in somno excitatur. Flexuosum iter habet, in quid imnare posse, si simplex, di rectum pateret; provisum etiam, ut si qua minima befiola conaretur irruptere, in forâbus aurium, tanquam in visco, inhæresecet. Cicer. de Nat. Deor. 1. 2. c. 57.

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 Sub stance, whereby the Tympanum is guarded against the Water in the Secundine, and against the Injuries of the Air as soon as the Infant is born.

(l) It is remarkable, that in most, if not all Animals, whole Ears are tunneled, 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 found, because none is necessary to the Ears so well guarded, and so little tunneled.
Chap. III. Of the Ear.

Excrement (m), afforded from the Glands (n) 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 (o), (because there is no such) the

(m) The Ear-wax was thought by the old Anatomists to be an Excrement of the Brain: Humor biliosus à cerebro expugnatus, the Bartholines say of it, l. 3. c. 9. But as Schelhammer well observes, Nil absurdus, quâm cerebri excrementum hoc statuere. Nam & ratio nulla suader, ut in cerebro fieri excrementum tale credamus: neque via patent per quas ab eo seclusum in meatum auditorium posse penetrare. As to its Taste, Casserius gives Inflances of its being sweet in some Creatures. But Schelhammer says, Ego vero semper, cum amaritie aliquid dulcedinis in illo apprehendi. Vid. Schel. de Aud. p. 1. c. 2. § 10. But I could never distinguish any Sweetness in it; but think it insipid mixed with a Bitterness.

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

Pliny attributes a great Virtue to the Ear-wax; Morsus hominis inter aperrimos numeratur: medentur fordes ex auribus: ac ne quis miretur, estiam Scorpioum icibus Serpentinumque statim imposite. 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.

(o) 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 beat against the Tympanum. When the Passage to the Throat is by any Means stopp'd, as by a Cold in the Head, or. the Hearing thereby becomes dull and blunt; by Reason the Communication between the outward 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
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the Passage to the Palate (p), 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 (q). 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 ætherial Matter, that there may be no loss, nor Confusion in the Sound; but that it 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 *Tympaminum*, or Mem-

fudden 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 faith, Par. Ult. c. 4. §. 8.) *sed non nihil immutatus, ac temperatus, calore ex medio ventre exspirante; imò fortassis non facile alius, nisi ex pulmonibus.*

(p) *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 stoop 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.

(q) *Os petrofum* ex quo interiores [Labyrinthi] cavitation parietes conflati sunt, album, durissimum, necnon maximè compacium. *Id autem à Naturâ ita comparatum esse videtur, ut materia ætheræa Sonorum objectorum impressionibus omnibus, dum prædictis impingitur Parietibus, nihil aut saltem fere nihil motus sui amittat, atque adeò illum qualum ab Objectis sonoris accepit, talem communicet spiritui animali contento intra expansiones rami mollioris Nervorum auris.* Dr. Raym. Vicussens of Montpellier, in Phil. Tranf. No. 258.
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brana Tympani (r), with its inner Membrane (f); together with the four little appendent Bones (t), and the three inner Muscles to move them, and adjust the whole Compages to the several Purposes of

(r) 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 faith, It is not equally fastened to the whole Circumference of the bony Circle, in which it is inclosed; 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 Enstachiana, 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 found 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.

(f) Dr. Vieuiffens, before-named, discovered a Membrane, tenuissima rarae admodum texture intra cavitate Tympani; as he describes it. Whose use he faith is, 1. Ocludens Labyrinthis januam impedit ne naturalis purgissimus ac subtilissimus Aer intra cavitates—communicationem—habeat cum aere crasfo. 2. Labyrinthis 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 (d).

(t) 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, Hoc Officula antiquis Anatomicis—ignota fuere; primusque qui in lucem produxit [Malleum & Incum] fuit Iac. Carpenfis; primus quoque procul omni dubio Anatomice artis, quam Vefalius posuer perfecit, restaurator. Tertium [Stapedem] inventi ac promulgavit primus Feb. Phil. ab Ingraffia, Siculus, Philosophus ac Medicus do-

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Book IV.

of Hearing, to hear all Manner of Sounds, loud or languid, harsh or grateful (u).

From

c. 14.

ütissimus. Quartum, Thoma Bartholin. tesse, viro longè celeberrimo, Fran. Sylvio debetur Schel. ubi supr. c. 3. §. 9. 2: Their Difference in 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 Ear is very different: His unum Officulum solium largua est Natura, quod Collumellam fortè appellaveris: teres enim est & subtillus, bas ininitens latiori, rotunda. Huic adnexa est cartilago valde mobilis, quae 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 joint 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. No. 100.

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 the last cited Book VII. Chap. 2. Note (d).

(u) Videtur quod Tympanum Auditionis instrumentum preliminare, & quasi preparatorium fuerit, quod Soni impressionem, five species sensibiles primo suscipient, eas in debitâ proportione, & aptâ conformitate, versus Senforium, quod adhuc interiussum est, dirigat: simili officio fungitur respectu Auditus, ac tunice Oculi Pupillam constituentes, respectu Visus; utraque Membrana Species sensibiles refringunt & quasi emolliunt, eaque Senforio non nisi proportionatas tradunt, cui nudo sit advenient, teneriorem ejus crasfin facile ledant, aut obruant. Reverâ Tympanum non audit, sed melioris tuiorique Auditionis confert. Si hac pars defruatur, Senso adhuc aliquamdiu, rudi licet modo, peragi possit: quippe experimento olim in Cane facto, &c.—Sanitoris officio ut Tympanum recte defungi possit, expansum e jus pro datâ occasione stringi, aut relaxari debet, veluti nimirum Oculi Pupilla—Quapropter huius Auris Tympano, non secul us ac bellico, machine fve tenia quadam apponuntur, qua superficiem ejus modo tensiorem, modo laxiorem reddant: hoc enim efficiens tria Officula, 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 severely 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 collecteth those Rays into a focal Point, or scatters them? &c. And then saith, Ob has rationes a clariss. Viri, ac de re Medicæ præclarè meriti, sententia non possimus non esse alieniores; in quo uti ingenium admiror, quoties medicamentorum vires, aut morborum causas explicavit, sic ubi forum suum egressus, Philosophum agit, ac vel Partium usum, vel Chymiae rum rerum naturam scrutatur, ejus haud semen non modo judicium desidero, verum aliquando etiam fidem. This is so severe and unjust a Censure of our truly 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 Auditori, and shewed himself a Man of Learning and Industry; yet as our Countryman wrote more than he, (though perhaps not free from Errors 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 utraque Membrane 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 emollient, easque Sensorio non nis proportionatas tradunt. But indeed Dr. Schelhammer hath shewn himself a too rigid Censor, by making Dr. Willis say, the Ear-Drum hath such like Braces as the War-Drum, viz. Quod porro de machinis seu taniis Tympani bellici adducit, dicisque idem in Tympano auditorio confici, id proflus 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 training and relaxing it, as 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 one great Ufe
Ufe of the Ear Drum is for the proportioning 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 Ufes assigned by Dr. Scheibhammer, as the principal or sole Ufes of keeping out the external colder Air, Duft, and other Annoyances; but especially that, ob solius aeris interni potissimum irruptionis vim, hunc motum Tympani ac Mallei est, conditum, ut cedere primum, deinde fibi restituti queat; as his Words are, P. ult. c. 6. §. 13.

It was no improbable thought of Rohault, nos attentos percibere, nil alius est, nisi Typanum, ubi ita opus est factis, contendere aut laxare, & operam dare ut illud in ea positione intenter sit, in quâ tremulum aeris externi motum commodissime excitere posset. Roh. Phys. p. 1. c. 26. §. 48.

The Hearing of deaf Persons more easily by Means of loud Noifes, is another Argument of the Ufe of the Straining or Relaxation of the Typanum in Hearing. Thus Dr. Willis (ubi supra) Accipi olim à viro fide digno, se mulierem novisfe, quae licet surda fuerit, quosque tamen intra conclave Typanum pulsaretur, verba quævis clarè audiebat: quare Maritus ejus Typanifièam pro servo domestico conducebát, ut illius opè, colloquia inter dum cum Uxore suâ haberet. Etiam de alio Surdafrò mihi narratum est, qui prope Campanile degens, quoties undà plures Campane resonarent, vocem quamvis facilè audire, ὥς non alías, potuit.


Upon considering the great Difference in Authors Opinions, about the Ufe 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 to 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 (d) Book VII. Chap. 2. with relation to Birds. And as to Man and Beasts, the Ear is the fame, 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 Collumella; 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 the Membrana Tympani. Which Impressions are imparted to the auditory Nerve, in this Manner, viz. Firft they act upon the Membrane and Malleus, the Malleus upon the Incus, and the
pass to that of the Labyrinth \( (w) \), and therein survey the curious and admirable Structure of the Vestibulum, the Semicircular Canals \( (x) \), and Cochlea; particularly the artificial Gyations, and other singular Curiosities observable in the two latter.

But I shall not expatiate on these recluse Parts; only there is one special Contrivance of the Nerves, ministring to this Sense of Hearing, which mult

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**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 Procefs of Hearing; because, if the Membrane be mov'd, 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 \( (d) \) concerning the Mole; and as it may be seen in other Ears carefully opened, if the Parts remain in situ.

\( (w) \) 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, Monfieur de 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.

\( (x) \) In the semicircular Canals, two Things deservé 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 others, other Tones. And although there be some Difference as to the Length and Size of these Canals, in different Persons; yet, left 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. 1. Valsal. ubi supr. c. 3. §. 7. and c. 6. §. 4. 9.
not be passed by; and that is, the Branches of one of the auditory Nerves (y), spread partly to the Muscles of the Ear, partly to the Eye, partly to the Tongue and Instruments of Speech, and insculcated 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 surpriz’d, and terrify’d with any Noise, presently to shrill 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) (z), "That the Voice may correspond with the Hearing, and be a kind 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.


(z) Hujusmodi Nervorum conformatio in Homine usum alium insigniorem praefat, nempe ut Vox, &c. Willis Ibid.

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

II. Take Notice of the Object of this admirable Sentence, namely, Sound; and to conclude this Chapter. I shall not here enquire into the Nature and Properties of Sound, which is in a great Measure intricate, and hath puzzled the best Naturalists: Neither shall I shew how this admirable Effect of the divine Contrivance, may be improv'd to divers Uses (aa) and Purposes in humane Life; but my Business will be to shew that this Thing, of so admirable Use in the animal World, is the Work of God.

(aa) Among the Uses to which the Wit of Man hath employ'd 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 Particulars 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 Mr. Kircher's; at least he had contrived such an Instrument, before Sir Samuel hit upon his. Kircher in his Phonurg. faith, the Tromba published last Year in England, he had invented twenty-four Years before, and published in his Misurtia; that Jac. Albanus Chibbesius, and Fr. Kechinardus ascribe it to him; and that G. Schistes 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 preferred in the Vatican, which for Curiosity sake, I have from Kircher represented in Fig. 3. He faith its Diameter was five Cubits, and that it was suspended on a Supporter. 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.
God. And this will appear, let the subject Matter of Sounds be what it will; either the Atmosphere (bb) in Groß, or the ætherial Part thereof, or soniferous Particles of Bodies, as some fancy, or whatever

Kircher faith, he took one of these Trumpets of fifteen Palms length, along with him to the Mons Euphachianus, 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 Diversification. 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. Hist. l. i. c. 4. Such another Peter Martyr faith is in Hispaniola, which, with a small Weight cast into it, endangers Deafness at five Miles Distance. And in Switzerland, Kircher faith, in the Cucumer-Mountain is a Pit that sends out both a dreadful Noife and a great Wind therewith; and that there is a Well in his Country 3000 Palms deep, whose Sound is equal to that of a great Gun. Vid. Kirch. Phonoig.

Ol. Magnus speaking of the vall high Mountains of a Northern Province, call’d Angermannia faith, Ubì bases eorum in profundissimo gurgite stantes, cafa aliquo, vel propofito Nauce accesserint, tantum horrorem ex alta fluétum collifione percipiunt, ut nisi praecipiti remigio, aut valido vento eavérint, solo pavore ferè examines fiant, multoque dierum curriculo, ob capitis turbationem, priſline mentis, & sanitatis compotes vix eavārunt. Habent bases illorum montium in fluétum ingreffì, & regresfì tortuosas rinas, five fciifuras, fatis fupendò nature ophīficio fabricatas, in quibus longâ varagine formidabilis ille Sonitus quasi subterraneum tonitru generatur. Ol. Magn. l. z. c. 4. See also Chap. 12.

(bb) That the Air is the Subject, or Medium of Sound, is manifest from the Experiments in rarefied and condenced 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 compreffed, the Sound will be louder proportionably to the Compreffion or Quantity of Air crowded in, as I have often tried myself, and may be seen in Mr. Hawkesbee’s curious Experiments, p. 97. Also his Experiments in Phil. Trans. No. 321.
Neither doth this succeed only in forced Rare affections and Condenations of the Air, but in such alto as are natural; as is evident from David Frdличius in Varenus, upon the highest Eminencies of Carpathlus, near Kessarochi in Hungary. The Story of Frdличius is this, 180 Mengse Jnuni 1685. cum adolescentem, sublimitatem horum montium, cum duobus contribus Scholaribus, experiri volens, ubi, cum in prima rupis vertice, magnus labore, me sumnum terminum affectuum esse putarem, demum sepe obstuit alia multo altior causis, ubi pervasim caque vacillantia saxa (quorum unum, si loco aesti dimoventur — aliquid centena — rapit, & quidem tanto cum fragore, ut illi metuendum sit ut totus Mons currat, quinque obturat) cuius est esse, iterum alia sublimior prodiit, &c. donee summo vitae periculo ad sumnum cacumen penetraverim. Ex declivioribus montibus cum in subiectas valles, — nil nisi obscurum nottem, aut cordeum quid, inlar profundi aeris, quod vulgo sudum celatum appellatur, observare potui, mibique videbar, si de monte caderem, non in terram, sed recte in locus me pereapseram. Nimirum enim declivitate, species visibles extenuata & bebetata fuerunt. Cum vero altiorum montem pererem, quasi intra nebulas densissimas herbam — Et cum non procul a summo vertice esse de sublimique crepusculo animadverteri sis in locis, ubi mihi antea videbar infra nebulas hesitare, complices atque alas sepe movere nubes, supra quas, per aliquid milliarum, & ultra terminos suspicis commadis mihi prospectus patuim. Alias tamen etiam nubes aliore, aliis tem humiliores, nec non quasdam equaliter a terris diffusas vidi. Atque hinc tria intellexi, 1. Me cum transieris principio medio Aeris regionis. 2. Distantiam nubium a terrae, non esse equali. — 3. Distantiam nubium — non 72 Mill. Ger. ut quidam — sed tantum dimidiam Mill. Ger. In sumnum montis verticem cum pervenissim, adeo tranquillam & subtilitatem aerei ibi offendit, ut ne pili quidam motum sentirem, cum tamen in depressoribus ventum vehementem experius sim: unde collegi sumnum cacumen sius montis Carpathici ad Mill. Ger. a radicibus suis imis exsurgeri, & ad sumnum utque aeres regionem, ad quam Venti non ascendent, pertingere. Exploio in ea summitate Slopetum: quod non majorem sonitum primo pro se iuit, quam si ligillum vel bacillum conregisse; posl interim autem temporis murmur prolixum incutit, inferiorisque montis partes, convales & sylvas opplevit. Dependent per niveas annos intra convales, cum iterum Slopetum exoneraret, major & horribilior fragor, quasi ex termino capacitato

K 2.
omnipotent and infinitely wise God could contrive, and make such a fine Body, such a Medium, so susceptible of every Impression, that the Sense of 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


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 into the Atmosphere; and the magnifying the Sound by the Polyphonifins or Repercussions of the Rocks, Caverns, and other Phonocamp-tick 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 diller, 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 Merffenre faith, 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. Merfenn. 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 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. r.
and Sorrows in melancholick Tones; their Joys and Pleasures in more harmonious Notes; to send their Minds at great Distances (cc), in a short Time (dd), in loud Boations; or to express their Thoughts near at hand with a gentle Voice, or in secret Whispers! And to say no more, who less than the same most wise and indulgent Creator, could

(cc) 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 Sir Henry 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 fir'd for this purpose at Florence, and Persons were appointed on purpose to observe them at Leghorn, which they compute is no less than 55 Miles in a strait Line. But notwithstanding the Country between being 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 Leghorn Guns are often heard 66 Miles off, at Porto Ferrario; that when the French bombarded Genoa, they heard it near Leghorn, 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. No. 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 (bb).

(dd) 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 nothing else doth accelerate or retard it,
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 be 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 Inoscillations of the auditory Nerves before-mentioned, the Orgasms of the Spirits should be allay’d, and Perturbations of the Mind, in a great Measure quieted and still’d (ee): Or to express it in the Words

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 $9 \frac{1}{2}$ half Seconds, or 1142 Feet in one Second of Time. Vid. Phil. Trans. ibid.

(see) 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 truly Servants. More of this Power of Musick over the Affections, may be seen in Ath. Kirch. Phonurg. L. 2. § 1. Also in Is. Vossius de Poematum cantu, & Rhythm viribus.

And not only upon the Affections, but also on the Parts of the Body. Musick is able to exert its Force, as appears from the Gascoigne Knight, Cui Phormingis sono audito Vesica statim ad Urinam reddendam vellicabatur. Such another we have in Ao. 1. Ephemer. Nat. Curios. Obser. 134. Also Morhoff de Scyph. vitr. per cert. human. vocis sonum fractio; where there is not only the Account of the Dutchman at Amsterdam, one Nich. Peter, that brake Romer-Glasses with the Sound of his Voice; but also divers other Instances of the Powers and Effects of Sound. But to the Story of the Gascoigne Knight, Mr. Boyle, from Scaliger, adds a pleasant Passage, That one he had disoblige’d, to be even with him, caus’d at a Feast, a Bag-pipe to be played, when he was hemm’d in with the Company;
Company; which made the Knight bersis himself, to the
great Diversion of the Company, as well as Confusion of
himself. Boyl's Essay of the Effect of Lang. Mornen. In the
same Book are other Matters that may be noted here. One
whole Arm was cut off, was exceedingly tormented with the
discharge of the great Guns at Sea, although he was at a
great Dillance on Land. And a great Ship-Commander ob-
served his wounded Men, with broken Limbs, suffered in like
manner at the Enemies Discharges. An ingenious Donne-
flick of his own 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 Diletter, upon hearing the Noise of
a Tap running. The dancing to certain Tunes, of Persons
but with the Tarantula, he was affured of by an ingenious Ac-
quaintance at Tarentum, who saw several, among the rest a
Physician, affected with that Diletter. And many other
Accounts of this kind, seemingly credible, are related in
Mor-
hoff, Kircher, and many others; although Dr. Cornelio que-

tions the Matters of Fact relating to the cure of the Taran-
utula-bite, in Phil. Trans. No. 83. Mr. Boyl also faith, aSo-
ber Musician told him, he could make a certain Woman
weep, by playing one Tune, which others would be little af-

ected at. And he faith, that he himself had a kind of thive-
ring at the repeating two Verfes in Lucan. And I add, that
I very well know one to have a fort of chill about his Prac-
dia 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 own Minds and Bodies only affected with
Sounds, but inanimate Bodies are so also. 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 cum ipsi [claris. Illis] de experimento Vtrri per
vocem fratilinararam, ex eo audiuaffe, quod in aedibus Muscis fii
vicinis aliquotites collapsam pavimentum fuerit; quod ipse fons
continus adscribere non dubitavit. Morhoff cap. 12. Morsenni
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 Antipa-
thy, in his Quest. Comment in Genes. viz. That the Sound of
a Drum made of a 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 trem-
ble at the Sound of Organs; and that he hath felt his Hat
do so too under his Hand, at ceratain Notes both of Or-
Words of the last-cited famous Author (ff), "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 tur-"bulent Passions, which are excited in the Breast "by an immoderate Ferment, and Fluſtuation 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 (gg), as the most artful Melodies we hear, are the Voice or Performances of a living Creature!

gans, and in Diſcourſe, that he tried an Arch that would an-swer to C fa-ut, and had done so an 100 Years; and that an experienced Builder told him any well-built Vault will answer some determinate Note. And at Eaſbury-Houſe near Bark- ing, I my self discovered the Porch, (having firm Brick-Walls,) not only to found when struck on the Bottom, but alio to give almost as loud a Sound, when I founded the fame Note with my Voice.

(ff) Willis, ubi supra.

(gg) Ille Deus est — qui non calamo tantum cantare, & a-greſſe, atque inconditum carmen ad aliquam tantum obſeſtatio-nem moduli docuit, sed tot artes, tot vocum varietates, tot fonos, alios spiritu nostro, alios externo cantu edituros com-mentus est. Senec. de Benef. l. 4. cap. 6.
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 (a) can have an easy, 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 (b); 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 (c).

(a) 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 $\frac{3}{4}$ Days; neither did Assa striata in $\frac{5}{2}$ Days; but an Ounce of Nutmegs lost $\frac{5}{4}$ Grains in 6 Days; and Cloves $\frac{7}{4}$ Grains. Boyle’s Subtil. of Effluv. c. 5.

(b) Nares, cō quòd omnis Odor ad superiora fertur, recte sur- sum sunt: Et quōd Cibi & Potionis judicium magnum carum est, non sine causa vicinis:atem Oris secure sunt. Cicero de Nat. Deor. l. 2. c. 56.

(c) Had not the Contriver of Animal Bodies been minded that 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 open and shut the Nostrils; and so adjust it to every Occasion of this Sense.
And forasmuch as it is by Breathing (d), that the odorant Particles are drawn in, and convey’d to the Sensory; therefore there is a very wise Provision made in the Laminae, 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 (e); and partly, to receive the Divarications of the olfactory Nerves, which are here thick spread, and which do by these Means meet the Smells entring with the Breath, and striking upon them.

And accordingly, the more accurate this Sense is in any Animal, the longer we may observe those Laminae are; and more of them in number folded up, and crowded 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 (f); the chief Acts of many of whose Lives, are perform’d by the Ministry of this Sense.

In

(e) For a further Guard against the Ingress of noxious Things, the Vibriși, 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 easy Passage to the Breath and Odours.

(f) Multè præclarius emicat [Olfactus] in bruis animalibus, quam in homine: qua namque hoc solo indice, herbarum, aliorumque corporum præs ignotorum virtutes certissimè dignoscunt, quin id victum fum abstantem, vel in absurdo positum, odoratam venantur, ac facillimè investigant. Quod autem minus sagaces sunt hominum nares, illud non facultatis hujus abusus: prout nonnulli volunt) ascribi debet, verum in causa est ipsius Organis deæctus: hoc enim circa victus humani criteria (ubi ratio,
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. 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? With what Curiosity do the herbaceous Kind pick and choose such Plants as afford them wholesome Food, or sometimes such as are Medicinal, and refuse such as would hurt and destroy them? And all by the Help principally, if not only, of the Smell, as lifted by its near Ally the Taste. Of which I shall in the next Place speak very briefly.

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 Olfaory Nerves are not only remarkably large, (like as they are in other Brutes,) but their Branches and Filaments are, in the Lamina of the Nostrils, both more and larger than I have seen in any other Creature whatsoever. Also there are more Convulsions of the Lamina 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 (hbb).

See Book VII. Chap. 2. Note (e).

Of the Taste (a).

In this, as in the last Sense, we have an Apparatus abundantly sufficient to the Sense; Nerves curiously divaricated about the Tongue (b), 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, to perforated in the papillary Eminences, as to give a free Admission to Tastes.

But

(a) τὰ ζ ἐίκος ἡ χαρά, &c. Saporum genera, — dulcis, punguis, außerum, acerbus, acris, salius, amarus, acidus. Theophr. de Cauf. Plant. l. 6. c. 1. What may the Cause of the difference of Tastes, he faith is hard to assign, πότε προσ ρη πάντες ἔχεις, &c. Utrum affectionibus Sensuum — an figuras, quibus singuli constant, ut Democritus cenfet, id. ib. Δημοκρίτου δὲ τοίς, &c. Democritus — dulcem esse saporem qui rotundus: acerbum qui figura magna; aperum qui multis angulis, &c. id. ib. &c. But of the Diversities and Causes of Tastes, see Dr. Grew, Lett. 6. and Dr. Willis de Anim. Brut. c. 12.

(b) Intellectus Saporum est exterris in prima linguâ: Homini, ἐν παλάτῳ. Plin. 1. 11. c. 37.

The Opinions of Anatomists concerning the Organ of Taste, are various. Bauhin, T. Bartholin, Bartholomaeus, Veslinge, Deusinge, &c. place it in the lacer, 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 Cover 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 Tafte lieth. Malpighi's Words are, Quare cium dictis meatis insignibus occurrunt papillaria corpora, probabilis est in his ultimo, ex subintervenienti sapido humore titillationem, & mordicationem quandam fieri, que Gustum efficiat. Malpig. Op. Tom. 2. De Linguâ, pag. 18.
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 (c), in the Way to the grand Receptacle of our Food and Nourishment; to survey what is to be admitted therein; to judge between what is wholesome, and fit for Nourishment, and what is unsavoury and pernicious. And for this End, the all-wise Creator seems to have establisht a great Consent between the Eye, the Nose, and Tongue, by ordering the Branches of the same Nerves (d), 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 (e). By which

Precipium ac consecere solum Gustatus organon est Lingua; cui aliquaeuis subostr fugere sitem Palaatum, & superior Guile pars consentiens in omnibus verbo fibra nervosa immediata sensiones instrumenta sint. Quare observare est, Linguam pra alia qua-vis parte insigniter fibrosam esse, etiam textura valde porosa conficere, in curn nempe fiinem, ut particula rei sapide copiisius ac pensius intra Sensori: meatus admittance — Nervi autem qui fibris Lingue densissime intertextus famulantur, ac saporum impressiones tu decerni ad haecjus communica, sunt — Nervi e paribus tum quinto, tum nono; & ubique cum densa propaginum serie per totam ejus componagem distribuiti. Willis ibid.
(c) Gustatus, qui sentire curn quibus vesicinur genero debeat, habuatur in ea parte Oris, quâ esculentis & poculentis inter natura pateficit. Cicer. de Nat. Deor. l. 2. c. 56. Vide quoque supr. Note (b). Chap. 4.
(d) Multa hujus [quinti paris] Nervi propagines Masticationis operis destinantur; idque quoniam alimenta ingredunt in modo Gustus, ab etiam Ofisitius & Visus examen subire debent, ab eodem Nervo, cujus rami ad Palatum & Fauces missi, Manuducationis negotium peragent, propagines alie, velut exploratrices, ad Nares & Oculos feruntur, nempe ut ishac aliorum sensuum organa, etiam ad objecta Gustus melius dignoscenda probationem auxiliis quibusdam instruantur. Willis Nerv. Descrip. & Ulus. cap. 22.
(e) See Book V. Chap. 8.
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, the 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 (a).

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

(a) Malpighi is of this Opinion, that as Taste is performed by the Papille in the Tongue, so is Feeling by such like Papille under the Skin. From several Dissections, and other Observations, he thus concludes, _Ex his & similibus videbatur animus abunde certior redditus, earundem Papillarum pyramidalium copiam, quas alia in Linguâ descriptis, in locis præcipue acquisitiors Tactûs dicitis referiri, eodem prosigni nervofo & cuticulari corpore, simulque circumvolvulis reticulari involuro, & extimam cuticulam, veluti ultimum terminum attingere._ — Microscopio quilibet in manibus dorso pro sude ore orificia quadam mirò ordine dispersa intueri potest, circa que frequentia quædam capitula aspurgunt; hæc verò sunt Papillarum fines, dum à cute assimilantes interpositum superant rete, simulque extimam cuticulam. Hæc repetitis sectionibus dépendit; ex quibus non improbabiliiter deducam, sicuti ex elatio-ribus — papillis — in Linguâ, Gustús Organon elicitar, —ita ex copiosâ barum Papillarum congerie — in organis, ubi maximè animalia Tactûs motione afficiuntur, adeaquatum.
One is its Organ, the Nerves. For as all Sensation is performed by the Nerves (b), 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 perform'd, 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 observ'd, 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

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*(a) Although the Eye be the usual Judge of Colours, yet some have been able to distinguish them by their Feeling.*

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*(b) Although the Eye be the usual Judge of Colours, yet some have been able to distinguish them by their Feeling.*
Sense of Feeling throughout every Part (c); to distinguish between Pleasure and Pain; Things salutary, and Things hurtful to the Body.

Thus in the five Senses of Animals, we have an Economy 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.

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

CHAP. VII.

Of Respiration.

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

(a) The Uses assign'd 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, Pracipua Pulmonum functio, & usus sunt, sanguinem aerem per totas partium compages, intimosque recessus, atq; ductus quosque minutissimos traducere, & ubique invicem committere; in eum nempe finem, ut sanguis venosus a circuitu redux, & chymo recenti dilutas, tum perfectius miscetur vel subigatur, tum potissimum ut secundum omnes suas partes ab aere nitrofo de novo accendatur. Pharmaceut. p. 2. S. i. c. 2. §. 2. Mayow saith rightly, that one grand Use of Expiration is, Ut cum aere expulso, etiam vapores e sanguine exhalantes, simul exsuffiantur. And as for Inspiration, that it conveyeth a nitro-aerial ferment to the Blood, to which the Animal-Spirits are owing, and all Muscular-Motion. Mayow de Respir. p. 22. &c. mea 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, Diemerbroek, 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 Uses to be to move, or pass the Blood from the right to the left Ventricle of the Heart. Upon which account Perasons 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. Groon, Profess. Gresh. which he made before our R. S. by strangling a Pullet, so that
Of Respiration.  Book IV.
deed so congenial is this with Life, that Breath and Life are in Scripture Phrase and Common Speech

that not the least Sign of Life appear'd; 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 once tried by Dr. Walter Needham, before Mr. Boyle, and others at Oxford, by hanging a Dog, so that the Heart ceased moving. But hastily opening the Dog, and blowing Wind into the Duæts 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. Uf. p. 60, and 63. med. Edit.

Such an Experiment as Dr. Groon'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. Trans. No. 28.

For the farther Confirmation of Dr. Thurston's Opinion, the ingenious Dr. Musgrave cut off, and close stopped up the Wind-Pipe 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, diffented 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. Trans. No. 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 Esmullerus espoused, who being particular in reckoning up the Ufes of Respiration, I shall therefore the more largely cite him. Respiration, faith he, serves, 1. Ad Olfaum. 2. Ad Screamum & Sputationem. 3. Ad Oscitationem, Tussim, Stermutationem, Emunitionemque. 4. Ad liquidorum Sorbitiorem, Suctioremque. 5. Ad Loquelam, Cantum, Clamorem, Risum, Flatum, Flatum, &c. 6. Ad faciam Alvi, Urina, Facis Molave, necnon Secundinarum expulsionem. 7. Ad promovendi Ventricali, Intellinorum, Lacteorumque vacorum, &c. contenta. 8. Ad halitus aqueos Sanguinis e pulmonibus, aëris Ope, exposando,
Of Respiration.

Speech taken as synonymous Things, or at least necessary Concomitants of one another. Mos-

Chap. VII.

9. Ad Diapnoën. 10. Ad exafliem Chyli, Lymphæ-
que, necnon Sanguinis—misclam. 11. Ad conciliandum san-
guinii—coccineam rubedinem, &c. 12. Nec morose negabi-

mus, àerem—pulmones, & sauginem illos transcurrentem,

minnis calida reddere, &c. 13. Quod denique air sanguini sin-
gulis Respirationsibus aliquantili fui parte, admixture, pauco-

mas quasdam in spirituum animalium elaboratione particulas

fimul contribuat. All these Ufes, although of great Con-

sequence, yet he thinks rather conduce to the Well-Being, than

the Being of the Animal; because without any 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 prin-
cipal Ufe 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,

(lie a Perfon so considerable for his Years, as he was in his

Time,) not only eftablish'd this Notion of Respiration, but

also carries it farther, making it the true Cause of the Dia-

fôle of the Heart; which neither Borelli, Lower, or Cowper,
much lesa 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

confists in Conftriktion, is not to be doubted also. By which

means the Syftole is eafily accounted for. But forasmuch as

the Heart hath no Antagoni$t. Muscle, the Diafôle hath puzz-

led the greatf Wits. But Dr. Drake with great Judgment,

and much Probability of Reafon, maketh the Weight of the

Incumbent Atmosphere to be the true Antagoni$t to all the

Muscles which serve both for ordinary Infpiration and the

Conftriotion of the Heart. The Particulars of his Opinion

may be seen in his Anatomy, l. 2. c. 7. And in Philos.

Trans. 281.

And I remember when I was at the University, my most

ingenious and learned Tutor Dr. Wills, when he read Ana-
tomy to us, was of Opinion, that the Lungs were blown up

by the Weight of the incumbent Air, and repreffed the

manner of Respiration in this manner, víz. He put a Bladder

into a Pair of Bellows, turning back the Neck of the Blad-
der, and tying it fast, fo that no Air might enter in between

the Bladder and Bellows. This being done, when the Bel-
lows 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, fo as to

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blow
jes (b) expresseth animal Life, by [The Breath of Life]. Saith he, Gen. vii. 21, 22. All Flesh that moved on the Earth, Fowl, Cattle, Beast, creeping Things, and Man; all in whose Nostrils was the Breath of Life in the dry Land died. So the Psalmist, Psal. civ. 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 (c), are very admirable:

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 Notion of this Phenomenon, 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 commend-ed 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.

(b) Gen. ii. 7. vi. 17. and vii. 15.

(c) 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.
Of Respiration. 149

For (as the ingenious Dr. Keil faith) supposing the greatest Distance of the two Sides of the Glottis, to be one tenth Part of an Inch in sounding 12 Notes, (to which the Voice easily reaches;) this Line must be divided into 12 Parts, each of which gives the Aperture requisite for such a Note, with a certain Strength. But if we consider the Sub-division of Notes, into which the Voice can run, the Motion of the Sides of the Glottis is suitably nicer. For if two Chords sounding exactly Unions, one be shortened, \( \frac{1}{12} \) Part of its Length, a just Ear will perceive the Disagreement, and a good Voice will find the Difference, which is \( \frac{1}{10} \) Part of a Note. But suppose the Voice can divide a Note into 100 Parts, it follows that the different Apertures of the Glottis actually divide the tenth Part of an Inch into 1200 Parts, the Effect of each of which produces a sensible Alteration upon a good Ear. But because each Side of the Glottis moves just equally, therefore the Divisions are just double, or the Sides of the Glottis, by their Motion do actually divide one tenth Part of an Inch into 2400 Parts. Keil's Anat. c. 3. Sect. 7.

(4) Among the Instruments of Speech, the Tongue is a necessary one; and so necessary, that it is generally thought no Speech can be without it. But in the third Tome of the Ephem. Germ. is published, "Jac. Rolandi Aglossosophomographia, sive Descriprio Oris sine Langua, quod perfette loquitur, & reliquas suas functiones naturaliter exercet. The Person described is one Pet. Durand, a French Boy of eight or nine Years old, who at five or six loft his Tongue by a Gangrene, occasioned the Small-Pox. Notwithstanding which, he could (as the Title faith) speak perfectly, as also taste, spit, swallow, and chew his Food; but this latter he could do only on that Side he put it into, not being able to turn it to the other Side his Mouth.

In the same Tract, Chap. 6. is this Observation of ventriloquous Persons, "Memini me à quodam fat celebri Anatomico audivisse, dum de duplicaturâ Membrana ageret, sì Membrana ipsa duplex naturaliter unita in duas partes dividatur, loquem quaerit, ut ex pejlore procedere, ut circumstantes credant Demoniacum hunc, aut Sternomythum.

(e) The Variation of the Wine-pipe is observable in every Creature, according as it is necessary for that of the Voice. In an Urchin, which hath a very small Voice, 'tis hardly more than membranous. And in a Pigeon, which hath a low and soft Voice, 

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No. 9
Top, to fence against all Annoyances; its cartilaginous Rings (f) 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; there, I say, do all justly deserve our Admiration.

And no less prodigious are the Parts farther within; the Bronchi, the Vesicule (g), with their muscular

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. Grew's Cosmolog. Sacr. Book I. Chap. 5. §. 9, 10.

(f) It is a farther manifold 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 easy Passage to the Food; but after that, in the Bronchi; they are, some compleatly annular, some triangular, &c. And another observablc 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.

(g) 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 Vesicule in 1660, in his two Letters to Barelli de Pulmon. Also to Dr. Willis's Phærus,
lar Fibres (b), 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.

rat. p. 2. S. r. c. i. 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 Vesicula, or Lobuli of Vesicula admitting of Air from the Bronchi, is visible, because they may be blown up, cleansed of Blood, and so dried. But Mr. Cowper's faith, he could never part the Lobuli, (so as to make Dr. Willis's Fig. 1, Tab. 3. & 4.) so that probably the Vesicula are contiguous to one another throughout each Lobe of the Lungs. And not only Air; but Diemerbroeck proves, that the Vesicula admit of Dust also, from two athmatick Persons he opened; one a Stone-cutter's Man, the Vesicula 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.

(b) There is a considerable Difference between Dr. Willis, and Etmuller, viz. Whether the Vesicula of the Lungs have any muscular Fibres or not? Etmuller expressly faith, Nullas Fibras musculosas, mutio minus rubicundam Musculorum compagem (Sunt enim Vesicula albida & fere diaphana) in ipsis reputiri. ubi supr. c. 6. §. 2. And afterwards, §. 3. Pulmones esse molles flexileseque musculosis fibris seu propriis explicacionis organis destitutos. But Dr. Willis as expressly afferts they have muculous Fibres, and assigns an excellent Ufe of them; Cellulae isfa vesiculares, ut nixas pro expiratione contractiones 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 materiae extraffendi ejiciant, fibras muscularibus donata, sese arctius contrahunt, conientataque sua penitus exterminant. Et enim ordinaria pectoris Sypho, quis musculorum relaxationes ex parte efficiunt, aereum forsitan totum à Tracheâ et Bronchii, baud tamen à Vesiculâ, quique vice ejiciunt: propter hâs (quoties opus erit) imaniendas, et totius Pectoris cavitas plurimum augustatur, & cellulae ipsa vesiculares à propriis fibris constringebatur.
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From hence I might proceed to the commodious Form of the Ribs (i), the curious Mechanism of the Intercostal-Muscles (k), the Diaphragm, and all the other Muscles (l) ministring both to the ordinary, and extraordinary Offices of Respiration. But

(i) Circa hos motus [Sci. Pectoris dilatationem, &c.] divini Conditoris mechanicae, ad regulas Mathematicas plano adapta-
tam, satis admirari non possimus; quidem nulla alia in re manifestius O O O esse sequevit videtur. Quippe cum pectoris, tum ampliatio, tum coarctatio à quibusdam Musculis (quorum munus unicum est contrahere) perfecit debeat; res ita institui-
tur, ut Coeza que thoracis, velut parallelogrammi oblongi versus cylindrum incurvati, latera efformant, in figuram modò qua-
dratam, cum angulis rectis, pro pectoris ampliacione; modò in rhomboideum, cum angulis acutis pro ejusdem contractione, du-
cantar, &c. Willis, ubi supr. §§. 28.

Galen having spoken of the Parts ministring to Respiration, concludeth, Nihil usquam à Naturâ ullo pacto per incuriam, suisse præteritum, quà cum omnia prefentieret & provideret, quà sunt necessaria illa, qua causa alicujus extirpunt, consecutur, omnibus instaurationes parare occupavit, quibus apparatus copiosa facultas admirabilem Sapientiam testabant. De ut. part. l. 5. c. 15. See also l. 6. c. 1.

(k) For the Structure of the Intercostals, Midriph, &c. I shall refer to Dr. Willis, and other Anatomists. But Dr. Drake taxeth Dr. Willis with an Error in fancying there is an Oppo-
sition in the Office of the Intercostals, by reason that the Fi-
bres of the external and internal Intercostals decullate; 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 Decussion of their Fibres, the Power they exert upon, and the Motion they effect in the Ribs, is one and the same. Drake's Anat. l. 2. c. 7. and l. 4. c. 5. Mayow de Respir. c. 7.

(l) Although Dr. Drake and some others deny the Interc-
cestals being Antagonist-Muscles, as in the preceding Note, yet they, and most other Anatomists that I have met with, attribute a considerable Power to them in the act of Respira-
tion, as they do also to the Subclavian and Triangular Mus-
cles; but the learned Etruller denies it for these three Rea-
sons, 1. Quia respirando nullam in illis contractionem sensi,
2. Quia — si bi invicem non adducuntur, &c. 3. Quia
Coez omnes ab alis modo enarratis musculis movuntur, idque
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 (m), yet cannot be easily passed by in the Subject I am upon; and that is the Circulation of the Blood in the Foetus 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 (n) on purpose for the Transmission of the Blood without passing it through the Lungs.

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 accipiat: in Cane per tumultuos pectoris protentitur, & cartilagines omnes, etiam verarum Coftarum sternocostalatarum, occupat: Cujus discriminis ratio divinam circa Animam fabricas Providentiam plane indicatur. Quippe cunbo animal, ad curjus velocissimos & diu continuandos naturam, quo sanguis, dum intensius agitatur, rite accendatur eventileturque, aequum celerrimè & fortièe uti inspirare, ut etiam exspirare debet — idcirco propter hunc actum firmius obolelum (cujus in Homine haud magnus est usus) musculus caninus molem ingentem & tanto operi parem forsitur. Willis ubi supr. §. 32.

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

(n) Mr. Chefelden, an ingenious and most accurate Anatomist, having somewhat particular in his Observations about the Circulation of the Blood through the Heart of the Foetus, I shall present the Reader with some of his Observations, which he favoured me with the Sight of. The Blood (faith he) which is brought to the Heart by the ascending Cava, passes out of the right Auricle into the left, through a Passage called Foramen Ovale, in the Septum [common to them both] without passing through the right Ventricle (as after the Birth) while the Blood from the descending Cava passes through the
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Lungs. But as soon as the Fetus is Born, and become thereby a perfectly distinct Being, and breathes for itself, 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 (o).

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

the right Auricle and Ventricle into the pulmonary Artery, and thence into the Aorta through the Duct, betwixt that and the pulmonary Artery, called Ductus Arteriosus, whilst a small Portion of the Blood, thrown into the pulmonary Artery pasteth 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 Fetus, and to the Mother too. But after the Birth, the Blood being to be driven from the Aorta through the Fetus 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 itself, to whose Sides it soon adheres, and so stops up the 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.

(o) 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. Connor found it but half closed, and in the Form of a Crescent. And he thinks somewhat of this kind might be in the Peron 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. No. 215. and more largely in his Dissert. Med. Phys. de stupendo Offium coeliti, 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 quod Foramen Ovale serè erat occultum, in medio tam exilì foramine, per quod Turundam facile transmisi, erat pervium.
Of Respiration.

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

pervium, pag. 30. So Mr. Cowper (than whom none more accurate and a better Judge) faith, 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 state satís adhuc valens & vegetus, cum ante 18 annos, ali in aquas delapso opem ferre vellet, forte fortunâ & ipse per glaciem incantius procedens, aquas incidit 18 ulnas profundas: ubi ille, corpore erecto quasi ad perpendicularum, pelibus fundo adhaerit. Constitit sic per 16 horas, antequâm producere tur in auras. Dixit autem, simul ac infra aquarum superficiem suum demersus, statim obiectus totum, & se quem tum habuit motum & sensum, amississe, nisi quod sanitates Stockholmii campanas etiam sub aquis obscurius percipere sibi sit vixus. Sensit etiam, statim se velut vesiculas ori applicasse, addo ut aqua nulla es pene-traverit, in aures verò transitum, etiam sentiente illo, habuerit; atque inde auditum sum debilitatum aliquandiu esse. Hoc statu dum 16 horas permanebat frusfrâ quiescit, tamen repertum, conto in caput infixo, cujus etiam sensum se habuisset dixit, fundo extraxerunt, sperantes ex more aut persuasione gentis revi-teturam esse. Itaque pannis linteisque producuntur obvolutum, ne aér admittit possit: perniciosus futurus subito illapsu: custoditum sic falsis ab aere sensim sentimque repudiori loco admovent mox calidis adoriantur fascis, fricant, radunt, & suffummarunt tot horis finuins corporisque motum negotiosà illâ operâ redu-cunt: denique antapopletics & genialibus liquoribus vita red-dunt & prifline mobilitati. Resulit is atque offendit se etiamnum in capite circumferre vestigia violentia à conto illata, & cephalalgia vexari gravissimis. Et propter hunc ipsum causà, religiosè à popularibus, & hujusce rei testibus probatum, Sere-nissime Regia matris munificentia & annuo stipendio eft dona-tus — & Sereh. Principi — oblatus, vivus fui testis —

and Design of the great GOD of Nature? What is Thought and Contrivance, if this be not? Namely, 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 oc-


Shall we to this Cause, or to the Officication, 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 Anne Green, executed at Oxford, Dec. 14. 1650. is still well remembered among the Seniors there. 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. Af- ter she was in her Coffin, being observed to breath, a lofty Fellow flamped 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. Clark, 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 Resurrection, see in a little Pamphlet, called News from the Dead, written, as I have been inform- ed, by Dr. Bathurst, (afterwards the most vigilant and learn- ed President of Trinity-College, Oxon,) and published in 1651. with Verfes upon the Occasion.
casions 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 (p), 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 Torpiditude, 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 Lungs, the Heart, and other Parts of such

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

But the fore-commended Mr. Chefelden thinks the Foramen Ovale is neither open in amphibious Creatures, nor any adult Land-Animals. When I first (faith he) applied my self to the Dissection of Human Bodies, I had no distrust of the frequent Accounts of the Foramen Ovale being open in Adults: but I find since, that I misconceived the Ostium Venarum Coronarium 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 these Creatures to live under Water, as the Foetus doth in Utero, unless the Duæus Arteriosus was open also.

This Opinion of Mr. Chefelden hath this to render it probable, that the Ostium Venarum Coronarium 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.
Creatures (q), is manifestly the Work of him, who as St. Paul faith (r), giveth to all Breath, and Life, and all Things.

(q) Of the singular Conformation of the Heart and Lungs of the Tortoise, which is an amphibious Animal. See Book VI. Chap. 5. Note (b).
(r) Acts xvii. 25.

CHAP. VIII.

Of the Motion of Animals.

NEXT to the two grand Acts of animal Life, their Sense or 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 Foresight, Care, and especial Providence towards all the animal World.

And here I might view in the first Place the Muscles, their curious Structure (a), 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 Joint: Also their various Size and Strength; some large

(a) That the Muscles are compounded of Fibres, is visible enough. Which Fibres, the curious and ingenious Borelli faith, are cylindraceous; not hollow, but filled with a spongy, pithy Substantie, after the manner of Elder, as he discovered by his Microscopes. Borel. de Mot. Animal. Part 1.
large and corpulent, others lefs, 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 (b).

Next, I might survey the special Fabrick of the Bones (c), ministring to animal Motion. Next, I might

These Fibres, he faith, are naturally white; but derive
their Rednefs 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 at all tend the fame Way, but some run aflant, 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 Anatomifts, particularly Steno, Borelli, Cowper, &c.

(b) The infinite Creator hath generally 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 lefs 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 Baffe, 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 lefs Providence, that they are absolutely under the Power of the Will; so as that the Animal hath it in his Power to command the Muscles and Spirits of any part of its Body, to perform such Motions and Actions as it hath Occasion for.

(c) Quid dicam de Offibus? quae subjecta corpori mirabiles commissuras habent, & ad stabilitatem aptas, & ad artem finiendos accommodatas, & ad motum, & ad omnem corporis actionem. Cicer. de Nat. Deor. l. 2. c. 55.
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By Reason it would be endless to mention all the Curiosi-
ties observable 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 Asperi-
ties and Hollows, made for catching and holding; so as
firmly to lock and keep the Joynts from Luxations, but with-
al to afford them such a Motion, as is necessary for the In-
curvations 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 dif-
diferent, 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 con-
trived; for had it been all Bone, we could have had no Moti-
on 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 Positions we have occasion to
put our Selves in. If it had been made of several Bones with-
out 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 dislo-
cated. And lastly, The oblique Procceds of each superior and in-
derior 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 faith of the Articulations, Li-
gaments, Perforation, &c. of the Spine, to prove the Wisdom and
Providenee of the Maker of animal Bodies, against such
as found fault with Nature's Works; among which he names
Diagoras, Anaxagoras, Astelepiades and Epicurus. V. Galen de
Us. Part. L. 12. init. and Chap. II. &c. also L. 13. init.

2. The next Instance shall be in one or two Things, where-
in the Skeletons of Sexes differ. Thus the Pelvis made in
the Beily by the Ilium, Osse Coxendicis and Pubis, is larger
in a Female than Male Skeleton, that there may be more
room for the lying of the Viscera and Fetus. So the Car-
tilage bracing together the two Osse Pubis, or Sharebones,
Bartholine faith, is twice thicker and laxer in Women than
Men
might take notice of the Joynts (d), their compleat Form adjusted to the Place, and Office they are employed in; their Bandage, keeping them from Luxations; the oily Matter (e) to lubricate them.

Men: As also is the Cartilage that tieth the Os Sacrum to its Vertebra; and all to give way to the Passage of the Fætus.

Another considerable Difference is in the cartilaginous Production 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 fucking Infant, &c.

(d) It is remarkable in the Joynts, and a manifest Act of Caution and Design, 1. That altho' 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 Sub stance, they are incomparably prepared both for Motion and Strength. 2. That the Bones next the Joynt are not spongy, as their Extremities commonly are, nor hard and brittle, but capped with a strong, tough, smooth, cartilaginous Sub stance, serving both to Strength and Motion.

But let us here take notice of what Galen mentions on this Subject. Articulorum unusquisque Eminentiam Cavitatim immisssam habet: Veruntamen hoc fortasse non adeo mirabile est:


(e) For the affording this oily or mucilaginous Matter; there are Glandules very commodiously placed near the Joynts,
them, 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 (f). I might consider their Origin (g), 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 up-

so as not to suffer too great Compression by the Motion of the neighbouring Bones, and yet to receive a due Pressire, so as to cause a sufficient Emission of the Mucilage into the Joynets. Also another Thing considerable is, that the excre-
tory Ducts of the mucilaginoius 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 Expression of it at all Times, and on all Occasions, as particularly in violent and long-con-
tinued Motions of the Joynets, when there is a greater than ordinary Ex pense of it. See Cowper's Anat. Tab. 79.

(f) There is no doubt to be made, but that the Muscles receive their Motion from the Nerves. For if a Nerve be out, or straightly bound, that goes to any Muscle, that Mus-
cle shall immediately lose 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.

And this also is the cause of that Numness or Sleepiness we find oftentimes, by long sitting or lying on any Part.

Neither is this a modern Notion only: For Galen faith, Principium Nervorum omnium Cerebrum est, & spinalis Medulla. — Et Nervi a Cerebro animalem virtutem accipiant — Nervorum utilitas est faciulatem Sensis & Motus à principio in partes diducere. And this he intimates to have been the Opini

(g) Dr. Willis thinks, that in the Brain the Spirits are elaborated that minister to voluntary Motion; but in the Cere-
bellum, such as effect involuntary, or natural Motions; such as that of the Heart, the Lungs, &c. Cerebri Anat. c. 15.
on already, and more I shall mention hereafter (b), and it would be tedious here to insin upon them all.

I shall therefore only speak distinctly to the Locomotive Act itself, or what directly relates to it.

And here it is admirable to consider the various Methods of Nature (i), suited to the Occasions of 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 (k).

And first for swift or slow Motion. This we find is proportional to the Occasions of each respective Animal. Reptiles, whose Food, Habitation, and Needs, 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;

(b) See Book V. Chap. 8.

(i) 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 Refemblance of a young Fift,) which fall off when the Legs are grown. And the Nymphia and Aurelia, 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.

(k) Tam vero alia animalia gradiendo, alia ferendo ad pastum accedunt, alia volando, alia nando. Cic. de Nat. Deor. l. 2. c. 47.

Compare also what Galen excellently 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 Uf. Part. in the beginning of the third Book.
but their vermicular or sinuous 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* 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 of Business, or their want of Armature, and to secure them against Harms (*l*).

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 swifter or more slowly, a long or short a 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 a proper Place (*m*).

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 (*n*),

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(*l*) 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 swifter Motion; whereas they that are destitute thereof, are swifter. So also timid helplesss Animals are commonly swift; thus Deer and Hares: But Animals endowed with Courage, Craft, Arms, &c. commonly have a swifter Motion.

(*m*) See *Book VII. Chap. 1.*

(*n*) See *Book VII. Chap. 1. the end.*
or to the Bodies of those that creep (o). Neither can the Body be more compleatly poised for the 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 balanced (p). The Head not too heavy, nor too light for the rest of the Body, nor the rest of the Body for it (q). The Viscera are not let 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 balanced, as we could have balanced 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

(o) See Book IX. Chap. 1. Note (c.)
(p) Siquis unquam alius Opifex, equalitatis & proportionis magnam habuit providentiam, certe Natura habuit in anima- lium corporibus conformandis; unde Hippocrates eam rettiffimè justam nominat. Galen. de Uf. Part. 1. 2. c. 16.
(q) The Make of the Bodies of some Water-Fowl, seems to contradift what I here fay, the Heads and long Necks of some, as of Swans, Ducks and Geefe; and the hinder Parts of others, as of the Doucher 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 In- stance 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. 2. Note (i).

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 (k).
Of the Place

Book IV.

floop, to sit, and indeed to move any way, only with the Help of so small a Stay as the Feet (r): whose Mechanism of Bones, Tendons and Muscles to this purpose, is very curious and admirable.

C H A P. 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 spread. 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 and Services they perform therein. If all the

(r) See Book V. Chap. 2. Note (k).
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 Reit in the Temperate Zones only, and covered 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 covered 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 (a), the airy Inhabitants, and

(a) Est etiam admiratio nonnulla in beffa aquatilibus ills. qua gignuntur in terrâ: veluti Crocodili, fuviasalesque Testudines, quadamque Serpentes orae extra aquam, simul ac primum nisi possunt, aquam persequuntur. Quin etiam Animam.
and those on the dry Land Surface, and the Sub-
terraneous under it, they all live and act with Plea-
sure, they are gay, and flourish in their proper E-
lement 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 order-
ed, yet considering the World’s increase, there
would not be sufficient Room, Food, and other
Necessaries for all the living Creatures, without
another grand Act of the divine Wisdom and Pro-
vidence, which is the Balancing the Number of Indi-
viduals of each Species of Creatures, in that Place
appointed thereto: Of which in the next Chapter.

CHAP. X.

Of the Balance of Animals, or the due Pro-
portion in which the World is flocked with
them.

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 therefore the Balance even, is mani-
festly a Work of the divine Wisdom and Providence. To which end, the great Author of Life

ova Gallinis s£pe supponimus — [Pulli] deinde eas [matres]
relinquant — or effugiant, cum primum aquam, quasi natu-
ralum domum, videre poteurunt. Cic. de Nat. Deor. l. z. c. 48.
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-flock the World. And the same Benefit is effected, where the Increase is great, by the Brevity of such Creatures 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 (a), and others in lefs. 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 lefs useful, or by their Voracity pernicious, have commonly fewer Young, or do seldom or 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 (b): A Fowl of that Magnitude, Strength and Appetite, as to seize not only on the Sheep, and lesser Cattle, but even the larger Beasts, yea, the very Children too. Now these, as they are the most pernicious of Birds, so


(b) Captain J. Strong gave me this Account, together with a Quill-Feather of the [Cuntur or Condor of Peru.] On the Coas of Chili, they met with this Bird in about 33° S. Lat. not far from Mocha, an Island in the South-Sea,—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 (faith the Doctor) is 2 Feet, 4 Inches long; the Quill-part $\frac{5}{4}$ Inches long, and $\frac{1}{4}$ Inch about in the largest Part. It weighed 3 dr. 17½ gr. and is of a dark brown Colour. Dr. Sloane in Phil. Trans. No. 258.
so are they 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 (c); so equally in its 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, Mat. x. 29. that the most inconsiderable, common Creature, Even a Sparrow (two of which are sold for a Farthing) doth not fall on the Ground without our heavenly Father.

To this Account, the Doctor, (in a Letter to Mr. Ray, March 31, 1694, with other Papers of Mr. Ray's, in my Hands,) adds the Testimony of Jos. Acofa, l. 4. c. 7. and Garcilaff. de la Vega, who l. 8. c. 19. faith, There are other Fowls, call'd Cuntur, and by the Spaniards corruptly Condor. Many of these Fowls having been kill'd 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, deny'd them the Talons which are given to the Eagle; their Feet being tipp'd with Claws like a 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 Razor. 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.

(c) Eccles. i. 4.
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 Noab’s Flood, the Longevity of Men, as it was of absolute Necessity to the more speedy popling of the new World; so is a special Instance of the divine Providence in this Matter (d). And the same Providence appears in the following Ages, when the World was pretty well peopled, in reducing the common Age of Man then to 120 Years, (Gen. vi. 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

(d) The Divine Providence doth not only appear in the Longevity of Man, immediately after the Creation and Flood; but also in their different Longevity 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, arriv’d 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 Terab, arriv’d 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. xiv. 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, Egypt, Persia, &c. But learned Men generally, with great Reason, reject these as legendary Accounts.
sent Time) the lessening the common Age of Man to 70 or 80 Years (e), (the Age mentioned by Mo-
jes, Psal. xc. 10. this, I say,) is manifestedly an Ap-
pointment of 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 Methuselah'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 men-
tioned, the Balance is nearly even, and Life and
Death keep an equal Pace. Which Equality is so
great and harmonious, and so manifest an Instan-
tce of the divine Management, that I shall spend some
Remarks upon it.

It appears from our best Accounts of these Mat-
ters,

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, 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 Stillingsfleet's Orig. Sacr. Book III.
Chap. 4. §. 9.

(e) That the common Age of Man hath been the same in
all Ages since the World was peopled, is manifest from pro-
phane, 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 match'd by our modern
Histories; especially such as Pliny himself gave Credit unto.
Dr. Plot hath given us divers Instances in his History of Ox-
fordshire, c. 2. §. 3. and c. 8. §. 54. and History of Stafford-
sire, c. 8. §. 91, &c. Among others, one is of twelve Te-
nants of Mr. Biddulph's, that together made 1000 Years of
Age,
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. Trans. 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 Kimarsey and Demington in Shropshire, every sixth Soul was 60 Years of Age, or upwards, Phil. Trans. No. 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 Diftemper but mere old Age, faith Sir Rob. Siebald, Prodr. Hist. Nat. Scot. p. 44. and l. 3. p. 4.

As for Foreigners, the Examples would be endless; and therefore that of Job. Otsele shall suffice, who was as famous for his Beard, as for being 115 Years of Age. He was but two Brabant Ells ½ high; and his long grey Beard was one Ell ½ 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 Wandring few, named Joh Butadams, 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 Ann. 1542, conversed with by Paul of Eifien, Bishop of Slavwick; and before that, viz. in 1228, seen and convers'd with by an Armenian Arch bishop'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. 151. 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, fucking strange Nurseries, too hastily Marriages; but above all, to Luxury, high Sauces, strong Liquors, &c. The Longevity of the Ancients he ascribes to Temperance in Meat and Drink, anointing the Body, the Use of Saffron and Honey, warm Clothes, leffer Doors and Windows, less Phystick and more Exercise.

(f) The
Of the Numbers Book IV.

In our European Parts, and I believe the fame is throughout the World; that, I say, there is a certain Rate and Proportion in the Propagation of Mankind: Such a Number marry, and 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:

<table>
<thead>
<tr>
<th>Names of the Places</th>
<th>Marriages to Births: As</th>
<th>Births to Burials: as</th>
</tr>
</thead>
<tbody>
<tr>
<td>England in general</td>
<td>1 to 4:63</td>
<td>12 to 1</td>
</tr>
<tr>
<td>London,</td>
<td>1 to 4</td>
<td>10 to 1:1</td>
</tr>
<tr>
<td>Hampshire, from 1569, to 1658</td>
<td>1 to 3:7</td>
<td>26 to 1</td>
</tr>
<tr>
<td>Tiverton in Devon, 1560, to 1649.</td>
<td>1 to 3:9</td>
<td>6 to 1</td>
</tr>
<tr>
<td>Cranbrook in Kent, 1560, to 1640.</td>
<td>1 to 6</td>
<td>6 to 1</td>
</tr>
<tr>
<td>Ayhno in Northamptonshire for 118 Y Years</td>
<td>1 to 3:7</td>
<td>07 to 1</td>
</tr>
<tr>
<td>Leeds in Yorkshire for 122 Years.</td>
<td>1 to 3:4</td>
<td>23 to 1</td>
</tr>
<tr>
<td>Harwood in Yorkshire 57 Years.</td>
<td>1 to 4:6</td>
<td>08 to 1</td>
</tr>
<tr>
<td>Upminister in Essex 100 Years.</td>
<td>1 to 3:7</td>
<td>2 to 1</td>
</tr>
<tr>
<td>Frankfurt on the Main in 1695.</td>
<td>1 to 3:7</td>
<td>9 to 1</td>
</tr>
<tr>
<td>Old middle and lower March in 1698</td>
<td>1 to 3:7</td>
<td>6 to 1</td>
</tr>
<tr>
<td>Domin. of the K. of Prussia in 1698</td>
<td>1 to 3:7</td>
<td>5 to 1</td>
</tr>
<tr>
<td>Srejlaw in Slejna from 1687 to 1691</td>
<td>1 to 4:7</td>
<td>4 to 1</td>
</tr>
</tbody>
</table>

Which 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 Upminister. That from Ayhno Register in Northamptonshire, I had from the present Rector, the learned and ingenious Mr. Waffe: And I was promised some Accounts from the North, and divers others Parts of this Kingdom; but have not yet received them: Only those of Leeds and Harwood in Yorkshire, from my curious and ingenious Friend Mr. Thoresby.

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 by Mr. King's Estimate, (the best Computations I imagine of any, being derived from the best Accounts; such as the
of Animals. 175

so many are born, such a Number die; in Proportion 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 (b), not in a wide Proportion, 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

the Marriage, Birth, 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 a 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 Laetantius, Quare apud Poetas falacissimus Jupiter desir liberos tollere? Utroqu sexagenarius factus, & ei Lex Papia fabulum impofuit? Laetant. Inlitt. l. i. c. 16. By which Lex Papia, Men were prohibited to marry after 60, and Women after 50 Years of Age.

(b) 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, faith, there are 14 Males to 13 Females: From whence Mr. Graunt, 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 636 Males, and 623 Females in all that Time; yet there were baptized 709 Males, and but 675 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 Virtue, by Denial, &c. Also this Surplufage of Males
tain Place (i). 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 Diseases, and the Depredations of War, and the Seas; and to afford a sufficient Number for Colonies in the unpeopled Parts of the 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 are so far from being wasted, that they remain full of People.

And Males is very useful for the Supplies of War, the Seas, and other such Expences of the Men above the Women.

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 supposest 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. Phil. Trans. No. 328.

(i) The foregoing Table shews, that in England in general, fewer die than are born, there being but $1$ Death to $\frac{1}{4.2}$ Births. But in London more die than are born. So by Dr. Davenant's Table, the Cities likewise and Market-Towns bury $1$ to $\frac{1}{2}$ to one Birth. But in Paris they out-do London, their Deaths being $\frac{1}{2}$ to one Birth: The Reason of which I conceive is, because their Houses are more crowded than in London. But in the Villages of England, there are fewer die than are born, there being but $1$ Death to $\frac{1}{4.2}$ Births. And yet Major Graunt, and Dr. Davenant, both observe, that
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 (k); especially such as are of a ferine, not of 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 Beginning, (as who can deny it (l); or

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 Gram., Chap. 7. and Davenant ubi supr. p. 21.

The last Remark I shall make from the foregoing Tables 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 Months, those Places bid the fairest for being most healthful; and next to them Aynho and Cranbrook for English Towns.

(k) Quid loquar, quanta ratio in beliis ad perpetuam conservationem earum generis appareat? Nam primum alia Mares, alia Femina sunt, quod perpetuitatis causa machinata natura est. Cic. de Nat. Deor. l. 2. c. 51.

(l) Altho' Aristole 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
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 Dou-
bling (m) should cease; or that it should be com-
penfated by some other Means? That the World
should be as 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 stock'd, can
never be made out, without allowing an infinite
Providence.

I con-

first Book he affirms, that God is the Cause and Beginning of
all Things; and in his Book de Mundo he faith, 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
frenuously contended that the Contrivance and Beauty of the
Heavens and Earth, and all Creatures was owing to a wise,
intelligent Agent. Of which Tully gives a large Account in
his second Book de Nat. Deor. in the Person of Balbus.

(m) I have before in Note (g), 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 Ser-
vants, 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 Hakewill, Camden, and
other Authors; but having now before me the Names, with
some Remarks (which I received from a pious neighbouring
Descendant of the same Mrs. Honywood) I shall give a more par-
ticular Account than they. Mrs. Mary Honywood was Daugh-
ter, 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
Robes
I conclude then this Observation with the Psalmist's Words, Psal. civ. 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.

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, men-

Robert Honywood, of Charing in Kent, Esq; 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 third two hundred and twenty eight; and nine in the fourth Generation. So that she could say the same that the Diſſick doth, made of one of the Dalburg's Family of Batif:

1 2 3 4
Mater ait Nata, die Nata, filia Natam
5 6
Ut moneat, Nata, plangere Filiolam.

1 2 3 4
Rise up Daughter, and go to thy Daughter, for her Daughters
5
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 Venue-Glass against the Ground, which she had then in her Hand. But the Glass escaped breaking, as credible Witnesses attested.
tioned in Verse 27, 28, of the last cited Psalm civ. 
These [Creatures] wait all upon thee, that thou may'st 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 ascertained in Psalm cxlv. 15, 16. The Eyes of all wait upon thee, and thou givest them their Meat in due Season. Thou openest thy Hand, and satisfiest the Desire of every living Thing.

What the Psalmist here ascertains, affords us a glorious Scene of the divine Providence and Management. Which, (as I have shew'd it to concern it self in other lesser Things;) so we may presume doth exert itself 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:

I. From the subsisting and maintaining such a large Number of Animals, throughout all Parts of the World.

II. From the proportionate Quantity of Food to the Eaters.

III. From the Variety of Food suited to the Variety of Animals: Or the Delight which various Animals have in different Food.

IV. From the peculiar Food which peculiar Places afford to the Creatures suited to those Places.

V. From the admirable and curious Apparatus made for the gathering, preparing, and Digestion of the Food. And,

VI. and lastly, From the great Sagacity of all Animals, in finding out and providing their Food.

I. It is a great Act of the divine Power and Wisdom, as well as Goodness, to provide Food for such a World of Animals (a), as every where

(a) Psalm animantibus largè & copiosè natura eum, qui cuique aptus erat, comparavit. Cic. de Nat. Deor. l.2. c.47. 
Ille Deus est, —— qui per totum orbem armenta dimisit, qui gregibus ubique passim vagantibus pabulum praebat. Senec. de Benef. l.4. c.6.
possess the terraqueous Globe; on the dry Land; and in the Sea 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 likely 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 carefully provided Food for their Subsistence there.

But I shall leave this Consideration, because it will be illustrated under the following Points; and proceed,

II. To consider the Adjustment of the Quantity of Food, in Proportion to the Eaters. In all Places there is generally enough; nay, such a Sufficiency, as may be styled a Plenty; but not such a Superfluity, as to waste 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 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; to the dryland Surface we find everywhere almost naturally carpeted over with Grass, and other agreeable wholesome Plants; propagating themselves in a Manner everywhere, 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 a large Increase doth it produce? Pliny's Example of Wheat (b), is a sufficient

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(b) Tritico nihil est fertilis: hoc ei natura tribuit, quoniam maxime alas hominem; ut poa cim e modio, si fit aperta.
ent 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 extremes of Heat or Cold, so as scarce to refuse any Clime.

III. Another wise Provision the Creator hath made relating to the Food of Animals, is, that various Animals delight in various Food (c); some in Grass and Herbs; some in Grain and Seeds; some in Flesh; some in Insects; some in this (d), some in that; some more delicate and nice; some voracious 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 choosing various Food, and perhaps abhorring that which others like, 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 wholesome Food

\[ solum --- 150 \text{ modii reddantur. Mi} \text{fit D. Augusto procurator} --- \text{ex uno grano (vix credibile dicta) 400 paucis minus germ} \text{mina. Mi} \text{fit \& \text{Neroni} similiter 340 stipulas ex uno grano.} \text{Plin. Nat. Hist. 1. t8. c. 10.}

(c) \text{Sed illa quanta benignitas Natura, quod tam multa ad vescentum, tam varia, tam lucunda gignit: neque ea uno tempore anni, ut semper \& novitiae deleti} \text{emur \& copia. Cic. de Nat. Deor. 1. 2. c. 53.}

(d) \text{Swammerdam observes of the Ephemeron Worms, that their Food is Clay, and that they make their Cells of the same. Upon which occasion he faith of Moths, that eat Wool and Fur, 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, blue or black Cloth, you will also find their Dung of the same Colour. Swammerd. Ephem. vita. Published by Dr. Tyson, Chap. 3.}
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to one, is nauseous, and as a Poyfon to another; what is a sweet and delicate Smell and Taste to one, is foetid and loathsome to another: By which Means all the Provisions the Globe affords are well dispos'd 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 cherishing and refreshing it. 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 poyfon us: Nay, those Animals which are become Carrion, and many other Things that are noyfome, both on the Dry-land, and in the Waters, would be great Annoyances, and breed Diseases, was it not for the Providence which the infinite Orderer of the World hath made, by causing these Things to be sweet, pleasant, and wholesome Food to some Creature or other, in the 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 supply'd with convenient Food. Which Providence of God, particularly in the Supplies afforded the Ravens, is divers Times taken Notice of in the Scriptures (e); but whether for the Reasons now hinted, or any other special Reasons, I shall not enquire. Thus our Saviour, Luke xii. 24. Consider the Ravens; for they neither sow nor reap, which neither have Storehouse, nor Barn, and God

(e) Jefb xxxviii. 41. Psal. cxliv. 9.
Of the Food

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...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 (f), Pliny (g), and Aelian (h), report of their unnatural Affection and Cruelty to their Young: "That they expel them their Nefts as soon as they can fly, and then drive them out of the Country".

Thus having considered the wise Appointment of the Creator, in suitting the Variety of Food, to Variety of Animals: Let us in the

IV. Place, Take a View of the peculiar Food, which particular Places afford to the Creatures inhabiting therein.

It hath been already observed (i), 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 (k), the various Soils, the Seas, the Waters,

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(g) Pliny. affirmis this of the Crow as well as Raven: Cetera omnes [i.e. Cornices] ex eodem genere pellunt nidis pullos, ac volare cognunt, sicunt & Corvi, qui — robustos suas satus fugans longius. Nat. Hist. l. 10. c. 12.
(h) Var. Hist.
(i) Chap. 9.
(k) Admiranda Nature dispensatio est, ut aliter, alioque modo, semponde, & industria colatur terra septentrionalis, aliter Ethiopia, &c. Quoad Aquilones, hoc certum est, in plerique...
Waters, nay our very Putrefactions, and most na-
fly Places about the Globe, as they are inhabited by
some or other Animals, so they produce some pro-
per Food or other, affording a comfortable Subsi-
dence to the Creatures living there. I might for
Instances (l) of this, bring the great Variety of
Herbs, Fruits and Grains 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 fore-cited civ th 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 Main-
tenance from thence.

que agris Vestrogenororum, parte objecta Meridionali plaga, Hor-
dem spatio 36 Dierum à fomine proiecto maturum colligi, hoc
est à fine Junii usque medium Augufti, aliando celerius. Fa-
quamque maturitas ex foli natura, aerisque elementis, ac hu-
more lapillorum sovente radices, Soleque torrente, necessario pro-
venit, ut ita nascatur, ac maturetur, talesque spicis sex ordi-
nes in numero arisfe habent. Ol. Mag. Hifl. l. 15. c. 8. Pra-
ta & pascua tantâ luxuriant graminum ubertate ac diversi-
tate, ut necessum fit inde arcre jumounta, ne nimio herbarum
est crepens, &c. Id. ib. l. 19. c. 36.

(l) Among the many noble Contrivances for Food, I can-
not but attribute that universal Aliment, Bread, to the Reve-
lation, or at least the Inspiration of the Creator and Conser-
vator 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. Boyle. " He extracted a Mensurum from Bread alone,:
that would work on Bodies more Compact than many
hard Minerals, nay even on Glass itself, and do many
Things that Aqua-fortis could not do. Yet by no
means was this so corrosive a Liquor as Ag. fort. or as the
other acid Mensurum”. Vid. the ingenious and learned
Dr. Harris’s Lex. Tech. verbo Mensurum, where the way of
preparing it may be met with.

Now
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 faith (m) 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 Gaiety 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 aquatic 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 them, and by that means become a Prey, and plentiful Food to the Inhabitants of the Waters. And besides these, what prodigious Shoals do we find of minute Animals, even sometimes discoloring the Waters (n)! Of these (not only in the Water, but in the Air and on Land) I have always thought there was some more than ordinary

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(m) Psal. civ. 26.
(n) The Insects that for the most part discolor the Waters, are the small Insects of the Shrimp-kind, called by Swammerdam, Pulex aquaticus arboreficans. 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 Schuyt, viz. Se aliquando Studiis intentum, magno quodam & horrisco somnoso suece tur-
nary 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 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 (o).

The Cause of this great Concours, 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, fripling 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? Vid. Book VIII. Chap. 4. Note (f).

These small Insects, as they are very numerous, so are Food to many Water-Animals. I have seen not only Ducks shovell them up as they swim along the Waters, but divers Insects also devour them, particularly some of the middle-sized Squilla aquatic, which are very voracious Insects.

(o) 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 prodigious Numbers of 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 Nympha 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, p. 430.
But now the usual Objection is, that Necessity maketh Use (p). 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, when in greater Plenty, they pick and chuse.

But this Objection hath been already in some measure answered by what hath been said; which plainly

(p) Nil adeò quoniam natum'f in Corpore, ut uti
Possens, sed quod natum'f, id procreat usum.
And afterwards,
Propterea captur 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. 831, &c.

Against this Opinion of the Epicureans, Galen ingeniously argues in his Discourse about the Hand. Non enim Manus ipsa (faith he) hominem artes docuerunt, sed Ratio. Manus autem ipsa sunt arsium organa; sicut Lyra musicæ —— Lyra musicæ non docuit, sed est ipsius artifex per eam, quæ predius est, Rationem : agere autem non potest ex arte absque organis, ita & una quilibet anima facultates quaädam & sua ipsius substantiâ obtinet, — Quod autem corporis particula animam non impellit, — manifeste videre licet, si animalia recens nata consideres, quæ quidem prius agere conantur, quàm perfectas habeant particulars. Ego namque Bonus vitulum cornibus petere conantem &penumero vidi, antequam ei nata essent cornua; Et pulsum Equi calictrantem, &c. Omne enim animal sua ipsius Animalia facultates, ac in quos usus partes sua polleant maximè, nullo doctore, praebent. — Qua igitur ratione dixi potest, animalia partium usus à partibus doceri, cùm & ante quâm illas habeant, hoc cognoscere videantur? Si igitur Ova tria acciperis, unam Aquile, alterum Anatis, reliquam Serpentis, & calore modico fovereis, animaliaque quæcivisse; illa quidem alis volare conantia, antequam volare possint; hoc autem revolvi videbis, & serpere affecliis, quamvis molle adhuc & invalidum fuerit. Et si, dux perfecta erunt, in unâ cædemque domo nutriversis, deinde ad locum subdialam ductâ emisérhis, Aquila quidem ad sublimie; Anas autem in paludem; — Serpens vero sub terrâ irrepit — Animalia quidem mihi videntur Naturâ magis quàm Ratione artem aliquam [artificiose] exercere: Apes fingere alveolos, &c. Galen de usu Part l. c. 3.
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,

V. 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 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 (q), for the Formation of Speech,

and every other such like Use (r). In some Creatures it is wide and large, in some little and narrow: in some with a deep Incisurc up into the Head (/), for the better catching and holding of Prey, and more easy Comminution of hard, large and troublesome Food; in others with a much shorter Incisurc, for the gathering and holding of herbaceous Food.

In Insects it is very notable. In some forcipated; to catch hold and tear their Prey (r). In some acu-

(r) Because it would be tedious to reckon up the Bones, Glands, Muscles, and other Parts belonging to the Mouth, it shall suffice to obserue, 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 the late 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.

(f) 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 Incisurc, with only one canine Tooth on a side, and flat Nails, because, faith he, Hic Natura certò sciebat, se animal manfuetum ac cività effingere, cui robur & vires effent ex sapientia, non ex corporis fortitudine. But for Lions, Wolfs and Dogs, and all such as are called καρχαγόδοτες, (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. Vid. Galen. de Us. Part. l. 11. c. 9.

(r) Among Insects the Squilla aquatica, 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 Pouflage 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
aculeated, to pierce and wound Animals (w), and 
fuck their Blood. And in others strongly rigged 
with Jaws and Teeth, to gnaw and scrape out their 
Food, to carry Burdens (w) to perforate the Earth, 
yea the hardest Wood, yea even Stones themselves,
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.

(a) For an Inflance 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 fanguifuga. Among us in 
Essex, they are called Nidios, by Mouffet Midges. It is a 
about 1 of an Inch, or somewhat more long, with short 
Antenna, plain in the Female, in the Male feather'd, some-
what 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, Vi. Fig. 6. It lies quietly 
on the top of the Water, now and then gently wagging it 
sel this way and that.

These Gnats are greedy Blood-Suckers, and very trouble-
some, where numerous, as they are in some Places near the 
Thames, 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 flung 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 the Gnats, because, although it be common, 
it is no where taken notice of by any Author I know, ex-
cept Mouffet, who, I suppose, means these Gnats, which he 
calls Midges, c. 13. p. 82.

(w) Hornets and Wasps have strong Jaws, toothed, where-
with 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 (c).
Of Animals Mouths. Book IV.

for Houses (x) 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 thro' 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 (y), in catching and holding their Prey, and in the Commination thereof by tearing; to others it is no less serviceable to their Climbing, as well as neat and nice Commination of their Food (z). Its extraordinary Length and Slenderness is very useful to some, to search and grope for their Food in moorish Places (aa); as its Length and Breadth is to others to hunt and

(x) Monsieur de la Voye tells of an ancient Wall of Free-Stone in the Benedictines-Abby 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. Trans. No. 18.


(z) Parrots have their Bills nicely adapted to these Services, being hooked, for climbing and reaching what they have occasion for; and the lower Jaw being compeately fitted to the Hooks of the upper, they can as minutely break their Food, as other Animals do with their Teeth.

(aa) Thus in Woodcocks, Snipes, &c. who hunt for Worms in moorish Ground, and, as Mr. Willughby faith, 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.
search in muddy Places (bb): And the contrary Form, namely, a thick, short, and sharp-edg'd 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 (cc); the Slenderness and Neatness of such as pick up small Insects; the Cross-form of such as break up Fruits (dd); the compressed Form of others (ee), with many other curious and artificial Forms, all suited to the Way of Living, and peculiar Occasions of the several Species of Birds. Thus much for the Mouth.

Let us next take a short View of the Teeth (ff),

(bb) Ducks, Geese, and divers others, have such long broad Bills, to quaffer and hunt in Water 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 (e).

(cc) 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 Woodpecker's Bill, as if an Artist had designed it for Strength and Neatness.

(dd) 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, which are its Food, as if the crossing of the Bill was designed for this Service.

(ee) The Sea-Pie hath a long, sharp, narrow Bill, compressed side-ways, and every way so well adapted to the raising Limpers from the Rocks (which are its chief, if not only Food) that Nature (or rather the Author of Nature) seems to have framed it purely for that Use.

(ff) Those Animals which have Teeth on both Jaws, have but one Stomach; but most of those which have no upper Teeth, or none at all, have three Stomachs; as in Beasts, the Paunch,
In which their peculiar Hardness (gg) is remarkable, their Growth (bb) also, their firm Insertion and Bandage in the Gums and Jaws, and their various Shape and Strength, suited to their various Occasion and Use (ii); the foremost weak and 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

the Read, and the Beck; and in all granivorous Birds, the Crop, the Echinoth and the Gizard. For as chewing is to an eafie Digestion, so is swallowing whole to that which is more laborious. Dr. Grew's Cosmol. Sacr. c. 5. §. 24.

(gg) J. Peyer faith, the Teeth are made of convolved Skins hardened; and if we view the Grinders of Deer, Horses, Sheep, &c. we shall find great Reason to be of his Mind. His Observations are, Mirium autem eos (i. e. Dentes) cum primium & pelliculis imbricatis convolutis & muco vificido confinent, in tantum dirigescere solididatem, quae offa cuncta superet. Idem fit etiam in Officulis Cerasorum, &c. — Separatione facta, per membranas conditur Magma locellis, quo formant lamina tenues, ac duriuscula ad Dentis figuram antea divinitus composita. J. Peyer Merycol. l. 2. c. 8.

(bb) Qui autem (i. e. Dentes) renascuntur, minimè credendi sunt a facultate aliqua plastiæ Brutorum denuò formari, sed latentes tantummodo in conspectum producuntur augmento molis ex effluente succo. Id. ibid.

(ii) From these, and other like Considerations of the Teeth, Galen infers, that they must needs be the Work of some wise, provident Being; not Chance, nor a fortuitous Concours of 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 Iniators, &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 flight Error in their Disposal only? Upon which he argues, As siquis choream hominum 32 (the Number of the Teeth) ordisn dispositis, cum ut hominem indugium laudaremus: cum vero Dentium choream Natura tam belle exornat, 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
Chap. XI. Of Animals Mouths. 195

the Center of Motion and Strength. Likewise their various Form (kk), in various Animals is considerablc, being all curiously adapted to the peculiar Food (ll), and Occasions of the several Species of Animals (mm). And lastly, the temporary Defect of them (nn), is no less observable in Children, and

Tenon into a Mortice, doth as well infer the Art and Act of the wife 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. Galen. de Uf. Part. I. II. c. 8.

(kk) 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. Vaughtion's Compleat Body of Chirurg. Oper. Chap. 53.

(ll) 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 herbaceous to Gathering and Commination of Vegetables: And such as have no Teeth, as Birds, their Bill, Craw and Gizard, are afflicted with Stones, to 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 they have Wings to enable them to fly to it.

(mm) 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 Snails 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 itself; in the bottom of whose Stomachs are three of those Grinders, with peculiar Muscles to move them.

(nn) 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
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 easie 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 Muscles and Tendons (oo), all ministering to this so necessary an Act of Life, as Mastication is; they are such Contrivances, such Works, as plainly set forth the infinite Workman’s Care and Skill.

Next to the Mouth, the Gullet presenteth it self; in every Creature well-siz’d to the Food it hath occasion to swallow; in some but narrow, in o-


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 ’em.

(oo) It would be endless to particularize here, and therefore I shall refer to the Anatomists; among the rest, particularly to Galen, for the sake of his Descant upon this Subject. For having described the great Accuracy of the Contrivance and Make of these Parts, he faith, Haud scio an hominum fit fabrorum ad Fortunam opificem id revocare: aliqui quid tandem erit, quod cum Providentia atque Arte efficitur? Omnino enim hoc ei contrarium esse debet, quod casu ac fortuito fit. Galen. de Uf. Part. I. 11. c. 7. ubi plur.chers
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thers as large and extensive (pp); in all exceeding-

ingly remarkable for the curious Mechanism of its

Muscles, and the artificial Decullation and Position

of their Fibres (qq).

And now we are arriv'd to the grand Recepta-

cle of the Food, the Stomach; for the molt Part

as various as the Food to be convey'd therein.

And here I might describe the admirable Mecha-
nism of its Tunicks, Muscles, Glands, the Nerves,

Arteries and Veins (rr); all manifesting the su-

per-eminent Contrivance and Art of the infinite

(pp) The Bore of the Gullet is not in all Creatures alike an-

swerable to the Body or Stomach. As in the Fox, which both

feeds on Bones, and swallows whole, or with little chewing;

add next in a Dog, and other omnivorous Quadrupeds, 'tis very

large, viz. to prevent a Contusion therein. Next in a Horsel

which though he feeds on Grafs, yet swallows much at once,

and so requires a more open Passage. But in a Sheep, Rabbit,
or Ox, which bite short, and swallow less at once, 'tis smaller.

But in a Squirrel, still lesser, both because he eats fine, and to keep

him from disgorging his Meat upon his descending Leaps. And so

in Rats and Mice, which often run along Walls with their

Heads downwards. Dr. Grew's Comp. Anat. of Stom. and

Guts. Chap. 5.

(qq) Of this see Dr. Willis's Pharm. Rat. Part 1. Sect. 1.
c. 2. Steno also, and Peyer Mery, l. 2.

The Description these give of the muscular Part of the

Gullet, the late ingenious and learned Dr. Drake faith is very

exact in Ruminants, but not in Men. In Men, this Coat

(the second of the Gullet) consists of two sibby Lamellae,
like two distinct Muscles. The outward being composed of straight

longitudinal Fibres. — The inner Order of Fibres is annular,
without any observable Angles. — The Use of this Coat, and

these Orders of Fibres 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. vol. 1. l. 1. c. 9.

(rr) See Willis, ibid. Cowper's Anat. Tab. 35. and many

other Authors.
Of Animals Stomachs.  Book IV.

Workman (//); 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 (tt) all the several Sorts of Food appropriated to their Species; even sometimes Things of that Consistency as seem insoluble (uu); especially by such seemingly simple and weak Menstrua that we find in their Stomachs: But I shall only give these Things a bare mention, and take more peculiar Notice of the special Provision made in the particular Species of Animals, for the Digestion of that special Food appointed them.

(f/) Promptuarium autem hoc, alimentum universum excipiens, cæ Divinum, non Humanum fit opificium. Galen. de Ur. Part. l. 4. c. 1.

(tt) 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 itself, which is also Flesh? Dr. Grew's Cosmol. Sacr. c. 4.


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 itself, with the Concurrence of the Air and Heat of the Body; as in Dr. Papin's Digestor. Vid. Dr. Anat. vol. 1. c. 14.
And in the first Place it is observable, that, in every Species of Animals, the Strength and Size of their Stomach \((ww)\) is conformable 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 answer their Bulk, their Labours, and waste 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 \((xx)\). In such as make a sufficient Commination 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 supply'd by one thin membranaceous Ventricles, to receive and moisten the Food, and another thick, strong, muscular one, to grind and tear \((yy)\) it. But in such Birds, and other Creatures, whole

\((ww)\) All carnivorous Quadrupeds have the smallest 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 Granivorous, 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 free 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.

\((xx)\) The Dromedary hath four Stomachs, one whereof is peculiarly endowed with about twenty Cavities, like Sacks, in all Probability for the holding of Water. Concerning which, see Book VI. Chap 4. Note (a).

\((yy)\) To assist in which Office, they swallow small angular Stones, which are to be met with in the Gizzards of all granivorous
whose Food is not Grain, but Flesh, Fruits, Insects, or partly one, partly the other, there their Stomachs are accordingly conformable to their Food (zz), stronger or weaker, membranaceous or muscular.

But as remarkable a Thing, as any in this Part of Animals, is, the curious Contrivance and Fabric of the several Ventricles of the ruminating Creatures. The very Act itself 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 (aaa).

Having thus far pursu’d 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 Latieals, and so into the Blood (bbb), and afterwards

nivorous Birds; but in the Gizzard of the Lynx, 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.

(zz) In most carnivorous Birds, the third Ventricle is Membranous; where the Meat is concaved, 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 Gizzard; wherein the Meat, as in a Mill, is ground to Pieces. Grew, ubi supra, Chap. 9.

(aaa) It would be much too long a Task to insist upon it here as it deserves, and therefore concerning the whole Business of Rumination, I shall refer to J. Conr. Peyerè Mercuriolog. seu de Ruminantibus & Ruminaintenance Commentari. where he largely treateth of the several Ruminating Animals, of the Parts miniftring to this Act, and the great Use and Benefit thereof unto them.

(bbb) There are too many Particulars to be insisted on, observable in the Passages of the Chyle, from the Guts to the
wards into the very Habit of the Body: I might also take 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 Lymphaducts; and, to name no more, I might further view the exquisite Structure of the Parts mi-

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 Lacleals, by the Peristaltick Motion and Valvute connivences of the Guts. 2. It is an admirable Provision, that the Mouths of the Lacleals, and indeed the Lacleals primi generis themselves are small and fine, not wider than the Capillary Arteries are, left by admitting Particles of the Nourishment groser than the Capillaries, dangerous Obstructions might be thereby produced. 3. After the Reception of the Aliment into the Lacleals primi generis, it is a noble Provision for the Advancement of its Motion, that in the Mesenterick Glands, it meets with some of the Lympha-Ducts, and receives the Impregnations of the Lympha. And passing on from thence, it is no less Advantage. 4. That the Lacleals, and Lympha-Ducts meet in the Receptaculum Chyli, where the Aliment meeting with more of the Lympha, is made of a due Confluence, 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. Coper faith) 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 Vertebrae of the Back, together with the Ducts discharging their refulent 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. Introduc,
nistring 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 (ccc), and perifaltick Motion in all Creatures; and their cochleous Passage (ddd) 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 mention'd. 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 further Conutation from the

VI. 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 inferior Creatures; which answereth all his Occasions relating to this Business: But then even here the Creator hath shewed his Skill, in not

(ccc) 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. No. 125. and Mr. Cowper's elegant Cuts in Anat. Tab. 34, 35. and Appendix, Fig. 39, 40.

(ddd) 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 strait along, but 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. Dewglas, who is labouring in those Matters.
over-doing 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 inferior Creatures, who want Reason, the Power of that natural Instinct, that Sagacity (see) 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 (fff). For among every Species of them, we may find notable Acts of Sagacity, or Instinct, proportional to their Occasions 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 (ggg), doth justly deserve Praise. But for such

(see) Quibus bestiis erat is cibus, ut alius generis bestiis vestimentur, aut vires natura dediit, aut celeritate: data est quibusdam etiam machinatio quaedam, atque solertia, c. Cic. de Nat. Deor. l. 2. c. 48.

(fff) Among Reptiles that have a strange Faculty to shift for Food, cruc. may be reckoned Eels, which, although belonging to the Waters, can creep on the Land from Pond to Pond, cruc. Mr. Mosely 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 Snails in the Grass. Plot's Hist. of Staffordshire, 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. Vide. Hakewill's Apol. l. 2. Chap. 7. S. 2.

(ggg) Enumerare possit, ad pastum capessendum conscientiam, quae sit in figuris animantium et quam soleris. Subilisque descriptio partium, quaeque admirabilis fabriça membroum.
Of Animals Sagacity  Book IV.

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 (bbb), and pursue their Game and Prey! And others watch and way-lay theirs (iii)! With what prodigious Sagacity do others grope for

rum. Omnia enim qua intus inclusa sunt, ita nata, atque ita locata sunt, ut nihil corum supervacuum sit, nihil ad vita re-
tinendam non necessarium. Dedit autem eadem Natura bel-
lius & sensum, & appetitum, ut altero conatus haberent ad
naturales passus capellendoris; altero secernerent periferia a fa-
lutaribus. Cic. de Nat. Deor. 1. 2. c. 37. See Book IV. Chap. 4.

(bbb) It would be endless to give Instances of my own and
others Observations of the prodigious Sagacity of divers Ani-
imals in Hunting, particularly Hounds, Setting-Dogs, &c. one
therefore shall suffice of Mr. Boyl’s, viz. A Person of Qua-
lity—— to make a Trial, 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 abovementioned 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 be sought refed himself, and found him in an upper
Room, to the wonder of those that followed him. Boyl. de-

(iii) 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 Houles;
feigning himself dead, to catch such Animals as come to
feed upon him; laying his Tail on a Wasp-Neft, and then
rubbing it hard against a Tree, and then eating the Wasps
so killed: Ridding himself of Fleas, by gradually going in-
to Water, with a Lock of Wool in his Mouth, and so driv-
ing the Fleas up into it, and then leaving it in the Water:
By catching Crab-Fish with his Tail, which he faith he him-
sel was an Eye-Witness of; Vidi & ego in Scopulis Norve-
giae Vulpem, inter rupes immissa caudâ in aquas, plures educere
for it under Ground, out of Sight, in moorish Places, in Mud and Dirt (kkk); and others dig and delve for it, both above (ill), and under the Surface of the drier Lands (mmm)! And how curious and well designed a Provision is it of particular 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 (mmm); and some by their sharp and piercing Sight, aloft in


(kkk) 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 (e).

(lll) *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, tough 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.

(mmm) 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 (kkk). Which Pair of Nerves I observed to be much larger in this Animal than any other Nerves proceeding out of its Brain.

(mmm) Predacious Creatures, as *Wolves*, *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.
the Air, or at other great Distances (ooo)! An Insta-

nce of the latter of which GOD himself giveth, 

(Job xxxix. 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 (ppp). From thence she seeketh her Prey, and 

her Eyes behold afar off. What a commodious Pro-

vision hath the Contriver of Nature made for Ani-

mals, 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 (qqq); but also in 

the peculiar Structure of the principal Parts, act-

ing in the Acquest of their Food (rrr)! What a Provi-

(ooo) Thus Hawks 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. 

(ppp) Mr. Ray gives a good Account of the Nidification of 

the Chrysaetos caudat annulo albo cinet. Hujus Nidus Ann. 

1668. in sylvatis prope Derwentiam, &c. inventus est e baculis 

seu virgis ligneis grandioribus compositus, quorum altera extre-

mitas repetitam eminentia, altera duabus Betulis innite-

batur, — Erat Nidus quadratus, duas ulnas latus. — In eo pullus 

unicus, adjacentibus cadaveribus unius agni, unius leporis, et 


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, Quae Infantulum unius annis pan-

nis involutum arripuit (quem Mater tessellas usitiles pro igne 

allatura momento temporis deposevit in loco Houton-Hed dieo) 

eumque deportaspe per 4 milliarium passuum ad Hoiam; quâ re 

matri ejus libatibus cognita, quatuor illuc in naviculâ pro-

fecti sunt, & scientes ubi Nidus esset, infantulum illatum & in-


(qqq) See in Book VII. Chap. x. Note (l), the Characteri-

flicks of the Wood-Pecker-kind. 

(rrr) The Contrivance of the Legs, Feet and Nails [of the 

Opossum] seems very advantageous to this Animal in climbing
Provision also is that in nocturnal Birds and Beasts, in the peculiar Structure of their Eye (fff), (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 great Creator's Care. Of which I shall give two Instances.

1. The Provision made for young Creatures. That Στοργῇ, that natural Affection, so connatural to all, or most Creatures towards their Young (ttt), what an admirable noble Principle is it, implanted

Tres (which is 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 Vertebrae of the Tail; are a wonderful Piece of Nature's Mechanism. The first three Vertebrae had none of these Spines, but in all the rest they were to be observed. — They were placed just at the Articulation of each Joint, 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 swirled or wound about a Stick, this Hook of the Spinae 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 Opos. in Phil. Trans. No. 239.

(fff) See before Chap. 2. Note (z), (aa), (bb).

(cvi) Quid dicas quantus amor bestiarum sit in educandis et soidiendiisque suis, qua procreaverint, usque ad eum finem, dum possint seipso defendere? And having instanced in some Animals, where this Care is not necessary, and accordingly is not employed, he goes on, Jam Gallina, avesque reliquae, et quiesum requirunt ad partium locum, et cubilia sibi, nondum construunt, cosque quam possunt mollissime subterrunt, ut quam facilliimè ovum serventur. Ex quibus pullos cum excluserint, intra tuentur, ut & peninis siccant, ne frigore ladamur, et si os calor, à sole se oppannent. Cic. de Nat. Deor. l. 2. C. 51, 52.
ed 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 taken for them, no Dangers (uuu) 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 (www)? How will they cares

To this natural Care of Parent-Animals to their young, we may add the Returns made by the young of some towards the old ones. *Pliny* faith of *Rats*, *Genitores suos fessos senecta, alunt insigni pietate*. Nat. Hist. I. 8. c. 57. So *Cranes*, he faith, *Genitricum feneclam invicem educant*. L. 10. c. 23.


Hereto may be added also the conjugal *Στοργή* of the little green *Æthiopian Parrot*, which Mr. Ray describes from *Clufius*. *Fæmelæa feneclentes (quod valde notabile) vix edere volebant, nisi cibum jams mare caputum, & aliquandiu in prolobo reteniment, & quafi coelum rostro suo exciperent, ut Columbarum pulli a matre ali solent*. Synopf. Meth. Av. p. 32.

(uuu) The most timid Animals, that at other Times abscend, 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.

(www) 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 Skeleton) and four Pair of Muscles; and some say the Teats lie therein also. Dr. *Tyson*, *Anat. of the Opos* in *Phil. Tran*.
Chap. XI. of their Young.

... ress 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 so many Nurses, 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 immediately to their 'Himia, 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 the old ones do not wildly drop their Eggs and Sperm any where, at all Adventures, but so cautiously repose it in such commodious Places (some in the Waters, some on Flesh, some on Plants proper and agreeable to their Species (xxx); and some shut up agreeable Food in their Nefts, partly for Incubation, partly for Food (yyy), 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.

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Trans. No. 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 Glanclus, the same Author faith, have the same Care for their young, but receive them into different Receptacles.

(yyy) See Book VIII. Chap. 6.

(yyyy) See Chap. 13. Note (c).
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 cloath 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 (zzz), and take in their proper Food?

But for the young of Man, their Parents Reason, joined with natural Affection, being sufficient to help, to nurse, to feed, and to cloath them; therefore they are born helpless, and are more absolutely than other Creatures, cast upon their Parents Care (aaaaa). 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 Infected, and many other Animals. When the

(zzz) 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 little 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 (a).

(aaaa) Qui [Infantes] de ope nostrá ac de diviná misericordia plus merentur, qui in primo statim nativitatis sue ortu plorantes ac fertes, nil aliud faciunt quàm deprecantur. Cypr. Ep. ad Fid.
flowry Fields are divested of their Gaiety; when the fertile Trees and Plants are stripp'd 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 Hearts, and Circulation of their Blood (bbbb), as during that Season, not to suffer any waste of their Body, and consequently not to need any Recruits; but that they should be able to live in a kind of sleepy, middle State, in their Places of safe Retreat, until the warm Sun revives both them and their Food together.

The next Provision is for such as can bear the Cold, but would want Food then; and that is in some by a long Patience of Hunger (cccc), in others by

(bb) I might name here some of the Species of Birds, the whole Tribe almost of Insects, and some among other Tribes, that are able to subsist for many Months without Food, and some without Respiration too, or very little: But it may suffice to instance only in the Land-Tortoise, of the Structure of whose Heart and Lungs: See Book VI. Chap. 5.

Note (b).


To the long Abstinence mentioned of Brute-Animals, I hope the Reader will excuse me if I add one or two Instances of extraordinary Abstinence among Men. One Martha Taylor, born in Derbyshire, by a Blow on the Back fell into such a Prostration of Appetite, that she took little Sustenance,
by their notable Instinct in laying up Food beforehand against the approaching Winter (dddd). Of this many entertaining Examples may be given; particularly we may, at the proper Season, observe not only the little Treasures and Holes well-stocked with timely Provisions, but large Fields (eeee) here and there throughout bespread with considerable

but some Drops with a Feather, from Christmas 1667. for thirteen Months, and slept but little too all the Time. See Dr. Sampson’s Account thereof in Ephem. Germ. T. 3. Obs. 173.

To this we may add the Case of S. Chilton, of Tintbury, near Bath, who in the Years 1693, 1696, and 97, slept divers Weeks together. And although he would sometimes, in a very odd manner, take Sustenance, yet would lie a long Time without any, or with very little, and all without any considerable Decay. See Phil. Trans. No. 304.

(dddd) They are admirable Instincts which the Sieur de Beauplau relates of his own Knowledge, of the little Animals called Bohagues in Ukraine. They make Burroughs like Rabbits, and in October shut themselves up, and do not come out again till April. — They spend all the Winter under Ground, eating what they laid up in Summer. — Those that are lazy among them, they lay on their Backs, then lay a great handful of dry Herbage upon their Bodies, &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 practice 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 inferior 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 seeding. 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 Instinct of the Northern Galli Sylvestres, see in Chap. 13. Note (g).

As for the Scriptural Instinct of the Ant, see hereafter Book VIII. Chap. 5. Note (d).

(eeee) 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 beforehand.
Chap. XI. The Conclusion.

rable 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 pillaging the Treasures of those little provident Creatures.

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 such 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 Superintendency and Management, equal to, at least, that of the most prudent Steward and Householder? 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 studiously we survey them, the more accurately we view them beforehand 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.
Of Animals Cloathing. Book IV.

(of even the meanest of them with our blest Glasses) the least Fault we find in them, and the more we admire them: Whereas the best polished, and most exquisite Works, made by human 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 itself? 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 Methods and 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 more hereafter.

C H A P. XII.

Of the Cloathing 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 Cloathing (a); ano-

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(a) Concerning the Cloathing 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. I. 3. c. 10.
Chap. XII. Of Animals Cloathing.

other necessary Appendage of Life, and in which we have plain Tokens of the Creator's Art, manifested in these two Particulars; the Suitableness of Animals Cloathing to their Place and Occasions; and the Garniture and Beauty thereof.

1. The Cloathing 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 accoutred any other Way, than by God that made them, it must needs have come to pass, that their Cloathing would have been at all Adventures, or all made 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 Cloathing 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. vi. 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 Cloathing of Man, and of the irrational Animals. This Pliny (b) pathetically laments,

(b) Cujus [Hominis] causâ videtur cum ulla alia genuisse Na-
tura, magna & sua mercede contra tantâ sua munera: ut

P 4
ments, and says, *It is hard to judge, whether Nature hath been a kinder Parent, or more cruel Step-Mother to Man.* For, says he, *Of all Creatures, he alone is covered with other’s Riches, whereas Nature hath given various Cloathing 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, says he, *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 beginning 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 Cloathing; but for Man, he being endowed with the transcending Faculty of Reason, and thereby made able to help himself, by having


Let Seneca answer this Complaint of Pliny, although perhaps what he saith might be more properly noted in another Place: *Quisquis es iniquus alismator fortis humana, cogita quanta nobis tribuerit Parens nosfer, quanto valentiora animalia sub jugum miserimus, quanto velociora assequamur, quàm nihil sit mortale non sub istâ nostro poßitum. Tot virtutes atque artes, animam denique cui nihil non eodem quo intendit momento pervium est, Sideribus velociorem, &c.* Senec. de Benef. 1. 2. c. 29.
Thoughts to contrive, and withal Hands to effect, and sufficient Materials (c) afforded him from the Skins and Fleeces of Animals, and from various Trees and Plants: Man, I say, having all this Provision made for him, therefore the Creator hath

(c) Mirantur plurimi quomodo tute, & sunt vivant homines in horrendis frigorisibus plaga Septentrionalis; hancque levem questionem ultra 30 annos audieram in Italiâ, praerim ab Æthiopibus, & Indis, quibus onerosas videtur veslius sub Zonâ terrâ. — Quibus respondetur, — Gaudet indus multiplices plurârum genere, magis forsâm pro tegumento, quam necessitate: rursus Scythâ villoso vestitu — iâ sub pêlo Ærético adversus asperrimas hyenes — opportuna remedia facilitar administrâ [Natura], Ligna videlicet in maxima copia, & levissimo pretio, & demum Pelles diversorum animalium, tam sylvicium quam domesticorum. Then he gives a Catalogue of them, and laith, Quarum omnium experti pellisâces ita ingenioso nosterum mixturas componere, ut pulcherrimum decorum offendidat varietas, & calidissimum fomentum adjuneta mollities. Ol. Mag. Hift. l. 6. c. 20.  

To this Guard against the Cold, namely, of Fire and Cloathing; 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 faith, 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 prodigious Quantities of Minerals, and Metals, also afford Heat, and warm Vapours, Minera septentrionalium regionum satis multa, magna, diversa, & opulenta sunt, faith the same curious, and (for his Time,) learned Archbishop, l. 6. c. 1. and in other Places. And for the Warmth they afford, the Volcano's of those Parts are an Evidence; as are also their terrible Thunder and Lightning, which are observ'd to be the most severe and mischievous in their metal- line Mountains, in which large Herds of Cattle are sometimes destroy'd; the Rocks so rent and shatter'd, that new Veins of Silver are thereby discover'd; and a troublesome Kind of Quinie is produc'd in their Throats, by the stench, and poisonous Nature of the fulphureous Vapours, which they dissolve, by drinking warm Beer and Butter together, as Olens 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
hath wisely made him naked, and left him to shift for himself, being so well able to help himself.

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 helples irrationals Animals, and in his not over-doing his Work; but also as it is most agreeable to the Nature and State of Man (d), both on natural and political Accounts. That Man should cloath himself is most agreeable to his Nature, particularly

giously large, of 130 Italian Miles in Length, and not much less in Breadth;) also of their Rivers, especially the Vapours which arise 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 suffer'd 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 Phil. Trans. No. 324. I shall thither refer 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 flave off the Cold above? Consult Book II. Chap. 5. Note (c).

(d) Sicut enim fì innata fìbi [i. e. Hominì] aliqua haberet arma, illa ei sola semper adefserit, ita & fì artem aliquam Naturam forteitus effet, relicquas fane non haberet. Quia vero ei melius erat omnibus armis, omnibusque artibus uti, neutrum eorum à natura ipsi propter earum datum cèst. Galen. de Uf. Part. i. 1. c. 4.
Chap. XII. Of Animals Cloathing.

( among other Things,) as being most salutary, and most suitable to his Affairs. For by this Means, Man can adapt his Cloathing 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 grand Means of Health, namely, insensible Perpiration (e) is perform’d, at least greatly promoted, without which an human Body would be soon over-run with Disease.

In the next Place, there are good political Reasons for Man’s cloathing himself, inasmuch as his Industry is hereby employ’d 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 render’d visible to others, in the several Nations of the Earth.

Thus it is manifestly best for Man that he should cloath himself.

(e) Concerning insensible Perpiration. Sanctorius observes, That it much exceeds all the Sensible put together. De Stot. Med. Aph. 4. That as much is evacuated by insensible Perpiration 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 Perpiration, A;hor. 59. 60. That if a Man eats and drinks 8 l. in a Day, 5 l. of it is spent in insensible Perpiration, §. 1. Aph. 6. And as to the Times, he faith, Ab assumpto cibo 5 horis et circiter perspiratur — exhalare soleat, à 5 h. ad 12am 3 l. circiter; à 12a ad 16am vix felibrarum, Aph. 59.

And as to the wonderful Benefits of insensible Perpiration, they are abundantly demonstrated by the same learned Person, ubi supra; as also by Borelli in his second Part, De Mot. Animal. Prop. 168. who faith, Necessaria est insensibilis Transpiration, ut vita Animalis conservetur.
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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 Cloathing, as is proper to their Place and Business (f). Some covered with Hair (g), some with Feathers.

(f) Animantium verò quanta varietas est? Quanta ad eam sem vis, ut in suo quaque genere permaneant? Quorum alia coria testē sunt, alie villis vestīta, alie spinis hirsūta: plūmā alias, alies squamā vidēmus obductās, alies esse cornibus arma-tas, alias habere effugia pennarum. Cic. de Nat. Deor. l. 2. c. 47.

(g) 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] demonstrant lusratio pilorum a caudā & collo Equorum, &c.—præcipue setarum Aprī, que patenti-arem ex fistulis compositionem exhibent. Est autem ditius Aprī pilus Cylindricum corpus quasi diaphanum—fistularum aggre conflatum, & speciem columnae striate præ se fort. Componentes fistulae in gyrum situate in apice pateniiores redduntur; nam hi-ans pilus in germinas dividitur partes, & componentes minima fi-stula—liberiores reddite manifestantur, ita ut enumerati possint; has autem 20, & ultra numeravi.—Exposita fistulae—tubulosae sunt, & frequentius tunicis transversali-ter situatī, veluti valvulis pollent. Et quoniam Spina, in Erina-icis præcipui, &c. nil alīud sunt, quam duri & rigidi plī, ideae, &c. And then he describes the Hedgehog’s Spines, in which those Tubes manifestly appear; together, with medullary Valves and Cells; not inegual, which he hath figur’d in Tab. 16. at the End of his Works.

That which this fagacious, 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 observ’d in some Measure to be true, in the Hair of Cats, Rats, Mice, and divers other Animals; which look very prettily when view’d with a good Microscope. The Hair of a Mouſe, (the most transparent of any I have view’d,) seems to be one single transparent Tube, with a Pith made up of a fibrous Substance, running in dark Lines; in some Hairs tranversely, in others spirally, as in Fig. 14, 15, 16, 17. These darker medullary Parts, or Lines, I have observ’d, are no other than small Fibres convolved round, and lying closer together than in other Parts of the Hair. They run from the Bottom, to the Top.
Chap. XII. Of Animals Cloathing.

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 larger 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.

(b) See Book VII. Chap. 1. Note (d) (e).
(i) See Chap. XIV. Note (e).
(k) It is a Sign some wise Artist was a Contriver of the Cloathing of Animals; not only as their Cloathing varies, as their Way of Living doth; but also because every Part of their Bodies is furnished with proper suitable Cloathing. Thus divers Animals, that have their Bodies cov'rd 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 Nails; to guard off, or give warning of Annoyances.
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ing 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 easie Passage through the Air (l), and to assist in the wafting their Body through that thin Medium. For which Service, 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 buoyant, 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 (m), 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 (n). Thus curious, thus artifi-

(l) The Feathers being placed from the Head towards the Tail, in close and neat Order, and withal preened and dress’d by the Contents of the Oil-Bag, afford as easie a Passage through the Air, as a Boat new cleaned and dress’d 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 (b).

(m) In Book VII. Chap. 1. Note (e): 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.

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cial, thus commodious is the Cloathing of Beasts and Birds: Concerning which, more in proper Place.

And no less might I shew that of Reptiles and Fishes (o) to be, if it was convenient to enlarge upon this Branch of the Creator's Works. How 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 (p), and in a word, to perform all the Offices of their Reptile State, much better than any other Tegment 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 confident enough with their flower Motion; and the Scales and Skins of others, affording them an easy and swift Passage through the Waters. But

(o) See Book IX.

(p) For a Sample of this Branch of my Survey, let us chuse the Tegment 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, fluff, 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 Juice, that they emit, as Occasion is, at certain Pertorations between the Annuli, to lubricate the Body, and facilitate their 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 Cloathing of the other Creatures. See more concerning this Animal, Book IX. Chap. i. Note (a).
it may be sufficient to give only a Hint of these Things, which more properly belong to another Place.

Thus hath the indulgent Creator furnish'd the whole animal World with convenient, suitable Cloathing.

II. Let us in the next Place take a short View of the Garniture (q), 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 Cloathing of the most fordid Animals, those that are the leaft beautified with Colours, or rather whose Cloathing may regrate the Eye (r); 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, Eccl. iii. 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 pleas'd, as it were on Purpose, to give surprising Beauties to divers Kinds of Animals. What radiant Colours are many of them, particularly some Birds and Insects (f), bedeck'd with! What a prodi-

(q) Aristotle, in his Hist. Anim. l 3. c. 12. names several Rivers, that by being drank of, change the Colour of the Hair.

(r) For an Example; Let us take the Cloathing 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 tack'd together, as to exceed any human Composures: Of the Latter see more in Book IX. Chap. 1. Note (c).

(f) 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
a prodigious Combination is there often of these, yea, how nice an Air frequently of meaner Colours (t), 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, cloathed 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 accouter'd and provided for; when such incomparable Strokes of Art and Workmanship appear in all, and such inimitable Glories and Beauties in the Cloathing 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 Cloathing 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!

which are observed as much to exceed our Birds in their Colours, as ours do theirs in their Singing.

(t) The Wryneck, at a Distance, is a Bird of mean Colour; neither are indeed its Colours radiant, or beautiful, singly considered: But when it is in the Hand we see its light and darker Colours so curiously mixed together, as to give the Bird a surprising Beauty. The same is also observable in many Insects, particularly of the Phalena kind.
CHAP. XIII.

Of the Houses and Habitation of Animals.

Having in the last Chapter, as briefly as well I could, surveyed the Cloathing of Animals, I shall in this take a View of their Houses, Nestes, 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 architectonic 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, ennoble 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
great Varieties of Trees (a), 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 Help to enable him to do so, if he would but make use of them, and the Sense and Reason which God hath 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 (b). If some Creatures make their Neifs in Houses, some in Trees,

(a) — Dant utile lignum
Navigis Pinos, domibus Cedrosque, Cupressosque:
Hinc radios trivere Rotis, hinc tympana plaustris
Agricole, & pandas ratibus posueri carinas.
Viminibus Salices secunda, frondibus Ulmi:
At Myrtus validis haftilibus, & bona bello
Cornus; Ityreos Taxi sequegentur in arcis,
Nec Tilia leves, ant torno rafile Buxum,
Non formam accipiunt, ferroque cavantur acuto:
Necon & torrentium undam levii innatas Alnus
Missa Pado: necon & apes examina condunt
Coricibusque cavis, vitiosaque ilicis alveo.

(b) See Chap. 15. and Book VIII. Chap. 6.
some in Shrubs, some in the Earth (c), 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 Creatures Use and Occasions. They can there sufficiently and well repose, and secure themselves, lay, and breed up their Young. We are so far from discovering 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

(c) Many of the Vespa-Ichneumones are remarkable enough for their Nidification and Provision for their Young. Those that build in Earth (who commonly have golden and black Rings round their Alvi) having lined the little Cells, they have perforated, lay therein their Eggs, and then carry into them Maggors 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 Cell was coated about with an odoriferous, resiny 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 Maggors, 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, (but I believe he was scarce aware of the Eggs sealed up with the Spiders). Ὄτι ἦν τῇ ἑμοῖς ἑκάστῳ ἐκ τοῦ καλύβρου, &c. As to the Vespa, 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. Anim. 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 placed for gnawing and scraping those compleat little Holes they perforate in Earth, Wood, yea in Stone it self. 
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 Habitation, 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 (d), or in no Danger, as other Creatures, from Abroad. If others repose their Young in Holes (e) 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 (f). 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 (g), some on Rocks and Crags on high (of which God himself hath given

(d) Tully having spoken of the Care of some Animals towards their Young, by which they are nourished and brought up, faith, Accedit etiam ad nonnullorum animantium, & cum rerum quas terra gignit, conservationem, & salutem, hominem etiam solertia & diligentia. Nam multis & peculis, & frivolis sunt, quae non procreationem hominum salve esse non possunt. Cie. de Nat. Deor. l. 2. c. 52.
(e) Prov. xxx. 26. The Conies are but a feeble Folk, yet make they their Houses in the Rocks.
(f) See Note (f).
(g) It is a notable Instinct which Ol. Magnus tells of the Galli Sylvae in his Northern Country, to secure themselves against the Cold and Storms of the Winter. Cinni in terras superficiem ubique cooperiunt, vanosque arborum distis deprimunt & condenjant, certos frexus bene le arboris —— in formâ longi Piparis vorant, & glutiam indigetis; idque tantâ aviditate, ut quantitate, ut replesum guttor toti corpore majus appareat. Deinde partitam agminibus sejâ inter medios vivium colles immergent, preservâm in Ian. Fabr. Martio, quando nives vs turbines, typhones, vel tempes- dates gravissime & nubibus descendunt. Gammob cooperita sunt.
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given an Instance in the Eagle, Job xxxix. 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 Water 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 its Fecundity, and the Continuance and Increase of its Species; to which every Species of Animals is naturally prompt and inclined.

Thus admirable is the natural Sagacity and In-

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(itinet (b) of the irrational Animals in the Convenience and Method of their Habitations. And no less is it in the Fabrick of them. Their architectonic 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 imitable Art (i) 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 they many of them thatch over, 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 (k)? With what prodigious Subtily do


(b) 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 sive dignus narravit mihi, quod cium semel, animi gratiâ, nidum avicula ligno obturátæst, sequace occultásser, cupidus videndi, quid in tali occasione præstaret; ita cium frustra sepies tentásser, rostro illud anserre, casus adminum impatientes, abiiit, et post aliquod temporis spatium reversa est, rostro gereus plantulam, qui obturamento applicata, paulo post, illud veluti tulum eripuit tantà vi, ut dispersa impetus hercula, ac occasionem ipsi, ab aviculâ ejus virtutem discessit, præcipuerit. Colmop. divina, Sect. 5. C. i. Had he told us what the Plant was, we might have given better Credit to this Story.

(i) Of the Subtityl of Birds in Nidification, see Plin. Nat. Hist. l. 10. c. 33.

(k) Among many Instances that might be given of this Subtityl 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, call
some foreign Birds (l). not only plat and weave the fibrous Parts of Vegetables together, and curiously tunnel them, and commodiously form them into Nefts, 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 Artists are they in this Business of Nidification! With what great Diligence doth the little Bee gather its Combs from various Trees (m) and Flowers, the Wasp

out from them when they take their Flight see Book VIII. Chap. 4. Note (o). 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 arbores 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 handsomely 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 faith (Synops. Method. Avium, p. 74.) Ova inter omnes aviculas numerosissima ponit. See more of the Nest of this Bird, from Aldrovand. in Willughby. Ornith. p. 243.

(l) The Nest of the Guira tangeima, the Iliterus 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. Sect. 12, 13. Also Dr. Grew's Museum Reg. Soc. Part 1. Sect. 4. Chap. 4. These Nefts I have divers Times seen, particularly in great Perfection in our R. S. Repository, and in the noble and well-furnished Museum of my often-commended Friend Sir Hans 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.

(m) 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, performed with great Art and Dexterity.
from solid (n) 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 (o)! With what Accuracy do other Insects perforate the Earth (p), Wood, yea, Stone it self (q)! For which Service, the compleat Apparatus of their Mouths (r), and Feet (s), deserves particular Observation, as hath been

(n) Wasp's, at their first Coming, may be observ'd to frequent Potts, 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.

(o) 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 figure sunt, qua per seipfas locum circa idem punctum consistenter replere possint, Triangulum feu. Quadratum & Hexagonum, Apes illam qua ex pluribus angulis conflatur sapienter delgerunt, uspore suspicantes eam plus mellis capore quam utramvis reliquarum. At Apes quidem illud tantum quod ipsis usile est cognoscunt, viz. Hexagonum Quadrato & Triangulo esse majus & plus Mellis capere possit, minusum equali materiâ in constructionem unius ejusque consumpsit. Nos vero qui plus sapiant quam Apes habere profitemur, aliquid tiam magis insigne investigabimus, Collect. Math. I. 5.

(p) See before Note (c).

(q) See Chap. II. Note (x).

(r) See Chap. II. Note (y).

(s) 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 joyned 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,
been, and will be hereafter observ'd. And further yet; With what Care and Neatness do most of those little fagacious Animals line those their Houses within, and seal them up, and fence them without (t)! How artificially will others fold up the Leaves of Trees and Plants (w); others house themselves in Sticks and Straws; others glue light and floating Bodies together (w), and by that Artifice make themselves floating Houses in the Waters,

as well as downward, after 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 Ephemeran. To this Purpose, [to dig their Cells,] the wise Creator hath furnish'd them, (faith 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 furnish'd them with two toothy Cheeks, somewhat like the Sheers of Lobsters, which serve them more readily to bore the Clay. Swammerdam's Ephem. Vit. Publifh'd by Dr. Tyfon, Chap. 3.

(t) See the before-cited Note (c).

(w) They are for the most Part, some of the Phalana-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-hatch'd Maggots, (for doubtles it is they, not the Parent-Animal, because she emits no Web, nor hath any teetrine 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 flops up the two Ends, to prevent its own falling out; and Earwigs, and other noxious Animals getting in.

(w) The several Sorts of Phryganea, or Cadews, in their Nympha, or Maggot-state, thus house themselves; one Sort in Straws, call'd 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. glu'd together, where-with they float on the Top, and can row themselves therein about the Waters, with the Help of their Feet: Both these are call'd Cob-bait. Divers other Sorts there are, which the Reader may see a Summary of, from Mr. Willughby, in Rari Method.
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sters, to transport 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. xxx. 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 (x). I will not dispute the Truth of our English Translation of this Text, but supposing the Animal mention'd 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

Insect. p. 12. together with a good, though very brief Description of the Papilionaceos Fly, that comes from the Cod-bait Cadeu. It is a notable architectonick Faculty, which all the Variety of these Animals have, to gather such Bodies as are fittest for their Purpose, 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, together with 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 hinder Part of the Maggot is so fix'd, 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 wants; or withdraw it into its Cell, to guard it against Harms.

(x) Having mention'd the Spider, I shall take this Occasion, (although it be out of the Way,) to give an Infurance of the Poison of some of them. Scaliger Exerc. 186. relates, That in Gascony, his Country, there are Spiders of that Agility, that if a Man treads upon them, to crush them, their Poison will pass through the very Soles of his Shoe. Boyle. Subt. of Effluv. c. 4.

Mr. Leeuwenbock put a Frog and a Spider together into a Glass, and having made the Spider fling the Frog divers Times, the Frog dy'd in about an Hour's Time. Phil. Trans. No. 27.

In the same Transaction, is a curious Account of the Manner how Spiders lay, and guard their Eggs, viz. they cover them
And now from this short and transient View of the architectonic Faculty of Animals, especially the Irrationals; we may easily perceive some superior and wise Being was certainly concern'd 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 of a rational Creature? How could the Bodies of many of them, (particularly the last mention'd,) be furnish'd with architectural Materials?

them not out of the hindermost 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 Phil. Trans. No. 22. Dr. Nath. Fairfax, from S. Redi, and his own Observations, thinks Spiders not venomous; several Persons, as well as Birds, swallowing them without Hurt: Which I myself have known in a Person of Learning, who was advis'd 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, cur'd of a desperate Tympany, by a certain Debouchet, 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 would cure her; which the 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 that he had poison'd her, and fearing he might be call'd to account for it,) he gets out of Town as fast as he could. But instead of being poison'd, she soon recover'd. After some Months, the Quack gets privately to Town, when he thought the Bittie might be over; and enquiring how his Patient did, was inform'd of her Cure; and thereupon visiting her, and making an Excuse for his Absence, he receiv'd his Pay with great Applause and Thanks. Mouffe. Infett. 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 (e).
Chap. XIII. Of Animals Habitations.

How could they ever discover them to be 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 superior Acts, as Wisdom and Foresight, Discretion, Art and Care; or else, that they are only passive in the Cæf, and act by Instinct, or by the Reason of some superior Being imprinted in their Nature, or some Way or other, (be it how it will,) congenial with them. That they are Rational, or excel 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. ii. 6. The Lord giveth Wisdom; out of his Mouth cometh Knowledge and Understanding.
Having thus consider'd the Food, Cloathing, 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 endow'd 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 stay off the Harms of noxious Creatures.

But for others, who are destitute of this super-eminent Faculty; they are some Way or other provided with sufficient Guard (a), proportionate to their Place of Abode, the Dangers they are like to incur there (b); and in a Word, to their greatest Occa-


(b) Omnibus aptum est Corpus Anima moribus & facultatibus: Equo fortibus ungulis & jubâ est ornatum (etenim velox & superbum & generosum est animal.) Leoni autem, utpote animofo & feroci, dentibus & unguibus validum. Ita autem & Tauro & Apro; illi enim Cornua, huic exercit Dentes. Cervo autem & Lepori (timida enim sunt animalia) velox corpus,
Occasions, and Need of Security. Accordingly, some are sufficiently guarded against all common Dangers, by their natural Closething, by their Armature of Shells, or such like hard, and impregnable Covering of their Body (c). Others destitute of this Guard, are armed, some with Horns (d), some with sharp Quills and Prickles (e), some with Claws, 

pus, sed inerme. Timidis enim velocitas, arma audaeibus convenientiam —— Hominis autem (sapiens enim est ———) manus dedit, instrumentum ad omnes aures necessarium, paci non minus quam bello idoneum. Non igitur indigni Cornu sibi in nato cern meliora Cornibus arma manibus, quandocunque vol er, possit accipere: Etenim Ensis & Hasla majora sunt Arma, & ad incidendum præviona —— Neque Cornu, neque Ungula quicquam nisi cominus agere possint; Huminum vero arma e minus juxta ac cominus accuti: telum quidem & sagitta magis, quàm cornua. —— Non igitur est nudus, neque inermis. sed ipsi est Thorax ferreus, quandocunque libet, omnibus Corvis difficilibus sacriam organum. —— Nec Thorax solum sed & Domus, & Murus, & Turris, &c. Galen. de Uf. Part. I. c. 2.

(c) 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 Osnments 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 suppicth the Place of all the Bones in the Body, except thofe 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.

(d) Dente timentur Apri: defendeunt cornua Taurus: Imbelles Dana quid nisi prada sumus?


(e) The Hedgehog being an helpless, slow, and patient Animal, is accordingly guarded with Prickles, and a Power of rolling it self up in them. Clavis terebrati sibi pedes, & dis cindi
Claws, some with Stings (f) ; some can shift and change their Colours (g) ; some can make their Escape by the Help of their Wings, and others by the

fome others By counted and in have to thefe a fliparp, ed the vey er which a Side Flesh treating not arbitrium de Efcape change Claws, Sting below the Body Flefli; Better, the deep Body Flcfli; then being ready, being bearded Spears, found Sting, and of that Sting, and that Sting, pretty Stings out 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 the two Spears as they lie in the Sting. In Fig. 22. the two Spears are represented when squeež'd out of the Sting, or the Scabbard ; in which Latter, Fig. A c b, is the Sting, c d, and b e, the two bearded Spears thrust out.

(f) 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 observ'd the Sting to be an hollow Tube, with a Bag of sharp penetrating Juices, (its Poison,) joined to the End of it, within the Body of the Wasp, which is, in Stinging, injected into the Fleth 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 Fih-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 Fleth; which being once fix'd, 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 Fleth; after which the Sheath or Sting follows, to convey the Poison 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 Fleth, 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 the two Spears as they lie in the Sting. In Fig. 22. the two Spears are represented when squeež'd out of the Sting, or the Scabbard ; in which Latter, Fig. A c b, is the Sting, c d, and b e, the two bearded Spears thrust out.

(g) The Camelion is sufficiently fam'd on this Account. Besides which, Pliny tells us of a Beast as big as an Ox, called the Tarandus, that when he pleafeth, assumes the Colour of
the Swiftness of their Feet; some can screen themselves by diving in the Waters, others by tingling and disordering the Waters \((b)\), can make their Escape; and some can guard their Bodies, even in the very Flames, by the Ejection of the Juice of their Bodies \((i)\); and some by their accurate Smell, Sight or Hearing, can foresee Dangers \((k)\); others

of an \(\text{Asf}\), and Colorem omnium fruticum, arborum, florum, locorumque reddit, in quibus latet metuens, ideoque rarò 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 Animal’s choosing 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 observ’d, do fix themselves to such Things as are 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 the Kermes I ever saw was;) how artificially they not only inclose 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.

\((b)\) Contra metum & vim, suis se armis quaque defendit. Cornibus Tauri, Apri dentibus, morse Leones, alie fugae se, alia occultatione tuncantur: atramenti effusione Sepia, sorpore Torpedines. Multa etiam infectantes odoris intolerabili f extradite depellant. Cic. de Nat. Deor. l. 2. c. 50.

\((i)\) A Knight call’d Corvini at Rome, cast a Salamander into the Fire, which presently swell’d, and then vomited Store of thick slimy Matter, which put out the Coals; to which the Salamander presently retir’d, putting them out again in the same Manner, as soon as they re-kindled, and by this Means fav’d it self from the Force of the Fire for the Space of two Hours: After which it liv’d nine Months. Vid. Philos. Transact. No. 21. in Lowth. Abridg. Vol. 2. p. 816.

\((k)\) Pliny gives an Instance in each. L. 10. c. 69. Aquila clariss
thers by their natural Craft, can prevent or escape them (l); others by their Uncouth Noise (m); by the horrid Aéct, and ugly Gesticulations of their Body (n); and some even by the Power of their Excrements, and their Stink (o), can annoy

clarior cernunt [quam homines;] Vultures fagaciis odorantur: liquidius audienti Talpe abrura terrâ, tam denso atque surdo natura elemento.

(l) The Doubling of the Hare, before she goes to Form, thereby to dodge and deceive the Dogs, although a vulgar Observation, is a notable Inftinct for an Animal, less fam’d for Cunning than the Fox, and some others.

(m) It is natural for many Quadrupeds, Birds and Serpents, not only to put on a torvous angry Aéct, when in Danger; but also to snarl, hiss, or by some other Noise deter their Adversary.

(n) The lynx, or Wryneck, although a Bird of very beautiful Feathers, and consequently far enough off from being any way terrible; yet being in Danger, hath such odd Con- tortions of its Neck, and Motions of its Head, that I remember have scar’d me, when I was a Boy, from taking their Nesfs, or touching the Bird; daring no more to venture my Hand into their Holes, than if a Serpent had lodged in it.


Cameus Peruvianus Clama dicitus neminem offendit, sed mi- ro admodum ingenio fe ab ikata vindicat injury, nimirum vo- mitu vel cibi, vel humoris in vexautem retrorsum cum impetu ejaculato, ob proferam colli longitudinem. Id. ib. p. 146.

Tzquiepail (Anglicè Squneck Præf. and one that I saw they call’d a Stonck,) Cium quis eam infectatur, fundit cum ventris crepitu balitum fætidissimum; quin ipsa tota teterrum exha- lat odorum, & urina ftercoreaque est fætidissimum, atque adeo pe- fudentis, ut nihil fit reperire in nofro orbe, cui in hâc re perfici comparari: quo fit, ut in periculo conftituta, urinam & feces ad 8 plurimum passum intcrvallum ejicit, hoc modo fe ob omnibus vindicans injury, ac vesfes infecliiis maculis luteis indelebi- libus, & minquam satis perficirent odore: aliis innoxium Ani- mal eduleque, hac solâ ratione horrendissimum. Id. ib. p. 182.

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their Enemy, and secure themselves; and against some (p), the divine Providence it self hath provided a Guard.

By such Shifts and Means as these, a sufficient Guard is minisfrd 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 shew'd, 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, as their Necessities of Life require. To which Purpose, the natural Sagacity and Craft of the one intrapping (q), 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 consider'd, argues the Contrivance of the infinitely wise Creator and Preserver of the World.

(p) 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 Sir Hans 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 it is in turning, in which the pursu'd 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, p. 23.

(q) See Chap. 11. Note (iii).
Of the Generation of Animals.

There remains now only one Thing more of the ten Things in common to Animals, and that is what relates to their Generation (a), and Conservation

(a) Spontaneous Generation, is a Doctrine so generally exploded, that I shall not undertake the Disproof of it. It is so evident, that all Animals, yea, Vegetables too, owe their Production to Parent-Animals and Vegetables; that I have often admir'd at the Sloth and Prejudices of the ancient Philosophers, in so easily taking upon Trust the Aristotelian, or rather, the Egyptian Doctrine of equivocal Generation; that when they saw Flies, Frogs and Lice, for Instance, to be Male and Female, and accordingly to ingender, lay Eggs, &c. they could ever imagine any of these Creatures should be spontaneously produc'd, especially in so romantick a Manner, as in the Clouds; as they particularly thought Frogs were, and that they dropp'd 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, request'd of me, and was pleas'd to publish in his last Edition of his Wisdom of God manifest'd, &c. p. 365.

But some will yet affert 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 Lord 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 inquir'd into. In a Scarcity in Silesia, a mighty Rumour was spread of its raining Millet-Seed; but the Matter being inquir'd into, 'twas found to be only the Seeds of the Ivy-leaved Speedwell, or small Henbit, growing in the Place in great Plenty. Eph. Germ. An. 3. Obs. 40. So in the Archipelago, it was thought Athes were rain'd, Ships being cover'd therewith at a hundred Leagues Distance; but in all Probability, it was from an Eruption of Vesuvius, that then happen'd. About Warminster in Wilts, 'twas reported it rain'd Wheat; but a curious Ob-
server, Mr. Cole, found it to be only Ivy-Berries, blown thither in a considerable Quantity by a Tempest. In the Year 1696, at Cranfield near Wrotham in Kent, a Pallure-Field was over-spread with little young Whitings, suppos'd to fall from the Clouds, in a Tempest of Thunder and Rain; but doubless they were brought thither with Waters from the Sea by the Tempest. See the before-commended Mr. Lowisb. Abridg. Philos. Trans. Vol. 2. p. 143, 144.

Neither needeth it 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 carry'd 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 Titchhurst, twenty Miles from the Sea, as he rode along pluck'd some Tops of Hedges, and chewing them, found them Salt: That some Grapes hanging on the Vines at Lewes were so too. That Mr. Williamfon Reator of Ripe, found the Twigs in his Garden Salt the Monday after the Storm; and others observ'd the same a Week after. That the Grasfs of the Downs about Lewes, was so Salt, that the Sheep would not feed till Hunger compell'd them: And that the Miller of Berwick, (three Miles from the Sea,) attempting with his Man to secure his Mill, were so wash'd 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.

I call'd this Doctrine of equivocal Generation, an Egyptian Doctrine; because probably it had its Rise in Egypt, to sate the Hypothetis, 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 Diod. Sicul. faith,) produce this Observation, That about Thebes, when the Earth is moistened by the Nile, by the Intense Heat of the Sun, an innumerable Number of Mice do spring out. From whence he infers, That all Kinds 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 Hypothetis. 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. Leeuwenhoek, infers three Things concerning Generation as highly probable. 1. That Animals are ex Animalculo. 2. That the Animalcules are originally in feminine Marium, & non in Feminis. 3. That they can never come forward, or be formed into Animals of the respective Kind, without the Ova in Feminis. His Proofs and Illustrations, see under the Word Generation, in his Lex. Techn. Vol. 2.
vation of their Species (b), 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 (c), I shall confine my self to these five Matters.

I. Their natural Sagacity in chusing the fittest Places to reposite their Eggs and Young.

II. The fittest Times and Seasons they make use of for their Generation.

III. The due and stated Number of their Young.

IV. Their Diligence and earnest Concern in their Breeding up.

V. Their Faculty of Feeding them, and their Art and Sagacity exerted therein.

I. 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 (d) of Animals, intending then to have wholly pass'd by this Busines 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 (e) farther appear, that the Places in which the several Species of Animals lay up their Eggs, and

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(b) At certe Natura, si fieri potuisset, maximè optasse situm opificium esse immortalis: quod cùm per materiam non liceret (nam quod—ex carne est compositum, incorruptibile esse non posset) subsidium quod posuit ipsè ad immortalitatem esse fabricata, sapiens cujusdam urbis conditoris exemplo, &c. Nam mirabilem quandam rationem invent, quomodo in demortui animalis locum, novum aliud sufficiat. Galen. de Usu Part. I. 14. c. 22.

(c) Animantia Bruta Obstetricibus non indigent in edendo Partu, cùm indita Natura vi Umbilicis seipsum occludat. OI. Rudbeck in Blasii Anat. Felis.

(d) Chap. 13.

(e) Book VIII. Chap. 6.

Young,
Young, are the best for that Purpose; Waters (f) for one; Flesh for another; Holes in Wood (g), Earth, or Stone (h), 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 superior 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 (i).

(f) The Ephemerone, 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 determin'd 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 Ephemerone 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 Life: For in the Beginning of its Life, it sheds its Coat; and that being done, and the poor little Animal thereby render'd light and agile, it spends the rest of its short Time in frisking over the Waters, and at the same Time the Female droppeth her Egg 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 hatch'd 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. \textit{Vid. Ephem. vita}, translated by Dr. Tyson from Swammerdam. See also Book VIII. Chap. 6. Note (r).

(g) See Chap. 13. Note (c), and Book VIII. Chap. 6.

(h) The Worms in Chap. 11. Note (x), breed in the Holes they gnaw in Stone, as manifest from their Eggs found therein.

(i) See Book VIII. Chap. 6. Note (q).
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 Nefts to lay up their Young; yet what abundant Amends is there made them, in the Power they have either to extend the Abdomen (k), and there-

(k) 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 Mousset, (p. 62.) Σωλίγες, i. e. Curvicauda, and the Whame or Barrel-Fly, which is vexatious to Horses in Summer, not by flinging them, but only by their bombylious Noise, or tickling them in tickling their Nits, or Eggs on the Hair; which they do in a very dexterous Manner, by thrusting out their Uropygia, bending them up, and by gentle, flight Touches, tickling 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 by him in the Water of an hollow Tree, but I have found it in Ditches, Saw-Pits, Holes of Water, in the High-way, and such-like Places where the Waters are most still and foul. This Maggot I mention, as being a singular and remarkable Work of God, not so much for its being so utterly unlike as it is to its Parent Bee-like Fly, as for the wise Provision made for it by its long Tail; which is so joyned 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
Chap. XV. of Animals.

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 (l), Trunk (m), Fruit

to reach the Bottom of very shallow, or deeper Waters, as it hath Occasion, for the gathering of Food. At the end of this tapering is a Ramification of Fibrille, 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.

(l) The Excrecences on the Root 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, Phalena, Scarab, or Scolopendra, I could never discover, being not able to bring them to any thing in Boxes.

(m) 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 Excrecences, or rather Tumours of the Briar-Stalk: From which proceeds a small black *Ichneumon-Fly*, with red Legs; black, smooth jointed Antenna; 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 venereous, 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 the 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 (said he) lately observed many Eggs in the common Rusby. One sort are little transparent Eggs, in Shape somewhat like a Pear, or Rert, lying within the Skin, upon, or in the Medulla, just against a brownish Spot on the outside of the Rusb; which is apparently the Creatrix 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,
The Generation

Book IV.

Fruit (n), Leaves (o), and the tender Buds of Vegetables (p), or some other such curious and secure Method they are never destitute of. To which we may add,

3. The natural Poison (q), (or what can I call it?) which many or most of the Creatures, last intended, have, to cause the Germination of such 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.

(n) See Book VIII. Chap. 6. Note (d).

(o) I have in Chap. 13. Note (ii), and Book VIII. Chap. 6; Note (e), (f), taken Notice of the Nidification and Generation of some Insects on the Leaves of Vegetables, and shall therefore, 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, Weevle Colour, that leapeth like a Grasshopper, although its Legs are but short. Its Eyes are blackish, Elytra thin, and prettily furrowed, with many Concavities in them; small club-headed Antenna, and a long Rostrum like a Proboscis.

The same, or much like this, I have met with on Tips of Oaken and Holly-Leaves. How the Scarab lays its Eggs in the Leaf, whether by terebrating 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 most of 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 'em, considering how thin and very tender the Skins of that Leaf (particularly) are.

(p) See Book VIII. Chap. 6. Note (z).

(q) See Book VIII. Chap. 8. to Note (bb), &c.
Chap. XV. of Animals.

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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 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.

II. 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 (r). 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

(r) Πολλά ἡς ἡς προς τὰς ἐνθέντες ὑπὸ τῶν τερατομομάχων ἐκ την ἀπαφῆς. Αριστ. Ηιδ. ΑΝ. 5. c. 8. uπ. plura.
distant Regions, which (when others fail) afford those helpless Creatures the Necessaries of Life.

III. 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 (f). 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 Rote 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 (t) Kind) producing their due Number at

(f) Chap. 10.

(t) Mr. Ray allidges 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.
their Choice and 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.

IV. 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 ἐστεγήν, or natural Affectation, 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 (w), or else the one kindly seeking out, and carrying Food to the other (w), engaged in the


(w) Of the common Crow, Mr. Willughby faith, The Females only sit, and that diligently, the Males in the mean time bring them Vitæuals, as Œritotle faith. In most other Birds, which pair together, the Male and Female sit by Turns. Ornithol. l. 2. §. 1. c. 2. §. 2. And I have observed the Female-Crows to be much fatter than the Males, in the Time of Incubation, by Reason the Male, out of his conjugal Affection, almost [arves himself, to supply the Female with Plenty.
Office of Incubation. But of these Matters in a more proper Place (x).

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 (y), 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 flying from him; and expose themselves to every Danger, rather than hazard and forswear their Young.

With this earnest Concern of the irrational Animals for their Young, we may join in the

V. And last Place, Their Faculty and Sagacity of feeding them. About 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 (z), together with the Willingness of

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(x) See Book VII. Chap. 4.
(z) In his animantibus qua laète aluntur, omnis ferè cibus matrum latetere incipit: eaque, quæ paulo ante nata sunt, sine magistro, duce naturâ, mammas appetunt, earumque ubertate saturantur. Atque ut intelligamus nihil horum esse fortitum, ex hac omnia esse provida, solertisque natura, qua multiplices factus procreant, ut Sues, ut Canes, his Mammarum data est multitudo; quas easdem paucas habent ea bestia, qua pauca gignunt. Cic. de Nat. Deor. l. 2. c. 51. Consulue quoque Galen de Uf. Part. l. 14. c. 4. & l. 15. c. 7.
all, even the most savage and fierce Animals, 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 Juice, the Milk, by Arteries and Veins to convey it to them, and proper Rivulets and Channels to convey it from them, with Dugs and Nipples, placed in the most convenient Part of the Body (aa) 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 for such Animals as do in another manner breed up their Young, by finding out Food, and putting it into their Mouth, the Provision made in them for this Service, to strike, catch, to pouch and

and convey their Prey and Food to their Young (bb), is very considerable. And so is also 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

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. Trans. No. 336.

(bb) For an Exemplification, I might name many Animals, particularly Birds, whose Parts are compleatly suited to this Service. They are Characteristics 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 off. R. Synops., Method. Av. p. 1. The Pelecan 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 ferrate on the Edge) the better to hold their Prey; a long sharp Bill to strike their Prey, and ferrate 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 cumberome for so small a Body, but) of greatest Use to enable them to carry the greater Load to their Nefts 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 Plaife, and other Fish, some Inches long, lying under the high Trees in which they build; and the curious and ingenious Owner thereof, D'Acre Barret, Esq; hath seen a large Eel convey'd by them, notwithstanding the great Annoyance it gave them in their Flight, by its twisting this Way and that Way about their Bodies.
their Eggs, lay up Provisions for their future Young. Somewhat of this is reported of some Birds (cc); 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 seal'd 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 (dd).

(cc) This is reported of the American Ostrich, mentioned by Acarette, in Phil. Trans. No. 89. Of which see Book VIII. Chap. 4. Note (e).

(dd) Hornets, Wasps, and all the Kinds of Bees provide Honey; and many of the Pseudopuhees, and Ichneumon Wasps and Flies, carry Maggots, Spiders, &c. into their Nets; of which see above, Note (c) Chap. 13.

C H A P. 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 senfitive 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, who is able to contrive and make this glorious Scene of Things, which I have thus 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
Way or other, and most of them serviceable to Man peculiarly, the Top of this lower World, and who was made, as it were, 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 Clothings for every Animal; such proper Houses, Nests and Habitations; such suitable Armature and 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 breath, 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, Joynets, 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
Chap. XVI. The Conclusion.

A Set of Senses, as the five Senses of Animals are; whose Organs are so dexterously contrived, so conveniently placed in the Body, so nearly 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 enraffishing Scene of Things as may excite us to admire, praise, and adore the infinitely wise, powerful, and kind Creator; to condemn all atheistical Principles; and with holy David, Psalm xiv. 1. to conclude that he is in good earnest a Fool, that dares to say, There is no God, when we are everywhere 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, when I come to take a View of Animals in particular.
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 the Superiority in the Animal World; Gen. i. 26. And God said, Let us make Man in our Image, after our
Chap. I. Of Man's Soul.

our Likeness; and let them have Dominion over the Fish of the Sea, and over the Fowl of the Air, and over the Cattle, 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.

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C H A P. I.

Of the Soul of Man.

MY Survey of Man, I shall begin with the Soul of Man, by Reason it is his his most noble Part (a), the Copy of the Divine Image in us (b), in which we have enough to fill us with Admiration of the Munificence, Power, and Wisdom of the

(a) Jam vero Animum ipsum, Mentemque hominis, Rationem, Consilium, Prudentiam, qui non divinâ curâ perficita esse perspicit, is his ipsis rebus mihi videtur carete. Cic. de Nat, Deor. 1. 2. c. 59.

(b) Sensum à Caelesti demissum traximus arce,
Cujus egent prona, & terram spectantium: mundi
Principio indulsit communis Conditor, illis
Tantum Animas; nobis Animum quoque.

Juven. Sat. xv. N. 144.

Et cum non aliter possent mortalia singi.
Adjunxit geminas, illa cum corpore lapse
Interunt: hes sela manes, butaque superfles
Evolat.

Claud. de 4 Consul. Hon.
Infinite Creator (c), when we contemplate the noble Faculties of this our superior Part, the vast Reach and Compass of its Understanding, the prodigious Quickness and Piercingness of its Thought, the admirable Subtilty of its Invention, the commanding Power of its Wisdom, the great Depth of its Memory (d), and in a word, its Divine Nature and Operations.

But I shall not dwell on this, tho' the superior Part of Man, because it is the least known. Only

(c) Nam siquis nulli se&te addidit, sed liber& sententi&re- rum considerationem inierit, conspicatus in tanta carnium ac succorum colluviie tantam mentem habitate; conspicatus item et cuiusvis animalis constructionem (omnia enim declarant Opif- cis Sapientiam) Mentis, qua h&mini ine&st, excellentiem intelliget, tum opus do partium utilitate, quod prius exiguum esse sibi vide- batur, perfectissima Theologia verum principium constituat: quae Theologia mulio est major atque praestantior tota Medicina. Ga- len, de usu Part. L. 17. c. 1.

(d) Among many Examples that I could give of Persons famous for Memory, Seneca's Account of himself may be one, Hanc [Memoriam] aliquando in me floruisse, ut non tamium ad usum sufficeret, sed in miraculum usque procederet, non nego. Nam & 2000 nominum recitata, quo ordine erant dicta, redde- bam: & ab his qui ad audiendum pr&ceptorem noftrum conver- nerunt, singulos versus a singulis datos, cium plures qu& 200 efficerentur, ab ultimo incipiens usque ad primum recitabam. After which, mention is made of the great Memory of La- tro Porcius (charissimi mihi sodalis, Seneca calls him) who re- tained in his Memory all the Declamations he had ever spo- ken, and never had his Memory fail him, not so much as in one single Word. Alfo he takes Notice of Gynesas, Ambassa- dor to the Romans from King Pyrrhus, who in one Day had so well learnt the Names of his Speculators, that pos vero die no- vus homo & Senatum, & omnem urbanam circumjuxtam Sena- tui plebem, nominibus suis perfanctavit. Senec. controverf. L. 1. init. Vid. quoque Plin. L. 7. c. 24. where he also adds other Examples, viz. Cyrus rex omnibus in exercitu suo militi- bus nominu reddidit; L. Scipio populo Rom. Mithridates 22 gen- tium rex, totidem lingu& jura dedit, pro concione singulas fine interprete affatus. Charmidas (feu potius Carneades) —

que quis exegeras volumina in bibliothecis, legentis modo repre- sentavit.
there are two Things I can't easily pass by, because they manifest the special Concurrence and Design of the infinitely Wise Creator, as having a particular and necessary Tendency to the Management and good Order of the World’s Affairs. The

I. Of which is the various Genii, or Inclinations of Men’s Minds to this, and that, and the other Business (e). 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

(e) Diversis etenim gaudet natura ministris,
Ut sieri diversa quaeant ornantia terras.
Nec paritur iunctos ad eandem currere metam,
Sed varias jubet ire vias, variosque labores
Suffitore, ut vario cultu sit pulchrior orbis.

Paling. in Scorp.

Oitus ω τινες ό ἡ χειρίνα δίδωτι
‘Ανδράν, &c. Ιτα non omnibus hominibus sua dona dat Deus,
neque bonam indolem, neque prudentiam; nee eloquentiam:
alius namque vultum belci deformatem; sed Deus formam elo-
quentiæ ornat, &c. Homer. Ódyf. 8. The like alio in Ílad.,
L. 13,
Of Man's Invention. Book V.

Pleasure, and Diversion to him. For so far it is from being a Toil, that the greatest Labours (f), Cares, yea, and Dangers too, become pleasant to him who is pursuing his Genius; and whose Ardour of Inclination eggs him forward, and buoyed him up under all Opposition, and carrieth him through every Obstacle, to the End of his Designs and Desires.

II. The next is, The inventive Power of the Soul (g). 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 Senses, that

(f) Although Solomon declares, Eccles. xii. 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. Caroem vidi in Bibliotheca fedentem, multis circumfutum Stoicorum libris. Erat enim, ut seisi, in eo inexhausta aviditas legendi, nec satiari poterat: quippe ne reprehensionem quidem vulgi inanem reformidans, in ipsa curia soleret legere saepe, dum senatus cogeretur — ut Heluo librorum — videbatur. Cicer. de finib. L. 3. c. 2.

(g) Mentem hominis, quamvis eam non videas, ut Deum non videas, tamen ut Deum agnoscis ex operibus ejus, sic ex memoriam rerum, & Inventionem, & celeritate motus omnique pulchritudine virtutis vim divinam mentis agnoscite. Cicer. Tus. Quæst. 1. q. c. 29.
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 fix'd
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 en-
dow'd 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, Ge-
ographer and Sailor? And lastly, What a wonder-
f ul Sagacity is shewn in the Business of Optics, and
particularly in the late Invention of the Telescope;
wherewith new Wonders are discover'd 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, e-
ven the very Shrubs of the Field; in a Word, what
of all the excellent Variety, the Creator has fur-
nish'd the World with, for all its Uses and Occas-
ions, in all Ages; what, I say, that Man's Contri-
vance doth not extend unto, and make some Way
or other other advantageous to himself, and useful
for Building, Cloathing, Food, Physick, or for
Tools or Utensils, or for even only Pleasure and
Diversion?

But now considering the great Power and Ex-
tent of human Invention.

2. There is another Thing, that doth farther de-
monstrate the Super-intendence of the great Crea-
tor, and Conservator of the World; and that is,
That Things of great, and absolutely necessary Use,
have soon, and easily occurr'd to the Invention of
Man; but Things of little Use, or very dangerous
Use, are rarely and slowly discover'd, or still utter-
ly undiscover'd. We have as early as the Mosaic
History, an Account of the Inventions of the more
useful.
useful Crafts and Occupations: Thus Gen. iii. 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 (b). And the Posterity of these, are in the latter End of Gen. iv. record- ed, Jabal to have been the Father of such as dwell in Tents (i); i. e. He was the Inventor of Tents, and pitching those moveable Houses in the Fields, for looking after, and depasturing their Cattel in the Deserts, and uncultivated World. Tubal-Cain was an Instruer of every Artificer in Brass and Iron (k), or the First that found out the Art of melting, and malleating (l) 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 (m); 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 this we might give divers Instances: In Mathematicks, about squaring the Circle (n); in Mechanicks

(k) Gen. iv. 2.
(j) Ý. 20.
(k) Ý. 22.
(l) Συναὶστετεως, the LXX call him, i. e. A Worker with an Hammer.
(m) Ý. 21.
(n) Although the Quadrature of the Circle, hath in former Ages exercis'd some of the greatest mathematical Wits; yet nothing
channicks (o), about the Art of Flying; and in Navigation, about finding the Longitude. These Things, although some of them in Appearance innocent, yea, perhaps very useful, yet remain for the most Part secret; not because the Discovery of

nothing has been done in that Way 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 straight 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 1688, in a Demonstration of my Lord Brounker's Quadrature of the Hyperbola, by Dr Wallis's Reduction of a Fraction into an infinite Series by Division. But the penetrating Genius of Sir Isaac Newton, had discovered a Way of attaining the Quantity of all quadrable Curves analytically, by his Method of Fluxions, some Time before the Year 1668, as I find very propable 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 appeas't that the said Method was invented some Years before, by the said Mr. Newton, and generally apply'd. 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 Inventor thereof; with much more of this Nature. The Design, I find, of that indefatigable Promoter of Mathematicks, Mr. Collins, was to acquaint Mr. Townley, in his Letter, with what had been done; and to get the Affiance of that ingenious Gentleman, towards the compleating a Body of Algebra.

(o) I do not mention here the perpetual Motion, which hath exercis'd the mechanical Wits for many Ages; because it is a Thing impossible, if not a Contradiction: As the before-commended Dr. Clarke afferts in Rerubul. Phys. p. 133.
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 discover'd 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 pleas'd 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 (p) observes, by making Men 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 Nefts upon Rocks".

That this is the true Reason of these Matters, is manifest enough from holy Scripture, and Reason (q) also gives its Suffrage thereto. The Scripture expressly tell us, That every good Gift, and every

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(p) Grew's Cosmol. Sacr. l. 1. c 5. §. 25.
(q) Nemoigitur virmagnus sine aliguo afflatudivinounguamfruit. Cic. de Nat. Deor. l. 2. c. 66.
perfect Gift, is from above, and cometh down from the
faith, The Lord giveth Wisdom; out of his Mouth co-
meth Knowledge and Understanding. And Elisha is 
very express, Job xxxii. 8. But there is a Spirit in 
Man, and the Inspiration of the Almighty giveth them 
Understanding, Πνεϋ πανοξενορος την η διδασκαλια, 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, superi-
our Acts of Wisdom or Science; but much inferior 
also, bear the Name of Wisdom, Knowledge 
and Understanding, and are ascrib'd unto GOD. 
'Tis well known that Solomon's Wisdom is wholly 
ascript'd unto GOD; and the Wisdom and Under-
standing which GOD is said to have given him, 
1 Kings iv. 29. is particularly set forth in the fol-
lowing 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 Αίγυπτος, and the eastern Nations were 
celebrated of old (r): And Solomon's Wisdom excelled 
the Wisdom of all the Children of the east Country, 
and all the Wisdom of Αίγυπτος. For he was wiser 
than all Men, than Ethan, &c. And he spake 3000 
Proverbs: And his Songs were 1007. 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 Wise-
dom of Daniel, and his three Companions, is as-
crib'd unto GOD, Dan. i. 17. As for these four

(r) Αίγυπτος, and some of the eastern Nations, are celebra-
ted for their Skill in polite Literature; both in Scripture and 
profane Story: Job was of those Parts; so were the Ἤσφαλ 
and Μαυρσ, the Brachmans and Gymnosophists. Moses and Da-
niel had their Education in these Parts: And Pythagoras, De-
ocrates, and others, travell'd into these Parts for the Sake 
of their Learning.
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. 26. 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 inferior mechanick Art, is call'd by the same Names, and ascrib'd unto GOD: Thus for the Workmanship of the Tabernacle, Exod. xxxi. 2. to v. 6. See, I have call'd Bezaleel; and I have fill'd him with the Spirit of God, in Wisdom, and in Understanding, 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 Spinners, Weavers, and other Crafts-people, are call'd wise-hearted, Exod. xxxiv. 10. 25. and other Places. And in Exod. xxxvi. 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 Kings vii. 14. and 2 Chron. ii. 14. call'd a cunning Man, fill'd with Wisdom and Understanding, to work in Gold, Silver, Brass, Iron, Stone, Timber, Purple, Blue, fine Linen, and Crimson; also to grave, and find out every Device which should be put to him.

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 Transfation of the same almighty Governor of the World's
World's Affairs. And who indeed but HE, could make such a divine Substance, endow'd with those admirable Faculties, and Powers, as the rational Soul hath; a Being to bear the great Creator's Vicegerency 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 deject 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 Concours of Atoms, or the Cartesian (f) his created Matter put in Motion; yet with what tolerable Sense could he, in his Way, produce such a divine, thinking, speaking, contriving Substance as the Soul is; endow'd exactly with such Faculties, Power, 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 con-

(f) As we are not to accuse any falsely; so far be it from me to detract from so great a Man as Monsieur Cartes was: Whole Principles, although many have perverted to atheistical Purposes, and whole Notions have, some of them, but an ill Aspect; yet I am unwilling to believe he was an Atheist; since in his Principia Philosophia, and other of his Works, he vindicates himself from this Charge; and frequently shews seemingly 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 discar'dth 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; it being the Business of a Divine, rather than a Philosopher, to treat of them.
triv'd 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 (t), improve

(t) 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 Happines to be able to vie with any Age for the Number of learned Men of all Professions, and the Improvement made in all Arts and Sciences; too many, and too well known to need a Specification.

But for Ignorance, we may take the ninth Age, and so down to the Reformation; even as low as Queen 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 of Godliness. Spar. Collect. p. 82. But this is nothing, in comparison to the Ages before, when the Monk said, Gracum non est legi; or as Espancaus more elegantly hath it, Gratia non est susspetium, Hebraice prope Hareticum. Which Suspicion, (said the learned Hakewill,) Rhemigius surely was not guilty of, in commenting upon diffamatus, 1 Thef. i. 8. who faith, that St. Paul somewhat improperly put that for divulgatus, not being aware that St. Paul wrote in Greek, and not in Latin. Nay, so great was their Ignorance, not only of Greek, but of Latin too, that a Priest baptiz'd in nomine Patrista, & Filia, & Spiritus sancta. Another suing his Parishioners for not paving his Church, prov'd it from Jer. xvii. 18. Paveam illi, non paveam ego. Some Divines in Erasms's Time, undertook to prove Hereticks ought to be burnt, because the Apostle said, Hareticum devita. Two Fryars disputing about a Plurality of Worlds, one prov'd it from Annón decem sunt facti mundi? The other reply'd, 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 admonish'd 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.
Chap. I. Of Man's Invention.

in every Thing, as well as this, or that Age, or Nation (u) only? why should the Greeks, the Arabians, the Persians, or the Ægyptians 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 it come to pass that the

(u) There is (it seems) in Wits and Arts, as in all Things beside, 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 Re-flourishing again. The Arts flourished for a long Time among the Persians, the Chaldaëans, the Ægyptians. 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, Huns, 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 Mansur, 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 Areseine, Philelphus, Valla, &c. And those were followed by Aeneas Sylvius, Angelus Politianus, Hermolaus Barbarus, Marsilius Ficinus, and Joh. Picos, of Mirandula. These were backed by Rud. Agricola, Ruecline, Melanëthon, Joach. Camerarius, Wolphlasius, Beat. Rhenanus, Almaines; By Erasmus of Rotterdam; Vives a Spaniard; Bembus, Sadolecus, Eugubinus, Italians: Turnebus, Mureus, Ramus, Pitheus, Budeus, Amiot, Scaliger, Frenchmen; Sir Tho. More and Linnaker, Englishtmen. And about this Time, even those Northern Nations yielded their great Men; Denmark yielded Olau Magnus, Holster, Tycho Brak, and Hemingius; and Poland, Hofilus, Friexius, 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.
Dr. Gilbert, the most learned and accurate Writer on
the Magnet, shews, that its Attractive Virtue was known as
early as Plato and Aristotle: but its Direction was a Discover-
y of later Ages. He saith, Superiori ævo 300 aut 400 la-
bentibus annis, Motus Magneticus in Boream et Austrum re-
pertus, aut ab hominibus rursum recognitus fuit. De Mag.
L. i. c. i. But who the happy Inventor of this lucky
Discovery was, is not known. There is some, not incon-
 siderable, Reafon, to think our famous Country-man, Rog.
Bacon, either discovered, or at least knew of it. But for
its Use in Navigation, Dr. Gilbert saith, in regno Neapolitan
Melphitani omnium primi (ut ferunt) pyxidem inaccessible
nauticam. edicti à cive quodam Iol. Goia A. D. 1300.
ibid. If the Reader hath a mind to fee 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. ro.
§. 4. or Purchas Pilgr. L. i. c. i. §. 1.
As to the Magnetick Variation, Dr. Gilbert attributes the
Discovery of it to Sebastian Cabot. And the Inclination,
or Dipping of the Needle, was the Discovery of our inge-
nious Rob. Norman. And laftly, The Variation of the Va-
riation was first found out by the ingenious Mr. H. Gellibrand.
Math. on the Variat. of the Mag. Need. and its Variat. An-
n o 1635.
But since that, the before commend Dr. Halley, having
formerly, in Philos. Trans. No. 148, and 195, given a pro-
bable Hypothesis of the Variation of the Compas, 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 Sytem of the Magnetical
Variations: Which being soon after published, has been since
abundantly confirmed by the French, as may be seen in se-
veral of the late Memoirs de Physique et de Mathematique,
publish’d by the French Academie des Sciences.
To these Discoveries, I hope the Reader will excuse me,
if I make 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 Ne-
de is continually varying up and down, towards the E. and
W. so is the Dipping-Needle varying up and down, to-
wards
wards or fromwards the Zenith, with its Magnetick Tendency, describing 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 its 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, which I mentioned three or four Years ago at a Meeting of our Royal Society, 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.

(x) 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 Guttenburg, a Knight of Argentine, about 1440, and say, that Faustus was only his Assistant. Bertius ascribes it to Laurence John, of Harlem, and faith, Faß or Faust, stole from him both his Art and Tools. And to name no more, some ascribe it to John Faß or Faust, and Peter Schoesfer (called by Faß in some of his Imprimaturs, Pet. de Gernsfem puere meus.) But there is now to be seen at Haerlem, a Book or two printed by Laz. Koster, before any of these, viz. in 1430, and 1432. (See Mr. Ellis's Letter to Dr. Tyfon, in Phil. Trans. No. 286.) But be the first Inventer who it will, there is however great Reason to believe, the Art receiv'd great Improvements from Faß and his Son-in-Law Schoesfer, 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.

(y) Concerning the Antiquity and Invention of Clocks and Clock Work, I refer the Reader to a little Book, called the Artificial Clock-maker, chap. 6. Where there is some Account of the Ancients Inventions in Clock-Work, as Archimedes's Sphere, Cresibius's Clock, &c.

(z) The Invention of Telescopes, Hieron. Syrtorum gives this Account of, Prodii Anno 1609, Seni Genius, sen alter T 2
manner, Anaximenes, Posidonius, or other great Virtuoso’s of the early Ages, whose Contrivances of various Engines, Spheres, Clepsydræ and other curious Instruments are recorded (aa)? And why cannot


(aa) Among the curious Inventions of the Ancients Archytas’s Dove was much famed; of which Aul. Gellius gives this Account: Scripserunt Simulachrum Columbae è ligno ab Archytâ ratione quâdam disciplinâque mechanicâ factum, volasse: Ista erat soliciet libramentis suspensum, & aurâ spiritus inclusâ atque occulta concitat. Noct. Attic. L. 10. c. 12. The fame eminent Pythagorean Philosopher (as Favorinus in Gellius calls him) is by Horace accounted a noble Geometrician too, Te maris C. terra, numeroque carentis arenae Memorem Archytâ. Among the rest of his Inventions, Children’s Rattles are ascribed to him. Aristotle calls them ‘Aρχυτας πλατάγι, Polit. S. i. e. Archytas’s Rattle. And Diogenianus the Grammarian, gives the Reason of his Invention, ‘Aρχυτας πλατάγι επὶ τῶν, &c. That Archytas’s Rattle was to quiet Children; for he having Children, contrived the Rattle, which he gave them to prevent their [tumbling, διαπλαταγιω]\ 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 off his Hands, and taking a Round, returned thither again. Vid. Hakewill ub. supr. c. 10. §. 1.

As to other Inventions of the Ancients, such as of Letters, Brick and Tiles, and building Houses, with the Saw, Rule, and Plumber, the Lath, Augre, Glue, &c. also the making Brass, Gold, and other Metals; the use of Shields, Swords, Bows and Arrows, Boots, and other Instruments of
cannot the present or past Age, so eminent for polite Literature, for Discoveries and Improvements in all curious Arts and Business (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 of the great Creator and Ruler of the World;

of War; the Pipe, Harp, and other Musical Instruments; the building of Ships and Navigation, and many other Things besides; the Inventors 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 (faith 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. I. B. I. c. 4.
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 (bb), 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 latter 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 All-wise Ruler of the World will transact the Affairs of our most Holy Religion, e'er 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 a Way for us into some of the largest and farthest

(bb) 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 (x). After which followed the Reformation about the Year 1517.
distant Nations of the Earth; particularly into the great Empire of China (cc).

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 thence on every Man, to pursue the Ends, and answer all the Designs 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 some Secondary Causes; that they are Matters of them, and at Liberty to use them as they please, to gratifie their Lust or Humour, and satisfy their depraved Appetites. But it is evident, that these Things are the Gifts of God, they are so many Talents entrusted with us by the infinite Lord of

(cc) 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 registered. 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 Verbiesf 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.
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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 the parabolical Representation of this Matter by our Blessed Saviour, Matt. xxv. 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. i. 6. we must stir up the Gift of God which is in us, and not let it lie idle, concealed or dead; but we must ἀνακατηρεῖν τὸ χάρις, 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 and Service of the World, for which he gave it. Our Stewardship, our Craft, our Calling, be it that of Ambassadors of Heaven, committed to us, as 'twas to Timothy, (dd) 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 the 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 we said to the unfaithful Steward, Luke xvi. 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, Mat. xxv. 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

(dd) 1 Tim. iv. 14. 2 Tim. i. 6;
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into the Joy of thy Lord. Since now the Case is thus, let us be persuaded to follow Solomon's Advice, Eccles. ix. 10. Whosoever thy Hand findeth to do, do it with thy Might (ee) "Lay hold on every Occasion 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 Wisdom and Virtue, 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.

(ee) Bishop Patrick in loc.

CHAP. II.

Of Man's Body, particularly its 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 of View of this admirable Machine, and that somewhat briefly too, being prevented by others, particularly two excellent
Of Man’s Posture. Book V.

I. Thing that presents itself to our View, is the Erect Posture (b) 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 practise curious Arts. For without this erect Posture, he could not have readily turned himself to every Business, and on every Occasion. His Hand (c) particularly could not

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(b) Ad hanc providentiam Nature tam diligentem [of which he had been before speaking] tamque solertem adjungi multa possunt, et quibus intelligatur, quanta res hominibus à Deo, quamque eximia tributa sunt: qui primum eos humo excita- tos,セルsとereceos consituit, ut Deorum cognitionem, cœlum intuentes, capere possunt. Sunt enim terrâ homines non ut in- cola, atque habitatores, sed quasi spectatores superarum rerum, atque cœlestium, quarum spectaculum ad nullum alium genus animantium pertinet. Cic. de Nat. Deor. L. 2. c. 56.

(c) Ut autem sapientissimum animalium est Homo, sic & Man- nus sunt organa sapienti animali convenientia. Non enim quia Manus habuit, propterea est sapientissimum, ut Anaxagoras dîcebat; sed quia sapientissimum erat, propter hoc Manus ha- buit, ut retiissimè consint Aristoteles. Non enim Manus ipse hominem artes docuerunt, sed Ratio. Manus autem ipse 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 faith, ch. 5. Num eam omnino Constitutionem habeat [manus] quà meliorem aliæm 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 Heathen. 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. I. 2. 24. The Reason of this Mecha-
not have been in so great a 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 (d), and
an ample Horizon on Earth (e), to entertain
his Eye.

And

nism, he faith, is, That the Tops of the Fingers may come
to an Equality, *cum magnas aliqus meles in circuitu compre-
prehendant, & *cum in seipsis humidum vel parvum corpus con-
tinere conantur.—Apparent vero in unam circuli circumfe-
rentiam convenire Digitit quingen in actionibus huysmodi ma-
ximè quando exquisiti sphericum corpus comprehendunt. And
this Evenness of the Fingers Ends, in grasping spherical,
and other round Bodies, he truly enough faith, makes the
Hold the firmer. And it seems a noble and pious Deign
he had in so strictly surveying the Parts of Man's Body,
which take in his own translated Words, *cum multa namque
esse apud veteres, sam Medicos, qunam Philosophos de utilitate
particularum diffensio (quidam enim corpora nostra nullius gra-
tiæ esse fæcia existimant, nullæque omnino arte; alii autem &
aliqus gratia, & artificios.—) primum quidem tante
huys diffensionis nostræ invenire studi: deinde vero & unam
aliquam universalem methodum constituere, qua singularum
partium corporis, & eorum que illis accident utilitatem inven-
ire possimus. Ibid. cap. 8.

(d) Pronaque cum speciante animalia catera terram,
Os Homini sublime dedis, columque tueri
Jussit, & erectos ad sidera tollere vultus.

Ovid. Metam. L. I. car. 84.

(e) 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 Trian-
gles, 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 its 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 there are given H C 398,386 Miles, or 21034781 En-
glipp Feet, (according to Book II. Chap. 2. Note (a);) $C E$ 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 $E H C$ 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 $H E$, the Proportion is, As the Side $C E$, to the Angle at $H$; so the Side $H C$, to the Angle at $E$, which being subtracted out of 90 gr. the Remainder is the Angle at $C$. And then, As the Angle at $E$, is to its opposite Side $H C$, or else as the Angle at $H$ is to its opposite Side $C E$; so the Angle at $C$, to its opposite Side $E H$, the visible Horizon. Or the Labour may be shorten'd, 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 requir'd, nearly. For an Example, We will take the two Sides in Yards, by Reason scarce any Table of Logarithms will serve us farther. The Semidiameter of the Earth is 7011594 Yards; the Height of the Eye is two Yards more, the Sum of both Sides, is 14023190.

\[
\begin{align*}
\text{Logar. of which Sum is} & \quad 7,1468468 \\
\text{Logar. of two Yards (the Differ.) is} & \quad 0,3010300 \\
\text{Sum of both Logar.} & \quad - \ \\
\text{The half Sum,} & \quad 3,7239384 \\
\end{align*}
\]

is the Logar. of 5296 Yards = three Miles, which is the Length of the Line $E H$, or Distance the Eye can reach at six 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 rais'd 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.

(f) See
And as this Erection of Man's Body is the most compleat Posture for him; so if we survey the Provision made for it, we find all done with manifest Design, the utmost Art and Skill being employ'd 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 (f); 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 plac'd from the Head to Foot! The Vertebrae of the Neck and Back-bone (g), made short and complanated, and firmly braced with Muscles and Tendons, for easy Inc rivations 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 tack'd together, (to which must be added the Ministry of the Muscles (b), to answer all the Motions

(f) See Book VI. Chap. 5. Note (g).
(g) See Book IV. Chap. 8. Note (c).
(b) The Mechanism of the Foot, would appear to be wonderful, if I should descend to a Description of all its Parts; but that would be too long for these Notes; therefore a brief Account, (most of which I owe to the beforecommended 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
Motions of the Legs and Thighs, and at the same Time to keep the Body upright, and prevent its 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 (i).

And as the Bones are admirably adapted to prop; so all the Parts of the Body are as incomparably plac'd to poise it. Not one Side too heavy for the other; but all in nice Æquipoise: The Shoulders, Arms, and Side æquilibrated on one Part; on the other Part the Viscera of the Belly counterpois'd 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, plac'd throughout the Body for this Service; that they should so readily answer to every Posture; and comply with every Motion thereof, without any previous cros's one another at the Bottom of the Foot, in the Form of a St. Andrew's Cross, to incline the less' er Toes towards the great One, and the great One towards the less'er. The short Flexors are chiefly concern'd 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, (fall'y so call'd,) and makes it become a Flexor. And lastly, the peroneus Longus runs round the outer Ankle, and obliquely forwards cros's 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.

(i) It is very well worth while to compare here what Borelli faith, de motu Animal. Par. i. cap. 18. De fatione Animal. Prop. 132, &c. To which I refer the Reader, it being too long to recite here.
Chap. III. Of Man's Figure.

Thought or Reflex act, so that (as the excellent Borelli \((k)\) faith), "It is worthy of Admiration, that in so great a Variety of Motions, as running, leaping, and dancing, Nature's Laws of \(\text{Æ}\)quilibration should always be observed; and when neglected, or wilfully transgressed, that the Body must necessarily and immediately tumble down.

\((k)\) Borel. ibid. Prop. 142.

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 Inconveniencies, those before-mentioned of his Flying would have been some. In a word, any other Shape of Body, but that which the All-wise 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 it in his Power to have been more pernicious, or deprived him of Ten thousand Benefits, or
Of Man's Stature. Book V.
or 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 (a), nor too Gigantick (b), either of which Sizes would in some particular or other, have been incommodious to Himself, or to his Busines, 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 inferior Creatures, would have exposed him to the Assaults of the weakest Animals, to the ravenous 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 Busines, unable to carry Burdens, and in a word, to tranfact the greater part of his Labours and Concerns.

And on the other hand, had Man's Body been made too monstrously strong, too enormously Gi-

(a) 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 montes?


(b) Haud facile fit ut quisquam & ingentes corporis vires, & ingenium subtile habeat. Diodor. Sic. L. 17.
Chap. IV. Of Man's Stature. 289

gantick (c), it would have rendered him a dange-
ous

(c) Altho' we read of Giants before Noah's Flood, Gen. vi. 4. and more plainly afterwards in Numb. xiii. 33. Yet there is great Reason to think the Size of Man was always the same from the Creation. For as to the Nephilim or Giants, in Gen. vi. 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 Numb. xiii. which were evidently Men of a Gigantick Size, it must be considered, that it is very probable, the Fears and Discontentments 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 Theusobocihus, 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 Starcbater, among the Men; and among the Women, reperta est (faith he) puella ——— in capite vulnerata, ac mor- tua, induta chlamyde purpurca, longitudinis cubitorum 50, la- situdinis inter humeros quatuor. Ol. Mag. Hift. L. 5. c. 2.

But as for the more credible Relations of Goliath (whose Height was 6 Cubits and a Span, 1 Sam. xvii. 4. which according to the late curious and learned Lord Bishop of Peterbor-rough is somewhat above 11 Feet English, vid. Bishop Cumber-land 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 inscrib- ed, Marcus Antoninus; of which an Account is given by Mr. Chefelden, who judgeth by the Dimensions of the Bones, that the Person was 8 Foot high, vid. Philof. Trans. No. 333. These antique Examples and Relations, I say, we can match, yea, out-do, with modern Examples; of which we have di-
ers in J. Ludolph. Comment. in Hift. Ethiop. L. r. c. 2 §. 22. Magus, Conringius, Dr. Hakewill, and others. Which later relates from Nannez, of Porters and Archers belong-
Of Man's Stature. Book V.

The Emperor of China, of 15 Feet high; and others from Purchas, of 10 and 12 Feet high, and more. See the learned Author's Apolog. p. 208.

These indeed exceed what I have seen in England; but in 1684, I my self measured 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 of so great a Person as was 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 (faith 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 fright 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 Ray's 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 Pifa, that are some thousand Years old, are not longer than ours; so is Asbeltane's in Malmesbury-Church; so Sebba's in St. Paul's, of the Year 693; so Etheldred's, &c. Apol. 216, &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 Mentorum, which was not doubted to have been left there at the Overthrow of AshdubaL, will fit one of our Men at this Day.

Nay, besides all this, probably 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. Hakew, ib. p. 215.
rous Tyrant in the World, too strong (d) in some Respects, even for his own Kind, as well as the other Creatures. Locks and Doors might per-

(d) 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, Hēctor, 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, Bardešín, Tamerlane, Šiska, and Hunniades. Anno 1529, Klunker, Prevoft of the great Church at Miſsia, carry'd a Pipe of Wine out of the Cellar, and laid it in the Cart. Mayolas saw one hold a Marble Pillar in his Hand 3 Foot long, and 1 Foot diameter, which he tosf'd up in the Air, and catched again, as if it were a Ball. Another of Mantua, and a little Man, named Rodamas, could break a Cable, &c. Ernando Burg, fetched up Stairs an Afs laden with Wood, and threw both into the Fire. At Constantino-

poulos, 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 Mindelhaim, 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 its Place. Cardan saw a Man dance with two Men in his Arms, two on his Shoulders, and one on his Neck. Pataqua, Captain of the Cossacks, could tear an Horse-Shoe (and if I mistake not, the fame 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 Bar's Length, 6 Buffel 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 à mineralibus, quam a
liis Scotiae at Gothiae provinciis adducere congruit, tantâ for-
situdine praeditos, ut quisque eorum in humeros sublevatum E-
quum, vel Bovem maximum, imd ubi ferri 600, 800, aut
1000 librarum (quaie & aliquae Puelle levare possunt) ad plu-
na statim portaret. Ol. Mag. ubi supr.
haps have been made of sufficient Strength to have barricaded our Houses; and Walls, and Ramparts might perhaps have been made strong enough to have fenced our Cities. But these Things could not have been without a great and inconvenient Expense of Room, Materials, and such Necessaries, as 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 (e). "Had Man been a Dwarf (laid he) he had scarce been a reasonable 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 Business—Or had the Species of Mankind been Gigantick, he could not have been so commodiously 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 Reason; in that he would have done many Things by mere 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 (faith he) no other Cause can be assigned why a Man was not made five or ten Times bigger, but his

(e) Grew's Cosmol, Sacr. B. i. ch. 5. §. 25.
Chap. V. Of the Structure, &c. 293

"Relation to the rest of the Universe. Thus far our curious Author.

C H A P. 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 its 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 (a), 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;

(a) 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 Human 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 a 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.
made of the most proper Strength and Texture; shaped in the completest Form; and in a word, accouter'd with every Thing necessary for its 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 Combinati-
on have we also of the most exquisite Workman-
ship and Contrivance in the Eye, in the Ear, in the Hand (b), in the Foot (c), in the Lungs, and other Parts already mention'd? What an Abridgment of

(b) Galen having described the Muscles, Tendons, and other Parts of the Fingers, and their Motions, cries out, Con-
sidera igitur etiam hic mirabilem CREATE ORIS sapientiam! De Uf. Part. L. i. c. 18.

(c) And not only in the Hand, but in his Account of the Foot (L. 3.) he frequently takes notice of what he calls Ar-
tem, Providentiam & Sapientiam Conditoris. As Ch. 13. An igitur non aquan est hic quoque admirari Providentiam Condi-
roris, qui ad utrumque usum, est certe contrarium, exacte convenientes & consentientes in invicem fabricatus est totius mem-
bri [tibiae] partimas? And at the end of the Chap. Quod si omnia que ipsarum sunt partum mente immutaverimus, ne-
que inueniernus positionem aliam meliorem ea quam nunc for-
tita sunt, neque figuram, neque magnitudinem, neque connexionem, neque (at paucis omnia complectar) aliam quidquam
sorum, que corporibus necessariis insunt, perfectissimam pronun-
ciare oportet, & undique recte constitutam presentem ejus con-
structionem. The like also concludes, Ch. 15.
Art, what a Variety of Uses (d), hath Nature laid upon that one Member of the Tongue, the grand Instrument of Taste, 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 beside? But I must desist from proceeding upon Particulars, finding I am fallen upon what I propos’d to avoid.

And therefore for a Close of this Chapter, I shall only add Part of a Letter I receiv’d from the before-commended very curious and ingenious Physician Dr. Tancred Robinson, What, (faith he,) can possibly be better contriv’d 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 Secretion, sensible and insensible; whereas 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 that Secretion may accompany the general Colliquations, as in Fluxes, hotick Sweats and Coughs, Diabetes, and other Consumptions. What a mighty Contrivance is there to preserve these due Secretions from the Blood, (on which

(d) At enim Opificis industrii maximum est indicium (quem-admodum ante septenmero jam diximus) iiis qua ad alium us-sum fuerunt comparata, ad alias quoque utilitates abuti, neque laborare ut singulis utilitates singulas facias proprias particulas. Galen. ub. supr. L. 9. c. 5.
Of the Structure, &c.  Book V.

Life so much depends,) by frequent Attritions, and Communications of the Fluids in their Passage through the Heart, the Lungs, and the whole System of the Muscles? What Meanders and Contortions of Vessels, in the Organs of Separation? And, What a Course of Elastic 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 Elastic Fibres, which impress that Velocity on the Fluids.

Now I have mention'd 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 poisonous, 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 ruin'd; of such Importance is the Air to all the Parts of it. Thus my learned Friend.
Of the Placing the Parts of Man's Body.

In this Chapter, I propose to consider the Lodgement of the curious Parts of Man's Body, which is no less admirable than the Parts themselves, all set in the most convenient Places of the Body, to minister to their own several Uses and Purposes, and assist, and mutually to help one another. Where could those faithful Watchmen the Eye, the Ear, the Tongue, be so commodiously plac'd, 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 (a), near the Brain (b), 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 (c), than to dilperse it to all Parts of the

(a) *Sensus, interpretēs ac nuntii rerum, in capite, tanquam in arce, ministere ad usus necessarios & facti, & collocati sunt. Nam oculi tanquam spectatores, alrissimum locum obtinunt; ex quo plurima conscientes, surgantur suo munere. Et aures cum sonum recipere debeant, qui natura in sublimé fertur; rest. in illis corporum partibus collocata sunt.* Cic. de Nat. Deor. L. 2. c. 56. ubi plura de cæteris Sensibus.

(b) 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 lodg'd 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. Pari. L. 8. c. 5. 6.

(c) See Book IV. Chap. 6. Note (c).
Body? Where could we plant the Hand (d), 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 (e)? 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 lodg’d and secur’d? Where could we more commodiously Place, than in the Thorax and Belly, the useful Viscera of those Parts, so as not to swag, and jog, and over-set 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 of what is useless, or would be burdensome or pernicious to the Body (f)? 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

(d) Quam vero aptas, quamque multarum artium ministras Manus natura homini dedit? The Particulars of which, enumerated by him, see in Cíc. ubi supr. c. 60.

(e) See Book VI. Chap. 5.

(f) Ut in adificiis Architeæti avertunt ab oculis et naribus dominorum ea, que profuentia necessario tetræ effent aliquid habitura; sic natura res similes (scil. excrementa) procul amanda-vit à sensibus. Cíc. de Nat. Dór. L. 2. c. 56.
Chap. VI. of the Parts of Man's Body. 299

Body, to perform their several Offices? How could we secure and guard them so well, as in the very Places, and in the same Manner in which they are already plac'd 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 (g)? 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 although 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 defensible by the Power of Man's Reason and Art, is therefore much the properest Tegument for a reasonable Creature.

(g) Compare here Galen's Observations de Uf. Part. L. 15. c. 15. Also L. 2. c. 6. See also Cowper. 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 papille Pyramidales, the sudoriferous Glands and Vessels, the Hairs, &c.

CHAP.
C H A P. VII.

Of the Provision in Man’s Body against Evils.

Having taking 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 stay off Evils, and to discharge (a) them when fallen. 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 its Services? The Brain, the Nerves, the Arteries, the Heart (b), the Lungs; and in a

(a) 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, for the Reader’s Ease, may be met with in Dr. Harris’s Lex. Tech. Vol. 2. under the Words Glands, and Animal Secretion.

(b) 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 secur’d, and lies immur’d, or capsulated in a Cartilage, or grisy Substance, which includes the Heart, and its Auricle, as the Skull—doth the Brain in other Animals. Powers Microf. Obs. 22.
Word, all 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 contriv'd, and made to prevent Evils; so no less Art and Caution hath been us'd 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 our selves, what Eunumterories (c), what admirable Passages (d), are dispers'd throughout

(c) Here [from the Pustules he observ'd in Monomotapa,] were Grounds to admire the Conivance of our Blood, which on some Occasions, so soon as any Thing destructive to the Constitution of it, comes into it, immediately by an intense Convulsion, endeavouring 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 administered, are not only sent out of the Body themselves; but likewise great Quantities of morbid Matter; As in Salivation, &c. Dr. Sloane's Voy. to Jamaica, p. 25.

(d) Valsalva discover'd some Passages into the Region of the Ear-drum, of mighty Use, (among others,) to make Discharges of Bruises, Imposthumes, or any purulent, or mor-
bifick 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 discover'd, was through those Passages.

The other was an apoplectic Café, wherein he found a large Quantity of extravasated Blood, making Way from the Ventricles of the Brain, through those fame Passages. Valsal. de Aure hum. c. 2. §. 14. and c. 5. §. 8.

(e) 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 late 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 gather'd under his Arm, which, when they expected it would have broken, discharg'd it self by a more than ordinary large and foetid Stool; the Sore having no other Vent for it, and immediately becoming found and well thereon.

Like to which, is the Story of Jof. Lazonius, of a Soldier of thirty five Years of Age, who had a Swelling in his right Hip, accompany'd with great Pain, &c. By the Use of emollient Medicines, having ripen'd the Sore, the Surgeon intended the next Day to have open'd it; but about Midnight, the Patient having great Provocations to stool, disbursed him self three Times; immediately upon which, both the Tumor and Pain ceas'd, and thereby disappointed the Surgeon's Intentions. Ephem. Germ. Anno 1690. Obf. 49. More such Instances we find of Mr. Tonges in Philos. Transaét. No. 323. But indeed there are so many Examples of this Nature in our Phil. Trans. in the Ephem. German.Tho. Bartholine, Rhodius, Sennertus, Hildanus, &c. that it would be endless to recount them. Some have swallow'd Knives, Bodkins, Needles and Pins; Bullets, Pebbles; and twenty 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 Nature's own providing. But passing over many Particulars, I shall only give one Instance more, because
bled to make, to discharge the peccant Humours, to correct the morbid sick 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, (faith he,) is so contriv'd, as "to be well enough secur'd against the Mutati-"ons in the Air, and the leffer Errors we daily "run upon; did we not in the Excesses of Eat-"ing, Drinking, Thinking, Loving, Hating, or "some other Folly, let in the Enemy, or lay vio-"lent Hands upon our selves. Nor is the Body "fitted only to prevent; but also to cure, or mi-"tigate Diseas'es, when by these Follies brought "upon us. In most Wounds, if kept clean, and "from the Air,— the Flesh will glew together, "with its own native Balm. Broken Bones are "cemented with the Callus, which themselves "help to make". And so he goes on with am-"ple Instances in this Matter, too many to be here specify'd (f). Among which he instanceth in the Distempers of our Bodies, shewing that even ma-"ny of them are highly serviceable to the Discharge of malignant Humours, and preventing greater Evils.

And no less kind than admirable is this Con-"trivance of Man's Body, that even its Distempers

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-stones, 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. And at this Day, a young Man, living not far off me, laboureth under very trouble-some and dangerous Symptoms, from the Stones of Siles and Bullace, which he swallow'd eight or ten Years ago.

(f) Grew's Cosmol. §. 28, 29.
should many Times be its Cure (g); that when the Enemy lies lurking within to destroy us, there should be such a Reluctancy, and all Nature excited with its utmost Vigour to expel him thence. To which Purpose, even Pain itself is of great and excellent Ufe, 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.

(g) Nor are Diseases themselves useless: For the Blood in a Fever, if well govern'd, like Wine upon the Fret, discharged 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 supr. §. 52.

And as Diseases minister sometimes to Health; so to other good Ufes in the Body, such as quickening the Senses: Of which take these Inftances relating to the Hearing and Sight.

A very ingenious Physician falling into an odd Kind of Fever; 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 Bystanders, 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 asur'd me, that when he wak'd in the Night, he could for a while plainly see and distinguish Colours, as well as other Objects, discernible by the Eye, as was more than once try'd. Boyl. deter. nat. of Effluv. ch. 4.

Daniel Frafer—continu'd Deaf and Dumb from his Birth, till the 17th Year of his Age—After his Recovery from a Fever, he perceiv'd 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. Philof. Tranf. No. 312.
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 the Consent and Harmony between the Parts thereof: Of which let us take St. Paul's Description, in 1 Cor. xii. 8. But now hath God set the Members, every one of them in the Body, as it hath pleas'd 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 temper'd 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 rejoice, [and sympathize] with it, v. 26.

This mutual Accord, Consent and Sympathy of the Members, there is no Reason to doubt (a), is made by the Commerce of the Nerves (b), and

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(a) See Book 4. Chap. 8.
(b) Tria propo{\textit{s}}t\textit{a} i\textit{ps}i N\textit{ature} i\textit{n} N\textit{ervorum dispositionem} su\textit{e}-\textit{run}t. 1. Ut sen\textit{foriis} in\textit{strumentis} Sen\textit{ium} impet\textit{ert}. 2. Ut mot\textit{oriis} Motum. 3. Ut omn\textit{ibus} ali\textit{i} part\textit{ibus} d\textit{are}, ut qu\textit{ae} \textit{si} do\textit{lorem} ad\textit{ferrent}, digno\textit{serent}. And afterwards, Si quis in \textit{dis}\textit{f\textit{icien}nibus spec\textit{tar}vat, cons\textit{ider}a\textit{vitate} ju\textit{be}n\textit{e}, \textit{an} \textit{ec}us \textit{Na}\textit{tura} Nervos non \textit{ea\textit{dem} men\textit{sur}a} omnib\textit{us} part\textit{ibus} distribuerit, \textit{sed ali\textit{i} quidem} liberal\textit{iis}, ali\textit{i vero} par\textit{ci\textit{s}}, eadem cum Hip-\textit{pocrates}, ve\textit{lis} no\textit{lis}, de \textit{Natur\textit{a}} omnino pro\textit{nunciabit}, quod \textit{ea} \textit{\textit{scilicet} sagax, ju\textit{sta, \textit{arti\textit{ficiosa, \textit{an}imaliumque pro\textit{vid\textit{a\textit{e}}}}}}. Ga\textit{\textit{len. de \textit{Uf. Part. L. 5. c. 9.}}}

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their
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 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 promis'd before (c), the great Sympathy occasion'd 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 dispatch'd in fewer Words. Now this fifth Conjugation of Nerves, is branch'd 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 (d); 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 its Nerves; and lastly,

(c) Book 4. Chap. 5.

(d) Dr. Willis gives the Reason, cur multa Amasiorum oscula labis impressa, tum præcordia, tum genitalia afficiendo, a morem ac libidinem tam facile irritant, to be from the Consent of those Parts, by the Branches of this fifth Pair. Nerv. Defer. c. 22.

And Dr. Sachs judges it to be from the Consent of the Labia Oris cum Labis Uteri, that in April 1669, a certain breeding Lady, being affrighted with seeing one that had scabby Lips, which they told her were occasion'd by a pestilential Fever, had such like Pustules brake out in the Labia Uteri. Ephem. Germ. T. 1. Obs. 20.
Chap. VIII. Consent of the Parts.

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 (e) 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 is shameful, affects the Cheeks with modest Blushes; but on the contrary, if it pleases and tickles the Fancy, 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 it self by causing the Glands of the Eyes to emit Tears (f), and the Muscles of the Face to put on the sorrowful Aspect of Crying. Hence also that torvious sour Look produc'd 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 a suitable Configuration of the Muscles and Parts of the Face without. And an admirable Contrivance of the great GOD of Nature this is; That as a Face is given to Man, and as Pliny saith (g), to Man alone of all Creatures; so it should be, (as he observes,) the Index of Sorrow and Cheerfulness,

(e) Consult Willis ubi suprâ.

(f) 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 lacrymis: Flectus aurumnus levât.

of Compassion and Severity. In its ascending Part is the Brow, and therein a Part of the Mind too. Therewith we deny, therewith we consent. With this, it is we shew our Pride, which hath its Source in another Place; but here its Seat: In the Heart it hath its Birth; but here it abides and dwells; and that because it could find no other Part throughout the Body higher, or more craggy (b), where it might reside alone.

Thus I have dispatch’d 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, deserv’d to have been enlarg’d upon: But what hath been said, may suffice for a Taste and Sample of this admirable Piece of God’s Handwork; at least serve as a Supplement to what others have said before me. For which Reason I have endeavour’d 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.

(b) Nihil altius simul abruptiusque invent.

C H A P. IX.

Of the Variety of Mens 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 expressly 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
A Chap. IX. *The Variety of Men's Faces, &c.*

**The Variety throughout the World of Men's Faces (a), Voices (b), and Hand-writing.** Had Man's Body 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 founded 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 (c); no Justice between

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(a) 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.

(b) As the Difference of Tone makes a Difference between every Man's Voice, of the same Country, yea, Family; so 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 very much in their Pronunciation, Accent and Tone, although all one and the same Language. And the Way of the Gileadites proving the Ephraimites, Judg. xii. 6. by the Pronunciation of Shibboleth, with a Schin, or Sibboleth with a Samech, is well known. So à Lapide faith, the Flemings prove whether a Man be a Frenchman or not, by bidding him pronounce, *Acht en tachtentich*; which they pronounce, *Aet en tachtentic,* by Reason they can't pronounce the Aspirate *h.*

(c) *Regi Antiocho unus ex equalibus—nomine Artemon, perquam similis suffisse traditur. Quem Laodice, uxor Antiochi, interfecto viro, dissimulandi seeleris grasiâ, in lecţulo perinde X 3 quess*
between Man and Man; no Distinction between Good and Bad, between Friends and Foes, between Father and Child, Husband and Wife, Male or Female; but all would have been turn'd topsyturvey, by being expos'd to the Malice of the Envious and Ill-natur'd, to the Fraud and Violence of Knaves and Robbers, to the Forgeries of the crafty Cheat, to the Lusts of the Effeminate and Debauch'd, and what not! Our Courts of Justice (d), 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 order'd 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 (e).


(d) Quid Trebellius Calca! quam afferveranter se Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium adeo favorabilis defendit, ut vix justis & aquis sentissent consenuntio populi ullum relinquueret locum. In illa tamen quaestione neque calumnia, neque violentia plebis judicantium religio cessit. Val. Max. ib. c. 15.

(e) 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 seem'd to me somewhat odd, but very providential; and that is, the Value that Mankind, at least the civiliz'd 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, Clothing, and all other Necessaries and Conveniences of Life. Where-as 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
of Nero, who sph'd with a Net gilt with Gold, and shod his Mules with Silver; but his Wife Poppea, shod her Horses with Gold. Vit. Ner. c. 30. Plin. N. H. L. 33. c. 11. So the same Suetonius tells us, Jul. Caesar lay in a Bed of Gold, and rode in a silver Chariot. But Heliogabalus rode in one of Gold, and had his Clofe-Stool Pans of the same Metal. And Pliny faith, *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, Imperibility, and Ductility. Of which last, the great Mr. Boyle hath among others, these two Instances, in his Essay about the Subtilty of Effluviums. Chap. 2. Silver, whose Ductility, and Tractility, are very much inferior to those of Gold, was, by my procuring, drawn out to so flender a Wire, that—a single Grain of it amounted to twenty seven Feet. As to Gold, he demonstrates it possible to extend an Ounce thereof, to reach to $777600$ Feet, or 155 Miles and an half, yea, to an incredibly greater Length.

And as to Gems, the very Stories that are told of their prodigious Virtues, 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 Poifons; that the Ruby should dispose to Cheerfulness, cause pleafant Dreams, change its Colour against a Misfortune befalling, &c. that the Sapphire should grow foul, and lose its Beauty, when worn by one that is Lecherous; that the Emerald should fly to pieces, if it touch the Skin of any unchaste Perfon in the Act of Uncleanness: That the Chryfolette should lose its Colour, if Poyson be on the Table, and recover it again when the Poyfon is off: And to name no more, that the Turcoife, (and the fame is faid of a gold Ring,) should strike the Hour when hung over a drinking Glas, and much more to the fame Purpose: All these, and many other such fabulous Stories, I fay, of Gems, are no great Arguments, that their Virtue is equivalent to their Value. Of these, and other Virtues, consult *Worm in his Museum, L. 1. §. 2. c. 17,* &c.

But as to Gems changing their Colour, there may be somewhat of Truth in that, particularly in the Turcoife last mention'd. Mr. Boyle observ'd the Spots in a Turcoife, 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 observ'd to be more illuftrious at some Times than others: Which a curious Lady told him she had also observ'd in hers. So likewise a rich Ruby did the fame. Boyle of *Absol. Refl in Bodies.*
AND now having taken a View of Man, and finding every Part of him, every Thing relating to him contriv'd, and made in the very best Manner; his Body fitted up with the utmost Fore-sight, Art and Care; and this Body, (to the great Honour, Privilege, and Benefit of Man,) possefs'd 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 Praisef 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 (a), in some of his noblest Works?

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(a) It was a pious, as well as just Conclusion, the ingenuous Laurence Bellini makes of his Opusculum de Motu Cordis, in these Words: De Motu Cordis isfìbìc. Què equidem omnia, si à rudi intelligence Hominis tantum consilii, tantum ratiocini, tantum peritis mille rerum, tantum scientiarum exigunt, ad hoc, ut inventiqur, seu ad hoc, ut percipientur posquum facta sunt; ilium, cujus operà, sabrefacta sunt hoc singula, tam vanì
Works? Should we so abuse our Reason, yea, our very Senses; should we be so befuddled by the Devil, and blinded by our Lusts, as to attribute one of the best contriv'd 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 (b) in any Age since the Creation? No, No! But like wise and unprejudic'd Men, let us with David say, Psalm cxxix. 14.

vani erimus atque inanes, ut existimemus esse consilii impotem, rationis expertem, imperitum, aut ignorantium omnium rerum? Quantum ad me atiner, nolim esse Rationis compos, si tanum insudandum mihi esset ad consequendam intelligentiam earum rerum, quas fabre faceret nescio qua Vis, quae nibil intelligere eorum quae fabresceres: mihi etenim viderer esse vile quidam, atque ridiculum, qui vellem totam atatem meam, sanitatem, & qui quid humanum est deterere, nibil curare quicquid est ju- cunditatem, quicquid litterarum, quicquid commodorum; non divitias, non dignitates; non paenae etiam, & vitam, ipsam, ut gloriari possem posse reme invi nisse unum, aut Alterum, & for- tasse me invinisse quidem ex iis innumeris, quae produxisset, nescio quis ille, qui sine labore, sine cura, nibil cogitans, nibil cogitans, non unam aut alteram rem, neque dubie, sed certò produxisset innumeris innumerabilibus rerum in hoc tam immenso spatio corporum, ex quibus totius Mundus compingitur. Ab Deum immortalem! Video præfens numen tuum, & hisce tam prodigiosis Generationis iniuris, & in altissimâ eorum contemplatione defixus, nescio quo auro admirationis conciter, & quas dividit fiere nobis cohiberi mi minimè possum quin exclamem Magnus Dominus! Magnus Fabricator Hominum Deus! Magnus atque Admirabilis! Conditor rerum Deus quàm Magnus es! Bellin. de Mot. Cord. fin.

(b) Hoc [i.e. mundum effici ornatissimum, & pulcherri- mum ex concusione fortuitâ] qui existimatis fieri potuisse, non intelligite cur non idem putet, si innumerables unius, & v击isti forma literarum, vel aures, vel qualibet, aliquid conscianetur, posse ex his in terram exuflis annales Ennii ut deinceps legi pos- sini, effici, &c._—Quod si Mundum essetur potesconservus Atomorum, cur porticum, cur templum, cur domum, cur ur- bem non potes? Quæ sunt minus operosa, & multo quidem sa- ciliora. Cicero de Nat. Deor, L. 2. c. 37.
The Conclusion. Book V.
(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 inferior Creatures; and begin with Quadrupeds.
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 Superintendence 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 ministering 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, that 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, unwieldy Body (a); in others they are made for Agility and Swiftness (b), in some they are made for only Walking and Running, in others for that, and Swimming too (c); in others for Walking and Digging (d); and in others for Walking and Flying (e): In some they are made more lax and weak, for the plainer Lands; in others rigid, stiff, and less flexible (f), for travelling

(a) 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.

(b) Deer, Hares, and other Creatures, remarkable for Swiftness, have their Legs accordingly slender, but withal strong, and every way adapted to their Swiftness.

(c) Thus the Feet of the Otter are made, the Toes being all conjoined 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 joined together: And this was requisite for the Convenience of this Animal, which useth them as Hands like a Squirrel, when he eats. Memoirs for a Nat. Hist. of Animals, pag. 84.

(d) The Mole's Feet are a remarkable Instance.

(e) The Wings of the Bat are a prodigious Deviation from Nature's ordinary Way. So 'tis in the Virginia Squirrel, whose Skin is extended between the Fore-Legs and its Body.

(f) Of the Legs of the Elk, the French Academists say, Although some Authors report, that there are Elks in Mosco-

Chap. I. The Posture of Quadrupeds.

ing the Ice, and dangerous Precipices of the high Mountains (g); 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 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.

II. 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.

via, whose Legs are jointless; there is great Probability, that this Opinion is founded on what is reported of those Elks of Muscovia, 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 without slipping; which is a Way that is reported that they have to save themselves from the Wolves, &c. ibid. p. 108.

(g) The common tame Goat (whose Habitation is generally on Mountains and Rocks, and who delighteth to walk on the tops of Pales, Houfes, &c. and to take great and seemingly dangerous Leaps) I have observ’d, hath the Joints 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.

(h) Thus in Apes and Monkeys, in the Beaver before, and divers others.

And
And now I might here add a Survey of the excellent Contrivances of the Parts ministering to this Posture of the four-footed Animals, the admirable Structure of the Bones (i), the Joints 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 (k), and which are manifest Works of Design.

(i) It is a singular Provision Nature hath made for the Strength of the Lion, if that be true, which Galen faith 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 Uf. Part. L. II. c. 18.

(k) 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. i. B. i. c. 17.
Of the Heads of Quadrupeds.

It is remarkable, that in Man, the Head is of one singular Form; in the four-footed Race, as various as their Species. In some square and large, suitable to their slow Motion, Food, and Abode; in others less, slender, and sharp, agreeable to their swifter Motion, or to make their Way to their Food (a), or Habitation under Ground (b). 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 Subsistance 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

(a) 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.

(b) What hath been said of Swine is no less, rather more remarkable in the Mols, whose Neck, Nose, Eyes and Ears, are all fitted in the nicest Manner to its subterraneous Way of Life.
Part (c): "Since, faith 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; 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 capable of Speculation, the Cerebellum, (whose Business it is to minister to the Actions and Functions of the Precordia, the principal Office in those Creatures) in them is situated in the higher Place, and the Cerebrum lower. Also some of the Organs of Sense, as the Ears and Eyes, are placed, if not above the Cerebrum, yet at least equal thereto.

Another Convenience in this Position of the Cerebrum and Cerebellum, the last ingenious Anatomist (d) tells us is this, "In the Head of Man, faith 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 joggling, or flipping out of their Place. But in Quadrupeds, whose Head hangs down, the Base of the Skull makes a right Angle with the Horizon, by which Means the Brain is undermost, and the Cerebell uppermost; so that one would be apt to imagine the Cerebell should not be steady, but joggle out of its Place. To remedy which Inconvenience he tells us, And left the frequent Concussions of the Cerebell should cause a Fainting, or disorder-

(d) Id. paulo post. In capite humano Cerebri & Cerebelli, &c.
Chap. II. The Heads of Quadrupeds.

"ly Motion of the Spirits about the Præcordia, therefore, by the Artifice of Nature, sufficient Provision is made in all, by the dura Meninx clofely encompassing the Cerebellum; besides which, it is (in some) guarded with a strong bony Fence; and in others, as the Hare, the Coney, and such lesser Quadrupeds, a part of the Cerebell is on each Side fenced with the Os Petrosum: So that by this double Stay, its whole Mass is firmly contained within the Skull.

Besides these Peculiarities, I might take notice of divers other Things no less remarkable, as the Nictitating Membrane of the Eye (e), the different Passages of the Carotid Arteries (f) through the

(e) See Book IV. Ch. 2. Note (kk).
(f) Arteria Carotis Aliquanto posterius in homine quàm in alio quovis animali, Calvariae ingreditur, sicil. juxta illud foramen, per quod finus lateralis in Venam jugularem desideratur crania elabitur; nam in cätaris hac arteriá sub externitate, fēd processu acuto offis petros, inter cranium emergit: verum in ca-pite humano, eadem, ambage longiori circumducēt (ut sanguinis torrens, prīusquam ad cerebrī oram appellīs, frāctō imperu, leniūs & placidius fluat) prope spēcium ab ingressu sinūs lateralis faetum, Calvariae basin attingit; & in majore cautelam, sunicā insuper ascititiatr cæssiore invenitur. And so he goes on to shew the Conveniency of this Guard the Artery hath, and its Passage to the Brain, and then faith, Si hujusmodi conformationis ratio inquiritur, facile occurrīt, in capite humano, ubi generosi affeetus & magno animorum impetus ad ardores excitantur, sanguinis in Cerebrī oras appulsūm debere esse liberum & expeditum, &c. Atque hoc quidem rectē differt Homo à plerique Brūtis, quibus, Arteria in milla surculos divīsa, ne sanguinem pleniore alveo, aut citatione, quàm par est, cursu, ad cerebrum venhat, Plexus Retiformis constituit, quibus nempé efficiuer, ut sanguis tardò admodum, lenique & aquabili fere sillicidio, in cerebrum illabatur. And then he goes on to give a farther Account of this Artery, and the Rerum mirabile in divers Creatures. Willis, ibid. cap.8.
The Necks of Quadrupeds. Book VI.

Skull, their Branching into the Rete Mirabile (g), 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 enlarging upon these admirable Works of God.

(g) Galen thinks the Rete mirabile is for concocting and elaborating the Animal Spirits, as the Epididymides, [the Convolutions ενίκατερας ἐλικτον] 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 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 bridding the too rapid Current of 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 Pur- pose.

CHAP. III.

Of the Necks of Quadrupeds.

FROM the Head pass we to the Neck, no prin-
cipal Part of the Body, but yet a good In-
fstance of the Creator's Wisdom and Design, in-
asmuch 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
Chap. III. The Necks of Quadrupeds.

Legs (a), and in some of these long, and less strong, serving to carry the Mouth to the Ground; in others shorter, brawny and strong, serving to dig, and heave up great Burdens (b).

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 (c) 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

(a) 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 unwieldy Creature 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. Moulen'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 rostris facile contingat. Quae autem altiora sunt, ut Anseres, ut Cygni, ut Grues, ut Camelii, adjuvantur proceritate collorum Manus etiam data Elephas, qui propter magnitudinem corporis difficiles aditus habeant ad palatum. Cic. de N. D. L. 2. c. 47.


(b) As in Mules and Swine, in Ch. 2. Note (a).

(c) Called the Whistleather, Packwax, Taxwax, and Firfax.
Neck, that would otherwise be wearied by being so long put upon the Stretch.

**C H A P. 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. (a) 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 fute 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 peculiar

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(a) The peculiar Contrivance and Make of the Dromedary's or Camel's Stomach, is very remarkable, which I will give from the Parifian 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 faith, 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.
Chap. V. The Hearts of Quadrupeds.

particular Enquiry; but having formerly mention-
d it (b), and least I should be too tedious, I shall
pass it by.

(b) Book IV. 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 no-
tice of the remarkable Confirmation of the Hearts
of Amphibious Quadrupeds, and their Difference
from those of Land-Animals, some having but one
Ventricle (a), some three (b), and some but two
(like Land-Animals) but then the Foramen Oval
therewith (c). All which may be justly esteemed as

(a) Frogs are generally thought to have but one Ventricle
in their Hearts.

(b) The Tortoise hath three Ventricles, as the Parisian A-
cademists in their Memoirs affirm. Besides these two Venti-
cles [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. Buffere charges this as a Mi-
Istake in those ingenious Gentlemen, and afferts there is but
one Ventricle in the Tortoise's Heart. See his Description
328.

(c) 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 Ar-
ticles 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 pen-

as wonderful, as they are excellent Provisions for the Manner of thofe Animals living. But I fhall content my self with bare 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 (d). The Reasons of which I fhall give from one of the moft curious Anatomifts of that Part (e). "Seeing, faith he, the Trajec-
tion and Distribution of the Blood depends wholly on the Syftole of the Heart, and that its Liquor is not driven of its own Nature so readily into the upper Parts as into Veflels even with it, or downwards into those under it: If the Situation of the Heart had been further from the Head, it muft needs either have been made stronger to cast out its Liquor with greater Force; or else the Head would want its 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 moft part hanging down; and fo the Blood, as it hath farther to go to their Head than in others, fo it goes a plainer and often a steep Way (f).

The hearts of Quadrupeds. Book VI.

...
The other peculiar Matter is, the fastening (I formerly mentioned) which the Cone of the Pericardium hath in Man to the Diaphragm (g), 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 (h), which would be hindred, 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-fours, as Quadrupeds do: To express it in the Words of a great Judge in such Matters (i).
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 (a), 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) (b) of the intercostal Pair sent from the Cervical Plexus to the Heart, and Precordia. By which Means the Heart and Brain of Man have a

(a) 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.

(b) In plerisq; Brutis tansum hac viā (i. e. by the Par vagum) & vix omnino per idlos Paris Intercofalis nervos, aditus ad cor aut Appendicem ejus patēscit. Verum in Homine, Nervus Intercofalis, prater officia ejus in imo ventre huic cum catēris animalibus communia, etiam ante pectoris clausura internumcii specialis loco est, qui Cerebri & Cordis sensa mutua ultra sitaque referent. Willis Ner vor. descr. & usus, Cap. 26.
mutual and very 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 faith (c), "Brutes are as 'twere Machines made with a simpler, "and les operose Apparatus, and endowed there-
fore with only one and the same Kind of Motion, or determined to do the same Thing: "Whereas in Man, there is a great Variety of "Motions and Actions. For by the Commerce "of the aforesaid Cervical Plexus (d) he faith, "The Conceptions of the Brain presently affect "the Heart, and agitate its 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 contrary, when any Thing affects or alters "the Heart, those Impressions are not only re-
torted to the Brain by the same Duct of the "Nerves, but also the Blood it self (its Course "being once changed) flies to the Brain with a "different and unusual Course, and there agita-
ting the animal Spirits with divers Impulses, "produces 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

(c) Id. ib. Durn hanc utrinque speciei differentiam perpendo, suocurrit animo, Bruta esse velut machinam, &c.

(d) 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 faith, Pracipua autem discriminis nota quam inter illius & viri cordati partes advertemus, hece erat; nempt quod praedictus Nervi Interca-
stialis Plexus, quem Cerebri & Cordis internuncium & Homi-
讵 proprium diximus, in Stulto hoc valde exilis, & minori Nervorum satellitio stipatus fuerit. Ibid.
certainly (faith 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 pur-
pose. Upon the Account of this IntercoJial Com-
merce with the Heart, being wanting in Brutes, 
there is another singularly careful and wise Pro-
vision the infinite Creator hath made in them, 
and that is, That by Reason both the Par Vagum 
and the IntercoJial too, do not send their Branches 
to the Heart, and its Appendage in Brutes, there-
fore, left their Heart should want a due Propor-
tion of Nervous Vessels, the Par Vagum sends 
more Branches to their Heart than to that of 
Man. This as it is a remarkable Difference be-
tween Rational and Irrational Creatures; so it is 
as remarkable an Argument of the Creator's Art 
and Care; who altho' he hath denied Brute-Ani-
mals Reason, and the Nerves ministering 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 (e); " In-
asmuch, faith he, as Beasts are void of Discre-
tion, and but little subject to various and diffe-
rent Passions, therefore there was no need that 
the Spirits that were to be convey'd from the 
Brain to the Precordia, should pass two different 
Ways, namely, one for the Service of the vital 
Functions, and another for the reciprocal Impres-
sions of the Affections; but it was sufficient that 
all their Spirits, whatever Use they were de-
signed for, should be conveyed one and the same 
Way.

(e) Id. ib. cap. 29. In quantum Bestiae prudentia carente varis diversisque passionibus, &c.
Chap. VII.  

The Conclusion.

Here now in the Nervous Kind we have mani-

fest Acts of the Creator's Design and Wisdom, in

this so manifest and distinct a Provision for Ratio-

nal 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 wonder-
ful 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 Happi-

ness, 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 a-
ny way accidental, that every Thing is done for
the best; all wisely contrived, and incomparably
fitted up, and every way worthy of the great Cre-
ator. And he that will shut his Eyes, and not see

God
The Conclusion. Book VI.

God (a) in these his Works, even of the poor Beasts of the Earth, that will not say (as Elihu hath it, Job xxxv. 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. xlxix. 12. That he is like the Beasts (b) that perish.

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(a) Deum namque ire per omnes
Terraque tractusque Maris, Cælumque profundum.
Hinc Pecudes, Armenia, viros, genus omne Ferarum.


(b) Ilos qui nullum omnino Deum esse dixerunt, non modâ non Philosophos, sed ne homines quidem fuisse dixerim; qui, mutis simillimi, ex solo corpore consisterunt, nihil videntes animo. Laëtant. L. 7. c. 9.

BOOK
HAVING briefly, as well as 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 observ'd.

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 shap'd, 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
I. And most visible Thing, is the Shape and Make of their Body, not thick and clumsy, but incomparably adapted to their Flight: Sharp before, to pierce and make Way through the Air, and then by gentle Degrees rising to its full Bulk. To which we may add,

II. The neat Position of the Feathers throughout the Body; not ruffled, or discompos'd, or plac'd some this, some a contrary Way, according to the Method of Chance; but all artificially plac'd (a), for facilitating the Motion of the Body, and its 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 and regular Method, armed with warm and soft Down next the Body, and more strongly made, and curiously clos'd 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 (b), Glands, and whole Apparatus for that Service.


(b) Mr. Willoughby faith, 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 enquir'd 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 prefixed, 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.

III. And
Chap. I. The Wings of Birds.

II. And now having said thus much relating to the Body's Motion, let us survey the grand Instrument 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 (c), to give it an exact Equipoise 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 gaug'd 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 (d).

(c) 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 balance 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 Equipoise, 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 Book IV. Chap. 8. Note (q).

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. Chap. 4. Note (k) of this Book.

(d) The wise Author of Nature hath afforded an Example of the great Nicety in the Formation of Birds, by the Nicety observ'd in a Part no more considerable than the Vanes of the Flag-feathers of the Wing. Among others, these two Things are observables: 1. The Edges of the exterior or narrow Vanes bend downwards, but of the interior or 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 mis its full Force and Impulse upon
And no less exquisite is the textrine Art of the Plumage (e) also, which is so curiously wrought,

upon the Air. 2. A yet lesser Nicety is observ'd, and that is, in the very floping the Tips of the Flag-feathers: The interiour Vanes being neatly flop'd away to a Point, towards the outward Part of the Wing; and the exteriour Vanes flop'd towards the Body, at least in many Birds; and in the Middle of the Wing, the Vanes being equal, are but little flop'd. So that the Wing, whether extended or shut, is as neatly flop'd and form'd, as if constantly trimm'd with a Pair of Scissors.

(e) Since no exact Account that I know of, hath been given of the Mechanism of the Vanes, or Webs of the Feathers, my Observations may not be unacceptable. The Vane consists not of one continu'd Membrane; because if one broken, it would hardly be reparable: But of many Lamina, which are thin, fliff, and somewhat of the Nature of a thin Quill. Towards the Shaft of the Feather, (espacially in the Flag-feathers of the Wing,) those Lamina are broad, etc. of a semicircular Form; which serve for Strength, and for the closer shutting of the Lamina to one another, when Impulses are made upon the Air. Towards the outer Part of the Vane, these Lamina grow flender 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 flender and bearded above the other half. I have, as well as I could, represented the uppermost Edge of one of these Lamina in Fig. 18. with some of the Hairs on each Side, magnify'd with a Microscope. These bearded Briftles, or Hairs, on one Side the Lamina, have strait Beards, as in Fig. 19. those on the other Side, have hook'd Beards on one Side the flender Part of the Bristle, and strait ones on the other, as in Fig. 20. Both these Sorts of Briftles magnify'd, (only scattering, and not close,) are represented as they grow upon the upper Edge of the Lamina $f. t.$ in Fig. 18. And in the Vane, the hook'd Beards of one Lamina, always lie next the srait Beards of the next Lamina; and by that Means lock and hold each other; and by a pretty Mechanism, brace the Lamina close to one another. And if at any Time the Vane happens to be ruffled and discompus'd, it can by this pretty easy Mechanism, be reduc'd and repair'd. Vid. Book IV. Chap. 12. Note (m).
Chap. I. The Tails of Birds.

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 Joints, 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 (f) in Birds than in Man, or any other Animal, not made for Flying.

IV. Next the Wings, the Tail is in Flight considerable; greatly assisting in all Ascents and De-


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. I. c. I. § 19.
scents in the Air, as also serving to steady (g) Flight, by keeping the Body upright in that subtle and yielding Medium, by its readily turning and answering every Vacillation of the Body.

And now to the Parts serving to Flight, let us add the nice and compleat Manner of its Performance; all done according to the strictest Rules of Mechanism (b). What Rower on the Waters, what Artist on the Land, what acutest Mathematician could give a more agreeable and exact Motion to the Wings, than these untaught flying Artists do theirs! Serving not only to bear their Bodies up in the Air, but also to waft them along therein, with a speedy progressive Motion, as also to steer and turn them this Way and that Way, up and down, faster or slower, as their Occasions require, or their Pleasure leads them.

V. Next to the Parts for Flight, let us view the Feet and Legs ministering to their other Motion: Both made light, for easier Transportation through the Air; and the former spread, some with Membranes for Swimming (i), some without, for steady Going.

(g) Mr. Willughby, Ray, and many others, imagine the principal use of the Tail to be to steer, and turn the Body in the Air, as a Rudder. But Borelli hath put it beyond all doubt, that this is the least use of it, and that it is chiefly to assist the Bird in its Ascents and Descents in the Air, and to obviate the Vacillations of the Body and Wings. For as for turning to this or that Side, it is performed by the Wings and Inclination of the Body, and but very little by the help of the Tail.

(b) See Borelli ubi supr. Prop. 182, &c.

(i) It is considerable in all Water-Fowl, how exactly their Legs and Feet correspond to that way of Life. For either their Legs are long, to enable them to wade in the Waters: In which case, their Legs are bare of Feathers a good way above the Knees, the more conveniently for this Purpose. Their Toes also are all abroad; and in such as bear the Name
The Legs of Birds.

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Going, for Perching, for Catching and Holding of Prey (k), or for Hanging by the Heels to gather their Food (l), or to fix themselves in their Places of Retreat and Safety. And the latter, namely the Legs, all curved for their easy Perching, Roofting, 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 (m). To all which let us add the placing these last mentioned

Name of Mudfuckers, 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 whole 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.

(k) 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. Rail Synopf. Av. Method. p. i.

(l) Such Birds as climb, particularly those of the Wood pecker Kind, have for this Purpose (as Mr. Willughby observes, L. 2. c. 4.) 1. Strong and muscular 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.

(m) Swifts and Swallows have remarkably short Legs, especially the former, and their Toes grasp any Thing very strongly.
tioned Parts in the Body. In all somewhat out of the Center of the Body's Gravity (n), but in such as swim, more than in others, for the better rowing their Bodies through the Waters, or to help them in that Diving (o) too.

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 Grotto's, 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 Cornwall, saw at a very low Ebb, a black Lift 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, Chap. 3. Note (d) of this Book.

(n) 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.

(o) See Chap. 4. Note (k).

C H A P. II.

Of the Head, Stomach, and other Parts of Birds.

Thus having dispatched the Parts principally concerned in the Motion of the Feather'd Tribe, let us proceed to some other Parts not yet ani-
Chap. II. The Heads of Birds.

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 (a), and both very different from Man and Beasts; and lastly, to hint at no more, I might survey the peculiar Structure of the Larynx (b), the Tongue

(a) Cerebra Hominum & Quadrupedum in plerisque similia exsunt. — Capitibus Volucrum & Piscium contenita, ab urisque prioribus longè diversa, tamen inter se, quoad præcipius exsérpiung partes, Symbola referuntur. 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.


The Aspere Arteria is very remarkable in the Swan, which is thus described by T. Bartholin, viz. Aspere Arteria admittere sat is stru cutur. Nam pro Colli longitudine dorsum Oesophagi comes pretentiur donec ad sternum perveniat, in cujus capsulam se incurvo flexu insignat & recondit, veluti in tuto loco & theca, mosque ad fundum ejusdem cavitas delata sursum reflectitur, egrediaturque angustias Sterni, & Claviculis medius concen sit, quibus ut fulcro nititur, ad Thoracem se flectit — Miranda hercle modis omnibus constituto Respirationi invict
The Heads of Birds. Book VII.

Tongue (c), the inner Ear (d), and many Matters besides;

inferrvit & Voci. Nam eum in stagnorum fundo edulia pro
vištā quarat, longissimo indicuit collo, ne longa mora suffocationis
incurreret periculum. Et certe dum dimidiam fere horam
toto Capite & Collo pronis vado immersitur, pedibus in altum
elatis eoque obversis, ex ea Arteria quæ pectoris dixtæ vagina
reclusa est portione, tanquam ex condo promō spiritum haurit.
Blaf. ib. c. 10.

(c) 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 flab, to stick unto, and draw
out little Maggots out of Wood. Utilis enim Picis (faith
Coiter) ad Vermiculos, Formicas, aliaque Insecta venanda talis
Lingua foret. Siquidem Picus, innata suâ sagacitate cum de-
prehendit alibi in arboribus, vel carie, vel alia de causâ cava-
tis, Vermes insectaque delitescere, ad illas volitât, seseque
gitis, ungulísque posterioribus robustissimis, & Cauda pennis ri-
gidissimis suscentat, donec valido ac peracuto Rostrō arborem per-
tundat; arbore pertusa, foramīni rostrum immittit, ac quo a-
nimacula stridore excitet percellatque, magnam in arboris cavo
emittit vocem, insecta vociferatione hâc concitata huc illuque
repunt; Picus v. linguam suam exerit, atque aculeis, hamis-
que animalia insula, insixa attrabit & devorat. Vid. Blasii u-

(d) I have before, in Book IV. Chap. 3. Note (a), taken
notice of what others have observed concerning the inner
Ear of Birds, referring my own Observations for this Place:
Which I hope may be acceptable, not only for being some
of them new, but also shewing the Mechanism of Hearing
in general.

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, Baton 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 Car-
tilage, consisting of three Branches, a. b. c. in Fig. 23. The
longest
Chap. II. The Heads of Birds.

The longest middle Branch a. is joined 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. e. are joined 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. e. are joined to the outer Membrane, and make 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 side-ways, and to hinder them from flying too much back: There is a very fine slender Ligament extended from the opposite side, quite across the Meatus or Bason, to the Bottom of the Cartilage, near its joining to the Columella. Thus much for the Membrane Tympani, and their Cartilages.

The next Part is the Columella (as Schelhammer calls it.) This is a very fine, thin, light, bony Tube; the Bottom of which spreads about, and gives it the resemblance of a wooden Pot-lid, such as I have seen in Country-Houses. It exactly fits 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 Auditis. 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, Columnma, 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.
The Heads of Birds. Book VII.

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 Affurance 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 (e).

And now if we compare the Organ and Act of Hearing, with those of Sight, we shall find, that the Conclave is to Hearing, as the Retina is to Sight; that honorous 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 correspondent 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 Joints, 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 joined thereunto (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 displaced or relaxed, as it is in Man, by the Malleus and its Muscle, &c.

(e) Flat-billed Birds, that grope for their Meat, have three Pair of Nerves, that come into their Bills, whereby they have that Accuracy to distinguish what is proper for Food, and what to be rejected by their Taste, when they do not see it. This was most evident in a Duck's 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.
And now from the Head and Mouth, pass we to its near Ally, 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 membraneous, agreeable to the frugivorous, or carnivorous Kind; some musculus and strong (f), suited to the Commination, 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 other Things, no less curiously contriv’d, made and suited to the Occasions of these Volatiles; as particularly the Structure and Lodg-

smaller than any of the three Pair of Nerves, in the Bills of Ducks, but larger than the Nerves in any other round-bill’d Birds. And ’tis remarkable that these Birds, more than any other round-bill’d Birds, seem to grope for their Meat in Cow-dung, &c. Mr. J. Clayton, in Philos. Transact. No. 206.

I observ’d three Pair of Nerves in all the broad-bill’d Birds that I could meet with, and in all such as feel for their Food out of Sight, as Snipes, 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. A. Moulen. Ibid. No. 199. Or both in Mr. Lowthorp’s Abridg. V. 2. p. 861, 862.

(f) 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, try’d by Seigneur Redi, with glass Bubbles, solid Glass, Diamonds, and other hard Bodies. See his Exp. Nat.
ment of the Lungs (g); the Configuration of the Breast, and its 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 proportion'd to the Length of the Legs, or else longer, to hunt out Food, to search in the Waters (b); as also to counterpoise the Body in Flight (i). And lastly, I might

(g) 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 loofe, 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 Vifera, 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 Book I. Chap. 1. Note (b)); that is, into the foremention'd Bladders; so that by blowing into the aspera Arteria, the Lungs will be a little rais'd, 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 (i).

(b) 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 Bottom of Rivers, &c. Willughby's Ornithol. L. 1. c. 1. §. 7.

(i) We have sufficient Instances of this in Geese, Ducks, &c: whose Wings, (their Bodies being made for the Convenience of Swimming,) are plac'd out of the Center of Gravity, nearer the Head. But the extending the Neck and Head in Flight, causeth a due Aequipoise and Libration of the Body upon the Wings. Which is another excellent Use of the long.
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 (k), 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 a Glance of one or two Things, relating to their State; and so conclude this Genus of the animal World.

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 tuck'd up in Flight,) over-balance 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.


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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 himself instanceth in it,) shall be their Migration, mention'd, Jer. viii. 7. Yea, the Stork in the Heaven knoweth her appointed Times, and
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 (a), 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 appointed Times (b), in the Text, to be such Times as the Creator hath appointed those Animals, and hath accordingly, for this End, imprinted upon their Natures such an Instinct, as excite and


(b) From ὥθησεν, constituit, scil. locum, vel tempus, ubi vel quando aliquid fieri debet. Buxt. in verb.

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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 (c) 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 persuade them, that that Land is more proper for their Purposes, than this? That Britain, (for Instance,) should afford them better Accommodations than Egypt (d), than the Canaries, than Spain, or

(c) Quis non cum admiratione videat ordinem & politiam per-reginantium Avium, in sitinere, turmatim volantium, per longos terrarum & maris tracitus absque Acu marinâ?—Quis eas certum iter in aëris mutabili regione docuit? Quis præterita signa, & futura vie indicia; quis eas ductit, nutrit, & vitae necesaria miniatur? Quis insulas & hospitia, illa, in quibus victum reperiant, indicavit; modumque ejusmodi loca in per-regnationibus fuis inveniendi? Hac sanè superant hominum capsum & industriam, qui non nisi longis experiencis, multis iter-nariis, chartis geographicis,—& acis magnesia beneficio,—ejusmodi marium & terrarum tractus con amore tentant & audient. Lud. de Beaufort. Cosmop. divina Sect. 5. c. 1.

(d) In instance particularly in Egypt, because Mr. Willughby thinks Swallows fly thither, and into Ethiopia, &c. and that they do not lurk in Holes, or under Water, as Olaus Magnus Reports. Vid. Ornith. L. 2. c. 3. But Etmuller puts the Matter out of doubt; who faith, Memini me plures, quam quas Medimmus caperit, Hirundines arēs coacertaetas intra Piscina canhas, sub glacie profus ad sensum examines pulsantes tamen, reperisse. Etmuller Differt. 2. c. 10. §. 5. This as it is like what Ol. Magnus’ faith, so is a Confirmation of it. The Archbishops Account is, In Septentrionalibus aquis fapi-us casus Piscatoris extrahuntur Hirundines, in modum conglomera-
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 (e) for Flight.

merate massa, que ore ad os, & alâ ad alam, & pede ad pedem post principium autumni sese inter cannas descensura colligáruit. 


Since my penning this Note, we had, at a Meeting of the Royal-Society, Feb. 12. 1712.13. 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, faith, that he saw six-teen Swallows so drawn out of the Lake of Samrodt, and about Thirty out of the King's great Pond in Rosineilen; and that at Schlebitten, near an House of the Earl 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 observ'd the Swallows to be often weak for some Days after their Appearance.

(e) 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 in Mr. Willughby, faith, When we fail'd from Rhodes to Alexandria of Egypt, many Quails flying from the North towards the South, where taken in our Ship; whereas I am verily persua- ded, that they shift Places: For formerly also, when I fail'd out of the Isle of Zant to Morea, or Negropont, in the Spring Time, I had observ'd Quails flying the contrary Way, from South to North, that they might abide there all Summer. At which Time also, there were a great many taken in our Ship. Ornith. p. 170.
A Nother Thing relating to the State of this Tribe of Animals, is their Incubation.

And first, the Egg it self deserves our Notice. Its Parts within, and its 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 (a), before its Exit into the World, and another for its Nourishment, after it is come into the World, till the Bird is able to shift for, and help it self; and that these Parts should be so accurately braed, and kept in due Place (b), is certainly a design'd, as well as curious Piece of Workmanship.

And

(a) The Chicken is form'd out of, and nourish'd by the White alone, till it be grown great. The Yolk serves for the Chicken's Nourishment, after it is well grown, and partly also after it is hatch'd. For a good Part of the Yolk remains after Exclusion, being receiv'd into the Chicken's Belly; and being there serv'd, as in a Store-house, is by the [Appendicula, or Ductus intestinatis,] as by a Funnel, convey'd into the Guts, and serv'd instead of Milk, &c. Willugh. Ornith. L. 1. c. 3. Ipsum animal ex albo liquore Ovi corporatur. Cibus ejus in lutco est. Plin. L. 10. c. 53.

Aristotle faith, 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 Sott at Syracuse, that fate drinking so long, till Eggs were hatch'd; as also of the Custom of Egypt, of hatching Eggs in Dunghills.

(b) 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 Tredlle, so call'd, because it was formerly
And then as to the Act it self, 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 (c)? What 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 ἔργα is in bringing them up until, and only until, they are able to shift for themselves.

originally thought to be the Sperm of the Cock. But the Use of these, (faith Dr. Harvey in Willughb. Ornith. c. 3.) is to be as twere, the Poles of this Microcosm, and the Connections of all the Membranes twisted and knit together, by which the Liquors are not only conserv'd, 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 observ'd; for I find, that thes Chalazæ, or Treddles, serve not barely to keep the Liquors in their Place, and Position to one another; but also to keep one and the same Part of the Yolk uppermoft, let the Egg be turn'd 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 brac'd 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 two Whites, is by its own heavy Side kept with the same Side always uppermoft; which uppermoft Side I have some Reason to think, is that, on which the Cicatricula lies; that being commonly uppermoft in the Shell, especially in some Species of Eggs more I think than others.

(c) 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 Wis. of God, p. 137.

And
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 (d), 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. iv. 3. The Daughter of my People is become cruel, like the Ostriches in the Wilderness. This is more plainly expressed in Job xxxix. 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 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, i. Of this anomalous Way of Generation. It is not very strange, that no other Incubation but that of

(d) The Tabon is a Bird no bigger than a Chicken, but is said to lay an Egg larger than a Goose’s Egg, and bigger than the Bird itself. These they lay a Yard deep in the Sand, where they are hatch’d by the Warmth of the Sun; after which they creep out, and get to Sea for Provisions. Navarette’s Accounts of China in Collect. of Voyages, Vol. 1. This Account is in all Probability borrow’d from Nieremberg, or Hernandez, (that copy’d from him,) who call this Bird by the Name of Dais, and its Eggs Tapun, not the Bird itself, as Navarette doth. But my Friend Mr. Ray faith of it, Hist. islbæc procul dubio fabulosa & falsa est. Quamvis enim Aves nonnulla maxima ova parium, ut v. g. Alkae, Lomwiae, Anates, Ardeiae, &c. huysmodi tamen unum dumtaxat, 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 factum a limento subministrat, Rau Synop. Av. Method. p. 155.
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 ἐξηγητής (e), so that the Young should notwithstanding be bred up in those large and barren Deserts of Arabia and Africa, and such like Places where those Birds dwell, the most unlikely and unsuiting (in all human Opinion) to afford Subsistance to young helpless Creatures; but the fittest therefore to give Demonstrations of the Wisdom, Care, and especial Providence of the infinite Creator and Conserver 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 why the Ostrich is hardened against her Young Ones, as though they were not hers, 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 ἐξηγητής, that natural Instinct to provide for, and nurse up her Young, that most other Creatures of the same, and other Tribes are endowed with.

(e) 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 Acare 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. Acare's Disc. in Philos. Trans. No. 89.
Thus I have dispatched what I intend to inflict 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 (f), used among the various Species of Birds; the great Sagacity, and many Artifices used by them in the Investigation and Capture of their Prey (g), the due Proportion of the more and less useful, the Scarcity of the Voracious and Pernicious, and the Plenty of the Manueltre and Useful (h). 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 (i); the flower Motion and short Flights of others more domestick; and even the Aukwardness of some others to Flight, whose Food is near at hand, and to be gotten without any great Occasion of Flight (k). These and divers 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.

(f) See Book IV. ch. 13.
(g) See Book IV. ch. 11. and 14.
(h) See Book IV. ch. 10. beginn.
(i) See Book IV. ch. 8.
(k) The Colymbi, or Douchers, having their Food near at hand in the Waters, are remarkably made for Diving therein. Their Heads are small, Bills sharp-pointed, Wings small, Legs flat and broad, and placed backward, and nearer the Tail than in other Birds; and lastly; their Feet; some are whole footed, some cloven-footed, but withal fin-toed. Vide Willugh, Ornith, L. 3. §. 5.
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 fail through that subtle 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 (a) 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 Muscle, or Bone, no, not even a Feather (b) 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.

(a) Vid. Book V. ch. 1. Note (aa).
(b) Deus non folium Angelum, & Hominem, sed nec exiguí & contemptíbilis animantis viscera, nec Avis pennulam, nec Herba floselum, nec Arboris folium sine suarum partium convenientiis dereliquit. Augustin, de Civ. Dei, L. 5. c. 11.
CHAP. I.

Of Insects in general.

HAVING dispatch'd 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 (a), prefaceth his Treatise of Insects, to prevent the Reproach of condescending (as might be thought) to so mean a Subject: In great Bodies, faith he, Nature had a large and easy Shop to work upon obsequious Matter. Whereas, faith he, in these so small, and as it were no Bodies, what Footsteps of Reason, what Power, what

great Perfection is there? Of this having given an Instance or two of the exquisite Senses, and curious Make of some Insects (b), he then goes on, We admire, faith he, turrigerous Shoulders of Elephants, the lofty Necks and Crests of others; but, faith he, the Nature of Things is never more compleat than in the least Things. For which Reason he entreats 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, faith 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 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


Part
Chap. II. The Shape of Insects.

Part thereof, their Motion, their Instincts, their regular Generation and Production; and, to name no more, the incomparable Beauty and Luster of the Colours of many of them, what more admirable and more manifest Demonstration of the infinite Creator, than even this little contempted 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 Fabric 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 the 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 its 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 singular; not built throughout with Bones, and cover'd with Flesh and Skin, as in most other Animals; but cover'd with a curious Mail of a middle Nature (a), 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.

(a) Insecta non videntur Nervos habere, nec Ossa, nec Spinas, nec Cartilaginem, nec Pinguia, nec Carnes, nee curfam quidem fragilem, ut quaedam marina, nec qua jure dicatur Cutis: sed media cujufdam inter omnia hac nature corpus, &c. Plin. N. H. L. ii. c. 4.

CHAP. III.

Of the Eyes and Antennae of Insects.

To this last-mention'd Guard, we may add, that farther Guard provided in the Eyes and Antennae. 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 its own Hardness, yea, even its own accurate Vision, is a good Guard against external Injuries; and its Cornea, or outward Coat, all over beset with curious, transparent, lenticular (a) Inlets, enabling

(a) 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,
Chap. III. *Eyes and Antenne of Insects.*

ablimg 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 *Antenne,* 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 (b). Besides

markable, that every *Foramen* is of a lenticular Nature; so that we see Objects through them topsy-turvy, as through so many convex Glasse: Yea, they become a small Telescope, when there is a due focal Distance between them and the Lens of the Microscope.

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 octo-nocular, and some, (as Mr. Willughby thought, Rabi Hift. Insect. p. 12.) fenocular; so Flies, &c. are multocular, having as many Eyes as there are Perforations in their *Cornea.* By which Means, as other Creatures are oblig’d to turn their Eyes to Objects, these have some or other of their Eyes ready plac’d towards Objects, nearly all round them: Thus particularly it is in the *Dragon-Fly,* (Libella,) the greatest Part of whose Head is posses’d by its Eyes: Which is of excellent Use to that predarious Insect, for the ready seeing and darting at small Flies all round it, on which it preys.

(b) It is manifest, that Insects clean their Eyes with their Fore-legs, as well as *Antenne,* And considering, that as they walk along, they are perpetually feeling, and searching before them, with their *Feelers,* or *Antenne,* therefore I am apt to think, that besides wiping and cleaning the Eyes, the Uses here nam’d may be admitted. For as their Eyes are immove-
Eyes and Antennae of Insects. Book VIII.

fides which, they are a curious Piece of Workmanship, and in many, a very beautiful Piece of (c) Garniture to the Body.

immoveable, so that no Time is requir'd for the turning their Eyes to Objects; so there is no Necessity of the Retina, or optick Nerve being brought nigher unto, or set 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 distant 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 the wiping the Eyes, is the chief Use of the Feelers, is farther manifest from the Antenna 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.

(c) The lamellated Antenne of some, the clavellated of others, the neatly articulated of others, the feather'd and divers other Forms of others, of the Scarab, Papilionaceous Gnat, and other Kinds; are surprizingly beautiful, when view'd through a Microscope. And in some, those Antenna distinguish the Sexes: As in the Gnat-kind, all those with Tufts, Feathers, and Bush-horns, are Males; those with short, single shafted Antenne, are Females.

C H A P. IV.

Of the Parts and Motion of Insects.

FROM the Head, pass we to the Members, concern'd 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
Chap. IV. Parts and Motion of Insects. 363

those amphibious Insects that swim and walk (a); the incomparable Provision made in the Feet of such as walk, or hang upon smooth Surfaces (b); the great Strength and Spring in the Legs of such as leap (c); the strong and well-made Feet and Talons of such as dig (d): 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 (e), or some other Artifice to make

(a) All the Families of Hydrocanthari, Notonefti, &c. have their hindmost Legs made very nicely, with commodious Joyns flat, and Brilles on each Sides towards the End, serving for Oars to swim; and then, nearer the Body, are two stiff Spikes, to enable them to walk when Occasion is.

(b) I might here name divers Fites, and other Insects, who, besides their sharp hook’d Nails, have also skinny Palms to their Feet, to enable them to flick on Glafs, 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 large ones there are two Sorts, one largest, all black, with Antennes handfomely embos’d at the Ends. The other somewhat leffer, hardly so black, with capillary Antennes; the Forehead, Edges of the Vagine, and two Rings on the Thorax, of a tawney Colour. The Female hath Vagine prettily furrow’d, the Male smooth. But that which is most to our Purpose in this Male, is a Flap, or hollowish Cap near the middle Joyn of the Fore-legs; which when clap’d on the Shoulders of the Female in Coitus, 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.

(c) Thus Grasshoppers and Crickets have brawny strong Thighs, with long, slender, but strong Legs, which enable them to leap with great Agility and Strength.

(d) I have wonder’d to see with what great Quickness, Art and Strength, many Vespa-Ichneumons, Wild Bees, and Beetles, perforate the Earth; yea, even Wood it felf: But the moft remarkable Animal in this Way, is the Male-Cricket in Book IV. Chap. 13. Note (f).

(e) I have with Pleasure often seen Spiders dart out their Webs, and fall away by the Help thereof. For the Manner
364 Parts and Motion of Insects. Book VIII.

make their Bodies lighter than the Air (f): These, and a Multitude of other such like Things as these, I might,

of which, see Mr. Lowth. Abridg. Vol. 2. p. 794. from Dr. Lister and Dr. Hulse, who both claim'd the Discovery there-of. And do both seem to have hit thereupon, without any Foreknowledge of what each other hath discover'd, as is said in the last cited Place, and as I more particularly find by Mr. Ray's Philos. Letters, Printed Ann. 1718. p. 95, &c. 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 A r i s t o t. H i s t. An. L. 9. c. 30. And in Pliny, L. ii. 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 faith, 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 Minfier, [in York,] and could thence discern them yet exceeding high above me. Some that fell, and were intangled upon the Pinnacles, I took and found them to be Lupi; which Kind seldom or never enter Houses, and cannot be suppos'd to have taken their Flight from the Steeple.

(f) 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 Squillula, pulices Arborescentes, and microscopical Animalcules of the flag-nating Waters, so numerous in them, as to discolor sometimes the Water, and make them look as if they were tinged Red, Yellow or Green, or cover'd 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 flagnating 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 equivocal 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 ingen-
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 over-load 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 contriv'd, and made for this Service, than the Wings? Distended and strengthen'd by the finest Bones, and these cover'd with the finest and lightest Membranes, some of them adorn'd with neat and beautiful Feathers (g); and many of them provided with the finest Articulations, and Foldings, for the Wings to be withdrawn, and neatly laid up in their Vagire, and Cases, and again readily extended for Flight (b).

And

nious Friend, Mr. Charles King, shew'd me the Pulices aquat. arborees are; these I say,) can't be this Way accounted for. The Cause of these latter Suspicions was, that in the Summer Months, I have seen the Pulices arborees, and the green Scum on the Waters, (nothing but Animalcules, as I laid,) lie in a Manner dry on the Surface of the Waters; at which Time, (as I have shewn in Book IV. Chap. 11. Note (n),) 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.

(g) It is well known to all Persons any Way converfant in microscopical Observations, that these elegant Colours of Moths, and Butterfies, are owing to neat and well-made Feathers, set with great Curiosity and Exactness in Rows, and good Order.

(b) All that have Flytra, Scarabs (who have whole Flytra, or reaching to the Pedex,) or the Ἵμεραλδίστατας, such as Earwigs, and Staphylini of all Sorts, do, by a very curious Mechanism, extend and withdraw their membraneous Wings, (wherewith they chiefly fly;) and it is very pretty to see them prepare themselves for Flight, by thrusting out, and unfolding their Wings; and again withdraw those Joynets, and neatly fold in the Membranes, to be laid up safely in their
And then for the Poisoning 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 \((i)\); and in such as have but two, by Pointels, and Poises plac’d under the Wings, on each Side the Body.

And lastly, It is an amazing Thing to reflect upon the surprizing Minutenefs, Art, and Curiosity of the \((k)\) 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 mention’d this in the larger Animals; but to consider, that all these Things concur in minute Animals, even in the smallest Mite; yea,

their *Elytra* or Cales. For which Service the Bones are well plac’d, and the Joynts miniftring thereunto are accurately contriv’d, for the most compendious, and commodious folding up the Wings.

\((i)\) For the keeping the Body steady and upright in Flight, it generally holds true, (if I mistake not,) that all bipen-nated Insects have *Poises* joyn’d to the Body, under the hinder Part of their Wings; but such as have four Wings, or Wings with *Elytra*, none. If one of the Poises, or one of the lesser auxiliary Wings be cut off, the Insect will fly as if one Side overbalanc’d 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 *Pointells* 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 lie and move. The Ufe, 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, laden at the Ends with Lead, doth the *Ropedancer*.

\((k)\) As all the Parts of Animals are mov’d 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.
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the Animalcules, that, (without good Microscopes,) escape our Sight; to consider, I say, that those minutest Animals have all the Joyns, 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 (l), as plainly manifesteth the Power and Wisdom of the infinite Contriver of those inimitable Fineries. But having nam’d 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 form’d, and, (as far as our Scrutiny can possibly reach,) as neatly adorn’d as the largest Animal? Let us consider, that there we have Eyes, a Brain, a Mouth, a Stomach, En-

(l) The minute Curiosities, and inimitable Fineries, observable in those leffcr 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 ivory Cups, all gilt on the Edges, and having each of them a Foot, and yet affording Room for 400 more, in the Ephem. Germ. T. i. Addend. ad Obs. 13. Such also was Phaëton 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, faith he, ipsum minus fuerit, tanto majorem admirationem tibi excitabis; quod declarant Opifices cum in corporibus parvis aliqua insculpunt: cujus generis est quod nuper quidam in Annulo Phaëtona quatuor equis invelatum sculptus. Omnes enim equi frons, os, et densae anteriores habeant, &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, faith he, Major adhuc alia quadam esse videtur artis ejus, qui Pulicem condidit, Vis arque Sapientia, quod, &c. Cium igitur Ars tanta in tam abjectis animalibus appararet, quantam ejus Vim ac Sapientiam in praflantioribus inesse putabimus? Galen, de Uf. Part. L. 17. c. 1. fin.
trails, 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 cover'd and guarded with a well-made Tegument, beset with Bristles, adorn'd with neat Imbrications, and many other Fineries. And lastly, Let us consider in how little Compass all Art and Curiosity may lie, even in a Body many Times less than a small Grain of Sand (m); so that the least Drop of Water can contain many of them, and afford them also sufficient Room to dance and frisk about in (n).

Having survey'd 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.

(m) 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. Leuwenhoek, and others, in the Philos. Trans. and elsewhere.

(n) 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 thofe.

C H A P.
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 Dittresses 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, Nymphal-State, in the Summer-Months, they then retire to Places of Safety, and there throw off their Nymphal, 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 (a). But

(a) It would be endless to enter into Particulars here, because all the Papilionaceous, Flesh, and Ichneumon-Fly Tribes, and all others that undergo the Nymphal 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 Sagra-.
But there are 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 Expend of Spirits, and therefore no need of Food (b).

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 (c) Necessities.

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 Pots 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 Aurelia; in which State and Places they hang secure from Wet and Cold, till the Spring and warmer Months, when they are transmuted into Butter-Fies.

(b) 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 Stresses 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 itself 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.

(c) 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 solertiâ Formicarum, venture byemi maturè proficientium, sibique invicem sub onere sessis succurrentium; quodque
Chap. V. Insects Security against Winter. 371

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 itself gives us an Instance in the Ant, calling that little Animal exceeding wise, Prov. xxx. 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. vi. 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 subjoin an Observation of the farther great Wisdom of this little Creature; and that is their unparallelled ζητήσαντος, their Tenderness, Sagacity, and Diligence about their Young (d). Tis

quodque fruges arrosas condunt, ne rursus enascantur, sed per annum alimento sint; non rariocinationem Formicarum in causâ debemus credere, sed alnum matrem Naturam bruta quoque sic ornantem, ut eiam minimis addas sua quaedam ingenia. Orig. cont. Celf. L. 4.

But as for Wasps, Hornets, Humble Bees, and other Wild-Bees, Vespe ichneumones, and divers others that carry in Materials for Nefts 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 Nefts towards Winter, and retire to other Quarters, living (I conceive) without Food all that Time.

(d) Hos vermiculos [Formicarum Ova vulgo vocatos] incredibili 5ογην & cura Formica educant, summamque dantis opus, ne vel tiamillum, quod spectes eorum vermiculorum educationem asque nutritionem, omissant: quam in sim vibere semper eosdem ore circumstantia secum, ne alla eos lades injuris. In museo meo nonnullas sibi us generis formicas, utra
It is very diverting, as well as admirable 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 forlorn; 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 Conser-
Chap. VI. Insects Care of their Young.

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 (a) 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 suffici-

(a) 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 M Ray's Hist. of God, &c. p. 344. See also before, Book IV. Ch. 15. Note (a).
Infefts Care of their Young. Book VIII.

ent Incubation, and that the Young, when produced, may have the Benefit of proper and sufficient Food for their Nurture and Education, till 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 Subsistence is in the Waters (b), in the Water; those to whom Flesh is a proper Food; in Flesh (c); those

(b) 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 (r).

(c) As Seigneur Redi was one of the first that made it his Business to discard Anomalous Generation, so he tried more Experiments relating to the Vermination of Serpents, Flesh, Fisb, putrified Vegetables; and in short, whatever was commonly known to be the Nurser of Maggots, more I lay probably, than any one hath done since. And in all his Observations, he constantly found the Maggots to turn to Aurelie, and these into Flies. But then, faith he, Dubi

tare capi, utrium omne hoc vermium in carne genus, ex sola Muscarum femine, an ex ipsis putrescatis carnibus oriretur, tan
toque magis confirmabar in hoc meo dubio, quanto in omnibus generationibus ——— septus videram, in carnibus, ante quem verminare inciperent, resektse ejusdem species Muscar, cuius propago posse na'cebatur. Upon this he tells us, he put Fisb, Flesh, etc. 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, etc. 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. Insef.
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 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, Fih, &c. but the largest Sort, called by Aldrovand, Culices maxim, by Swammerdam, Tipula terrestres, lay their Eggs in Meadows, &c. under the Gras; 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 (r).

The Generation of the Second of these being akin to some of the foregoing Inflances, 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 off-spring of our Gnat, the smaller, of a small dark coloured Fly, tending to reddish; frequent in Cellars, and such obfence Places. All these Maggots turn to Aurelia, 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 jointed Antenna, Spotted Wings, reaching beyond its slender Albus; 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 Female's is.

(d) The Insects that infest Fruits, are either of the ichneumon-Fly Kind, or Phalene. Plums, Peasc, 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 three Bristles, where with it conveys its Eggs into Fruits: Its Antenna, or Horns, long, slender, recurved; its Belly longish, tapering, small towards
towards the Thorax; Legs reddish; Wings membranaceous, thin and transparent, in Number 4, which is one Characteristic of the Ichneumon Fly.

The Peafe Ichneumon-Fly, is very small, Wings large, reaching beyond the Podex; Antenna long; Alva short, shaped like an Heart, with the Point towards the Anus; it walketh and slieth 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 Peafe when they are young and tender, and other Things also, as I have Reason to suspect, having met with this (as indeed the former two) in divers Vegetables.

Pears and Apples I could never discover any Thing to breed in, but only the leffer Phalaena, about 3/4 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 in the Forehead; Antenna 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.

(e) There are many of the Phalaena 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 Phalaena, bred in its convolved Leaves, white, green, yellow, brown spotted prettily, and nearly dappled, and many more besides; and its Buds afford a Place for Cages, and Balls of various Sorts, as shall be shewn hereafter; its Leaves expanded, minister to the Germination of globular, and other spheroidal Balls, and flat These, some like Hats, some like Buttons excavated in the Middle, and divers others 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.

(f) And as Trees and Shrubs, so Plants have their peculiar Insects. The White-Butterfly lays its voracious Off-
stantly 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 (g); some in the Hair of Beasts (b); some

spring on Cabbage-Leaves; a very beautiful reddish occluded one, its no less voracious black. Off-spring of an horrid Aspect, on the Leaves of Nettles; as also both a very beautiful, 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 underwings edged with brown; these, I say, provide for their golden ring'd Brusca upon the Ragwort-Plant.

(g) 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 Signiour Redi of Insects. See also Mouset, 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 faith, would destroy the Birds, particularly Phaenax, if they did not dust their Feathers. Loco infr. citat.

(b) 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 *Afs,* 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 Aristotle. *Horse* Animal. L. 3. c. 31. who faith, *Quibus pilus est, non carent evodem [Pediculo] excepto Asino, qui non Pediculo tanyum, verum eiam Redivium immunit efs.* And a little before, speaking of those in Men, he shews what Constitutions are most subject to them, and instance in Alcman the Poet, and Pherecydes Syrius that died of the *Pthirias,* or Lowly Disease. For which foul Di temperament, if Medicines are directed, *Mouset de Insect.* p. 262. may be consulted. Who in the same Page hath this Observation, *Animadversionum nostrarum* —— ubi *Asores infutias à sermo relinquunt, Pediculos consedim omnes tabescre: atque ubi eas reviserint, iterum in numeros alios subito oriir. Which Observation is confirmed by Dr. Stubbs. Vid. Lowth. Abridg. V. 3. p. 558. And many Seamen have told me the same.
in the very Scales of Fishes (i); some in the Nofe (k); some in the Flesh (d); yea, some in
the

(i) 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 Codfish; especially such as are poor; which Worms have work'd themselves deeply into the Coats and Flesh, so that they could not easily be gotten out: So Aristotle, faith of some Fishes, Ballero & Tilloii Lumbricus infaeitut, qui debilitat, &c. Chalceis vito infe^itar dira; ut Pediculi sub Branchiis innati quàm multi interimant. Hift. An. L. 8. c. 20.

(k) Of Insects bred in the Nofe of Animals, those in the Noftrils of Sheep are remarkable. I have my self taken out not fewer at a Time than twenty or thirty rough Maggots, lying among the Lamina of the Noftrils. 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, call'd Trifeta, whose three Briftles seem very commodious for conveying its Eggs into deep Places.

I have also seen a rough whitifh Maggot, above two Inches within the Intestinum rectum of Horfes, 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.

(i) In the Backs of Cows, in the Summer-Months, there are Maggots generated, which in Eflax 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 Infe^t. 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 squeeze'd out at a Hole they have always open: They are round and rough, and of a dirty White. With my utmost Endeavour and Vigilance, I could never discover the Animal they turn into; but as they are somewhat like, so may be the fame 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.
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the very Bowels (m); and inmost Recesse of the

In Philos. Trans. Mr. Dent, and Mr. Lewis, relate divers Examples of Worms taken out of the Tongue, Gums, Nose, and other Parts, by a Woman at Leicesuter, which they were Eye-witnesses of. These, and divers others mention'd in the Transactions, may be seen together in Mr. Lowthorp's Abridg. Vol. 3. p. 132.

Narrat mihi vir fide dignus——Casp. Wendlande——se in Poloniis, puero cuidam rustico duorum annorum, Vermiculum album in palpebra extraxisse,——magnitudinis Ericea.—


The Worms in Deer are mention'd often among ancient Writers. Aristoteles saith, Σκάλπτα οὖν τοιαύται ἔχουσιν, ὡς τῇ κεφαλῇ ζώντας, &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 plac'd; their Size not less than of the largest Maggots; they are bred all together, in number about twenty. Aristot. Hist. Animal. l. 2. c. 15.

To these Examples may be added the Generation of the Ichneuomon-Fly in the Bodies of Caterpillars, and other Nymphæ of Insects. In many of which, that I have laid up to be hatch'd in Boxes, instead of Papilio, &c. as I expected, I have found a great Number of small Ichneuomon-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. W illughby's Observations in Philos. Trans. No. 76. But concerning the farther Generation of this Insect, I have taken Notice of other Particulars in other Places of these Notes.

(m) The Animals ordinarily bred in the Stomach and Guts, are the three Sorts of Worms call'd Lari, Terezes, and Asecarides; concerning which, it would be irksome to speak in Particular, and therefore I shall refer to Moutier, L. 2. c. 31, 32, 33. Dr. Tyson's Anatomy of them in Mr. Lowthorp's Abridg. V. 3. p. 121. Seignior Redi's Obs. and others that have written of them.
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 Countrymen. Dr. Lifter, (whose Credit and Judgment will hardly be question'd,) gives an Account of true *Caterpillars*, vomited up by a Boy of nine Years old; and another odd Animal by a poor Man. Mr. Jeffop, (another very judicious, curious and ingenious Gentleman, saw *Hexapods* vomited up by a Girl; which *Hexapods* liv'd and fed for five Weeks. See *Lowth.* ib. p. 135.

And to Foreigners, it is a very strange Story (but attested by Persons of great Repute,) of *Catharina Geileria*, that dy'd in Feb. 1662, in the Hospital of *Altenburg*, in Germany, who for twenty 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 *Lacerta Aquatica* in the Stomach, when their Spawn happeneth to be drank, there is a Story in the second *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, caus'd 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 recover'd 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.

(n) Not only in the Guts, and in the Flesh; but in many other Parts of the Body, Worms have been discover'd. One was voided by Urine, by Mr. *Mat. Milford*, suppos'd to have come from the Kidneys. *Lowth.* ib. p. 135. More such Examples *Moufet* tells of. *Ibid.* So the *Vermes Genuites*...
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

bisini are very common in the Vessels in Sheeps Livers: And Dr. 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. Lownd. ib. p. 120. Nay, more than all this: In Dr. Bern. Verzascha's sixth 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; who, 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 guessteth was the famous Olaus Wormius: Another, from a Country Woman of Dietmarbus; 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 (k), and even that Worm that was actually found in the Brain of the Paris Girl (when opened). I guess might be laid in the Lamina of the Nostrils, by some of the Ichneumon, or other Insect Kind, and might gnaw its way into the Brain, through the Os cribiforme. Of this he tells us from Bartholine, "Tandem cim tabida obiijet, statim aperto cranio præfentes Medici totam cerebelli substantiam, qua ad dexterum vergit, ad reliquum porione, mignragque sunicam involutam depredhendunt: hac sunita rupta, latente Vermem vivum, & pilosum, duobus punctis splendidis loco oculorum prodidit, ejusdem fere molis cum reliqua Cerebri portione, qua durum horaram spacio supervixit." B. Verzal. Obf. Medicae, p. 16.

Hildanus tells us such another Story, viz. Filius Theod. auff der Roulen, Avunciaeli mei, diurnurn vexabatur dolore capitis. — Deinde febriculæ & fermentatione exortæ,ruptus est Absceffus circa os cribrosum — & Vermis prorepst. By his Figure of it, the Maggot was an Inch long, and full of Bristles. Fabri Hildan. Cent. i. Obf.

Galenus Wierus (Physician to the Princ. Jul. & Cleve) he faith, told him, that he had, at divers Times, found Worms in the Gall-bladder in Perlons he had opened at Dusseldorp. Id. ib. Obf. 60.
Seal up Provisions, that serve both for the Production of their Young, as also for their Food and Nurture when produc'd (o).

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 observ'd by them in this Matter. You shall always see their Eggs laid carefully and commodiously up (p). When upon the Leaves of Vegetables, or other Material on Land, always glu'd thereon with Care, with one certain End lowermost, and with handsom juxta-Positions (q). 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 ty'd and fastened in the Waters, to prevent its Dissipation (r), or

(o) See before Book IV. Chap. 13. Note (e).
(p) Some Insects lay up their Eggs in Clusters, as in Holes of Flesh, and such Places, where it is necessary they should be crowded together; which, no question, prevents their being too much dried up in dry Places, and promotes their hatching. But,
(q) As for such as are not to be clustered up, great Order is used. I have seen upon the Pots 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 its 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.
(r) By Reason it would be endless to specify the various Generation of Insects in the Water, 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 Nature's Work, as he faith.
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 fix'd Thing in the Waters, by a small Stem, or Stake. In this gelatine, transparent Spawn, the Eggs are nearly 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 transversely, 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 Caves 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; 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, Gnar-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 resifting 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
or Wood, or building themselves Cells (s), or spinning and weaving themselves Cases and Webs, it is all a wonderful Faculty of those poor little Animals, whether we consider their Parts where with 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 (t), 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 Artift among Men, so much as tolerably to copy the nice Geometrical Combs of some (w), the Earthen Cells of others, or the Webs, Nets and Cases (w) woven

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 Attius, 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.

(s) See Book IV. Chap. 13. Notes (n), (o).
(t) Thus the Mouths and other Parts of the Ichneumon-Wasps in Book IV. Chap. 13. Note (c). So the Feet of the Gryllotalpa, ibid. Note (s).
(w) See the last cited Places, Note (o).

Besides these, Caterpillars, and divers other Insects, can emit Threds, or Webs for their Ufe. 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.
ven by others. And here that natural Glue (x) which their Bodies afford some of them to confoli-
ddate their Work, and combine its Materials to-
gether, and which in others can be darted out at
Pleasure, and spun and woven by them into silken Balls (y) or Webs. I say, this so peculiar, so
serviceable

And not only the Off-spring of the Phalaena-Tribe, but there are some of the Ichneumon-Fly Kind also, endowed
with this textuine 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 Fingers, not hollow within,
as many are, but filled throughout with Silk. These are
woven round Bents, Stalks of Ribwort, &c. in Meadows.
The other is a lump of many yellow, silken Cases, sticking
confusedly together on Posts, under Cole-worts, &c. These
Webs contain in them, small, whitish Maggots; which
turn to a small, black, Ichneumon-Fly, with long, capillary
Antenna; Tan-coulored Legs; long Wings reaching be-
yond their Body, with a black Spot near the middle; the Al-
vus, like an Heart; and in some, a small cutaneous Tail.
Some of these Flies were of a shining, beautiful green Co-
LOUR. I could not perceive any Difference, at least, not
specific, between the Flies coming from those two Pro-
ductions.

(x) I have often admired how Wasps, Hornets, Ichneu-
mon-Wasps, and other Insects that gather dry Materials for
building their Nefts, 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 usefull Material is in their own Bodies; as 'tis in the
Tinea vesicatora, the Cadew Worm, and divers others. Godart
observes of his Ernea, Num. xx. 6. that fed upon Sallow-
Leaves, that it made its Cell of the comminuted Leaves, glued
together with its own Spittle, hac pulvis aut arenæ
inflar comminuit, ac picturus quodam sui corporis suco ita
maceravit, ut inde accommodatum subeunda mutatione insianti
tlocum sibi exstruxerit. Demuncula hac à communi Saliciæ
ligno nihil diffère videbatur, nisi quod longè esset durior, adeò
ut culturo vix disrupi posset.

(y) 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
C C Cases,
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 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 itself 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 Nets and Cells (z); such as are the

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. Boyle Subtil. of Effluv. ch. 2.

(z) 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 for many Years as critically observed all the Excrecences, 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
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the Galls and Balls found on the Leaves and Branch-
es of divers Vegetables, such as the Oak, the Wil-
low (aa), the Briar, and some others.

Now

These Cones are, in outward Appearance, perfectly like
the Gems, only vaftly bigger; and indeed they are no other
than the Gems, increafed in Bignefs, which naturally ought
to be pushed out in Length: The Cause of which Obftruc-
tion 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 fay) the Parent-In-
sect thrfts one or more Eggs, and not perhaps without
some venemous Ichor therewith. This Egg foon becomes
a Maggot, which eats it felf a little Cell in the very Heart
or Pith of the Gem, which is the Rudiment of the Branch,
together with its Leaves and Fruit, as shall be hereafter
fhewn. The Branch being thus wholly destroyed, or at leaft
its Vegetation being obftrufted, the Sap that was to nourifh
it, is diverted to the remaining Parts of the Bud, which
are only the fcaly Teguments; which by these Means grow
large and flourifhing, and become a Covering to the Infeft-
Cafe, as before they were to the tender Branch and its Ap-
pendage.

The Cafe lying within this Cone, is at first but small, as
the Maggot included in it is, but by degrees, as the Maggot
increafeth, fo it grows bigger, to about the Size of a large
white Peafe, long and round, reftembing the Shape of a
small Acorn.

The Infeft it felf, is (according to the modern Infeftolo-
gers) of the Ichneumon-Fly Kind; with four Membranace-
ous Wings, reaching a little beyond the Body; articulated
Horns, a large Thorax, bigger than the Belly; the Belly fhort
and conical; much like the Heart of Animals: The Legs
partly whitifh, partly black. The Length of the Body from
Head to Tail, about \( \frac{1}{2} \) of an Inch; its Colour, a very beau-
tiful fhining Green, in fome tending to a dark Copper-Co-
lour. Figures both of the Cones, Cufes, and Infefts, may
be fen among Malpighi's Cuts of Galls, Tab. 13. and Tab.
20. Fig. 72. which Fig. 72. exhibits well enough fome others
of the Gall-Infefts, but its Thorax is fomewhat too fhort for
ours.

(aa) Not only the Willow, and fome other Trees, but
Plants also, as Nettles, Ground-luy, &c. have Cufes produ-
ced
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 its Circumstances, we must needs perceive manifest Design, and that there is the Concordance 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 its Particulars. But two or three Hints shall suffice.

In the first Place, ’tis certain that the Formation of those Cases and Balls quite exceeds 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 Juice, or Egg, or both, deposited on the Vegetable by the Parent Animal (bb). And as this Virulence is various, according to the Difference of

ced on their Leaves, by the Injection of the Eggs of an Ichneumon-Fly. I have observed those Cases always to grow in, or adjoining 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 therewith, some proper Juice of its Body, to pervert the regular Vegetation of it. From this Wound arises a small Excrecence, which (when the Egg is hatched into a Maggot) grows bigger and bigger, as the Maggot increases, swelling on each Side the Leaf between the two Membranes, and extending itself 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.

(bb) What I suspected myself, I find confirmed by Maltzlipi, who in his exact and true Description of the Fly bred in the Oaken Galls, saith, Non fat fuit natura tam mira artificio Terebram seu Limam condidisse; sed intuitu vulneris, vel excitato foramine infundendum exinde liquorem intra Terebram condidit:
of its Animal, so is the Form and Texture of the Cases and Balls excited thereby; some being hard Shells (cc), some tender Balls (dd), some

condidit: quare fracta per transversam muscarum terebrâ frequentissime, vivente animali, gusta aliquot diaphani humoris effluent. And a little after, he confirms, by ocular Observation, what he imagin'd before, viz. Semel prope Junii sinem vidi Muscam, qualem superius delineavi, insidentem querciae gemma, adhuc germinante; harebat etenim solilo fiubili ab a-pice biancis gemma erumpentis; & convulso in arcum corpore, terebram evaginabat, ipsamque tensam immittebat; & tumefacito ventre circa terebra radicem tumorem excitabat, quem interopolatis vicibus remittebat. In folioigitur, avulsâ Muscâ, minima & diaphana reperii ejecita ova, simillima iis, qua adhuc in tubis supererant. Non licuit iterum idem admirari spectaculum, &c.

Somewhat like this, which Malpighi saw, I had the good fortune to see myself once some Years ago: And that was, the beautiful, shining Oak-Ball Ichneumon strike its Terebrain to an Oak-Apple divers Times, no doubt to lay its Eggs therein. And hence I apprehend we see many Vermicules 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.

(cc) 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.

(dd) 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 Cafe 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 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 faith various Species of Flies come, but he names only two, and they are the only two I ever saw come out of them: Frequenter (faith he) subnigra sunt musca brevi musura terebrâ. inter has aliqua observantur aures, levi viridis tinéfurâ suffusa, oblongâ pollentes terebrâ. 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 Terebrâ) in all, as Malpighi seems to intimate: Perhaps they were hid in their Thees, 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, recurvus Tails, longer than their whole Bodies. And these I take to be the Females. And in the Oak-Apples themselves, I have seen the Aurelia, 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.

(ee) See before Note (z).

(ff) As in the preceding Note.

(gg) Of the rough or hairy Excrencences, those on the Briar, or Dog-Rose, are a good Instance. These Spongoids villosa, as Mr. Ray, Galla rumosa, as Dr. Malpighi calls them, are
are thus accounted for by the latter; _Ex copiosis relitlis ovis_ 
itu turbatur affluens [Rubi] succus, ut brunosa fiant compla-
ra tuberculæ simul confusa confeta, que urticulorum seriebus,
& librardum implicatione contexta, ramosas propagines germi-
nant, ita ut minima quasi sylva appareat. Qualiher propago
ramos, hinc inde villosos edit. Hinc inde pil pariter erump-
 punt, &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._

As to the _Insects_ themselves, they are manifestly _Ichneu-
on-Flies_, having four Wings, their _Alvus_ thick and large to-
wars 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 (z)._ But for a farther Description of
them, I shall refer to Mr. Ray, _Cat. Plant. circa Cantab._ un-
der _Rosa sylvest._

_(bb)_ 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, thinning black _Ichneumon-Fly_, about a tenth of an
Inch long; with jointed, 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, ende-
vouring 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.
Service, to bore and pierce the Vegetable, and to reach and inject their Eggs and Juice 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 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 its 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 its strange Faculty and Power, and teach it so cunningly and dextrously to employ it for its own Service and Good?
BOOK IX.

Of Reptiles, and the Inhabitants of the Waters.

CHAP. I.

Of Reptiles.

HAVING dispatch'd the insect Tribe, there is but one Genus of the Land-Animals remaining to be survey'd; and that is, that of Reptiles (a). Which I shall dispatch in a little Compars, by Reason I have somewhat amply treated of others, and many of the

(a) Notwithstanding I have before, in Book IV. Chap. 12. Note (p), 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 Drs. Willis and Tyson. Saith Willis, Luminous terrestris, licet vile et contemptibile habetur, Organ-
the Things may be apply’d 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 (b) 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 (c), or like that of the

na vitalia, necnon & alia viscera, & membra divino artificio admirabiliter fabrefacta sortitur: totius corporis compages musculorum annularium carena est, quorum fibra orbiculares contraherentur quernque annulum: prius amplum, & dilatum, angustiorum & longiorum 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 Augur,) the better bore their Passage into the Earth. Their reptile Motion also, may be explain’d by a Wire wound on a Cylinder, which when slip’d off, and one End extended and held fast, will bring the other nearer it. So the Earth-Worm, having foot out, or extended 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. Tyfon, Phil. Trans. No. 147.] Nam proinde cùm portio corporis superior elongata, & exsorretur, ad spatium alterius extenditur, ibidemque plano affigitur, ad ipsum quaës ad centrum portio corporis inferior relaxata, & abbreviata facile pertrahitur. Redunculi serie quadruplici, per totam longitudinem Lumbrici disponentur; bis quaës totidem uncis, partem modo hanc, modo isam, plano affigint, dum alteram exporrigit, aut post se deducit. Supra oris hiatum, Proboscide, quá 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 Vesels, the Stomachs and Intestines, the Foremima 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.

(b) In Book IV. Chap. 8.

(c) There is a great Deal of geometrical Neatness and Nicety, in the sinuous Motion of Snakes, and other Serpents. For the assifiting 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
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 Muscule, the outer Edge thereof, (or Foot it may be call'd,) is rais'd also a little from the Body, to lay hold on the Earth, and so promote and facilitate the Serpent's Motion. This is what may be easily seen in the Slough, or Belly of the Serpent-kind. But there is another admirable Piece of Mechanism, that my Antipathy to those Animals hath prevented my prying into; and that is, that every Scale hath a distinct Muscule, one End of which is tack'd 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.

(d) The wife Author of Nature, having deny'd 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, asilfed 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 Snail's Feet,) and their Undulation, See Dr. Lister's Exercit. Anat. 1. §. 1. and 37.

(e) 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 made by 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 flicking too, and these beset almost round with small sharp Nails, to hold and grasp what they are upon: Before, their Feet are sharp and hook'd, to draw Leaves, &c. to them, and to hold the fore-part of the Body, whilst the hinder-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...
pedous (f) or any other Way, or the Parts miniftring to it, particularly the Spine (g), and the Muscles co-operating with the Spine, in such as have Bone, 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 va-

Aurelia-State, they have neither Feet nor Motion, only a little in their hinder-parts: And in their Mature-State, they have the Parts and Motion of a flying Infeft, made for Flight.

(f) It is a wonderful pretty Mechanifm, observable in the going of Multipedes, as the Juli, Scelopendra, &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 describ'd in Words; 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.


That which is most remarkable in the Vertebrae [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 Il-chi; 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 observ’d of the Vertebrae of this Snake, is common to this whole Genus of Reptiles.
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rious Motions to be met with in the reptile Kind.

Another Thing that will deserve our Notice, is, the Poyfon (b) that many of this Tribe are stock'd 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 (i) some of the most stubborn

(b) My ingenious and learned Friend, Dr. Mead, examined with his Microscope, the Texture of a Viper's Poyfon, and found therein at first only a Parcel of small Salts nimbly floating in the Liquor; but in a short Time the Appearance was chang'd, and these saline Particles were shot out into Crystals, of an incredible Tenuity and Sharpness, with something like Knots here and there, from which they seem'd to proceed; so that the whole Texture did in a Manner represent a Spider's-Web, though infinitely finer. Mead of Poyfons, p. 9.

As to the Nature and Operation of this Poyfon, see the same ingenious Author's Hypothesis, in his following Pages.

This Poyfon 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 Poyfon to the Bags at the Teeth.

The Teeth are tubulated, for the Conveyance, or Emision of the Poyfon into the Wound, the Teeth make; but their Hollownes 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 Poyfon is emitted. These Perforations of the Teeth, Galen faith, the Mountebanks us'd to stop with some kind of Paste, before they suffer'd 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.

(i) That Vipers have their great Uses in Physick, is manifest from their bearing a great Share in some of our best Antidotes,
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 Chaftifements upon ungrateful

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 Cave in the curious Collection of Dr. Ol. Worm. related from Kircher, that I shall entertain the Reader with it. Near the Village of Saffa, about eight Miles from the City Bracciano in Italy, faith he, Specus seu caverna (vulg'd La Grotta delli Serpi) duorum hominum capax, sflulofis quibusdam foraminibus in formam cribri perforata cernitur, ex quibus ingens quadam, principio veris, diversicolorum Serpentum, nulla tamen, ut dicitur, singulari veneni qualitate imbutorum progenies quotannis pullulare solet. In hac spelunk-ça Elephantiacos, Leprosos, Paralyticos, Arthritis, Podagri- cos, &c. nudos exponere solent, qui mox balitum substerraneorum calore in sudorem resoluti, Serpentum propullulantium, rotum corpus infrimi implicantium, ficut lingueque ita omni vi-tioso virulentoque humore privare dicitur, ut repetito hoc per aliquod tempus medicamento, tandem perfecta sanitati resti-tuantur. 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 Exuvies, or Sloughs, 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 los-ting 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. Musewm 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 Fleth, &c. in the Elephantiasis, and stubborn Leprosies: But he recommendeth rather the Gel-ly 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.
and sinful Men. And I am apt to think that the Nations which know not God, are the most annoy'd 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, which might otherwise be too refract and strong, and if once escap'd, would hardly be again recover'd, 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 Reptiles Kind, they as well deserve our Notice for their Harmlessness, as the others did for their Poyson. For as those are endow'd with Poyson, because they are predaceous; so these need it not, because their Food is near at hand, and may be obtain'd without Strife and Contest, the next Earth (k) 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 (l), or but crawl to it.

(k) That Earth-worms live upon Earth, is manifest from the little curled Heaps of their Dung ejected out of their Holes. But in Philos. Transact. 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.

(l) 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 (d), to stick unto, and creep up Walls and Vegetables at their Pleasure.
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 to the other Part of the Terraqueous Globe, the Waters, and the Inhabitants thereof, not having Time to finish what I have begun on that large Subject, I shall be forced to quit it for the present, 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 (a), and of infinite Use (b) to

(a) Besides their absolute Necessity, and great Use to the World, there are several Topics, from whence the Waters may be demonstrated to be God's Work; as, the creating so vast a Part of our Globe; the placing it commodiously therein, and giving it Bounds; the Methods of keeping it sweet and clean, by its Saltiness, by the Tides, and Agitations by the Winds; the making the Waters useful to the Vegetation of Plants, and for Food to Animals, by the noble Methods of sweetening them; and many other Things besides, which are insinced on in that Part of my Survey.

(b) Pliny having named divers Mirabilia Aquarum, to shew their Power; then proceeds to their Uses, viz. Eadem cadentes omnium terræ nascentium causa sunt, prorsus mirabilia naturæ, quis velit reputare, ut fruges gignantur, arbores fruticesque vivant, in caelum migrare aquas, animamque etiam herbis vitalem inde deferre: justa confessione, omnes terræ quoque vires aquarum esse beneficia. Quapropter ante omnia ipsarum potentiae exempla ponemus: Cunctas enim quis mortalium enumerare quaesit? 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, &c.
Chap. II. The Watery Inhabitants.

that Part of the Globe already surveyed; and the prodigious Variety (c), and Multitudes of curious and wonderful Things observable in its Inhabitants of all Sorts, are an inexhaustible Scene of the Creator's Wisdom and Power. The vast Bulk of some (d), and prodigious Minutenesses of others (e), together with the incomparable Contrivance and Structure of the Bodies (f) 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 (g); the Business of Respiration per-

(c) 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.

(d) Pliny, L. 9. c. 3. faith, that in the Indian Sea there are Balene quaternum jugerum (i. e. 960 Feet) Prisies 200 cubitorum (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.

(e) 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. See Book IV. Chap. 11. Note (n), (o).

(f) 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 expos'd 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 plac'd 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 there.

(g) See before Book IV. Chap. 11.
form'd in a Way so different from, but equivalent to what is in Land Animals \((b)\); the Adjustment of the Organs of Vision \((i)\) to that Element in which the Animal liveth; the Poife \((k)\), the Support \((l)\), the Motion of the Body \((m)\), forwards with

\((b)\) Galen was aware of the Respiration of Fishes by their Branchiae. For having said, that Fishes have no Occasion of a Voice, neither respire through the Mouth as Land Animals do, he faith, \textit{sed earum, quas Branchias nuncupamus, constructio, ipsius vice Pulmonis est.} Cium enim crebris ac venibus foraminibus sunt Branchiae ha intercepta, æri quidem \& vapor per viis, subtiliaribus tamen quàm pro mole aqua; hanc quidem extra repellunt, illa autem prompte intromittunt. Galen de Uf. Part. L. 6. c. 9. So also Pliny held, that Fishes respired by their Gills; but he faith Aristotle was of a different Opinion. \textit{Plin.} L. 9. c. 7. And so Aristotle seems to be in his \textit{Hist. Animal.} L. 8. c. 2. and in other Places. And I may add our famous Dr. Needham. See his \textit{De form. Fætu.} Chap. 6. and \textit{Answer to Severinus.}

\((i)\) A protuberant Eye would have been inconvenient for Fishes, by hindring their Motion in so denfe 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 \textit{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 \textit{Crystalline} spherical in Fishes, which in Animals, living in the Air, is \textit{lenticular}, and more flat.

\((k)\) As I have shew'd before, that the Bodies of Birds are nicely pois'd to swim in the Air; so are those of Fishes for the Water, every Part of the Body being duly balanc'd, and the Center of Gravity, (as I said in \textit{Note (f)}, accurately fix'd. And to prevent Vacillation, some of the Fins serve, particularly those of the Belly; as Borelli prov'd by cutting off the Belly-fins, which caus'd the Fish to reel to the right and left Hand, and render'd it unable to stand steadily in an upright Posture.

\((l)\) 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.

\((m)\) The \textit{Tail} is the grand Instrument of the Motion of the Body; not the Fins, as some imagine. For which Rea-
with great Swiftneas, and upwards and downwards with great Readines, and Agility, and all without Feet and Hands, and ten thousand Things besides; all these Things, I say, do lay before us so var- rious, so glorious, and withal so inexhaustible a Scene of the divine Power, Wisdom and Good- ness, 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 preceding Survey hath cost me. Paffing by therefore that Part of our Globe, I shall only say somewhat very briefly concerning the insenfitive Creatures, particularly those of the vegetable Kingdom, and so conclude this Survey.

Fishe are more musculus 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 Fishe row themselves by their Tail, and other Curio- sities relating to their Swimming; I shall refer him to Borelli de mos. Anim. Part. i. Chap. 23. particularly to Prop. 213.
Book X.

Of Vegetables.

The Vegetable Kingdom, although an inferior 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 (a); 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 (b), some for Food,

(a) 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 Book IV. Chap. 13. Note (a).

(b) Invisses quoque herbis inferuit [Natura] remedia: quippe eum medicinas dedere etiam aculeatis — in quibus ipsis providentiam Natura satis admirari amplectique non est. Inde excogitavit aliquas aseptu hispidas, tectu truces, ut tantum non vocem ipsius fingeat illas, rationemque redentis exaudire videamur, ne se depauperat avide Quadrupes, ne procacis manus rapiant, ne neglecta vestigia obterant, ne insidens Ales infringat: his muniendo Aculeis, selisque armando, remediiis ut tuta at salva sint. Ita hoc quoque quod in ipsis odi- mus, hominum causâ excogitatum est, Plin, N. H. L. 22. c. 6.

Are
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Food, some for Pleasure; yea, the most abject (c) 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 (d), and shew the admirable

Are some of the Species of Nature noxious? They are also useful — Dost a Nettle sting? It is to secure so good a Medicine from the Rapes of Children and Cattle. Dost the Bramble cumber a Garden? It makes the better Hedge; where if it chanceth to prick the Owner, it will tear the Thief. Grew Cofmolog. L. 3. c. 2. §. 47.

(c) 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 membribus nocturno tempore pertransuntibus, imo & diurno, quando in remotioribus Aquilonis partibus ante, & post Solstitium hyemale continue noces habentur. Quique his remedii indigent, Cortices quercinos inquirunt, easque collocant certo interstitio interinis instituti, ut eorum splendore, quod voluerint, persiciant iter. Nec solium hoc præfaret Cortex, sed & Truncus putrescatus, 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 faith, 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. N. r. p. 265.

Quid majora sequar? Salices, humilesque Genista,
Aur illa pecori frondem, aur palioribus umbram
Sufficiunt, Sepemque satis, & pabula melli.


(d) Dr. Beal (who was very curious, and tried 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 ob-
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admirable Provision made for the Conveyance of the lymphatick and essentila Juices, for communicating the Air, as necessary to Vegetable, as Animal Life (e): 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 served 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 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.

(e) Tanta est Respirationis necessitas, & usus, ut Natura in singulis viventium ordinibus varia, sed analoga, paraverit instrumenta, qua Pulmones vocamus [and so he goes on with observing the Apparatus made in the various Genera of Animals, and then faith] In Plantis vero, quae simplex animalium attingunt ordinem, tantam Trachea copiam & produc tionem extare par est, ut his minus Vegetantium partes prater corticem irrigentur. — Plantae igitur (ut conjectari fas est) cium sint viventia, visceribus infixa terra, ab hac, seu potius ab aqua & aere, commixtis & percolatis à terrâ, Respiratio nis suæ materiam recipiunt, ipsarumque Trachee ab halitu ter re, extremas radices subingressa, replentur. Malpig. Op. Anat. Plant. p. 15.

These Trachee or Air-Vessels, are visible, and appear very pretty in the Leaf of Scabious, or the Vine, by pulling aunder some of its principal Ribs, or great Fibres; between which, may be seen the Spiral Air-Vessels (like Threads of Cob-web) a little uncoyled: A Figure whereof, Dr. Grew hath given us in his Anat. Plant. Tab. 51, 52.

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the neat Variety and Texture of their Leaves (f),
the admirable Finery, Gaiety, and Fragrance of
their Flowers (g). I might also inquire into the

(f) 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
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 al-
so for the Security of its Sap. Of all which see, Dr. Grew,
L. i. c. 4. §. 8, &c. and L. 4. Par. i. 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 Mallow; in some a tenth, but in most a twelfth,
as in Holy-Oak; or a sixth, as in Siryngea. Id. ib. Tab. 46, 47.

2. The Art in Folding up the Leaves before their Erupti-
on out of their Gems, &c. is incomparable, both for its E-
legancy and Security, viz. In taking up (so as their Forms
will bear) the leaf in 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 an-
other, but not plaited —— but where the Leaves are not so
thick set, as to stand in the Bow-lap, there we have the Plica-
ture, or the Flat-lap; as in Rose-tree, &c. And so that curi-
ous Observer goes on shewing the various Foldings, to which
he gives the Names of the Duplicature, Multiplicate, the
ib. L. i. c. 4. §. 14, &c. To these he adds some others, L. 4.
P. i. c. 1. §. 9. Consult also 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
faith, there are about six Ways, viz. Leaves, Surfoyls, In-
41, 42. Malpig. ibid.

(g) In the Flower may be considered the Empalement, as
Dr. Grew; the Calix, or Perianthium, as Mr. Ray and others,
call it, designed to be a Security, and Bands, to the other
Parts of the Flower. Floris velus basis et fulcimentum est.
Ray Hift. L. i. c. 10. Flowers, whose Petala are strong
(as Tulips) have no Calix. Carnations, whose Petala are
long and slender, have an Empalement of one Piece: And
others, such as the Knap-weeds, have it consisting of several
D d 4 Pieces,
wonderful Generation and Make of the Seed (b), 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 (i). And forasmuch as the

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 their curious Foldings in the Calix, 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 Blue-Bottles, &c. the Couch and Plait together, as in Marigolds, &c. the Row, as in Malows; and lastly, the Plait and Spire together, as in Convolvulus Doronic 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.


(b) As to the curious and gradual Process of Nature in the Formation of the Seed or Fruit of Vegetables, Cuts being necessary, I shall refer to Dr. Grew, p. 45, and 209, and Malpig. p. 57.

Malpig.
the Perpetuity and Safety 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,


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 praecupata mente, oculismicroscopio armatis, lufrret queso Phafeolorum, seminalem plantulam nondum satam, in qua folia flabilia, haecque ampla evidenter observabis; in eadem pariter gemmam, nodos, seu implantationes varias foliorum caulis deprehendet. Causum insignem fibris ligneis, & utriculorum seriebus constantem conspicue asinges. And whereas S. Triumphetti had objected, that vegetatione, metamorphosis, media plantas in alias degenerare, ut exemplo plurium [conflat] pracepue tritici in loliis, & lolii in triticum versi. In answer to this, (which is one of the strongest Arguments against Malpighi's Assertion) Malpighi replies, Nondum certum est de integritate, & successu experimenti, nam facienti mihi, & amici, tritici metamorphosis non cessit. Admissa tamen metamorphosis, quoniam hoc neglecta cultura, aut visuo soli, aut aëris contingit—ideo ex morbofo & monstruoso affectu non licet inferre permanentem statum a Naturâ intestion. Observe plantas sylvestres culturâ 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. Levenboeck, 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. Trans. No. 287. See also Rait 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.
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Year, how securely their Flower, Seed or Fruit is locked up all the Winter, together with their Leaves and Branches, in their Gems (k), and well fenced

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 paucarum seminibus nonnullarum seminibus non dico aqualia sunt, sed multo majora. Sic v. g. Semina Faba, &c. Semina Ulmi, &c. multis vicibus magnitudine superant. Raii ubi suprà, L. 1. c. 13.

Filicem reliquaque Capillares herbas Semine carere Veteres plerique — prodidere; quos etiam secuti sunt e Recentioribus nonnullis, Dodonaeus, &c. — Alii e contra, Bauhinius, &c. Filices & congeneres spermatorhoras esse contendunt: Parsum quia Historia Creationis, Genef. ii. 12. &c. — Hanc sententiam verissimam esse — autopia convincit. Fredericus Caesium, he faith, 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 by that ingenious Gent. are these, Pixidis sejus capsula semina continentes in plerisque hoc genus plantis perquam exilii granulo aere vulgari cinereae plus duplo minores sunt; imò in nonnullis speciebus vix tertiam quartamve arcnule partem magnitudine aequant, vesicularum quadrundam annulius aut fascialis vermissimobus obvolvaturam speciem exhibentes. Nonnulla ex his vesiculis 100 circiter semina continere deprehendebantur — adeò eximia parvitate ut nudo oculo prorsus essent invisibilia, nec nisi microscopii interventu detegi posset. — Osynanda Regalis, que aliis omnibus Filicis speciebus mole — antecellit — vasa seminalia obtinet aquæ cum reliquis congeneribus magnitudinis — quorum immensa & visum fugiens parvitas cum magnitudine planta collata — adeò nullam gerere proportionem invenietur, ut tantam plantam e tantillo semine produci attentum observatorem meritò 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.

(k) Vegetantium genus, ut debitam magnitudinem sortiatur, & sue mortalitatis jaæturam successiva prolix educatione reparet, static temporibus novas promit partes, ut tandem emergentes Uteri, recentes edant Soboles. Emanantes igitur à caele, caudis, ramis, & radicibus novelle hujusmodi partes, non illicco laxatae extenduntur, sed compendio quodam coaguntate intra foliis
fenced and covered there with neat and close Turnicks. And for such as dare not to expose themselves, with what Safety are they preserved under the Coverture of the Earth, in their Root (l), Seed (m), or Fruit, till invited out by the kindly

folii axillam cubantes, non parum subsidiunt, Gemma appellantis, &c. And then that great Man goes on to shew the admirable various Methods of Nature, in reposing 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 (f) and (g).

(l) 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.

(m) 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 preferred. Thus Seeds particularly, Mr. Ray thinks some, may probably retain their Fecundity for ten Years, and others lose it in five; but, faith he, in terra gremio latitantia, quamvis tot caloris, frigoris, humoris & siccitatis variari bus ibidem obnoxia, diutius tamen (ut puto) fertilitatem suam tuentur quam ab hominibus diligentissime custodita; nam & ego & alii ante me multii observarunt Sinapeos vim magnam evenam in aggeribus so farum recias facilitis inque areis gramineis effossis, ubi post hominum memoriam nulla unquam Sinapeos seges succretebat. Quam tamen non spotes ortsam sufficior, sed e feminibus in terra per tot annos residuis etiam prolificis. Ray. Hist. Pl. L. 1. c. 13.
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 Inconveniencies, by making some (for Instance) to lie down prostrate, and others, to close themselves up (n) upon the Touch of Animals, and the most to shut up their Flowers, their Down (o), or others 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


(o) I have observed that many, if not most Vegetables, do expand their Flowers, Down, &c. in warm, Sun-shiny 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 faith, he foretellleth what Weather shall follow the next Day; for faith he, if the Flowers be close shut up, it betokeneth Rain and foul Weather; contrarilywise, if they be spread abroad, fair Weather. Ger. Herb. B. 2. c. 183.

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elastick, springy Caffes, that when they burft and crack, dart their Seed at convenient Distances, performing thereby the Part of a good Husbandman (p); others by their agreeable Taste and Smell,

(p) So soon as the Seed is ripe, Nature taketh several Methods for its being duly Sown; not only in the opening of the 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 fo large and light, as to be expos'd to the Wind, they are often furnish'd 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 furnish'd with Wings or Feathers; partly with the Help of the Wind to carry them, when ripe, from off the Plant, as of Aib, &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 Soil 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 scatter'd not by flying abroad, but by being either spirited or flung 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 flurdy 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 turn'd Inside outward—and so smartly throws off the Seed. The Seeds of Hart's-tongue, is flung or shot away—by the curious Contrivance of the Seed-case, as in Codded-Aismart, only there the spring moves and curls inward, but here outward, viz. Every Seed-case—is of a fibrick Figure, and girded about with a flurdy 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 Halves, like two little Cups, and so flings the Seed. Grew. ib. p. 199. and in Tab. 72. all these admirable Artifices are handsomely represented.
Smell, and salutary Nature, inviting themselves to be swallow'd, and carry'd about by the Birds, and thereby also fertiliz'd by passing through their Bodies

Quin si quantitas modica seminum (Filicis Phyllitidis quoque) à folis in subjeétem charta munda —— schedam decu-

tiatur, detergatúræ, & deinde in acerum convèrtratur, ve-

cularum seminalium plurímis unà difilientibus, & sibi invicem

allísis, acervulus variè moveri per partes videbítur, non fecus

ac si Syronibus aut ifiusmodi beñiolis repletus effet——quin

si locus tranquillus sit, aure proxímè admotá, crepitantium in-
ter rumpendum vasculorum sonitus——percipietur; & si mi-
croscopio chartam oculis obrestes, semina per eam undique spar-

ta, & ad notabilem ab acervo dißantiam projeéta compríserunt.

Ray ibid. p. 132.

The admirable Contrivance of Nature, in this Plant is most plain. For the Seed-Vessels being the best Preserver of the Seed, sis 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 itself, 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 Gentia-

nella flore corulco, &c. or Spirit-Leaf.

The Plants of the Cardamine-Family, and many others, may be added here, whose Gods fly open, and dart out their Seed, upon a small Touch of the Hand. But the most remarkable Infantine is in the Cardamine impatiens, cu-

jus Silique (faith Mr. Ray) vel leviter tæta, actúrum ejaculan-
tur [Seminæ] imò, quod longè mirabilius videtur, etsi sitiáugas

non itergeris, si tamen manum velut tacturus proxímè admove-
as, semina in appropríquantem evibrabunt; quod tum Mo-

risonus fe sepíus expertum scribit, tum Johnstom us apud Gerar-

Neither is this Provision made only for Land Vegetables;

but for such also as grow in the Sea. Of which I shall give an Infantine from my before commended Friend Dr. Sloane.

As to the Fuci,—their Seed hath been discover'd, (and shew'd me feri,) by the Industry of the ingenious Herbarist, Mr. Sam. Doody, who found on many of this Kind, solid Tubercules, or Risings in some Seafons, wherein were lodg'd several round Seeds, as big as Mustard-Seed, which, when ripe, the out-

ward Membrane of the Tubercle breaking, leaveth the Seed to

float up and down with the Waves. The Seed coming near

Stones,
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dies (q); and others not thus taken Care of, do many of them by their Usefulness in human Life, invite the Husbandman and Gardiner carefully to sow and nurse them up.

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 conjectur'd at the Thing; yet the first that discover'd the Seeds in *Fuci,* was the before commend'd Dr. Tancred Robinson; as may be seen by comparing what Mr. Ray faith in his *Synopsis Str. Brit.* p. 6. with his *Append. Hist.* p. 1849. Befides which *Fuci,* the Dr. tells me, he observ'd Vessels and Seed in Coralloid Shrubs, as also in several *Fungi,* not only in the Species of *Crepitus Lupi,* but alfo between the Lamelle of other Species, and in that subterraneous Kind call'd *Truffles,* whole Seed and Veflcls open in the Cortex, at some Seasons he faith, like that of Mallovs in Shape.

As to the *Crepitus Lupi,* I have more than once examin'd their Powder, with those excellent Microscopes of Mr. Wilfon's Make: But the moft satisfactory View Mr. Wilfon himſelf gave me; by which I found the Seeds to be so many exceeding small Puff-Balls, with round Heads, and longer than ordinary Šarp-pointed Stalks, as if made on purpoſe to prick easily into the Ground. These Seeds are intermix'd with much dufy Matter, and become hurtful to the Eyes, probably by their Šarp Stalks pricking and wounding that tender Organ.

(q) The ancient Naturalifts do generally agree, that *Mif-ſelwe* is propagated by its Seeds carried about by, and paſsing through the Body of Birds. Thus Theophrasius de Cauſ. *Plants.* L. 2. c. 24. *To ἃ διπλος ἐγολος, &c.* *ininitum verò à paſlu avium:* ---- Quippe *Vifco deteræto conſecforque in al-veis, quod frigidiffimum est, ſeuen cum excremento purum di- mittitur, & faétæ mutatioe eiliqüi in arbole Stercoris cauſa pullulat, erumpitque, &c. So also Pliny faith, *vii.* Omnino autem satum [Vifcum] nullo modo nacituir, nec nisi per al- vum Avium reeditum, maxime Palumbis ac Turdi. Nec eſt natura, ut nisi maturatum in ventre Avium, non proveniat. Plin. N. H. L. 16. c. 44. Whether what Theophrasius and Pliny affirm, be conducive to the better Šertilizing the Seeds of *Mifſelwe,* I know not; but that it is not of abolute Ne- cessity, I can affirm upon mine own Experience, having seen the
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 spoil’d in the Earth themselves, nor thereby annoy us; but on the contrary,

the Seeds germinate, even in the Bark of Oak. But although they shot above an Inch, and seem’d to root in the Tree, yet they came to nothing, whether destroy’d by Ants, &c. which I suspeeted, 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 fertiliz’d after the same Manner, as Tavernier faith was confirm’d 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: And that the Nutmeg, then belinear’d with a viscous Matter, falling to the Ground, takes Root, and produces a Tree, which would never thrive, was it planted. Tavern. of the Commod. of the G. Mogul. And Monsieur Thévenot, in his Travels to the Indies, gives this Account; The Tree is produc’d after this Manner; there is a kind of Birds in the Island, that having pick’d 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 shap’d like a Cuckow, and the Dutch prohibit their Subjects under Pain of Death, to kill any of them. Vid. Sir T. Pope Blunt’s Nat. Hist.

minister to all their Ends, and our Uses; to afford us Houses, Utensils, Food (r), Physick, Clothing, yea, Diversion too, by the Beauty of their Looks, by the Fragancy 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 (s).

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, it is by


24. p. 46.
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 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 Equilibration of the Top (t).

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 (u), and using them as

(t) All Vegetables of a tall and spreading Growth, seem to have a natural Tendency to a hemispherical Dilation, 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 observ’d by Nature, &c. A visible Argument that the plastic Capacities of Matter are govern’d and dispos’d by an all-wise and infinite Agent, the native Strictnesses and Regularities of them plainly shewing from whole Hand they come. Account of the Origine and Format. of Foss. Shells, &c. Print. Lond. 1705. pag. 38. 41.

(u) In Hedera, succuli & rami hinc inde claviculis, quasi radiculas emitunt, que partitibus, vel occurrentibus arboribus veluti digitis firmantur, & in altum suspenduntur. Hujusmodi radicula subrosunde sunt, & pilis cooperiuntur; & quod mitigum est, glutinosum sunt usu humorem, seu Terebinthinam, quae arcite lapidibus neciuntur & agglutinantur.—— Non minori industriâ Natura utitur in Vite Canadensis, &c. The admirable and
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 well-being of the meanest, most weak, and helpless insensitive Parts of the Creation.

and curious Make of whose Tendrels and their Feet, see in the illuftrious Author, Malpiz. de Capreolis, &c. p. 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 is at Hand: Which they do by a natural Circumvolution which they have; (thofe of Briony have a retrograde 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 supply'd 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, thofe, or rather the Trunk-Roots of Chamomil; and for all three the Trunk-Roots of Strawberies. Harris Lex. Tech. in verb, Claspers.
Vegetables peculiarly useful. Book X.

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 design'd as 'twere on Purpose, by the most merciful Creator, for the Good of Man, or other Creatures (w). Among Grain, I might name the great Fertility (x) 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 design'd, as 'twere on Purpose, for almost every Use (y), and

(w) Vegetables afford not only Food to Irrationals, but also Physick, if it be true which Aristotle faith, and after him Pliny; which latter in his 8th Book, Chap. 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 Merfenne in Genef. pag. 933.

(x) See before Book IV. Chap. 17. Note (b).


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Folcus
and Convenience; some to heal the most stubborn and dangerous Distempers (z), to alleviate and ease the Pains (aa) 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

quoque affa & affecto loco imposita convulsionem curant, ac do-lores lenunt (principis si succis ipse calens bibatur) quamvis ab Indicis prorsis canitur luc, sensum hebetant, atque torporem in-ducunt. Radix succis humi Venerarem curar apud Indos ut Dr. Palmer. Ray. ib. L. 21. c. 7. See also Dr. Sloane Voy. to Jamaica, p. 247.

There are also two Sorts of Alae besides, mentioned by the same Dr. Sloane, one of which is made use of for Fishing-Lines, Bow-Strings, Stockings, 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.

(z) For an Instance here, I shall name the Cortex Peruvi-anus, which Dr. Morton calls Antidotus in levamen arimna-rum vitæ humana plurimarum divinitus concessa. De Febr. Ex-er. v. c. 3. In Sanitatem Gentium procuidubio à. Deo O. M. conditus. Cujus gratia, Arbor vitæ, siquà alia, jure merito appellari potest. Id. ib. c. 7. Ebeu! quos conviciis Herculea & divina hoc Antidotus jactabatur? Ibid.

To this (if we may believe the Ephemer. German. Ann. 12. Obler. 74. and some other Authors) we may add Trifolium paludosum, which is become the Panacea of the German and Northern Nations.

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growing more plentifully there than elsewhere (bb); or else to obviate some Inconvenience there, or to supply some constant Necessity, or Occasion, not possible, or at least not easy, to be supplied any other Way (cc). 'Tis, for Instance, an admirable Provision made for some Countries subject to Drought,


To this may be added Elsner's Observations concerning the Virtues of divers Things in his Observations de Vincetoxico Scrophularum remedio. F. Germ. T. i. 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. 'Avtdææa. Batav. five Introd. ad Medic. indigeminam.

(cc) 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 faith, 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 extend 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 rife perpendicular, or frait 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 suf-
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 Man and other Creatures, in their great Extremities (dd);

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. Trans. No. 251, where a Figure is of this notable Plant, as also in Lowthorp’s Abridg. V. 2. p. 669.

The Wild-Pine, so called, &c. hath Leaves that will hold a Pint and a half, or Quart of Rain-Water; and this Water refreshes the Leaves, and nourishes the Root. When we find these Pines, we flick our Knives into the Leaves, just above the Root, and that leas out the Water, which we catch in our Hats, as I have done many Times to my great Relief. Dampier’s Voy. to Campeachy, c. 2. p. 56.

(dd) Navarette tells us of a Tree called the Bejucó, 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, faith 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 Bejucó, and drink their Fill. Collect. of Voy. and Trav. Vol. I. in the Suppl to Navarette’s Account of China, p. 355.

The Waterwitch of Jamaica hath the fame Ues, 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 to the 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 disfressed Condition.

To this we may add what Mr. Ray takes notice of concerning the Birch-Tree. In initiiis Veris antequam folia prodiere, uncinerata dulcem succum copiosè effundit, quem siti pressi Paiores in silvis sapenumero potare solens. Nos etsiam non semel ex liquore recreati sumus, ciam herbarum grasiá vasis perragrumus silvæ, inquis Tragus. Rait Cat. Plant. circa Cantab. in Betula.
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 Sketch of another Branch of the Creation, which (although one of the 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 myself with those general Hints I have given; which may however serve as Specimens of what might have been more largely said about this inferior 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.

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CHAPTER 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 (a). 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

(a) Equidem ne laudare quidem saisis pro merito possim ejus Sapientiam ac Potentiam, qui animalia fabricatus est. Nam ejusmodi opera non Laudibus modo, verum eiam Hymnus sunt majora, qua priusquam inspexissimus, sieri non posse persuasum habeamus, conspicari vero, falsos nos opinione suisse compersipus. Galen. de Uf. Part. L. 7. c. 15.
about trivial Matters (b), 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 (c), that on the contrary they deserve (as shall be shewn in the next Chapter) to be sought out, enquired after, and curiously and diligently pried into by us; as I have shewed the Word in the Text implies.

(b) Non tamen pigere debet Lectores, ea intelligere, quemadmodum ne Naturam quidem piguit ea reipsa efficere. Galen. ibid. L. ii. fin.

(c) An igitur etiam si quenadmodum Natura hæc, & ejusmodi, summa ratione ac providentiam agere potuit, ita nos imitari aliquando possemus? Ego vero exiftimo multis nostrum ne id quidem posse, neque enim artem Naturæ exponunt: Eo enim modo omnino eam admirarentur, Sin minus, eam saltem non visuperarent. Galen. ib. L. io. c. 3.

CHAP.
That God's Works ought to be enquir'd 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 throughout all the World, and the Ages thereof. And therefore we may look upon it as a great Error, 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 approves of 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 expressly 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 see
fee 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 xxxvi. 24, 25. Remember that thou magnify his Work, which Men behold. Every Man may see it, Men may behold it afar off.

C H A P. III.

That God's Works are manifest to all: Whence the Unreasonableness of Infidelity.

The concluding Words of the preceding Chapter suggests a third Inference, that the Works of GOD are so visible to all the World, and without manifest Indications of the Being, and Attributes of the infinite Creator, that they plainly argue the Vilenes 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 mere Nothing (as Chance is) rather than to GOD (a). 'Tis a sign the Man is wilfully blind, that

(a) Galen having taken notice of the neat Distribution of the Nerves to the Muscles, and other Parts of the Face, cries out, Hæc enim fortuna sunt opera! Caterum tum omnibus [partibus] immitti, tantosque esse singulos [nervos] magnitudine, quanta particule erat nesse; haud scio an hominem sit fabrorum ad Fortunam opificem id revocare. Aliquid quid tandem erit, quod cum Providentia & Arte efficitur? Omnino enim hoc ei contrarium esse debet, quod Casu ac Fortuitó sit. And afterwards, Hæc quidem atque ejusmodi Artis scil. ac Sapientia opera esse dicemus, si modo Fortuna tribuenda sunt quæ sunt
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 (b) faith, from a Notion that Nature itself hath imprinted upon the Minds of Men. For, faith 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 Monstrous among rational Beings; a Thing hard to be met with in

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(b) Primum esse Deos, quod in omnium animis, &c. And a little after, Cum enim non instituto aliqua, aut more, aut leges sit opinio constituta, maneatque ad unum omnium firma consenso, intelligi necesse est, esse Deos, quoniam instas corum vel potius ensias cognitiones balemus. De quo autem omnium Natura consentit, id verum esse necessum est. Esse igitur Deos consitendum est. Cicer. de Nat. Deor. L. I. c. 10, 17.
the whole Tribe of Mankind; an Opposer of all the World (c); 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 pried farther than others into God's 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 (d), 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 (e) in God's Works of Creation; or with the Profane in Psal. lxxiii. 11. to say, How doth God know?

(c) The Atheist in denying a God, doth, as Plutarch faith, endeavour inmobilia movere, et bellum inferre non tam iam longo tempore, sed et multis hominibus, gentibus, in familiis, quas religuros Deorum cultus, quasi divino furore correptas, tenuit. Plutar. de Iside.

(d) See before Note (b).

(e) Galen having substantially refuted the Epicurean Principles of Astelepiades, 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: Conditorum nostrum in formandis particulis unum hunc sequi scopum, nempe in quod melius est eligat. Galen, de Us. Part. L. 6. c. 13.
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And is there Knowledge in the most High? For as the witty and eloquent Salvian faith (f), 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, faith he, as that when a Man doth not deny GOD to be the Creator of all Things, he should deny him to be the Governor 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, to whom 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 Control, and who hath our Life and whole Happiness in his Power. After this manner GOD himself argues with his own foolish People, and without Understanding, who had Eyes, and saw
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fear not, and had Ears, and heard not, Jer. v. 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 Hearts, 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 which 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 which he hath given of his infinite Goodness in his Works, may excite us to 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 (a); how they are all contrived

(a) Si pauca quis tibi donasset jugera, acceptis te diceres beneficium: immensa terrarum late patentium spatio negas esse
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contrived and made in the best Manner, placed in the fittest Places of the World for their Habitati-
on and Comfort; accoutered in the best Manner, and accommodated with every, even all the minu-
test Things that may minister to their Health, Happi-
ness, 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 cxlviii. Praise him all his Angels,
Praise him all his Hosts; Sun, Moon, Stars of Light,
Heavens of Heavens, and Waters above the Heavens.
The Reason given for which is, v. 5, 6. For he com-
manded, and they were created; he hath also established
them for ever and ever; he bath 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 Winds fulfilling his Word. Yea, the very
Mountains and Hills, Trees, Beasts, and all Cattle,
creeping Things, and flying Fowl. But in a particu-
lar 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.

esse beneficium? Si pecuniam tibi aliquid donaverit, — benefi-
cium vocabis: tot metalla desedit, tot flamina emissit in aer,
super qua decurrunt sola aurum vehentina: argenti, aris, ferver
immans pondus omnibus locis obratum, cujus investigandi ii i
faculatam dedis, — negas te accepisse beneficium? Si domus tu-
di donetur, in qua marmoris aliquid resplendet, &c. Num me-
diocre munus vocabis? Ingens tibi domicilium, sine ullo incen-
di, aut ruina metu fruvis, in quo videas non tenuas crustas
— sed integras lapidis pretiosissimi moles, &c. negas te ullum
munus accepisse? Et cium isfa que habes magno aeternes, quod es
ingrat hominis, nulli debere te judicas? Unde tibi ilium quem
tras his spiritum? Unde ilium, per quam ductus uita tua disponis
And great Reason there is we should be excited to true and unfeigned Thankfulness and Praise (b) to this our great Benefactor, if we reflect upon what hath been shewn in the preceding Survey, that 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.

(b) Tempestitum tibi jam fuerit, qui in hisce libris versaris considerare, in usum Familiam recipi malis, Platonicam ac Hippocraticam, & aliorum virorum, qui Nature operam mirantur; an eorum qui ea infestantur, quod non per Pedes natura constituit esfluere 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 CONDITIONIS nostri verum Hymnum compono, existimoque in eo veram esse pietatem, ut si noverim ipse primus, deinde & aliis exposuerim, quamnam sit ipsius Sapientia, quae Virtus, quae Bonitas. Quod enim cultu convenientie exornaverit omnia, nullique bona inspexerit, id perfectissime Bonaris speciem esse statu; & hac quidem ratione ejus Bonitas Hymnis nobis est celebranda. Hoc autem omne invenisse quo pacto omnia potissimum adornarentur, summa Sapiensia est: exsecisse autem omnia, quae voluit, Virtutis est invicte. Galen. de Us. Part. L. 3. c. 10.
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 Demonstration 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 andlargely 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 myself to two Things, the Time God hath taken, and the Business then to be performed.

I. 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, Gen. ii. 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 (a), and

blessing the Seventh Day, was setting it apart, as a Day of Distinction from the rest of the Week-Days, and appropriating it to holy Uses and Purposes, namely, the Commemoration of that great Work of the Creation, and paying Homage and Worship to that infinite Being, who was the Efferctor of it.

This Day, thus consecrated from the Beginning, for the Celebration of the τῇ κόσμῳ γενέσις 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. vi. 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
reft 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 Inconveniencies; 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 Reservavit and Rest on the Seventh Day, Deut. v. 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, Cattel, 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 Bonds-men and Beasts, but by this wise Provision, this great Burden was 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 Reservavit 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 Acknowledg-
ments 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 then to practice carefully the Duties incumbent upon us; which will fall under the Consideration of the

II. 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 (b) 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.

(b) נַשֵּׁת Cessatio, Requiès.
Chap. VI. Lord's Day must be remember'd. 439

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,

1st, 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.

2ly, That the keeping it holy, is a Duty of more than ordinary Consequence and Necessity. And of greatest Consequence this is,

First, 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 Ægypt; 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.

Secondly, To keep up a spiritual Temper of Mind, by those frequent weekly Exercises of Religion, as hath been already mention'd.

Thirdly, 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 us, 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 faith, 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 practis'd, 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. iv. 3, what was practis'd by religious Persons in the following Ages, till the giving of the Law; and at the giving of that, God was pleas'd 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 (c).

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. Mat. ix. 35. And St. Luke reporteth it as his constant Custom or Practice, Luke iv. 16. And as his Custom was, he went into the Synagogue on the Sabbath-Day.

(c) Vid. Lightfoot's Works, Vol. 2. p. 35. and 646.
Chap. VI. Publick Worship not indifferent. 441

Having thus mention'd 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 follow'd 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 join their Devotions to the common Services. If Persecution at any Time forc'd them to keep a little Close; yet no sooner was there the least Mitigation, but they presently return'd 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 pass'd upon them, &c. to express it in the Words of one of our best Antiquaries (d).

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 punish'd with Death among the Jews, the Sabbath being a

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(a) Dr. Cave's Prin. Chrift. Pat. 1. c. 7.
Sign, or Badge of the GOD they own’d and worshipp’d. (e) Thus Exod. xxxi. 13. My Sab-
baths 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 render’d, a Sign to ac-
knowledge, 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. xx. 20.
Hallow my Sabbaths, and they shall be a Sign be-

(e) 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. ix. 4. A Mark was
to be set on the Forehead of those that lamented the Abomina-
tions of the City. The like was to be done upon them in
Rev. vii. 3. and ix. 4. So the Worshippers of the Beast, Rev.
xiii. 16. were to receive a χασάγμα, A Mark in their right
Hind, on their Foreheads. Those χασάγματα, Σφεγγίδες, Bad-
ges, &c. were very common. Soldiers and Slaves bare them
in their Arms or Foreheads; such as were matriculated in
the Heteria, or Companies, bare the Badge or Mark of their
Company; and whoever lifted himself into the Society of
any of the several Gods, received a χασάγμα, or a Mark in
his Body, (commonly made with red-hot Needles, or some
burning in the Flesh,) of the God he had lifted himself un-
der. 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 Ance-
flors did the same; Sunday and Monday, (as the Romans
did,) to the Sun and Moon; Tuesday to Tuycso; Wednes-
day to Woden; Thursday to Thor; Friday to Friga; and Sat-
turday to Seater: An Account of which Deities, with the
Figures under which they were worshipp’d, may be met
with in our learned Verstegan. Chap. 3. p. 68.
Chap. VI. Necessity of Publick Worship. 443
tween me and you, that ye may know that I am the
LORD your GOD; or rather as before, to ac-
knowledge 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 un-
der Christianity, the Punishment is not made Ca-
pital, 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 wor-
ship, is the same: If after six Days Labour, he
was, by the Seventh, own'd to be GOD, the
Creator; no less is he by our Christian Lord's Day:
If by the Celebration of the Sabbath, the Remem-
brance 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 Mo'zes, even the blessed JESUS, whose Re-
surrection, and the Completion of our Redemp-
tion thereby, was perform'd on the Christian
Lord's-Day.

And now to sum up, and conclude these In-
ferences, 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 contriv'd, so accu-
rately made, as to deserve to be enquir'd 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; that
we be truly thankful for, and magnify and praise
his
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 Psalms, We love the Habitation of God's House, and the Place where his Honour dwelleth; and therefore take up his good Resolution in Psal. v. 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.
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**FINI S.**

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ye for my own satisfaction
In year 1808, I had made upon the Sun's
Observation I had made upon the Sun's
Crossing the line in March 1808 having
Head of in the Encyclopædia Observations
which had kept for 40 or 50 years saying
that whatever kind of weather it was then
the Sun crossed the line in March it was
likely to be for 3 or 6 Month afterwards
for year 1807 when the Sun crossed the line
Continued for six months
for a year 1806 heavy thunder and rain some day
before and at the time, the Sun crossed, 20 of March, George
Youth, son had been burnt with some hays on
Sunday evening by lightning continued wet
Till in August then very dry for six week
or longer in some places in Jersey but not
where I lived
1809 a few light showers when the Sun
Crossed the line best snow plenty before
afterward, 21 14 of April as large fall
of snow as had been at any one time.
May ye preceding winter, which had been the
harshest I ever remember, 4 older men than
myself say so too it is now if may 4 and
a day that I could be cold, warm has been
this since the summer cold is not snow
fell by no vessel and many people
did not gather their corn till autumn

1809: Cool summer, very dry in many parts.

March 1810, but little rain when the sun Cost ye line late showers through ye spring & summer. Though sometimes pretty dry with a good deal of cloudy weather. The season and a great deal of very hot weather. The mercury as high as 95 in the thermometer.